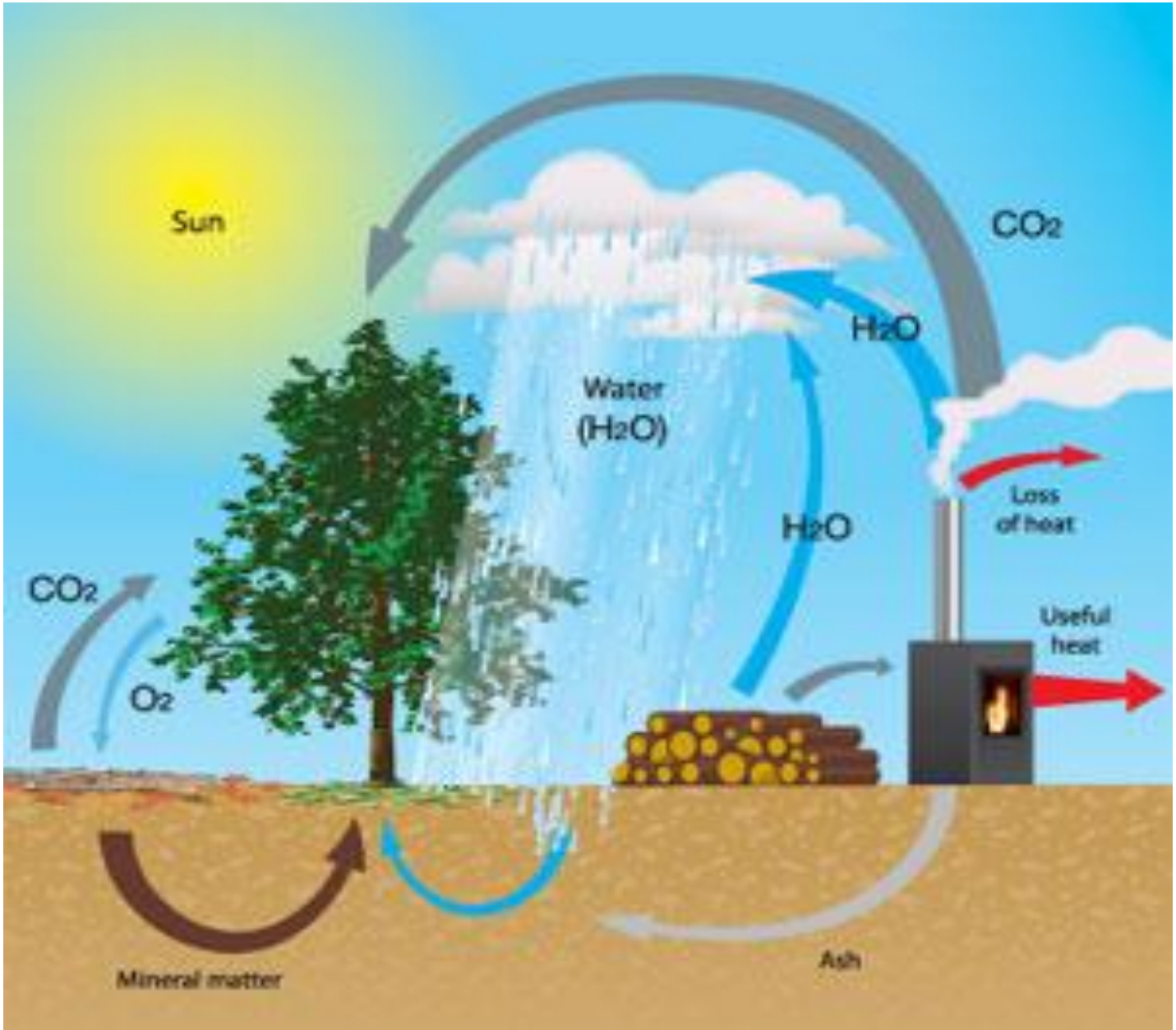
OUTLINE

- Introduction
- Biomass is green solution
- History
- Sources of biomass
- Methods of using biomass
- Biomass usages
- World consumption
- The impacts of biomass
- Case study

Biomass is “different materials of biological origin that can be used as a primary source of energy”

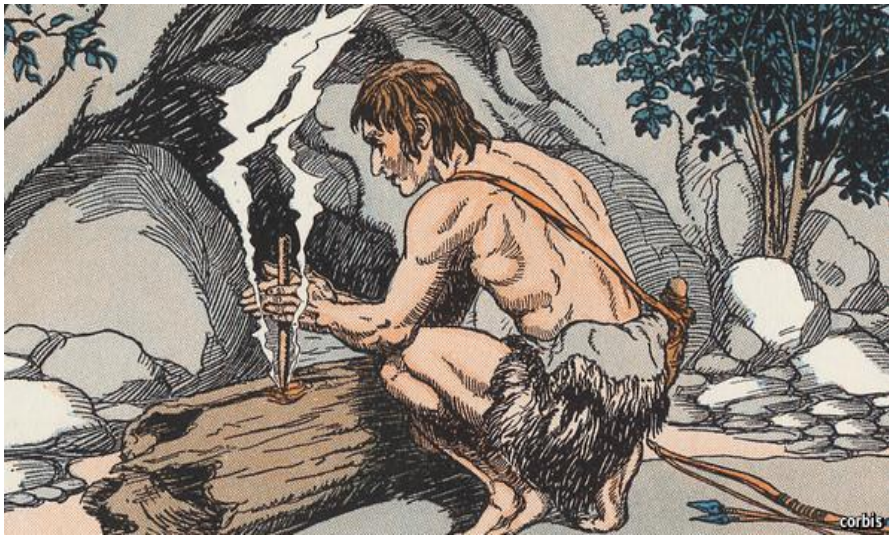
- Wood materials
- crop waste
- animal waste
- Food waste

Why biomass is renewable energy

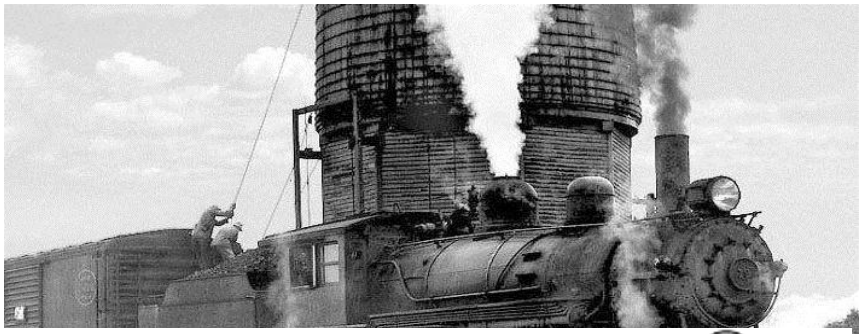


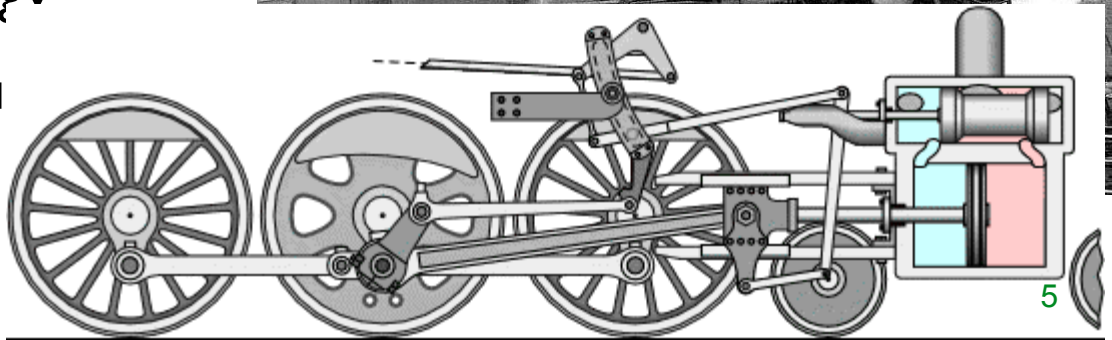
History

- Biomass is the oldest source of renewable energy, it is used by burning wood to cook and boil water.



- Wood was the primary fuel for industries, trains, and boats till the late 1800's when Coal fired energy systems were introdu





History

- In the1970's . Some industries switched to waste wood. (The paper and pulp industry)
- In the1980's Biomass power was introduced
- In the 90's biomass power was very expensive
- Today Most rural homes are still heated and cooked with wood

Biomass (other woody materials)

Waste

Agriculture

Energy crops

Food waste

Industrial waste & co-products

Wet residues

Dry residues

Grasses and non-woody energy

Agricultural energy crops

Aquatics (hydroponics)

Wet food waste

Waste oils

Paper pulp and waste

Textiles

Sewage Sludge

Biomass from woody materials

Waste

Industrial waste and co-products

Woody waste

Untreated wood

Treated wood

Wood composite and laminate

Energy crops

Short Rotation Coppice (SRC)

Short Rotation Forestry (SRF)

Virgin wood

Tree surgery residues

Forestry residues

Fuel wood

Virgin wood

Fuel wood

Forestry residues

Tree surgery residues

Energy crops

Short Rotation Forestry (SRF)

Short Rotation Coppice (SRC)

Waste

Industrial waste and co-products

Woody waste

Untreated wood

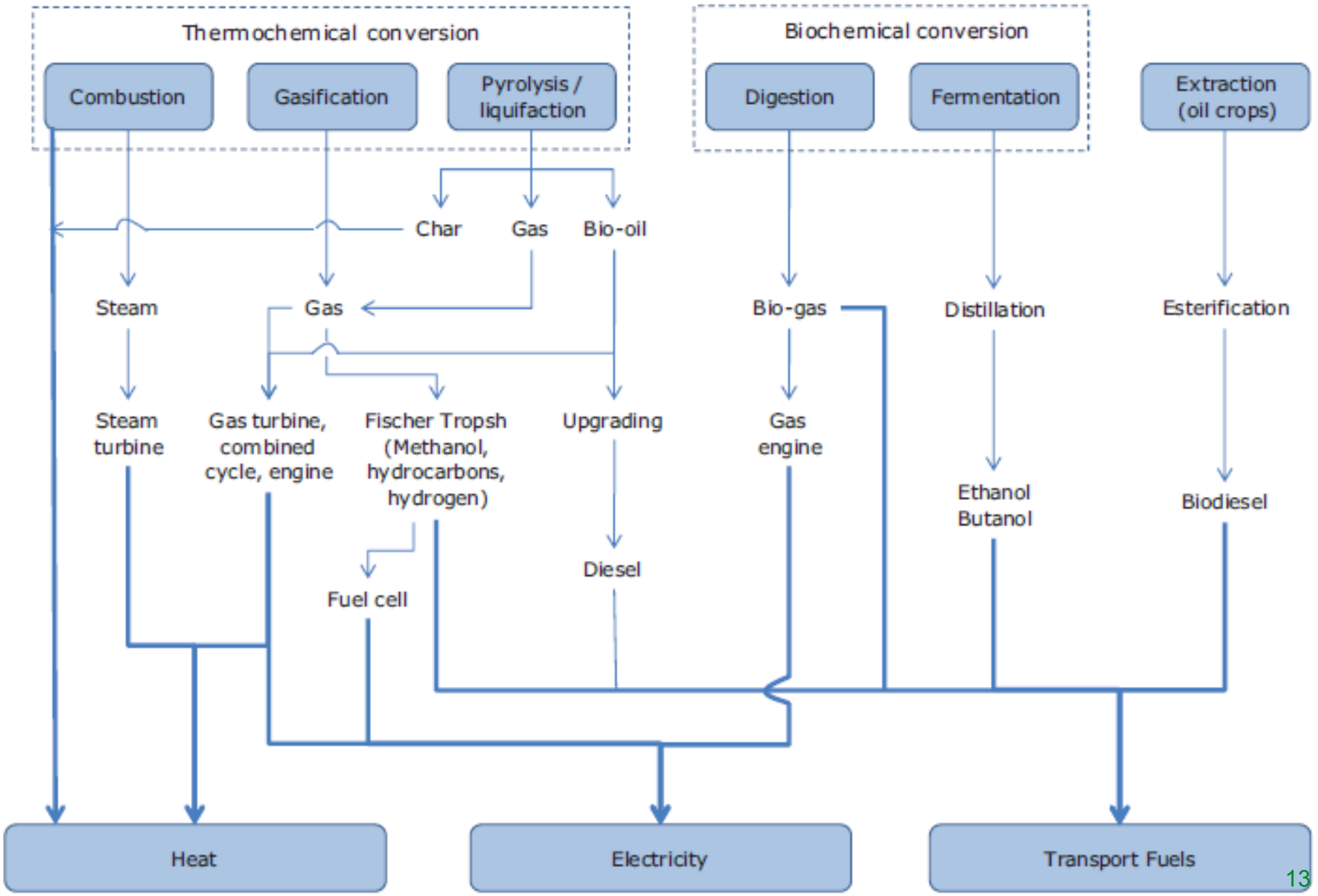
Wood composite and laminate

Treated wood

Methods of using biomass

- Direct Burning
- Converting Biomass to Other Forms of Energy

Conversion pathways: from biomass to energy services



Direct Burning

Wood processing

Raw material – wood

Wood splitter

Hammer mill

Wood Crusher

Dryer

Wood pelletizing machine

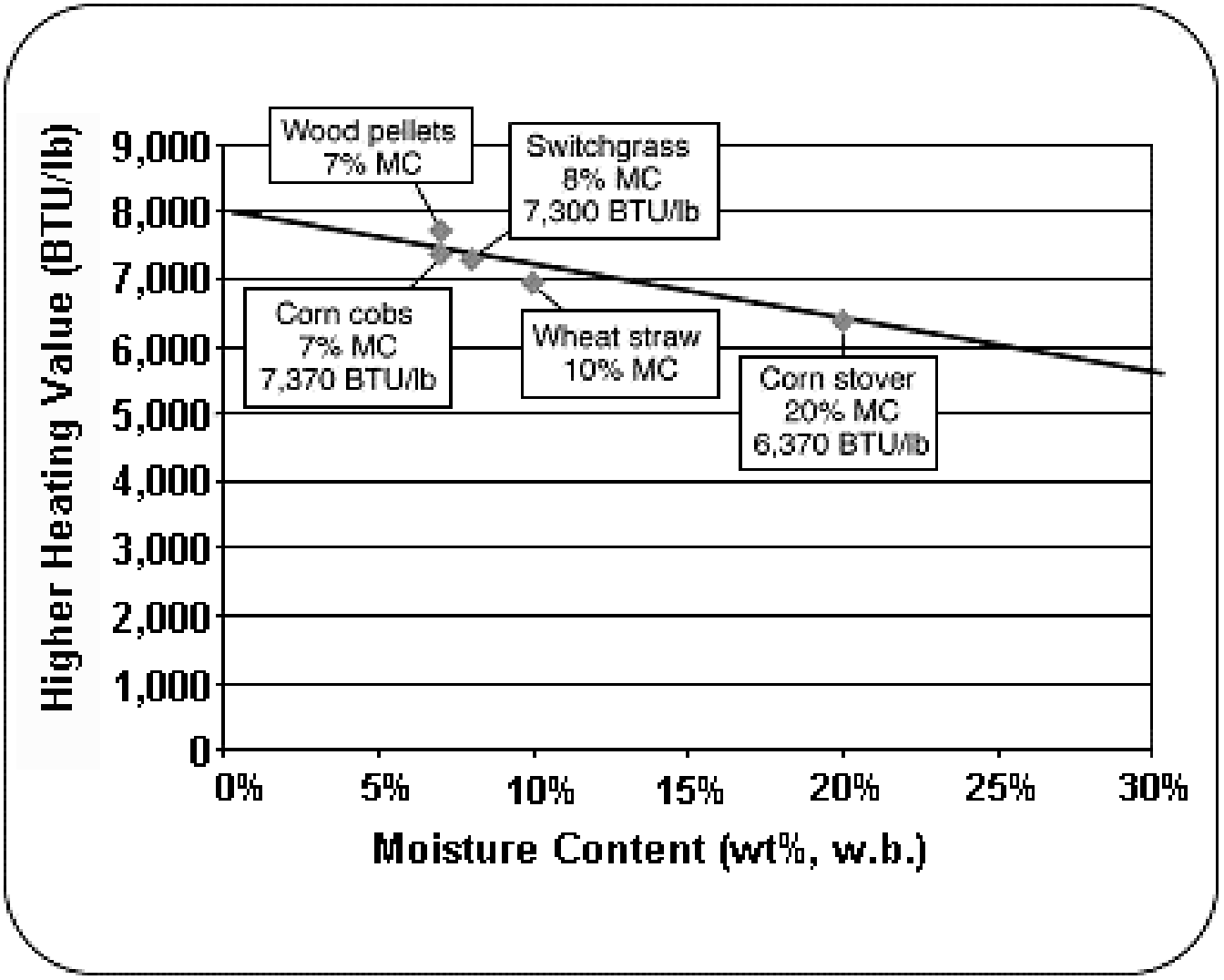
Pellet conveyor and cooler

Packing machine

Final product

http://www.chinapelletmill.com/Large-Scale-Biomass-Pellet-Line/1-Ton-Wood-Pellet-Line.html

Biomass Energy Content



Biomass Burn Characteristics, 2011

Typical heat losses during combustion

Form of the woody biomass	Moisture content (% wet basis)	Total weight of biomass (kg)	Weight of water present (kg)	Heat to evaporate moisture (MJ)	Heat to evaporate H_2O from hydrogen combustion (MJ)	LHV of the 2 000cm^3 volume (MJ)	LHV/kg of wet wood (MJ/kg)
Freshly harvested green wood	60	2.5	1.5	3.73	1.39	14.78	5.9
Drying for 1-2 weeks post harvest	50	2.0	1.0	2.57	1.39	15.94	8.0
Sawmill residues	40	1.67	0.67	1.72	1.39	16.79	10.0
Demolition timber / pallets	30	1.43	0.43	1.10	1.39	17.41	12.2
Air dried biomass	20	1.25	0.25	0.64	1.39	17.87	14.3
Wood processing off-cuts	10	1.11	0.11	0.28	1.39	18.23	16.4
Oven dry wood for comparison	0	1.0	0	0	1.39	18.51	18.5

A 2 000 cm3 piece of wood with basic density of 500 kg/m3 and high heat value (HHV) of 19.9 MJ/kg dry weight is combusted. The moisture content of the biomass fuel and combustion of the hydrogen contained in the fuel affects the þ nal useful heat energy available (lower heat value LHV).

Biomass & Other Fuel Energy Content

Fuel	Energy content		Fuel	Energy content	
	GJ t^{-1}	GJ m^{-3}		GJ t^{-1}	GJ m^{-3}
Wood (green, 60% moisture)	6	7	Straw (as harvested, baled)	15	1.5
Wood (air-dried, 20% moisture)	15	9	Sugar cane residues	17	10
Wood (oven-dried, 0% moisture)	18	9	Domestic refuse (as collected)	9	1.5
Charcoal	30	*	Commercial wastes (UK average)	16	*
Paper (stacked newspapers)	17	9	Oil (petroleum)	42	34
Dung (dried)	16	4	Coal (UK average)	28	50
Grass (fresh-cut)	4	3	Natural gas (at supply pressure)	55	0.04

Note that the composition of coal and most biofuels is variable and the energy content per kg can differ significantly from the above averages. The energy *per cubic metre* depends on the density and can vary even more widely. (* Indicates dependence on specific types of material.)

http://www.kth.se/

biomass Usages

- For heating and cooking
- Hot water generation
- Electricity generation
- Steam generation for industrial processes
- for industrial processing as raw materials

biomass Usages

- For heating and cooking

Jordan: using olive cake as a source of energy in industries and for heating

Jordan consumption of olive cake

Manufacturing of Vegetable & Animal Oil & Fat sector:

- 868 ton of Olive cake consuming as source of energy (2.8% of total)

Sources: Ministry of agriculture studies, 2009

Department of statistics/ environmental statistics 2008

Olive cake heat content

- olive cake are characterized by an average heating value of 19 MJ/kg

Market of Olive Residues for Energy, Report on best practices, 2008

Hot water generation

Pellet Boiler

Hot water generation

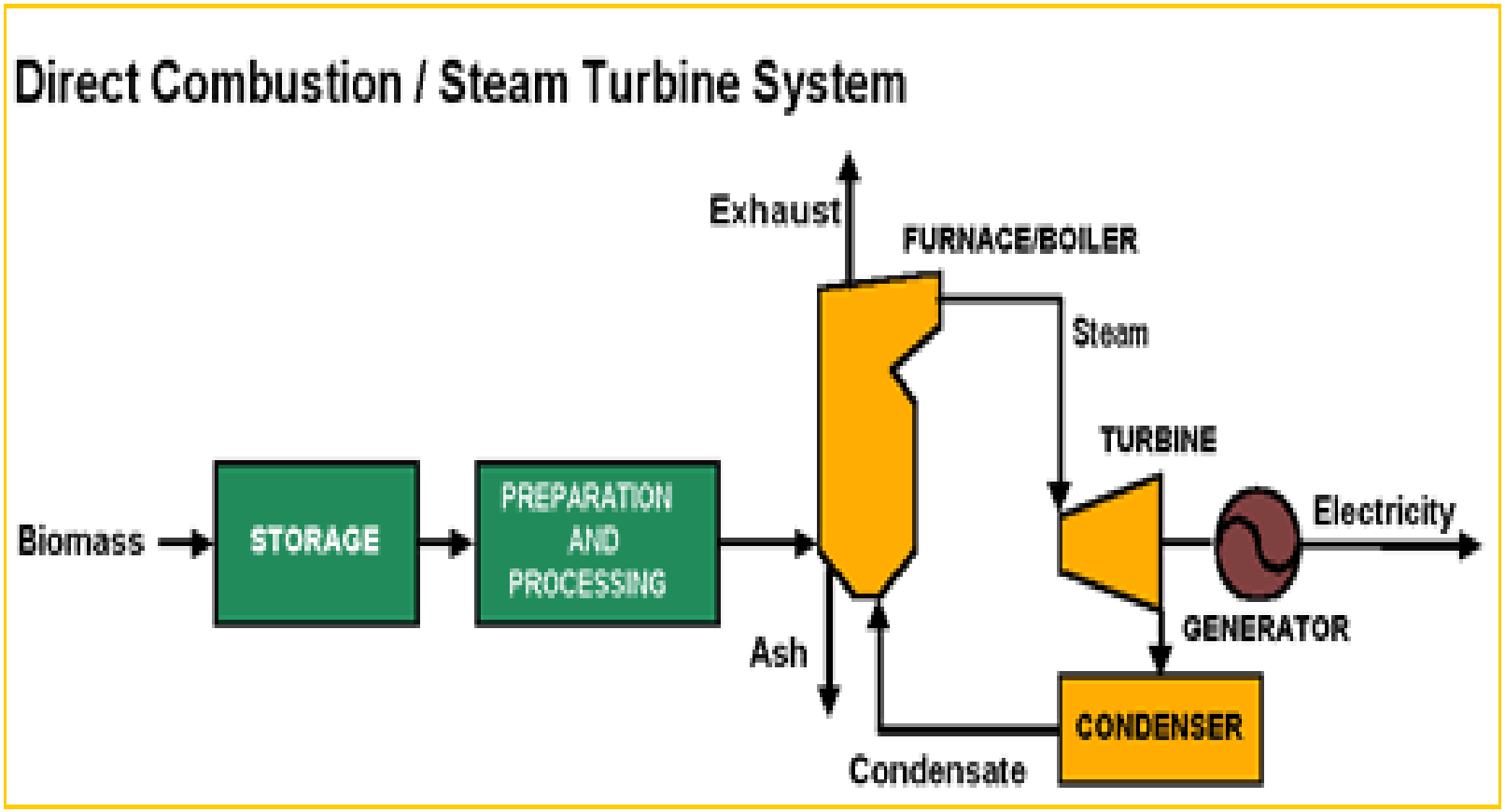
Camphill Community Glencraig

location: Belfast, Northern Ireland
industrial: District heating
output: 1 MW, 110 °C, 7 bar

Ilim Timber Bavaria GmbH

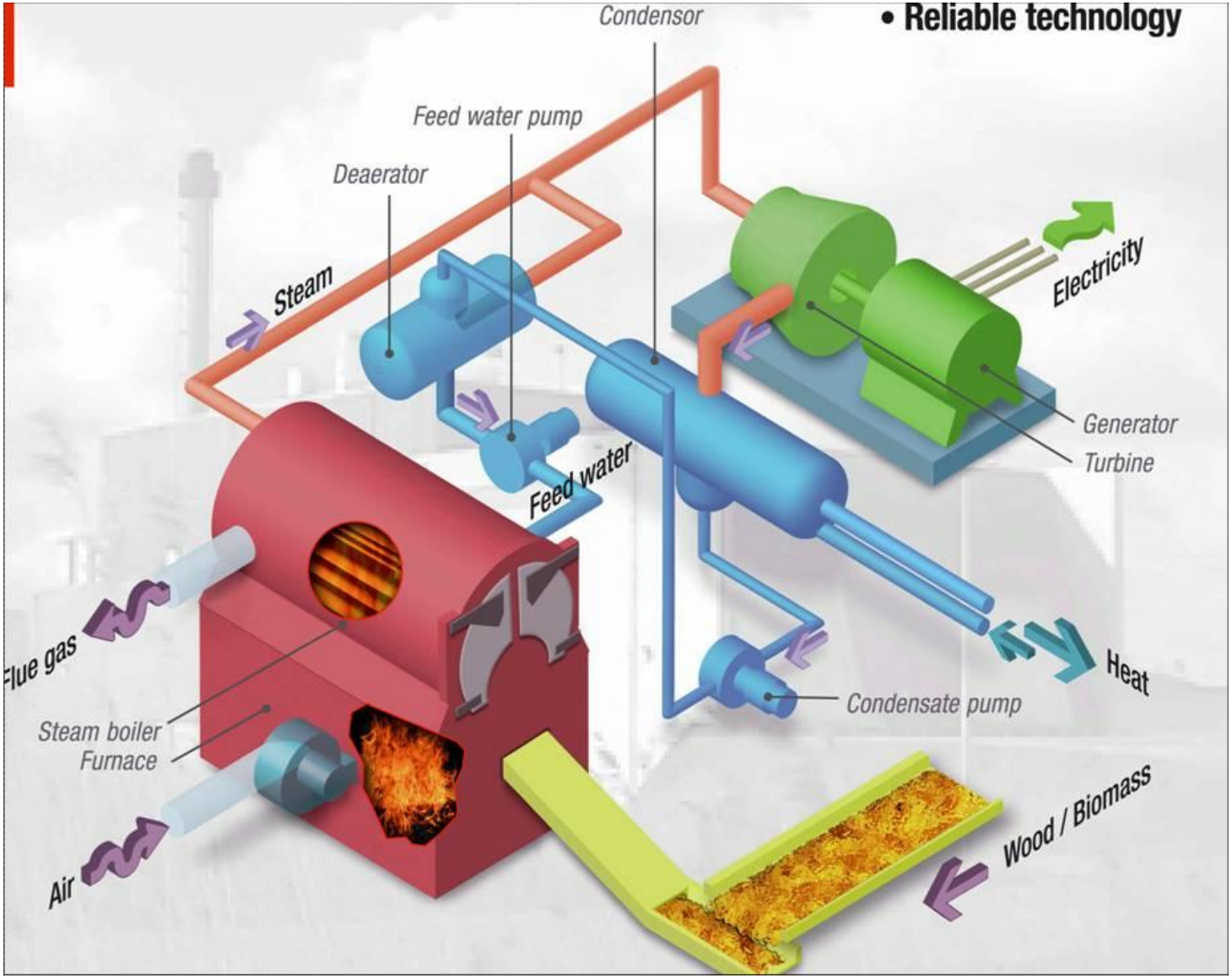
location: Landsberg, Germany
industrial: Sawmill industry
output: 20 MW, 120 °C, 6 bar

Electricity generation



Steam generation

Co-generation of heat and electricity



Bioenergy Bardejov s.r.o.

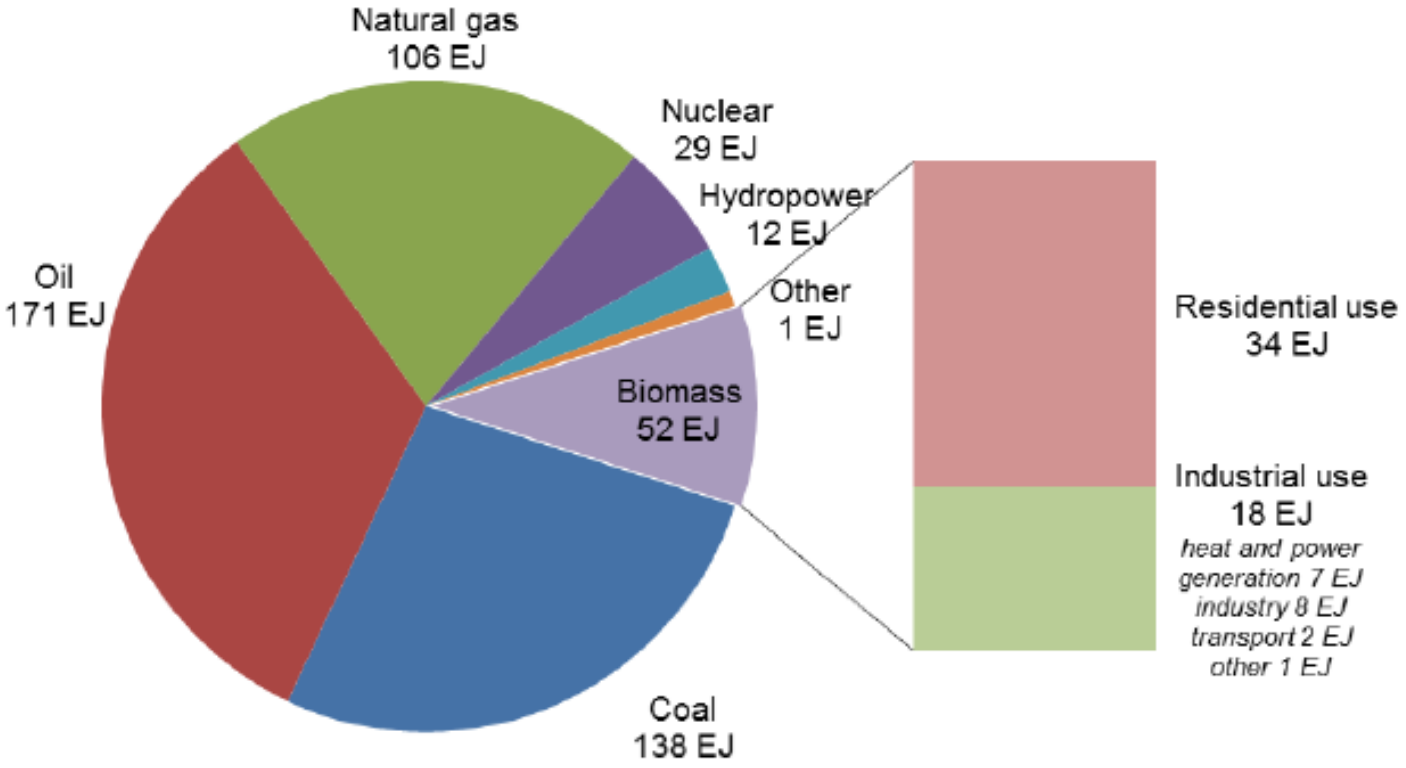
location: Bardejov, Slowakia
industrial: District heating
output: 35 t/h, 65 bar
8 MW_{el}, 20 MW_{th}

Typical scale of operation for various sizes and types of bioenergy plants

Type of plant	$Heat_{(th)}$ or $power_{(e)}$ capacity ranges, and annual hours of operation.	Biomass fuel required (oven dry tonnes/year)	Vehicle movements for biomass delivery to the plant	Land area required to produce the biomass (% of total within a given radius).
Small heat	100 - 250 kW_{th} 2 000 hr	40 - 60	3 - 5 / yr	1 - 3% within 1 km radius
Large heat	250kW_{th} - 1 MW_{th} 3 000 hr	100 - 1200	10 - 140 / yr	5 - 10% within 2 km radius
Small CHP	500 kW_e - 2 MW_e 4 000 hr	1 000 - 5 000	150 - 500 / yr	1 - 3% within 5 km radius
Medium CHP	5 - 10 MW_e 5 000 hr	30 000 - 60 000	5 - 10 / day	5 - 10% within 10 km radius
Large power plant	20 - 30 MW_e 7 000 hr	90 000 - 150 000	25 - 50 / day and night	2 - 5% within 50 km radius

for industrial processing

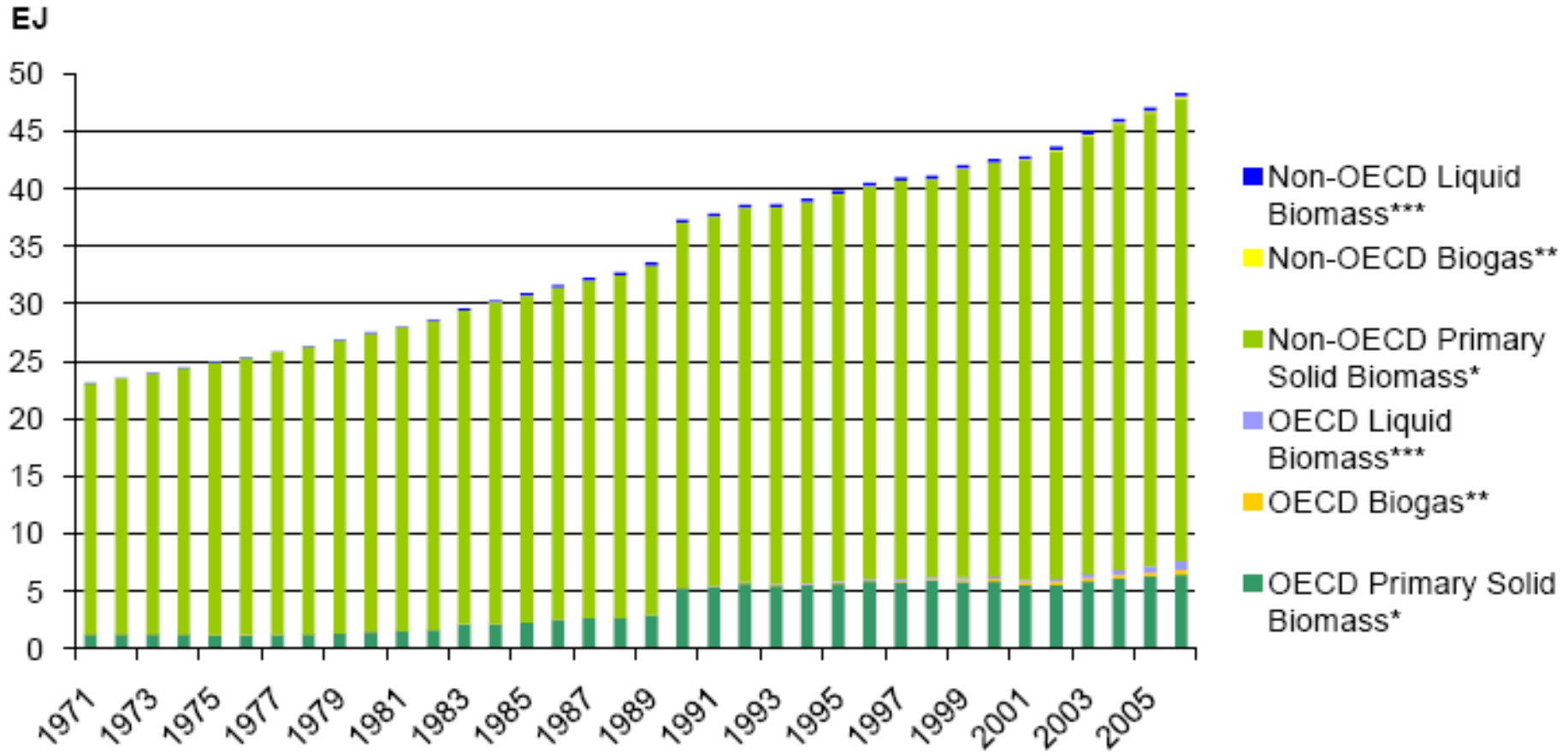
Global energy supply



Various energy sources in relation to the world's total primary energy supply in 2009. Total primary energy supply was 509 EJ in 2009

Source: International Energy Agency, 2012

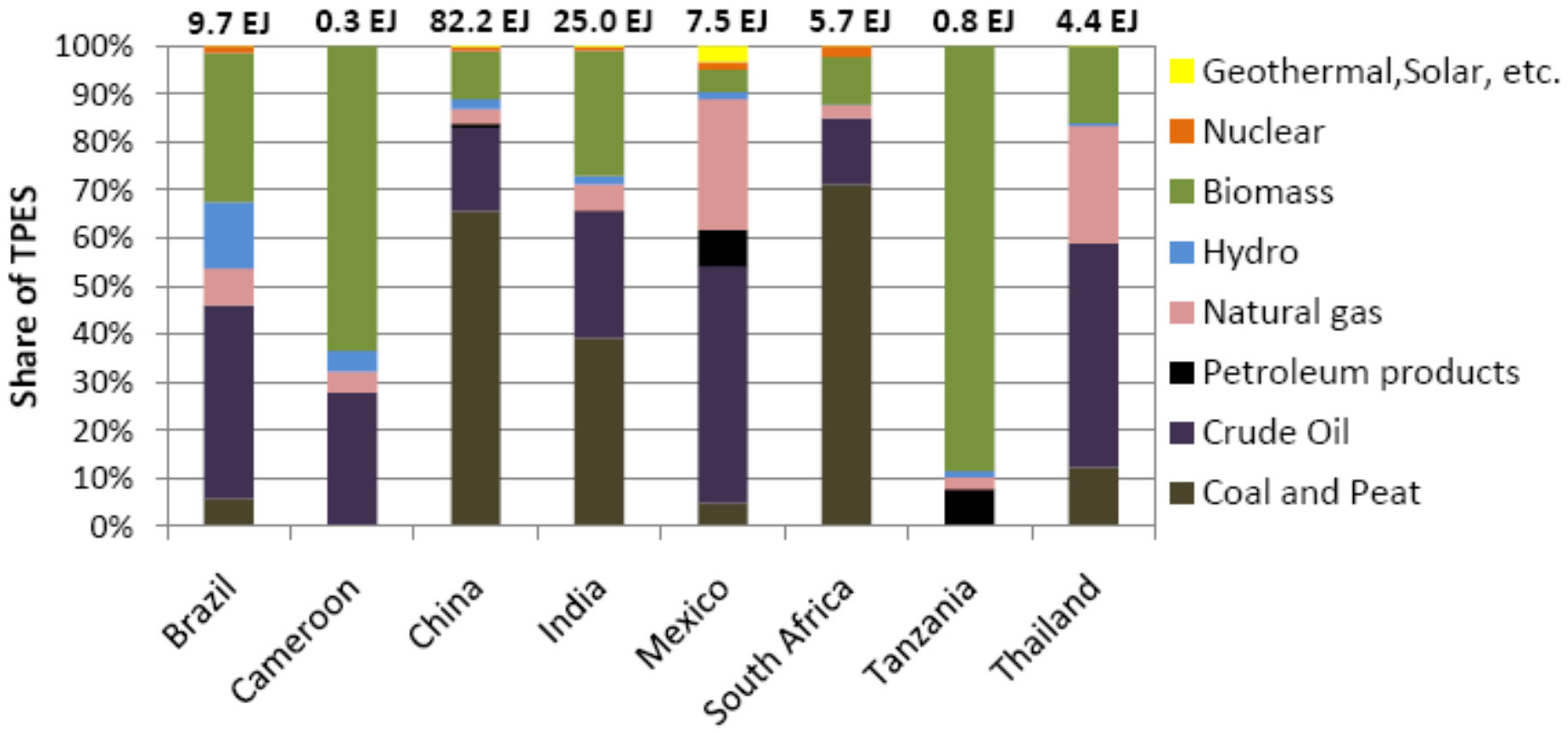
Global primary biomass consumption 1971-2007



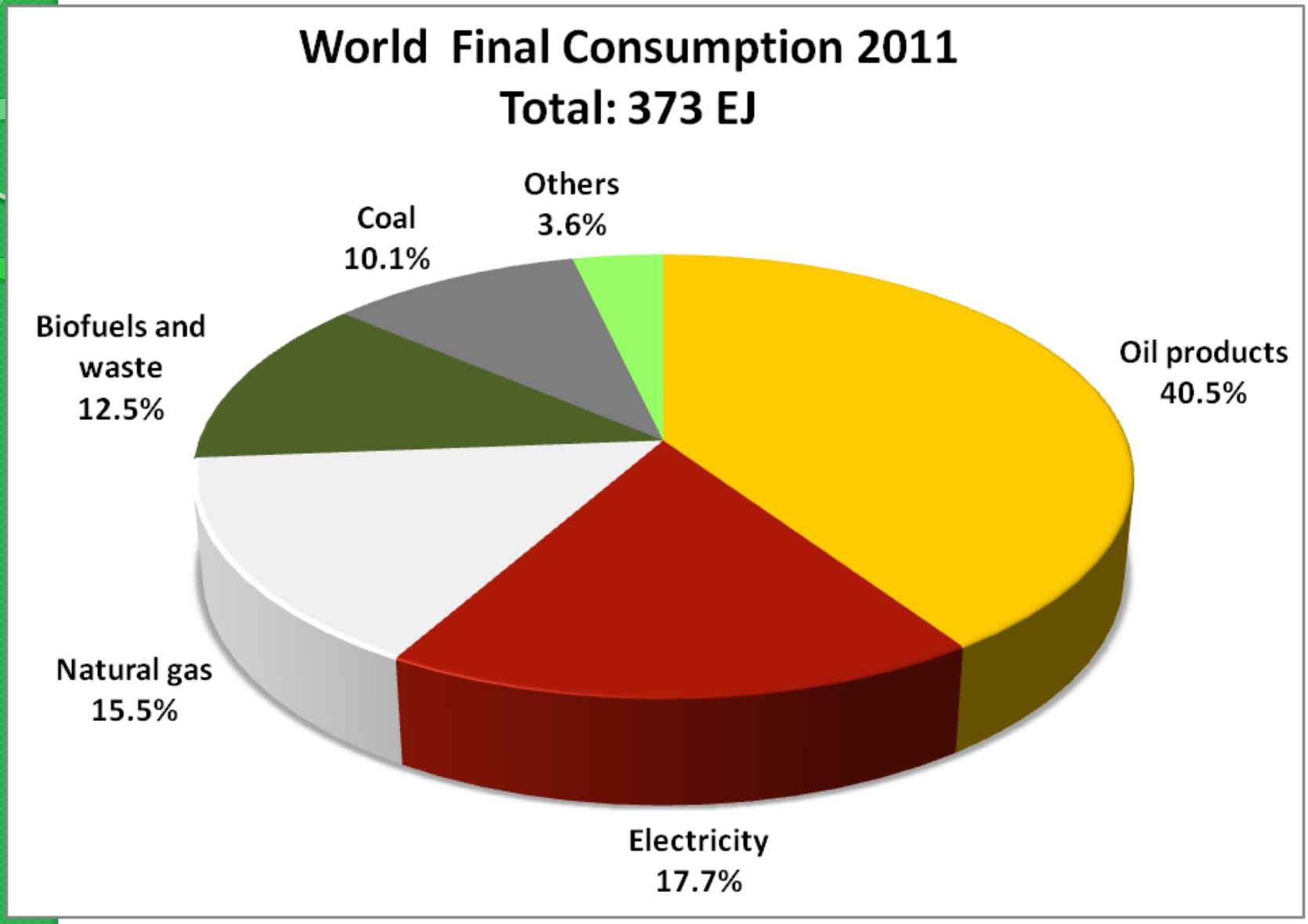
* Primary solid biomass includes wood, wood wastes, black liquor, other (straw, bagasse, etc.); ** biogas includes landfill-, sludge-, and other biogas; *** liquid biomass includes bioethanol, biodiesel and other biofuels.

Source: IEA Statistics, 2009

Biomass in total primary energy supply 2007 in selected countries

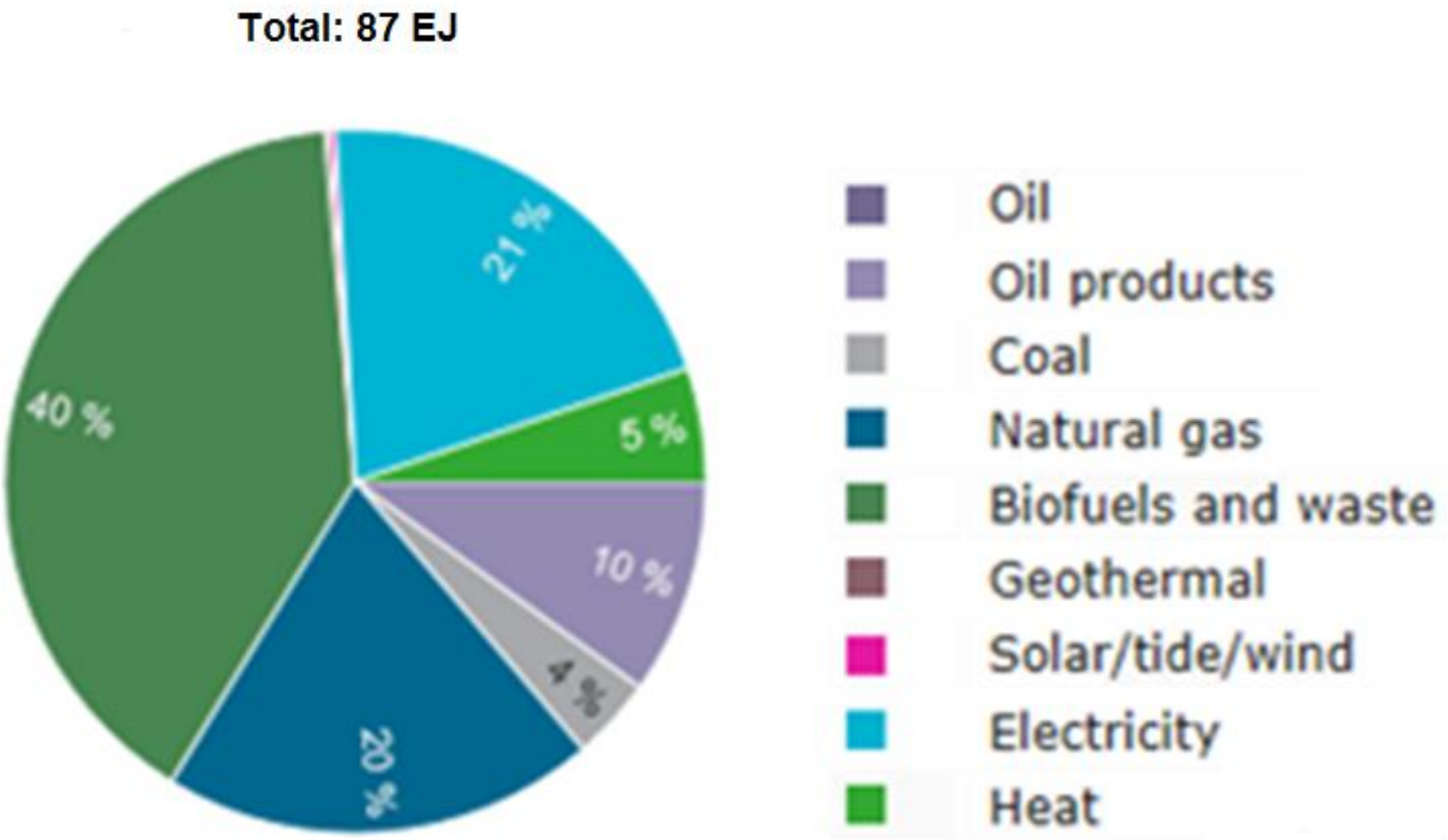


Source: IEA Statistics, 2009



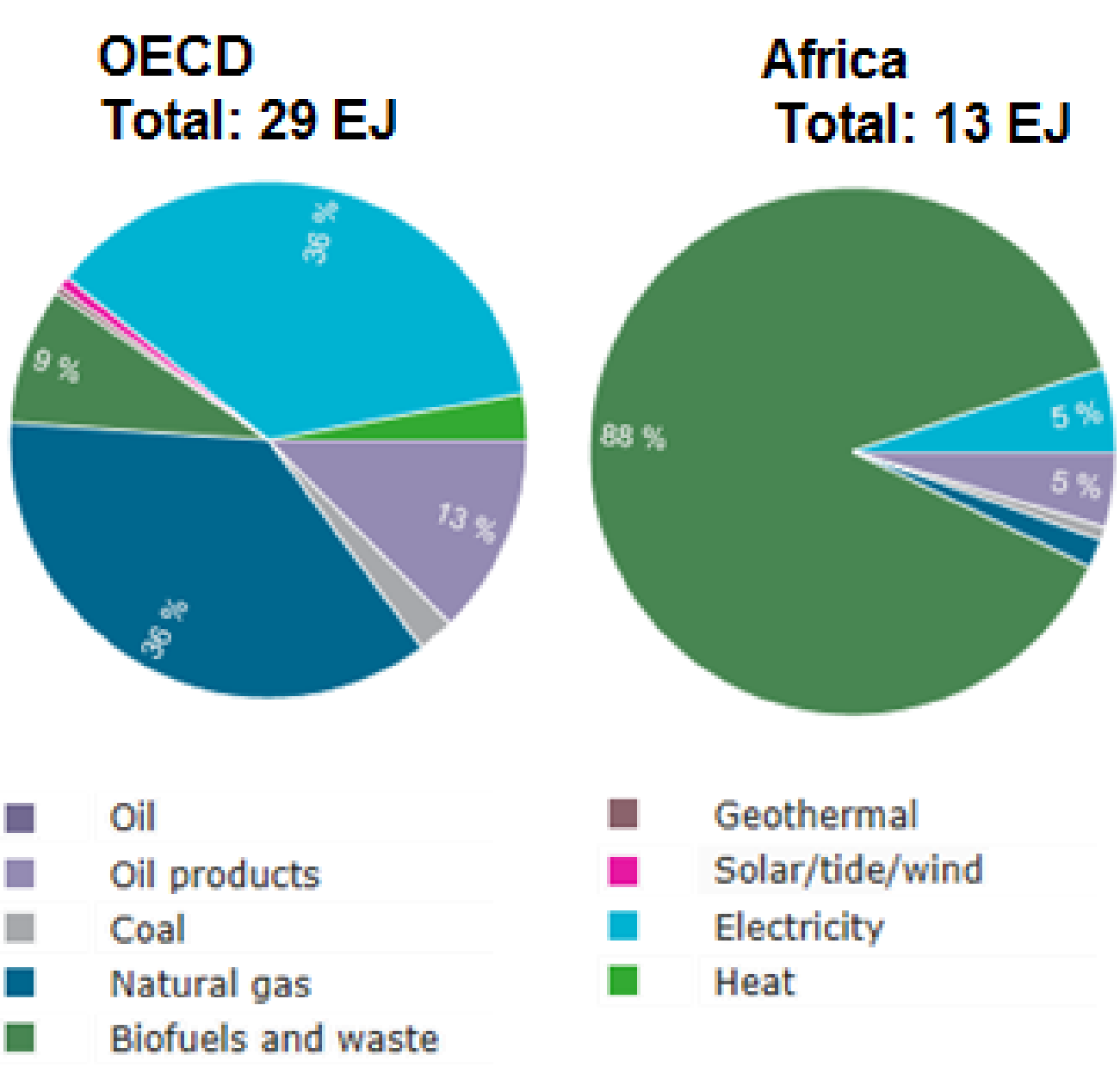
Source: International Energy Agency, 2013

World final consumption of Residential, 2011



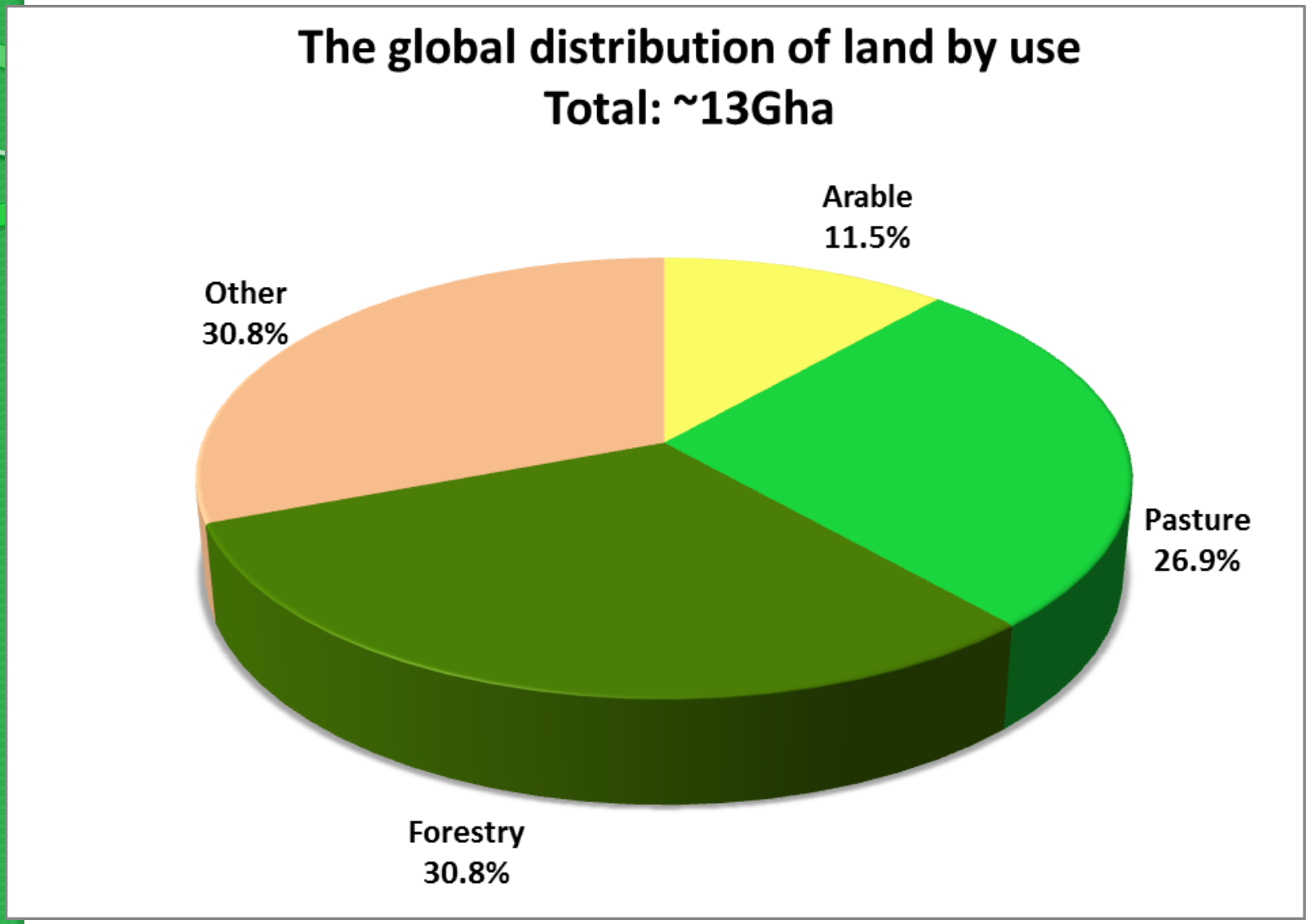
Source: International Energy Agency, 2013

Final Consumption of Residential 2011



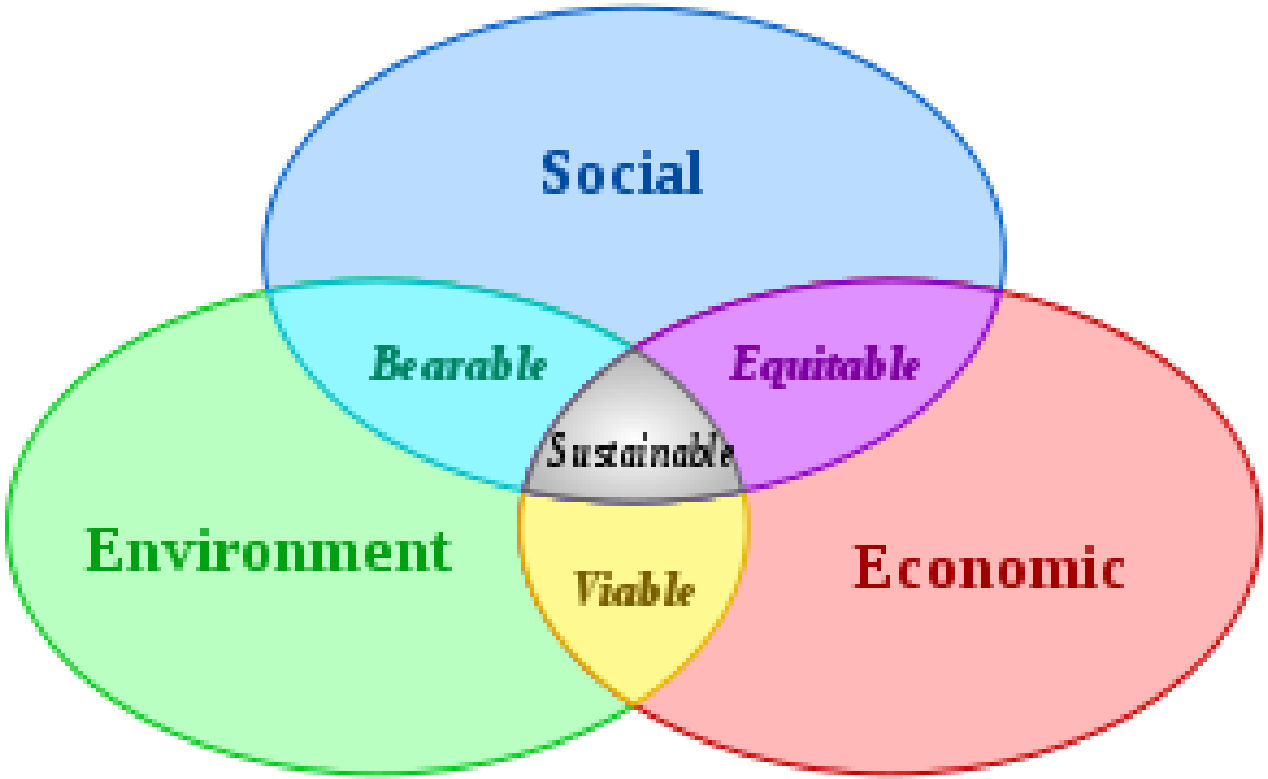
Source: International Energy Agency, 2013

Available amounts of biomass resources



Source data: FAOSTAT 2009

The impacts of using Biomass



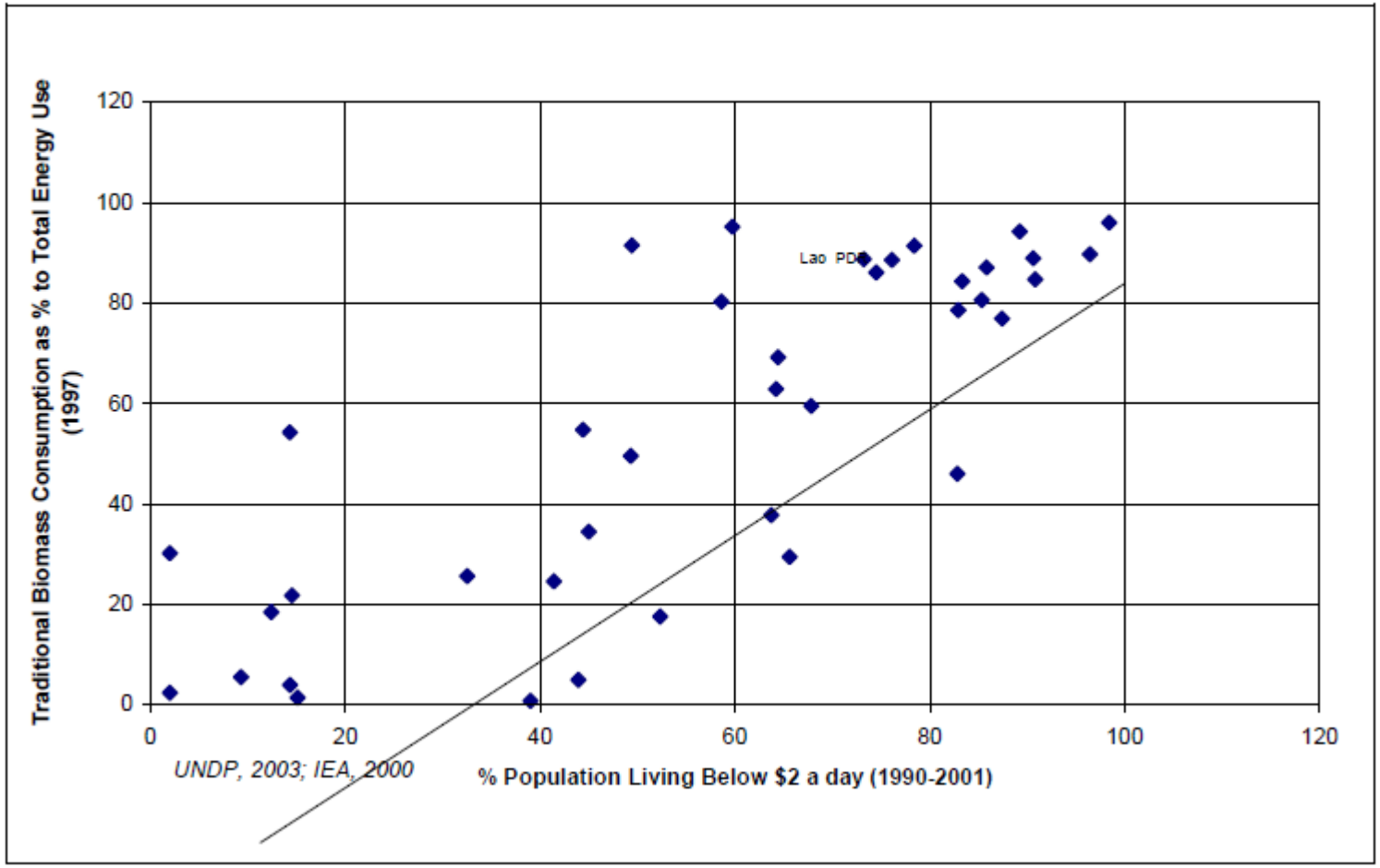
Social impacts

- At 2007, 2.5 billion people – 40% of the world's population – rely on traditional biomass (which is readily available) such as wood, agricultural residues and dung to meet virtually all their cooking energy needs.

Social impacts

- most often women and children, can spend many hours gathering wood.
- This reduces the time they can devote to more productive activities, such as farming and education

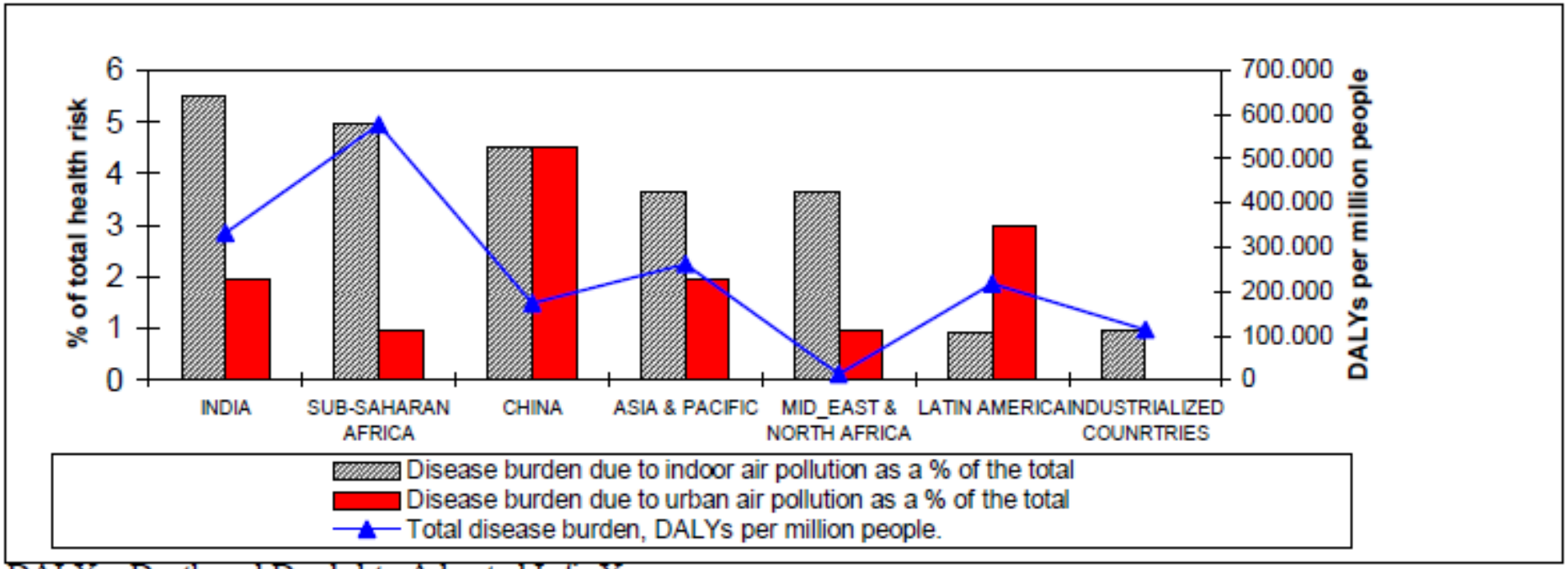
The Link Between Poverty and Traditional Energy Use



Health impacts

- The indoor air pollution from unvented bio-fuel cooking stoves is linked to respiratory diseases in many highland areas of developing countries

Comparison of Total Disease Burden and Disease Burden arising from indoor and urban air pollution



DALY – Death and Disability Adjusted Life-Years

Source: Schirnding, 2001

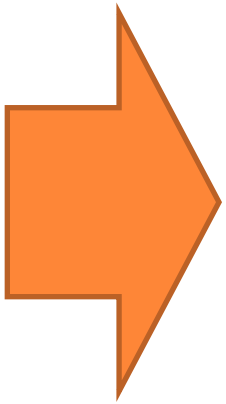
Environmental impacts

Wood gathering can also lead to deforestation, resulting in

- local scarcity of fuelwood
- severe damage to the ecosystem

Improved biomass technologies :

- reduce heat loss
- decrease indoor air pollution
- increase combustion efficiency
- attain a higher heat transfer



✓ savings in the amount of fuel used

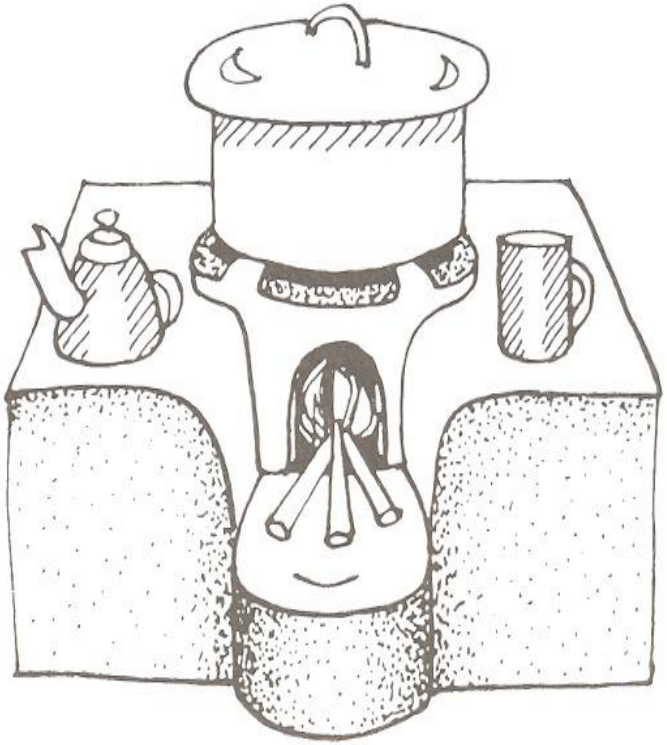
✓employment and job opportunities

✓freeing up more time for women and children in :

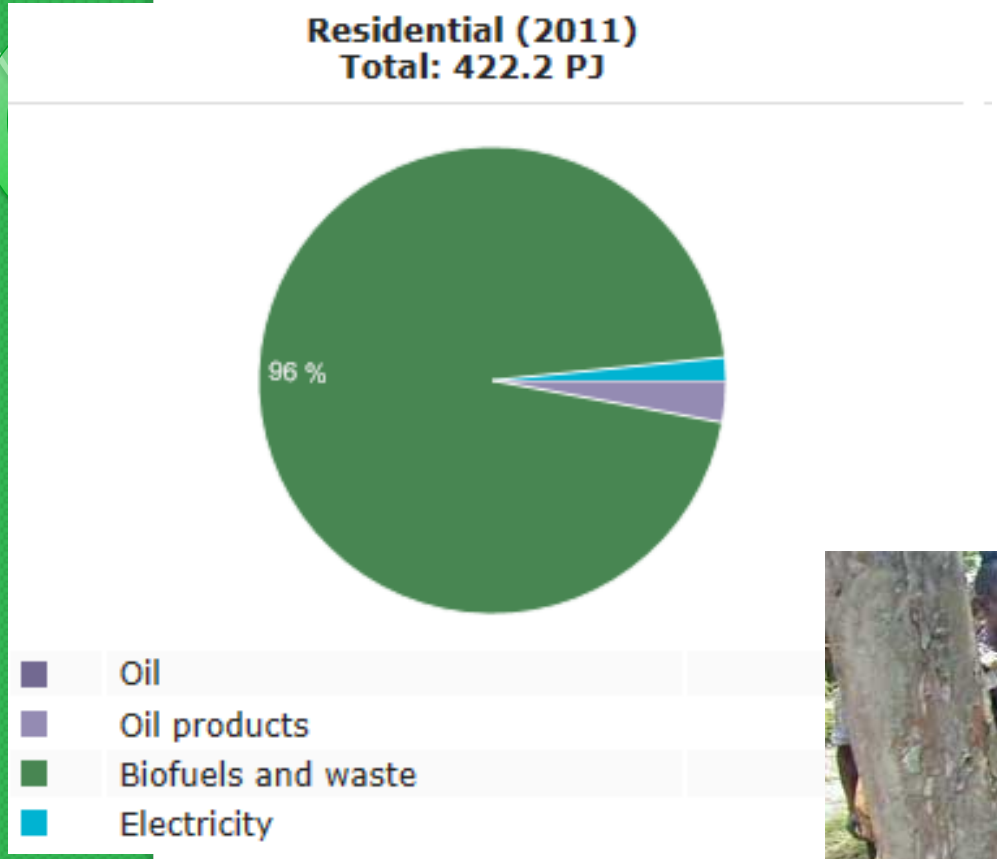
✓income generating activities

✓education

Case Study : Maendeleo/Upesi Improved Woodfuel Stove in Kenya



Kenya FINAL CONSUMPTION



Source: International Energy Agency, 2013

Comparison of job creation – Biomass and Conventional Energy Options

Comparison of job creation – Biomass and Conventional Energy Options

Sector	Jobs (person-years) Terawatt-hour
Petroleum	260
Offshore oil	265
Natural gas	250
Coal	370
Nuclear	75
Wood energy	1,000
Ethanol (from sugarcane)	4,000

Source: Goldemberg, 2003

ADVANTAGES

- reduces need for fossil fuels
- Biomass is always available and can be produced as a renewable resource
- Biomass fuel from agriculture wastes maybe a secondary product that adds value to agricultural crop

ADVANTAGES

- The use of waste materials reduce landfill disposal
- CO2 which is released when Biomass fuel is burned, is taken in by plants
- Less money spent on foreign oil

ADVANTAGES

- fuel from biomass has essentially no or very little sulfur (0.1 to 0.2%) or ash content

- Usage of fuel ethanol in transportation sectors due to the phaseout of MTBE as well as regulatory demand of oxygenated fuel

DISADVANTAGES

- Agricultural wastes will not be available if the basic crop is no longer grown.
- Additional work is needed in areas such as harvesting methods.
- Land used for energy crops maybe in demand for other purposes, such as faming, housing, conservation, resort or agricultural use.

DISADVANTAGES

- Some Biomass conversion projects are from animal wastes and are relatively small and therefore are limited.
- Research is needed to reduce the costs of production of Biomass based fuels.
- it is in some cases is a major cause of pollution.

THANKS