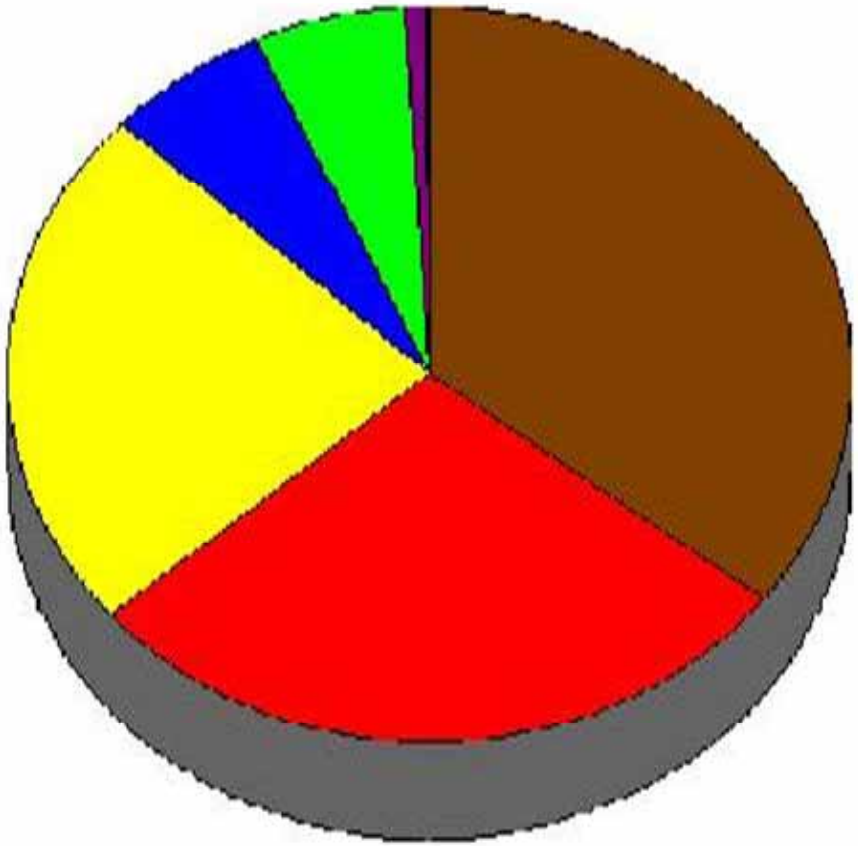
Biomass waste utilization and energy security in Malaysia

Agamuthu P. and Fauziah S.H.

Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia.

Email: agamuthu@um.edu.my

World energy consumption by types (2006)



Petroleum:	3527	~	35.43%
Coal:	2802	~	28.15%
Dry natural gas:	2335	~	23.46%
Hydro-electricity:	624	~	6.27%
Nuclear electricity:	576	~	5.79%
Geothermal, wind, solar, biomass :	86	~	0.86%
Geothermal, biomass, solar not used for electricity:	5	~	0.05%

Total: 9955

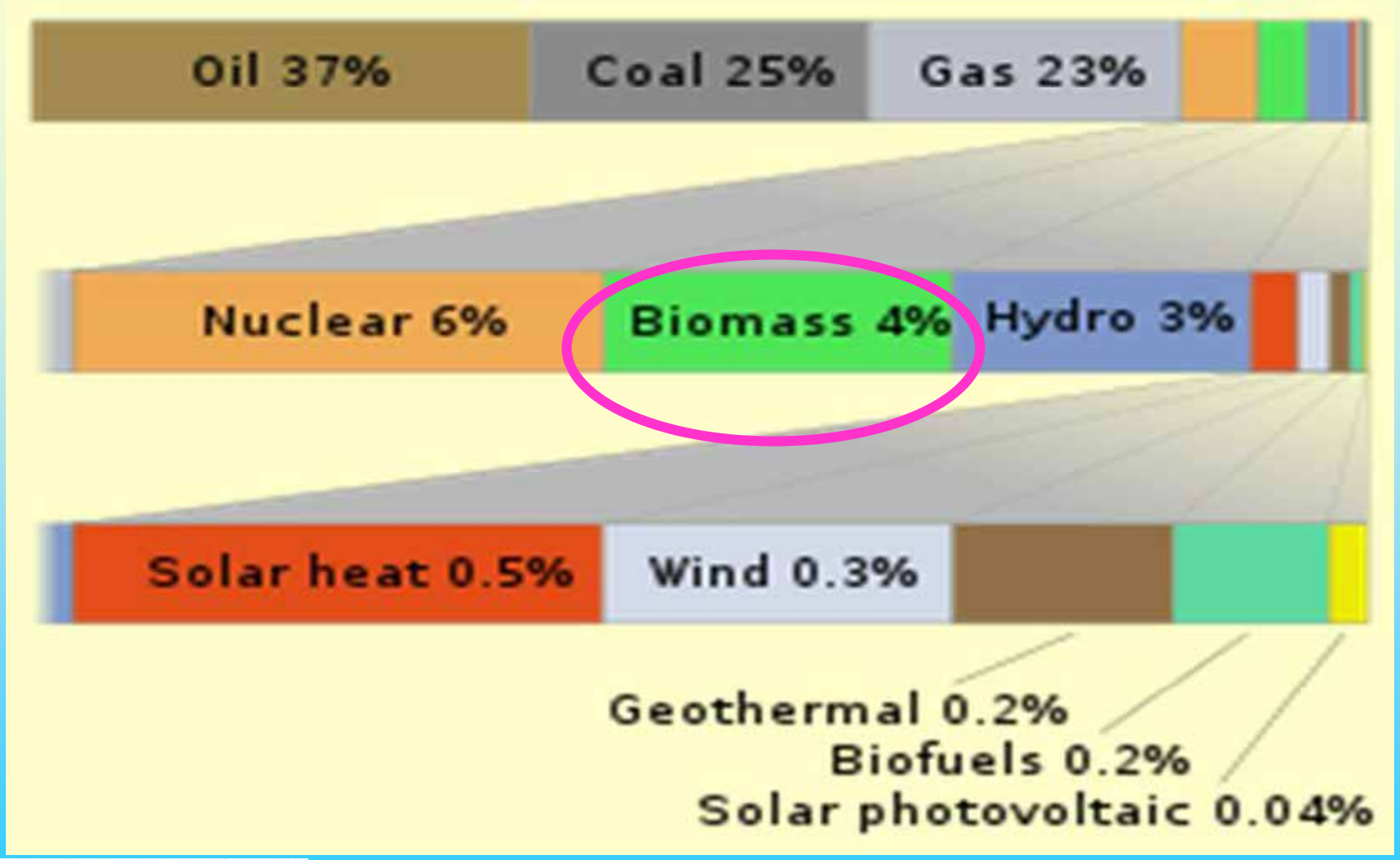
UNIVERSITY OF MALAYA
KUALA LUMPUR

Biomass role in energy supply

- The predominant fuel in 1900s and was eventually replaced with others particularly fossil fuel.
- In 2005,
  - total energy consumed from biomass = 264 GW (excluding biomass fires for cooking)
  - world production of bioethanol = 33 billion litres
  - world production of biodiesel = 3.9 billion litres
- The fastest growing renewable energy source in 2005.
- In 2008, it covers 4% of global energy sources

UNIVERSITY OF MALAYA
KUALA LUMPUR

Global sources of energy generation, 2008



UNIVERSITY OF MALAYA
KUALA LUMPUR

Energy sources for Malaysia

Energy source	Reserves	Duration of Production	Production capacity
Oil	400 Mt	10 years	Decrease (35 Mt against 39 Mt in 2003)
Gas	2 500 Gm^3	50 years	Increasing rapidly and reached 61.5 Gm^3 in 2006.
Coal	1 Gt.		

- Only a small part of hydroelectricity potential is exploited.
- Malaysia has renewable energy potential
- mainly resulting from palm oil and wood (potential estimated at 665 MW).

UNIVERSITY OF MALAYA
KUALA LUMPUR

Malaysia's demand for energy from Biomass waste

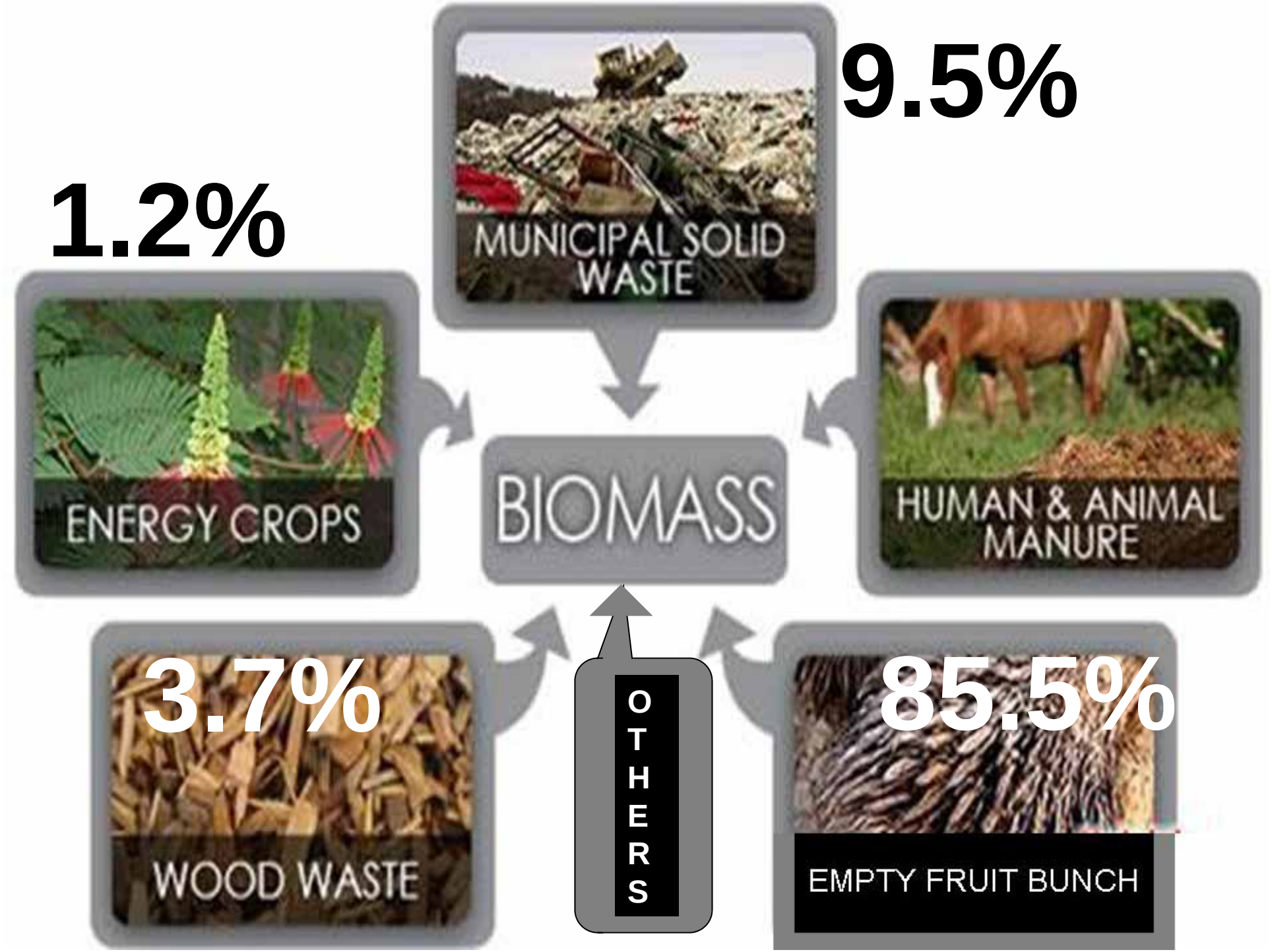
- Rapid industrialization towards a developed nation by 2020
- Will exhaust the national fossil fuel reserves in 30–40 years
- Will totally depend on imported fuel then– Net oil importer from 2040

UNIVERSITY OF MALAYA
KUALA LUMPUR

Types of Biomass Waste in Malaysia

- Domestic wastes (MSW)
- Agricultural residues
- Animal wastes
- Effluent sludge/wastewater
- Wood chips

UNIVERSITY OF MALAYA
KUALA LUMPUR


9.5%
MUNICIPAL SOLID WASTE
1.2%
ENERGY CROPS
BIOMASS
HUMAN & ANIMAL MANURE
3.7%
WOOD WASTE
OTHERS
85.5%
EMPTY FRUIT BUNCH

Solid Waste Generation in Malaysia

- **~30,000 tonnes daily, 95% landfilled**
  - **unsustainable landfilling**
  - **Loss of resources**
- **MSW contains**
  - **~ 80% combustible**
  - **> 50% organic matter**
- **Biomass waste has been identified as renewable energy (RE)**

UNIVERSITY OF MALAYA
KUALA LUMPUR

UNIVERSITY OF MALAYA
KUALA LUMPUR

MSW in Malaysia

Biomass Resources from Agricultural Residues

- Most abundant in Malaysia (>70 million tonnes annually)
- Production throughout the year
  - High sunlight intensity/ time and high rainfall
- Main contributor of biomass – palm oil industry

EFB	14 mil tonnes
POME	117 mil tonnes
Mesocarp fiber	5 mil tonnes
Palm kernel shell	8 mil tonnes
Palm kernel cake (residue)	2.1 mil tonnes

- Ligno-cellulosic materials

UNIVERSITY OF MALAYA
KUALA LUMPUR

BIOMASS WASTE FROM PALM OIL INDUSTRY

UNIVERSITY OF MALAYA
KUALA LUMPUR

Potential Power generation from Oil Palm Residue in Malaysia

Tonnage	Residue	Residue product ratio (%)	Generated residue (000 tonnes)	Potential Energy (PJ)	Potential Electricity Generation (MW)
59 800	EFB (65%) Fiber Shell	21.14 12.72 5.67	12 641 7 607 3 390	57 108 55	521 1032 545
Total			16 670	220	2090
Solid			38 870	-	320

POME is 3.5m^3 per ton of CPO/ 65% of FFB

UNIVERSITY OF MALAYA
KUALA LUMPUR

Biomass conversion process to useful energy

- Thermal conversion
  - Combustion,
  - Torrefaction
  - Pyrolysis,
  - Gasification.
- Chemical conversion
- Biochemical conversion
  - anaerobic digestion,
  - fermentation and composting
  - transesterification

UNIVERSITY OF MALAYA
KUALA LUMPUR

Energy Security in Malaysia

- **Total Energy Consumption (2006E)**
  2.56 quadrillion Btu*
- **Total Per Capita Energy Consumption (Million Btu) (2006E)**
  99.4 million Btu per person
- **Energy Intensity (2006E)**
  8,891 Btu per $2000-PPP**

UNIVERSITY OF MALAYA
KUALA LUMPUR

Need of National RE Policy

- To address market failure – as there is no/very weak market at the moment
- To promote long term sustainability by reducing our dependence on fossil fuels in electricity generation
- To stimulate a new growth industry
- To recognize the importance of the environment as an economic growth contributor as the need to satisfy principles of sustainable development will create demand for green products/technologies
- To develop human capital resources especially in R&D in RE technologies
- To improve the coherence of current policies. Currently, there is a lack of convergence in the existing framework among various current policies

UNIVERSITY OF MALAYA
KUALA LUMPUR

RE Policy and Action Plan

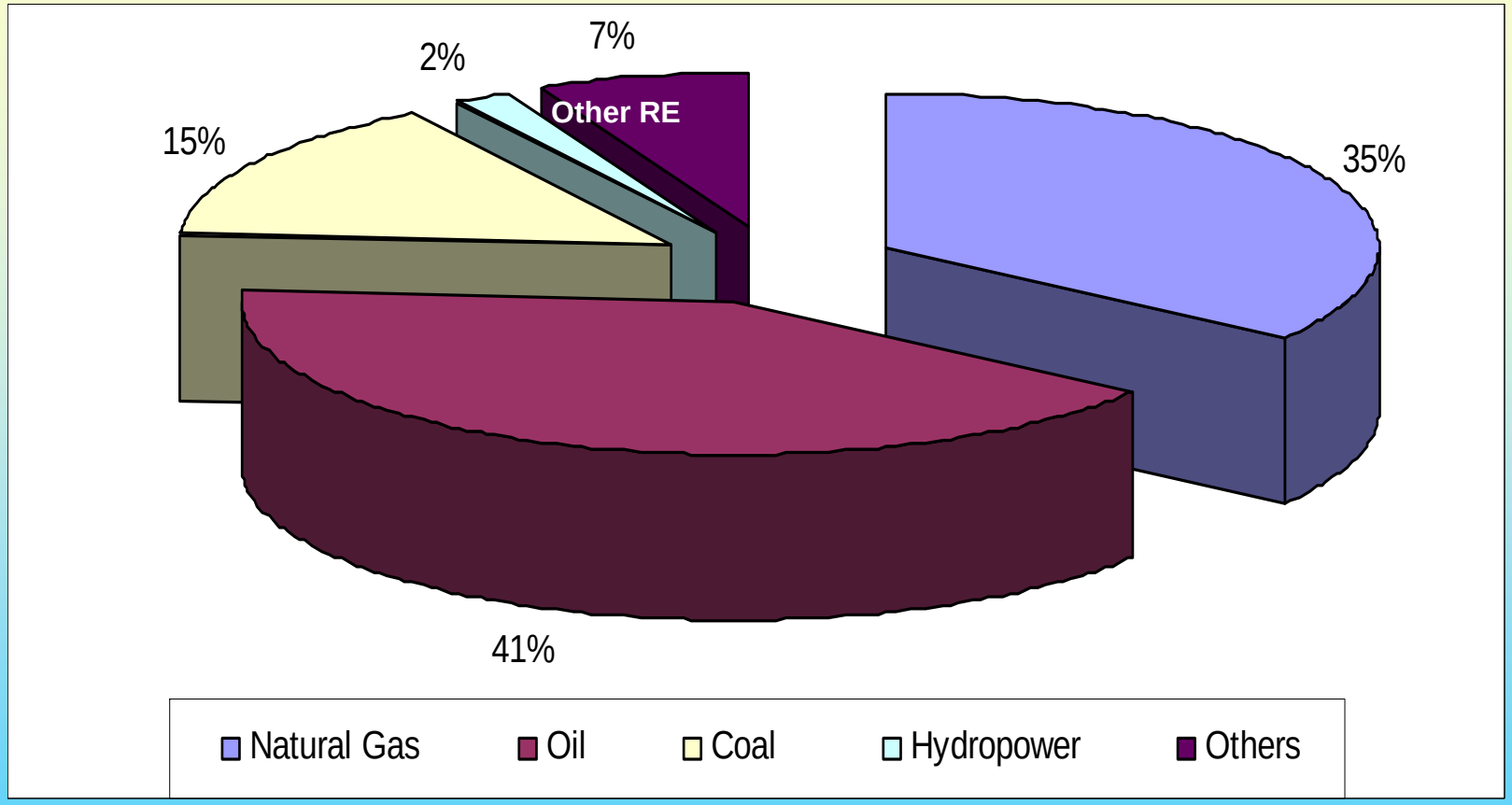
- was approved in April 2010
- expected to be implemented in the 10th MP and beyond

"Enhancing the utilization of indigenous renewable energy resources to contribute towards national electricity supply security and sustainable socio-economic development."

Objectives of RE Policy and Action Plan

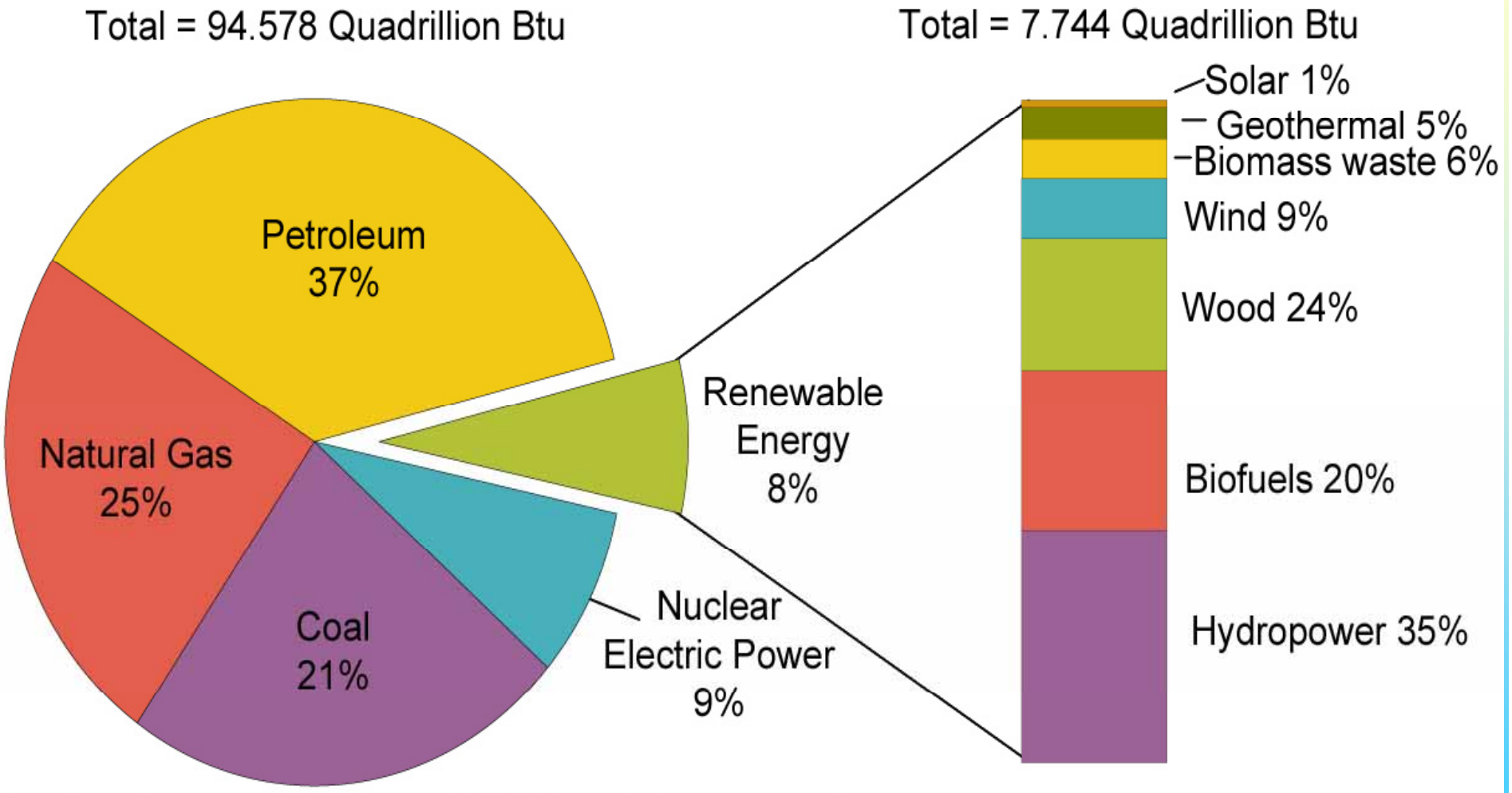
- To increase RE contribution in the national power generation mix;
- To facilitate the growth of the RE industry;
- To ensure reasonable RE generation costs;
- To conserve the environment for future generation; and
- To enhance awareness on the role and importance of RE.

UNIVERSITY OF MALAYA
KUALA LUMPUR



Sources of Energy in Malaysia, 2008

The Role of Renewable Energy in the USA Energy Supply, 2009



Note: Sum of components may not equal 100% due to independent rounding.
Source: U.S. Energy Information Administration, *Annual Energy Review 2009*, Table 1.3, Primary Energy Consumption by Energy Source, 1949-2009 (August 2010).

Performance of Biogas Pilot Plant

Process parameters	Open Digesters	Biogas Pilot Plant
COD removal (polluting strength)	81%	97%
Treatment time (days)	20	10
Methane utilization	No	yes
Methane production (kg/kg COD)	0.109	0.20
Methane content (%)	36	55
Biogas production (m^3/tonne POME)	(28*)	20
Solid discharge (g/L)	20	8

Estimated cost for Electricity generation (1000 kWh) in RM (million)

Construction of Biogas Tanks (3500t x 3 units)	4.6
Downstream processing (Gas scrubber & storage)	3.4
Gas turbine @ 1000 kWh (Methane productivity)	3.8
Total plant cost	11.8
Yearly maintenance and operation cost (5% of plant cost)	0.6

Estimated sale of CER @ € 19.60 per tonne CO2 per year – RM 1.8 million
(Assumption: mill capacity of 60t FFB/hr and 320 days of operation)

UNIVERSITY OF MALAYA
KUALA LUMPUR

Renewable energy and Biomass

- Energy policy promotes Renewable Energy (RE) as the 5th fuel with the target 5% of total electricity
- Under 8MP (2001 – 2005) and Outline Perspective Plan (OPP3) (2001 – 2010),
- the government will intensify and accelerate the development and utilization of biomass for RE
- Target for 2020, 11% energy will be generated from Renewable resources

UNIVERSITY OF MALAYA
KUALA LUMPUR

CDM Biomass Energy Plant in Malaysia

- Total of 83 CDM projects, e.g.
  - Bentong Biomass Energy Plant (2008-2014)- agricultural waste (thermal technology)
  - SEO Biomass Steam and Power Plant (2006-2013) - agricultural waste (thermal technology)
  - Bionersis LFG Project Malaysia (Penang) (2011-2018) – MSW landfill
  - Methane Recovery in Wastewater Treatment, Pahang and Negeri Sembilan (2009-2016)

UNIVERSITY OF MALAYA
KUALA LUMPUR

Issues in biomass utilization as sources of energy

Factors	Issues
Policy barriers	- limited incentives on biomass utilization
Supply & demand	- no reliable data on actual potential of biomass – slow implementation of 5th Fuel Policy (RE, including biomass) – limited effort to regulate and enforce biomass programs
Environment	- current technologies are inefficient and polluting
Financial & technical	- high initial investment – limited local technologies and equipment – poor financial support, no record on biomass industry
Institutional barrier	- limited coordination among the local agencies - unwillingness of the industry to change and to be proactive

UNIVERSITY OF MALAYA
KUALA LUMPUR

Challenges

- Fuel Security
- Electricity Sales Price
- Renewable Energy Power Purchasing Agreement
- Financial Assistance
- Lack of Promotion
- Conventional vs Renewable Energy Power Plant
- Subsidy for Conventional Energy

UNIVERSITY OF MALAYA
KUALA LUMPUR

Future Potential in Biomass Conversion to Energy in Malaysia (1)

- More opportunity with the implementation of feed-in-tariff (FIT) for 10 years
- Quota set for RE technologies (FIT Policy) by RE/Malaysia Building Integrated Photovoltaic (MBPIV) of Ministry of Energy, Green Technology and Water.
  - Amount of electricity that can be paid by Government

UNIVERSITY OF MALAYA
KUALA LUMPUR

Cumulative quota on RE capacity (MW)

Year	Biomass	Biogas	Mini-Hydro	Solar PV	Solid Waste	Total
2011	110	20	60	9	20	219
2015	330	100	290	65	200	985
2020	800	240	490	190	360	2 080
2025	1 190	350	490	455	380	2 865
2030	1 340	140	490	1 370	390	4 000
2040	1 340	410	490	7 450	410	10 100
2050	1 340	410	490	18 700	430	21 370

Future Potential in Biomass Conversion to Energy in Malaysia (2)

- Boost of RE contribution to Malaysia's electricity-generation mix
  - From 1% in 2009 (55MW) to 5.5% in 2015 (1GW)
  - Targeting 4GW by 2030
- Will take effect next year (2011)
- Possibility of individual or business owner to sell electricity generated to Tenaga Nasional Bhd and Sarawak Energy Bhd at premium rate
  - Biomass RM 0.27- 0.31
  - Biogas RM 0.28- 0.32

UNIVERSITY OF MALAYA
KUALA LUMPUR

Conclusion

- Malaysia has high potential in utilizing biomass for energy conversion

- Newly proposed policy under the RE/Malaysia Building Integrated Photovoltaic (MBPIV) of Ministry of Energy, Green Technology and Water paved better future for Biomass as RE

UNIVERSITY OF MALAYA
KUALA LUMPUR


© Original Artist
Reproduction rights obtainable from
www.CartoonStock.com
OIL
search ID: rmo0406
RON MORGAN
"You've got to overcome your dependency on fossil fuels."

THANK YOU