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Econometric Study on Long-term Energy Strategy of Malaysia to the year 2030

~ focusing on the impacts of renewable energy-based power generation

21century COE
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   - model structure, simulations, assumptions
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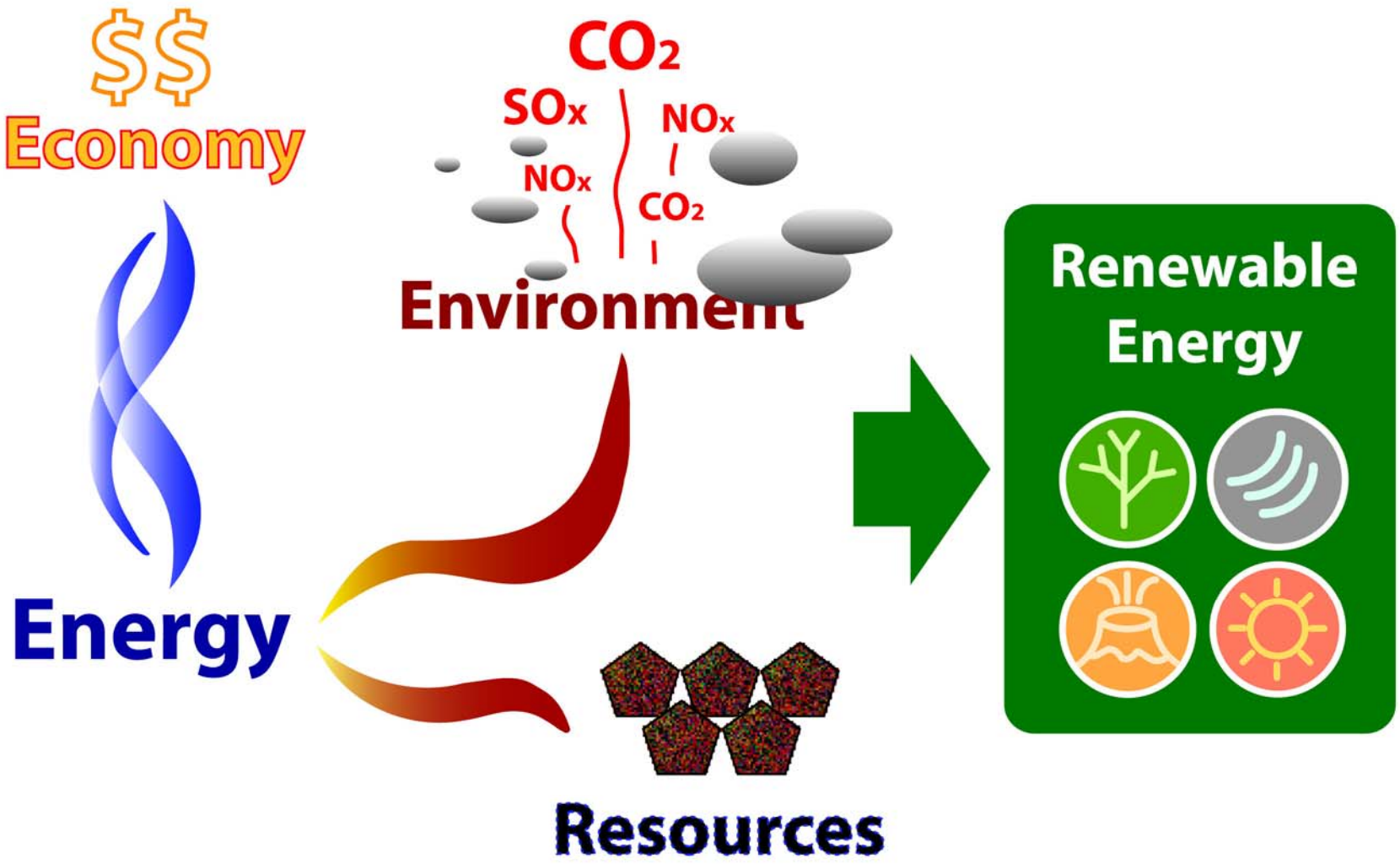
1 Background



Objective

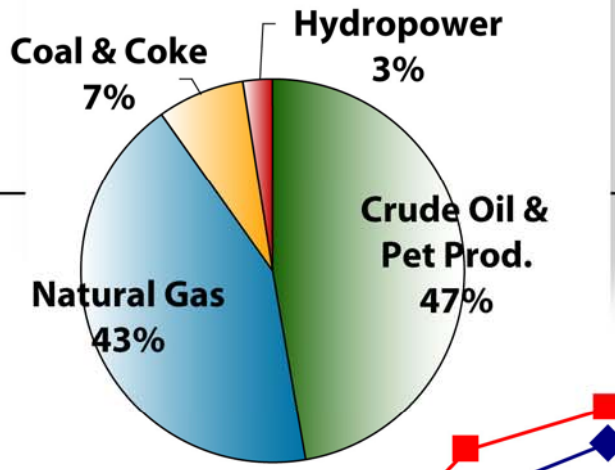
To analyse

the economy, energy and environment impacts of Renewable Energy-based power generation on the long-term energy demand of Malaysia using econometric method

2 Malaysia - Energy Demand & Supply

TPES Energy Mix in 2002

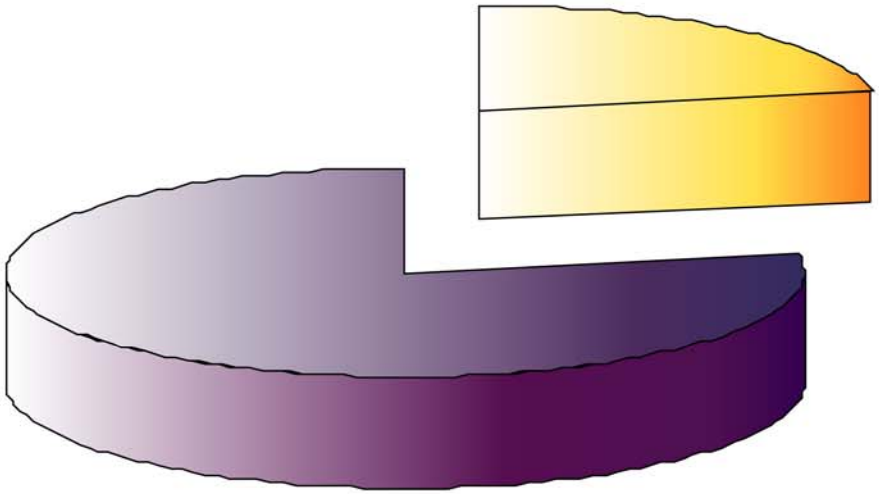
⇒ fossil fuels dominated !!



Compiled from National Energy Balance of Malaysia, various issues

Malaysia - Fossil Fuels Reserves

In 2003,



Oil
4.5 Billion barrel

R/P Ratio : 18 years
(<10 years, 2001)

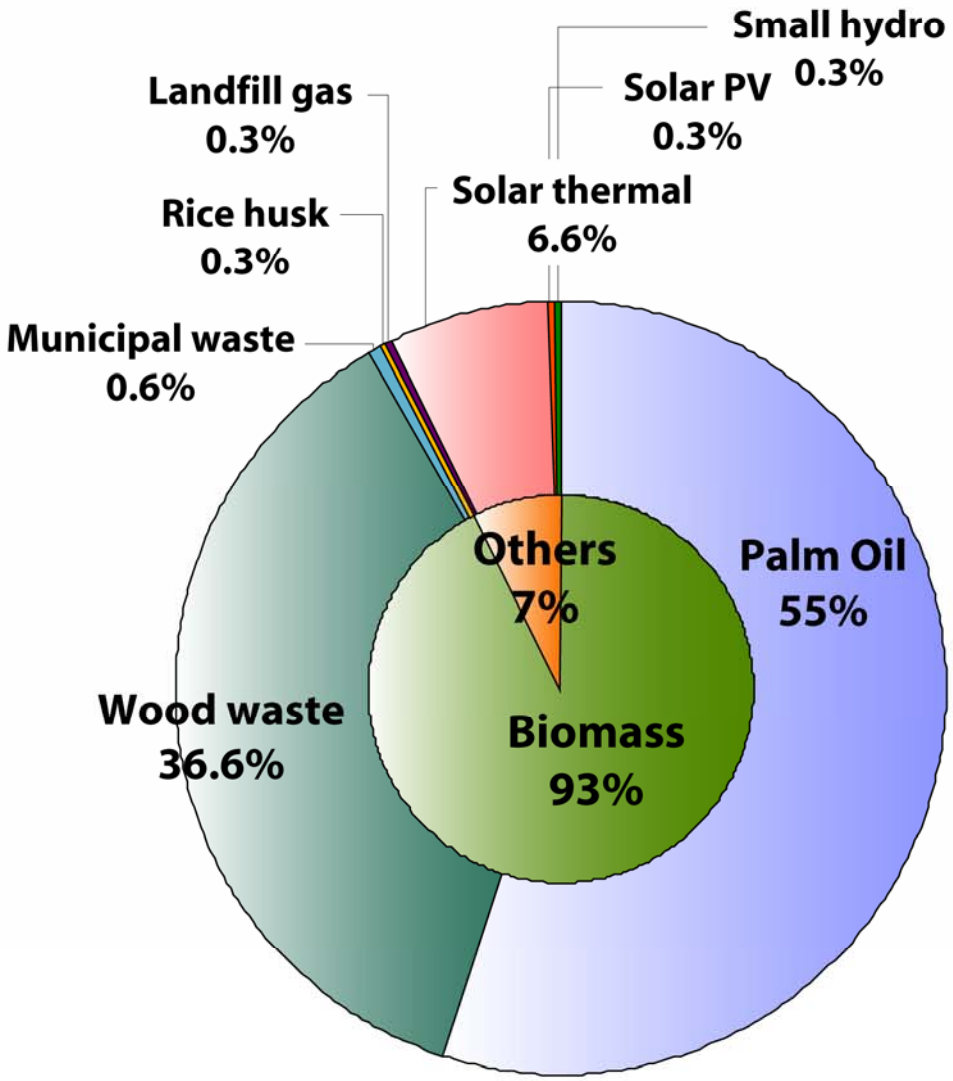
Natural Gas
16.2 Billion barrel

R/P Ratio : 35 Years
(> 70 years, 2001)

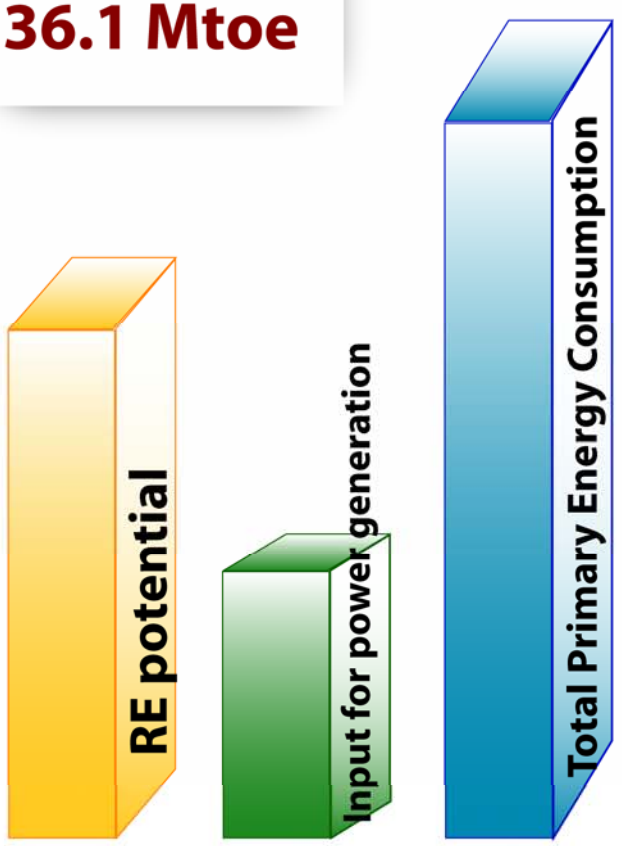
The government estimated that the country will be a
NET oil importer by 2008

source : PETRONAS

Renewable Energy Potential



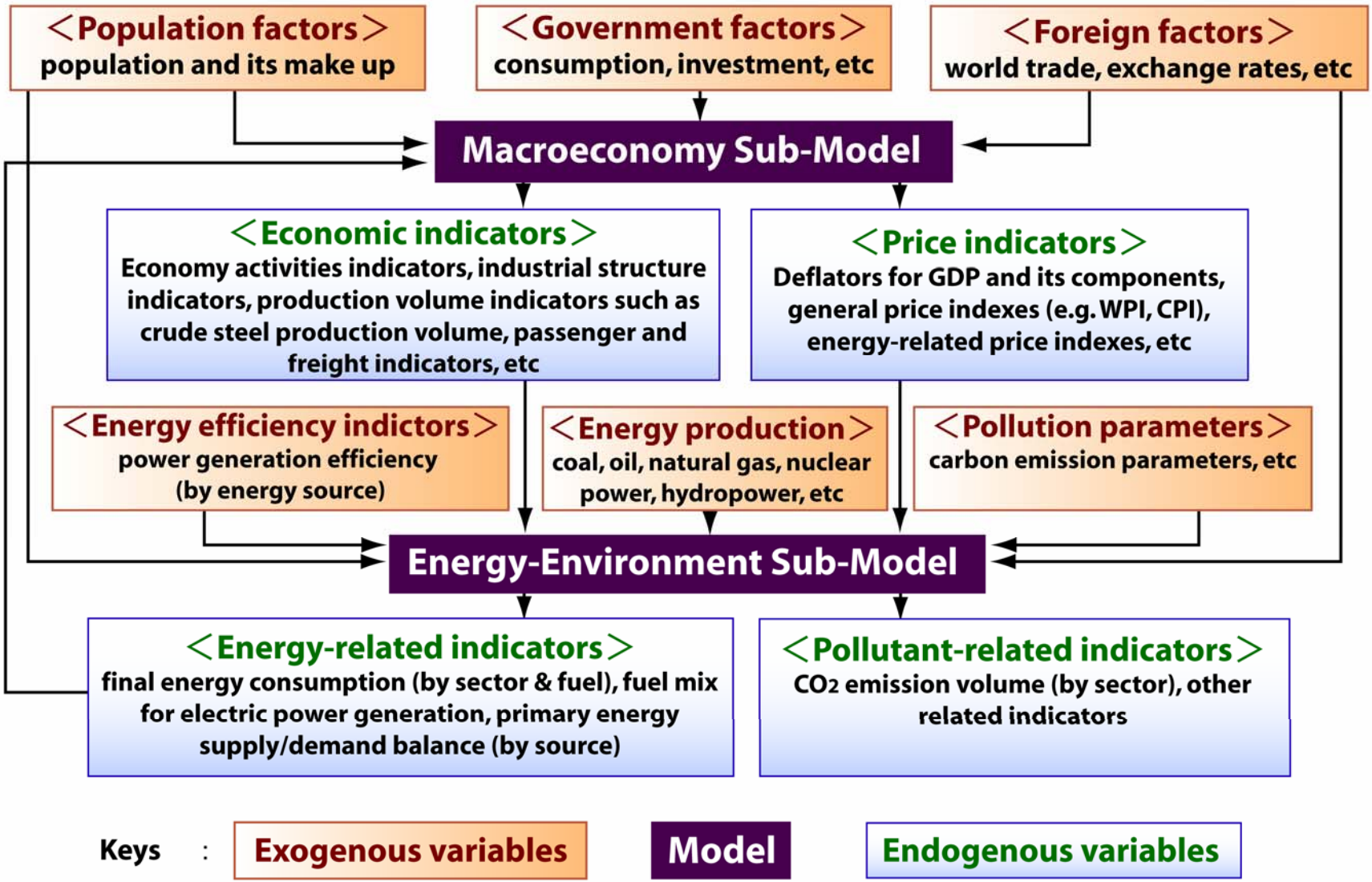
Yearly
36.1 Mtoe



** based on 2002 level*

Source : DANCED (1999); MECM (2003)

3 Integrated Econometric Model



Integrated Econometric Model

This model has 3 sub-models as follows :

- **Macroeconomy sub-model**
  provides indicators influencing energy demand, pollutants emissions
  ~ 40 Equations

- **Energy sub-model**
  determines energy flows by fuel & stages -- Final Energy Demand ⇒ Power Generation ⇒ Total Primary Energy Consumption

93 Equations

- **Environment sub-model**
  determines pollutants emissions (CO_2) by fuel & stages

Simulations

Simulation Cases :

① Macroeconomic - BAU Case (Business As Usual)

② Energy-Environment

- BAU Case
- Renewable Energy (RE) Case
  (utilization of RE for power generation)

Simulation Period :

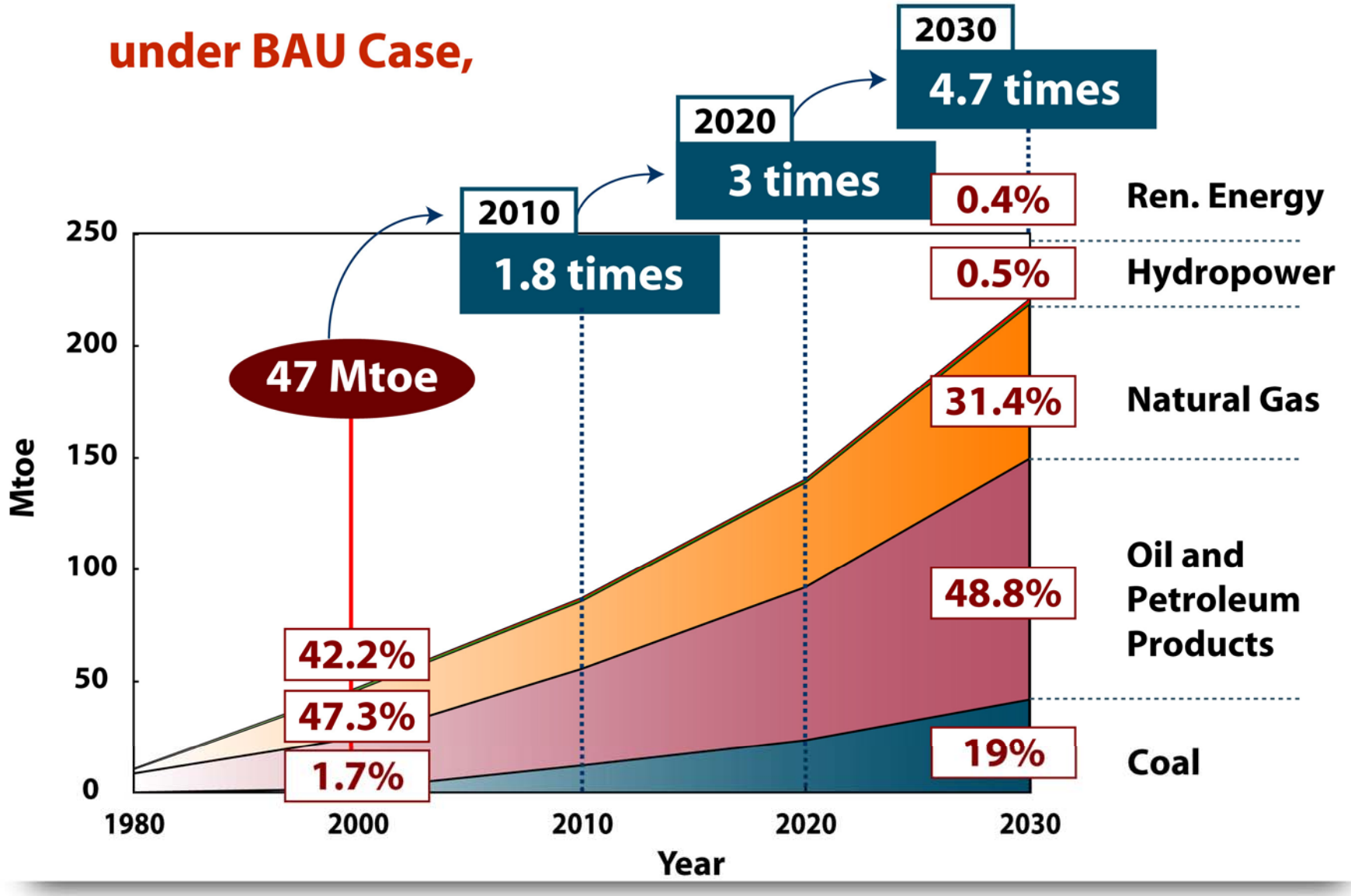
2000 to 2030

Assumptions :

for macroeconomic & energy-environment simulations

(please refer to text)

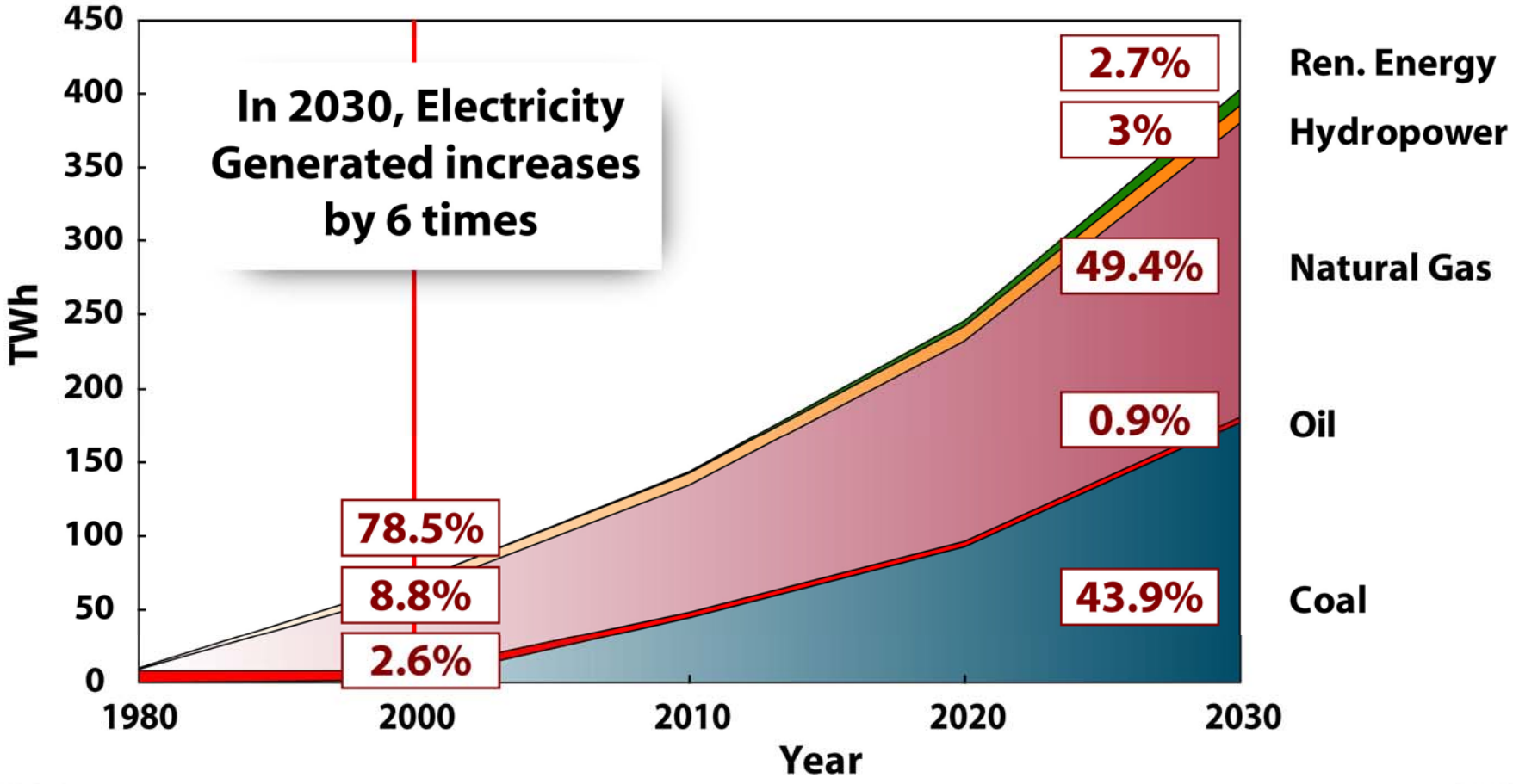
Malaysia - Total Primary Energy Consumption to 2030



Malaysia - Electricity Generation Mix to 2030

under BAU Case,

- Natural Gas ⇒ 50%
- Coal share ⇒ Increases



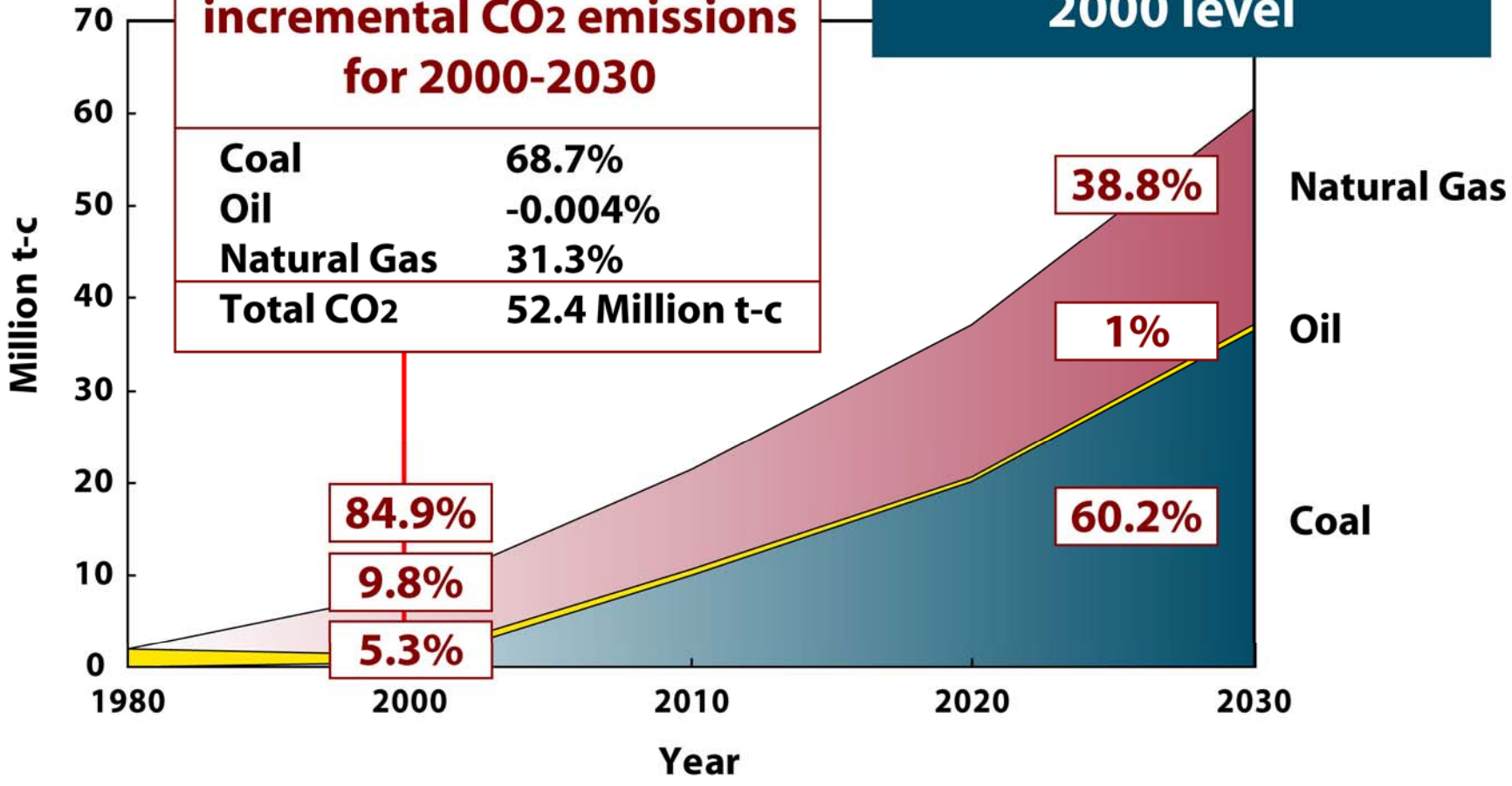
CO_2 Emission from Power Generation

Under BAU Case,

CO_2 emissions in 2030 ⇒ 7.4 times larger than 2000 level

Contribution of incremental CO_2 emissions for 2000-2030

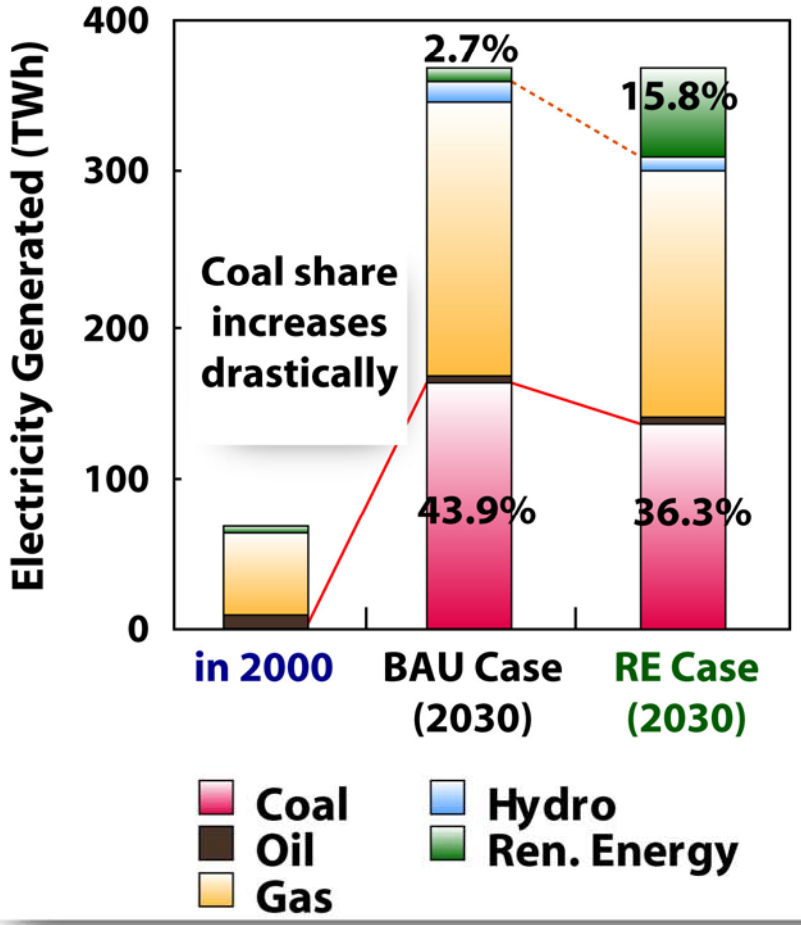
Coal	68.7%
Oil	-0.004%
Natural Gas	31.3%
Total CO_2	52.4 Million t-c

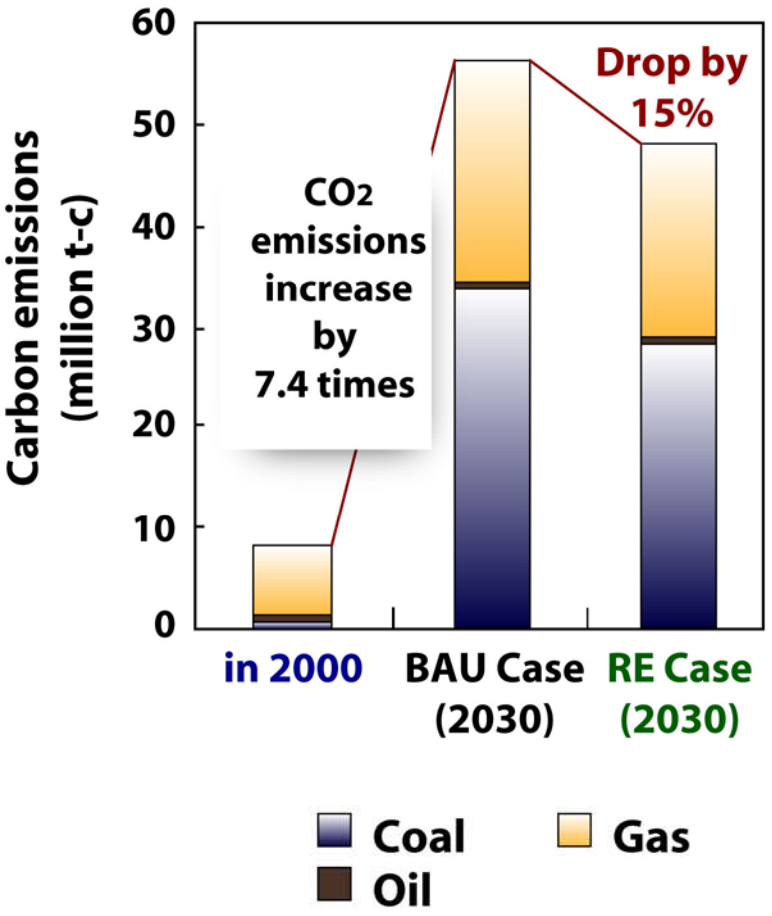


Comparative Scenario : Impacts of RE Utilization

if RE accounted for 15.8% of total electricity generated in 2030

⇒ REDUCE share of Coal & Natural gas, and total CO_2 emissions

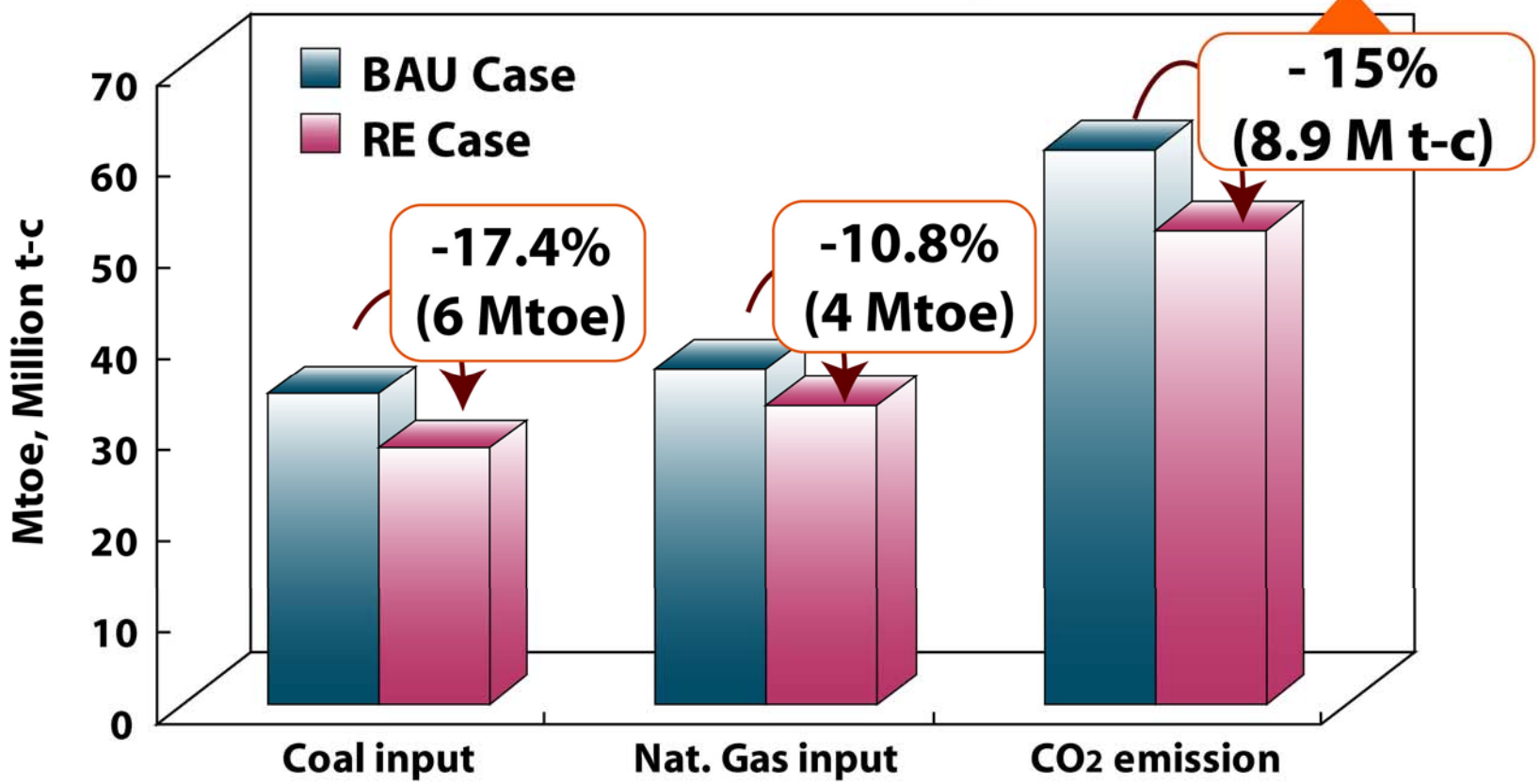




Comparative Scenario : Impacts of RE Utilization

if RE accounted for 15.8% of total electricity generated in 2030

Worth US$205 Million,
based on carbon price of 19 euro/t,
May 2005 CO_2 trading price

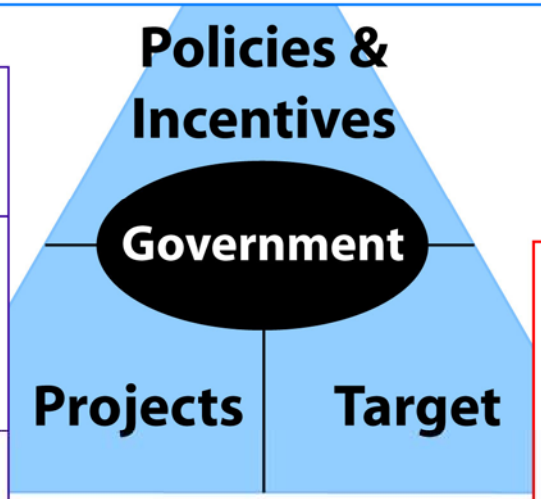


4 RE Development in Malaysia

* Policy framework supporting RE development *

Fifth Fuel Diversification Strategy, 1999

Fiscal incentives, 2000



1. **Small RE Power Progam (SREP), 2001**
2. **UNDP/GEF & Gov of Malaysia co-funded BioGen Project, 2002**
3. **UNDP/GEF & Gov of Malaysia co-funded MBIPV Project, 2005 (planning)**

Share of Grid-connected RE-based electricity

2005 : 5%

2010 : 10%

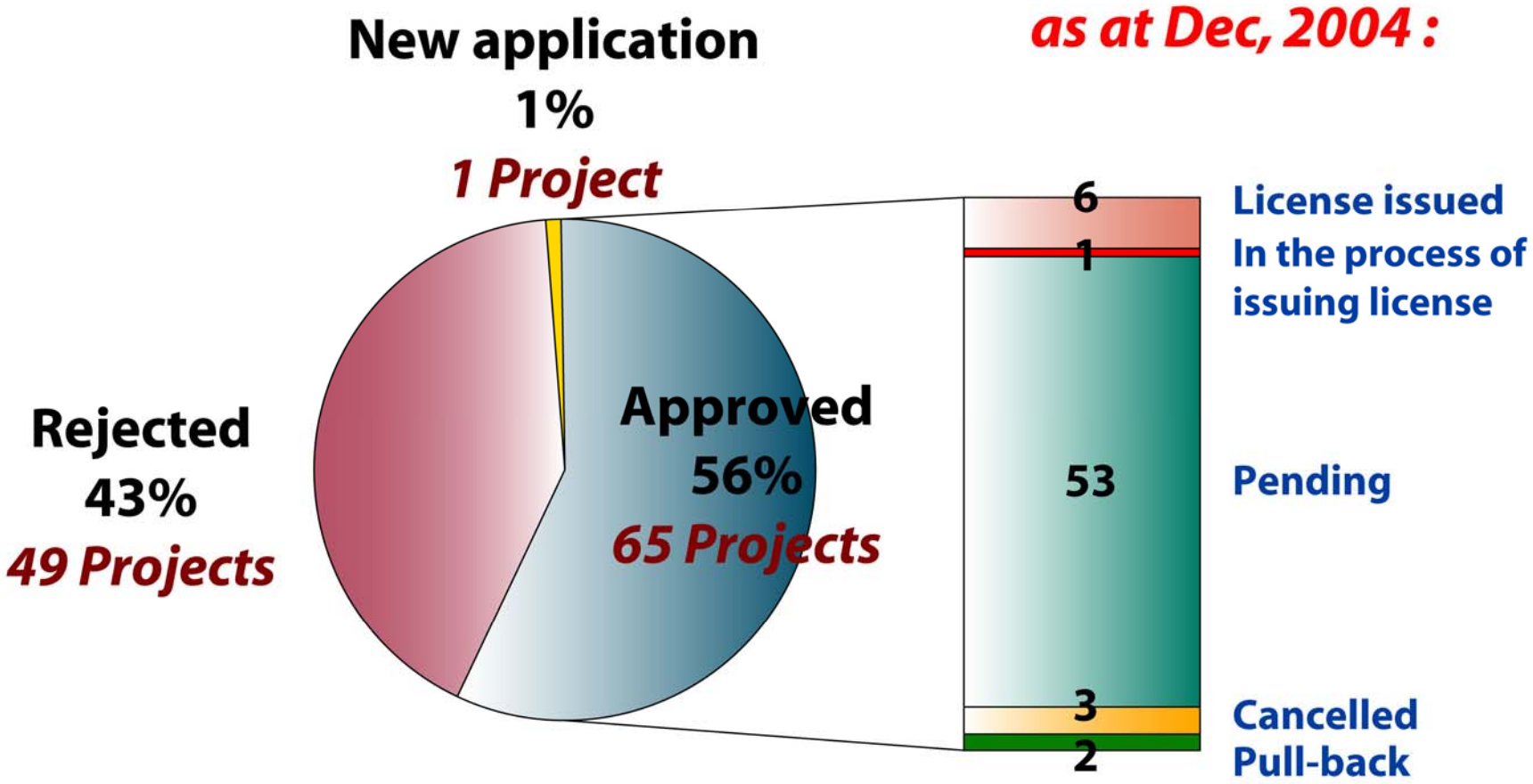
Todate : ONLY 2MW is connected

** equiv. to **0.01%**

of total installed capacity in Malaysia for 2003

Progress : Small RE Power Program

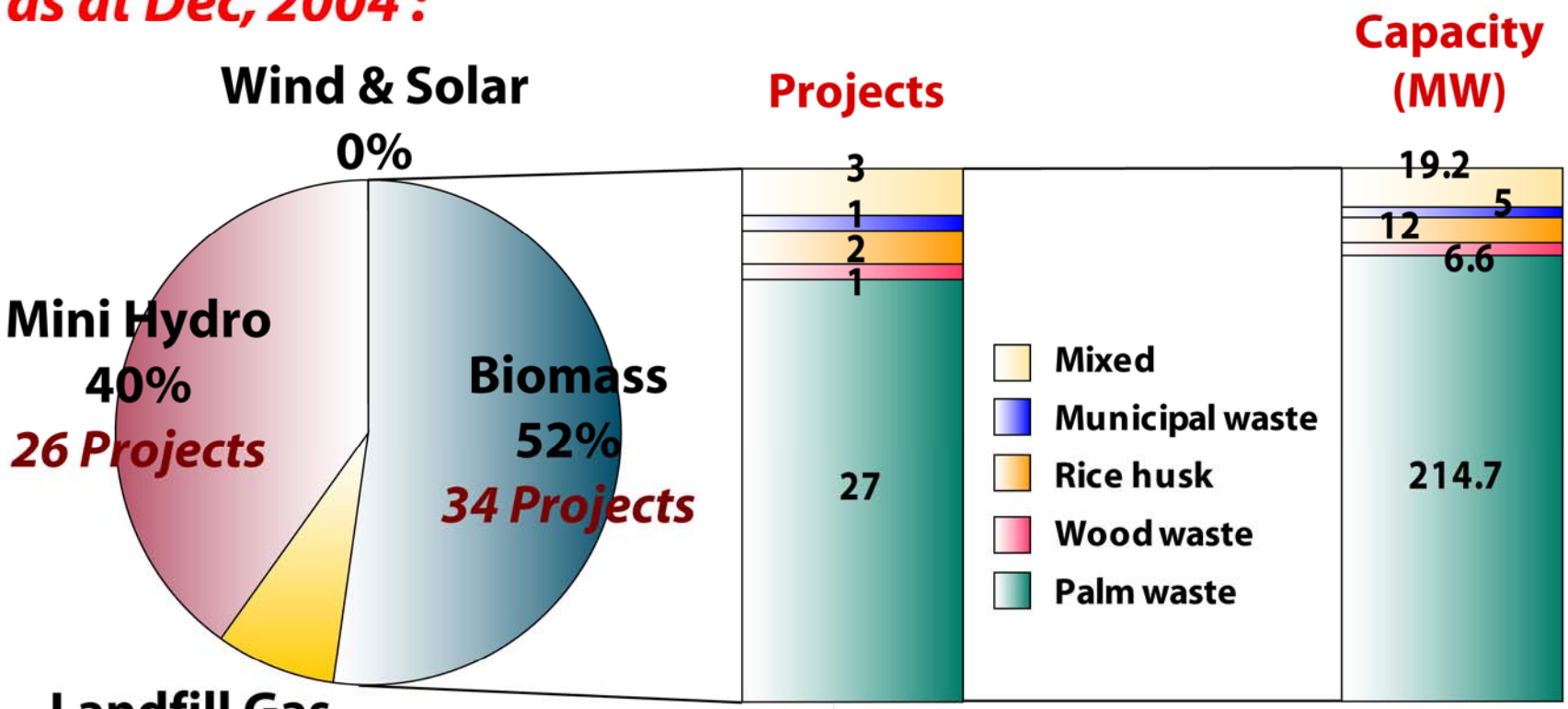
as at Dec, 2004 :



Source : SREP Centre, Energy Commission (Dec 2004)

Approved Project Breakdown by RE Sources

as at Dec, 2004 :



Capacity to be grid-connected : 326 MW

Todate : ONLY 2 MW is connected to grid

** equiv. to 0.01%

of total installed capacity in Malaysia for 2003

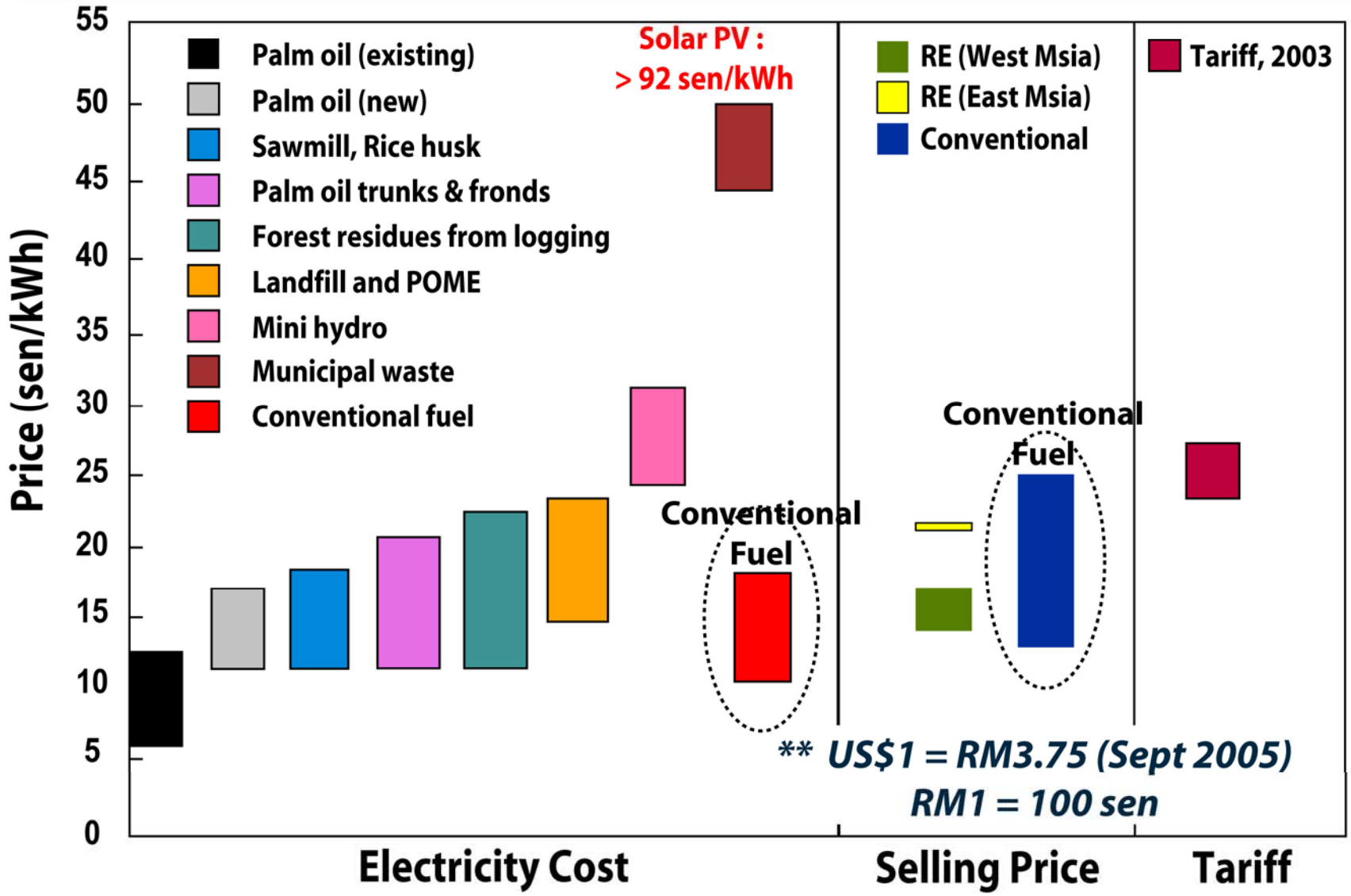
Source : SREP Centre, Energy Commission (Dec 2004)

Issues Inhibiting RE Development

Due to lack of supporting policy framework,

- **High RE electricity cost**
- **Disputes over selling price & terms of RE electricity**
- **Lack of participations from potential developers & palm oil millers**
- **Lack of cooperation from utility company - buyer of RE-based electricity**
- **Lack of a financing scheme to support RE-based power plants**

RE Costs & Selling Price - a comparison



Source : DANCED, 1999; EC, 2003; EC, 2004

Suggestions

"Pricing Law"

~ to govern RE-based electricity access to the market

- also called "feed-in law", "feed-in tariffs"
- selling price of RE-based electricity is fixed & guarantee over a specified period of time.
- prices are generally set higher than the regular market price
  ⇒ internalisation of environmental & socio-economic advantages.
- price may have a direct relationship with cost.
- utility companies are obligated to purchase any RE-electricity generated at this price.
- outstanding examples
  ⇒ wind energy industries in Denmark, Germany & Spain.

Source : International Conference for Renewable Energies, Bonn (2004)

Pricing Law for RE-development in Malaysia

Pricing Law

Government will determine the selling price,
**** amount of CO_2 avoided could be add-on as premium ****
Utility company MUST purchase RE-electricity at this price

- **A minimum selling price is guarantee**
- **Buyer is obligated to purchase**

Problems such as :

~ Financing

~ Lack of investment

~ Unable to sell electricity to the grid

~ Dispute over selling price

could be solved !!!

5 Conclusion

- **Econometric study found :**
  Utilization of Renewable energy for power generation
  ⇒ ***contributes 15.8% in 2030 :***
  Reduce coal input by 17.4%
  Reduce natural gas input by 10.8%
  Reduce CO_2 emissions by 15%

however,

- ***Key obstacle to RE development :***
  Lack of supporting policy framework

- ***Todate : ONLY 2 MW RE-based power plant is connected to grid.***

- ***Implementation of Pricing law is suggested.***

~ Acknowledgement ~

Deepest gratitude to :

* *21st Century COE Program, NUT*
* *Institute of Energy Economics, JAPAN*
* *Malaysia Energy Center &*
* *related institutions*
* *my supervisor : A.Prof. LI Zhi Dong*
  co-supervisor : Prof. Hideki HARADA
  A.Prof. Akiyoshi OHASHI

Spare

Selling Price

Comparison between RE and conventional power plants

Itinery	RE-based power plants	Conventional power plants
Selling price range	14-17 sen/kWh (Peninsular Malaysia), 21 sen/kWh (Sabah) ~ due to regional differing tariff structure	12- 25 sen/kWh
Selling price terms	fixed rate at point of contract and throughout contracting period	subject to review at 4 year interval
Selling price determination mechanism	negotiation between seller and buyer	government negotiates and awards power plant projects directly to the power plant developers
Payment mechanism	"Take and Pay" - paid based on the amount of electricity provided	"Take or Pay" - paid a fixed amount
Electricity export to the grid	maximum at 10 MW	no limitation
Connection point to the grid	at Distribution point	at Transmission point
Connection cost	both seller and buyer bear each connection cost up to the nearest connecting point	n.a.

terms & abbr.

sen : Malaysia currency 100 sen = ￥28

Examples of Equation

Definitional equation

Total Oil Consumption of Malaysia (PDOI.MYS)

$$f(PUOI.MYS + INOI.MYS + ROOI.MYS + NTOI.MYS + OTOI.MYS + NNOI.MYS)$$

(oil consumption by power generation sector, industrial sector, road transport, residential and commercial sector and etc.)

Econometrically estimated equation

Oil Demand by Road Transport (ROOI.MYS)

Econometrically estimated using time series data from 1971-2001, with the following variables :

**** Car ownership * Gasoline price***

= 714.512+1.89994*(CAR-CARCNG.MYS)
-10647.3*(PGSL.MYS/CPI.MYS)-883.106*(DUM98)

Checking for Equation's Conformity

Oil Demand by Road Transport (ROOI.MYS)

= 714.512+1.89994(CAR-CARCNG.MYS)*
-10647.3(PGSL.MYS/CPI.MYS)-883.106*(DUM98)*

t-value (7.64) (84.24) (-1.46) (-4.37)
Orrcut (1971-2001) R^2=.996 SD =188.9989 DW = 2.027

Check the equations based on :

- **t-value** : explanatory ability of variable, higher better
- **R^2** : percentage of equations explained by the variables, closer to 1 better
- **SD** : standard deviation
- **DW** : Durbin-Watson statistics ~ closer to 2 means no correlation between variables
- **+/- sign** : must reflect the relationship between variables

Assumptions

Common assumptions for macroeconomic simulation :

Variables (growth rate)	1980-2000	2000-2010	2010-2020	2020-2030
Population	2.7%	2.3%	2.0%	1.8%
Government Consumption	6.5%	7.4%	5.5%	5.5%
Government Investment	8.1%	6.7%	4.2%	4.2%
World Trade	5.7%	3.5%	4.5%	4.5%
Variables (level)	**2000**	**2010**	**2020**	**2030**
Exchange Rate (RM/$)	RM3.8	RM3.8	RM3.8	RM3.8
Crude Oil Price ($/BBL)	$28.2	$30.0	$40.0	$53.2

Assumptions

Common assumptions for energy-environment simulation :

Variables	2000	2030
Thermal efficiency in power generation (%)		
Oil-fired	45	45
Natural gas-fired	43	47
Coal-fired	39	45
Electricity generated from Renewable energy-based power plants (TWh)		
BAU Case	0	10.8
RE Case	0	63.5

Existing and Planned Coal-fired Power Plant

Plant	Capacity (MW)	In operation/ Completion	Coal Utilization (mtpa)
TNB Kapar Ph. 2	600	In operation	1.5
TNB Kapar Ph. 3	1,000	In operation	2.5
IPP- Sejingkat	100	In operation	0.3
TNB Janamanjung	2,100	2004/05	6.0
IPP- SKS	2,100	2005/06	5.7
IPP- Jimah	1,400	2005/06	3.5
TOTAL	7,200		19.5

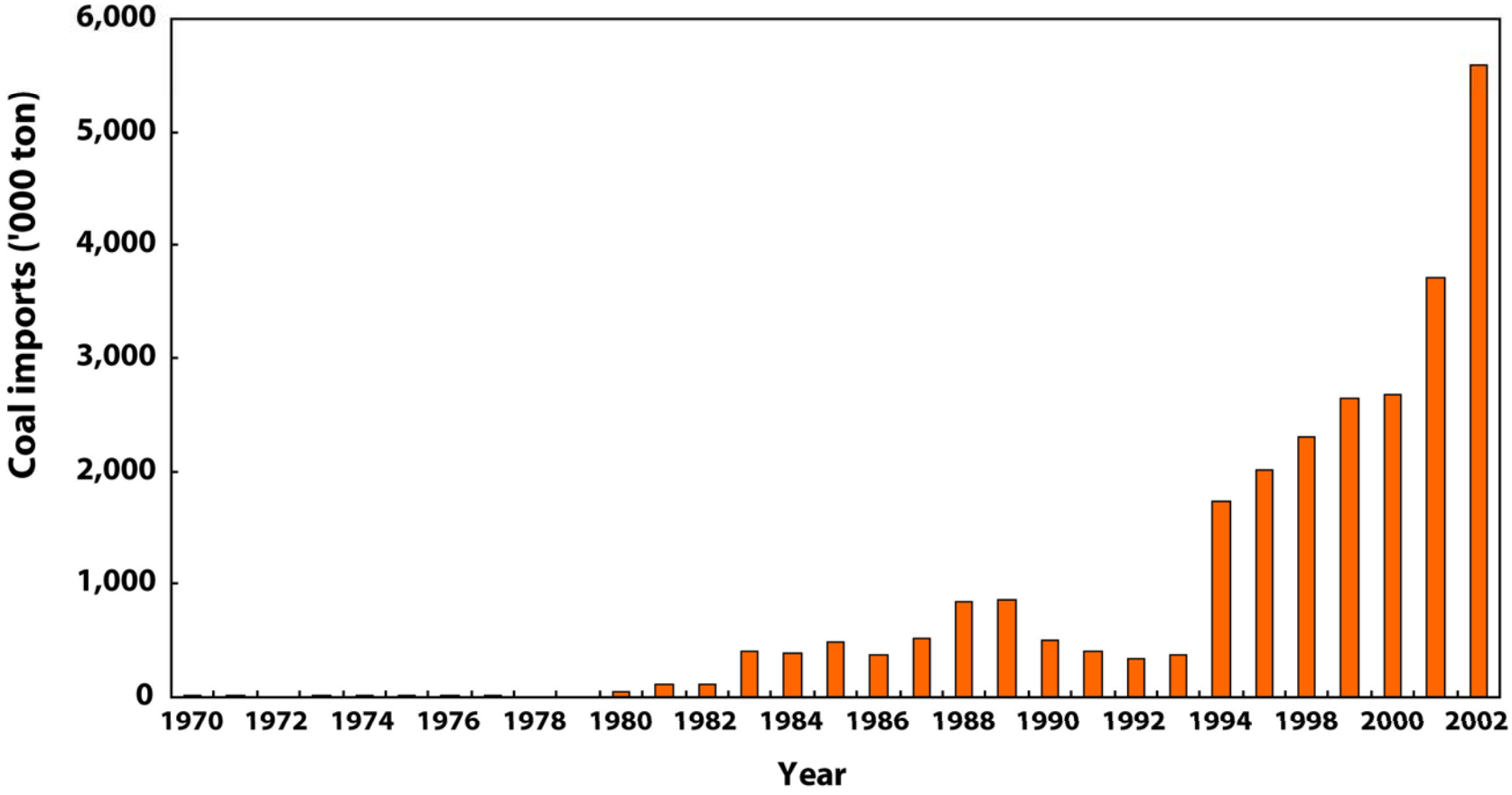
- almost all local coal consumed have been imported
  ~ Australia (60%), Indonesia (30%), China (5%), South Africa (5%)
- this will increase future coal imports

mtpa : million ton per annum

Source : M. Zainal b. Azirun., (2002)

Trends of Coal Import

Imported from : Australia (60%), Indonesia (30%), China (5%), South Africa (5%)



Source : Ademe and BCEOM (1996)., ADB (2003)

Palm Biomass Profile

Waste	Form	Quantity (ton/mt of FFB)	Moisture content (%)	Energy value (kcal/kg), (kcal/m3)	Current Use	
					Mill with plantation	Mill without plantation
EFB	Solid	0.23	40	2,507	Fertilizer	Sell/export as fertilizer, pulp & paper, particleboard
Fibers	Solid	0.15	38	4,418	Boiler fuel	Boiler fuel
Shell	Solid	0.07	18	4,943	Boiler fuel	Boiler fuel
POME	Liquid	0.67	-	-	Fertilizer	None
POME Biogas	Gas	28 m3/m3 of POME	-	4,740	None	None
Trunk & Fronds At Replanting*	Solid	8.3 million tons/year	dry	3,585	Fertilizer	None
Trunk and Fronds At Pruning	Solid	10.4 ton/hectare/year	dry	3,585	Fertilizer	None

Note :

* based on a density of 126 palm (85%) of the original stand of 148 palms/hetares, and assuming 3% is replanted annually, average dry weight of a palm trunk is estimated at about 600kg

Reference :

DANCED (1999); Hasan I. et al., (2002); Personnel communication with Energy Commission (2004)

6 Licensed SREP Projects

RE-based power plants	Fuel	Capacity (MW)	Selling Price (sen/kWh)
Jana Landfill Sdn. Bhd	Landfill Gas	2	16.50
TSH Bio Energy Sdn Bhd	palm oil waste	14	21.25
Bumibiopower Sdn Bhd	palm oil waste	6	16.70
Sunquest Sdn Bhd	palm oil waste	6.6	16.70
Recycle Energy Sdn Bhd	Landfill Gas	5	17.00
Naluri Ventures Sdn Bhd	palm oil waste	9	17.00
Conventional power plants	**Technology**	**Capacity (MW)**	**Selling Price (sen/kWh)**
Segari Energy Ventures	CCGT	1,303	15.50
YTL Power	OCGT, CCGT	1,212	15.05
Genting Sanyen Power	OCGT, CCGT	720	13.70
Port Dickson Power	OCGT	440	25.02
Powertek	OCGT	440	25.02
Janamanjung	Thermal	2,100	12.20

note : US$1=RM3.8 as at Jan 2005

What is REPPA

REPPA (Renewable Energy Purchase Agreement)

a CONTRACT defines the Terms and Conditions for the Supply and Purchase of Electrical Power between the Producer and Purchaser

a commitment by the producer to make dependable capacity available and commitment by the purchaser to purchase

Key terms of REPPA :

① Term/duration of the Agreement
② Price structure
③ Price level
④ Dispatchability
⑤ Billing and payments
⑥ Damage and penalties ... etc

Malaysia's Oil Palm Industry

Region	No of Mills	Capacity (ton of FFB/year)	Plantation Area (hectares)
Peninsular Malaysia	263	51,639,520	2,202,166
Sabah	109	24,005,000	1,135,100
Sarawak	38	6,912,400	464,774
TOTAL	410	82,556,920	3,802,040

Reference :
MPOB (2003) Malaysia Oil Palm Statistics

Power Requirements :

	Mill Capacity (ton FFB/year)				
	20	30	40	50	60
Power consumed (kWh/ton of FFB per hour	27.5	23.3	20	18	16.7

Reference : Nicholas Lim B.H. CSI Project Management Services Sdn Bhd. (2002) Power Generation from Palm Oil Mill Design Options and Costing, National Seminar On Palm Oil Milling, Refining Technology, Quality and Environment

Palm Oil Biomass Energy and Non-Energy Usage

Usage	Goods	Value	Annual usage (Dry EFB ton/year)	Remarks
Energy	Electricity	21.40 sen/kWh	vary by mill capacity, palm biomass & efficiency	average tariff for industrial sector as at 2000
Non-Energy	Fertilizer/Composting	RM11.47 per ton	3,290,000	equivalent value of inorganic fertilizer used as at Dec 2002
		RM10-20 per ton	n.a.	export to China
	Particleboard	n.a	3,000	producing ±2,400m3/annum
	Pulp & paper	US$800/t	615,000	Nil
	Sell to other industries as fuel	n.a	n.a	Nil
	Animal feed	RM330/ton	n.a	local market
		RM400/ton	n.a	export market
	Pellets	RM400~450/ton	2,500	export market (China)
	Fibre bales for export	n.a	n.a	
	Mulch mat/eco-mat for erosion contro	n.a	36,000	used by young palm due to its good nutrient content, soil improvement & biodegradability.However, current demand is small
	Car components	n.a	1,000	trial stage, will be commercialized soon
	Medium density fibre board	n.a	75,000	commercialized, using 90% rubber-wood and 10% EFB, currently has a total production capability of 556,800 ton/year

Reference : DEGS (2000); N.Ravi M. et al., (2003); EC (2004); MEC (2003); Yusof B. et al., (2000)

Why Millers are not interested to connect to Grid

- **Enjoying good profit from palm crude oil (highest selling price : RM2200/ton)**

- **Current power supply system**
  - ⇒ **self sufficient**
  - ⇒ **dispose off excess waste such as EFB without violating the law as emission from power generation activity does not violate Clean Air Act 1974**

Why Millers are not interested to connect to Grid

- **Additional investment** to connect to grid, where developer pays connection cost up to the nearest connecting point (RM 225 per m_1 ; RM150 per m_2)
- **Additional investment to upgrade** existing power generation facilities ~ PTM study : RM5M/MW
- Palm biomass (Empty Fruit Bunh, EFB) has **other competitive usage** & good market value

Reference

1 Nicholas Lim B.H. (2002); 2 DANCED (1999)

Why Miller are not interested to connect to Grid

- Unfavorable selling price ⇒ low return (demand above 17 sen/kWh)
- Unfavorable REPPA & selling price terms
- Financing diffculties
- 10 MW cap export capacity per power plant ~ unecoomic as excess palm biomass capacity could very likely above this

RE Power Plant Developer

- Requires the establishment of new power plant
- Unable to obtain financing
- Unable to sign REPPA contract ~ selling price
- Site procurement
- Unable to sign long-term palm biomass supply contract with palm oil plantation
- Requires selling price above 20 sen/kWh to attract new investment

Utility Company

- **Sole buyer** ~ strong bargaining power
- **Excess reserves margin** as at 2003

Company	Ins. Cap	Reserve Margin
① TNB	17,015MW	48.4%
② SESB	678MW	43.6%

- **Previous power purchase agreement** with Independent Power Producers (IPP) of conventional power plants

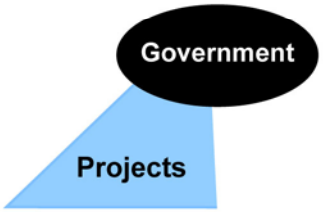
Note

TNB serves the electricity demand in Peninsular Malaysia on top of IPP
SESB serves the electricity demand in Sabah on top of IPP

Financial Institutions

- **Low confidence** toward RE-technologies, still taking "wait & see" attitude
- **No available example** to proof the viability of RE-power plant
- Only willing to **assess RE-projects as other investment projects**
- **No specialized financing scheme** to support RE-development
- Might related to **selling price**

SREP



SREP : Small Renewable Energy Program

Background :

① launched 11 May 2001 by Ministry of Energy, Communication & Multimedia

② Applies to ALL TYPES of renewable energy

③ Implemented in Peninsular Malaysia & Sabah only*

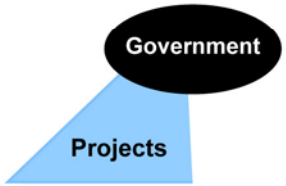
④ Based on the concept of selling electricity to utilities co. through national distribution grid based on REPA

Note :

* due to different jurisdiction, electricity industry in Sarawak is under the jurisdiction of Sarawak Government

Source : MECM (2004)

BioGen



BioGen = Biomass-based Power Generation and Cogeneration in Palm Oil industry

Between : UNDP/GEF and Government of Malaysia

Objective :

~ To reduce GHG emissions from fossil fuel fired combustion

~ Utilize biomass waste

Reasons :

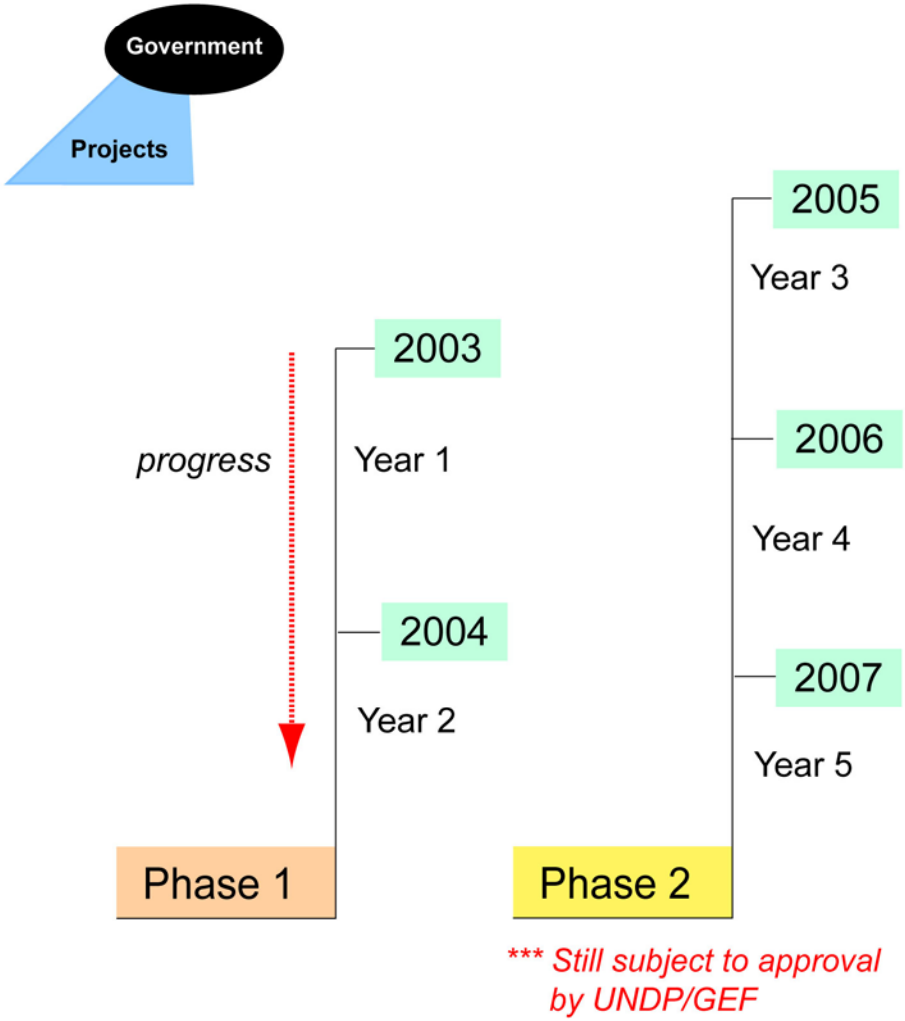
Energy sector is the major source of GHG emissions

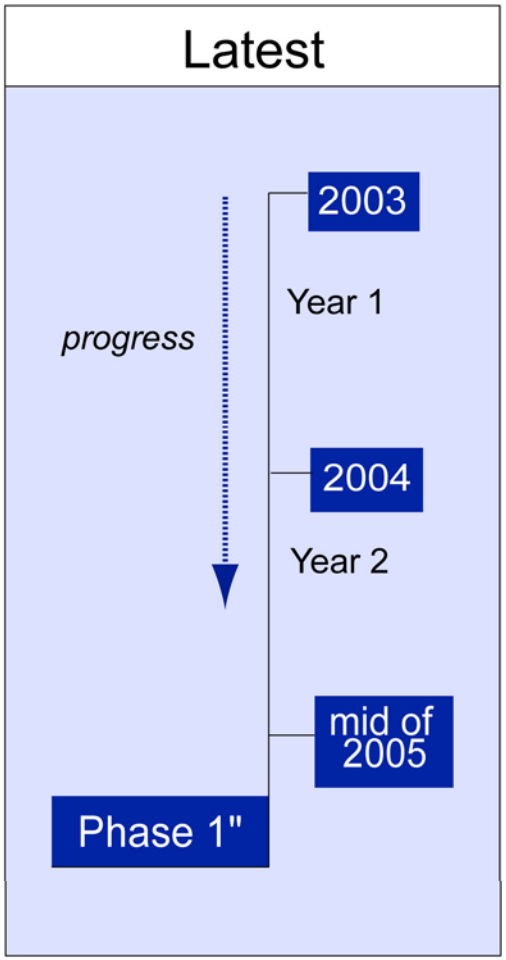
Develop a sustainable energy supply replacing fossil fuel-based electricity generation

Implementing institution :

PTM

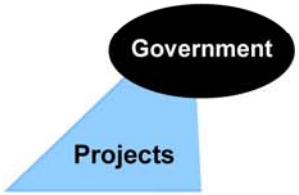
BioGen





Source : MEC (2004)

BioGen



Project Financial :

US$	Phase 1		Phase 2	
UNDP/GEF	4,000,000	27.15%	4,032,000	15.13%
Co-financing :				
Government of Malaysia	3,830,420	26.00%	6,851,820	26.00%
Private sector	6,903,770	46.83%	15,559,950	58.84%
TOTAL	**14,734,190**	**100.00%**	**26,443,770**	**100.00%**