Biofuel Policies, Regulations, Strategies for Sustainable Development in Malaysia

Presenter

Professor Dr. Masjuki Hj. Hassan

Centre for Energy Sciences

Department of Mechanical Engineering

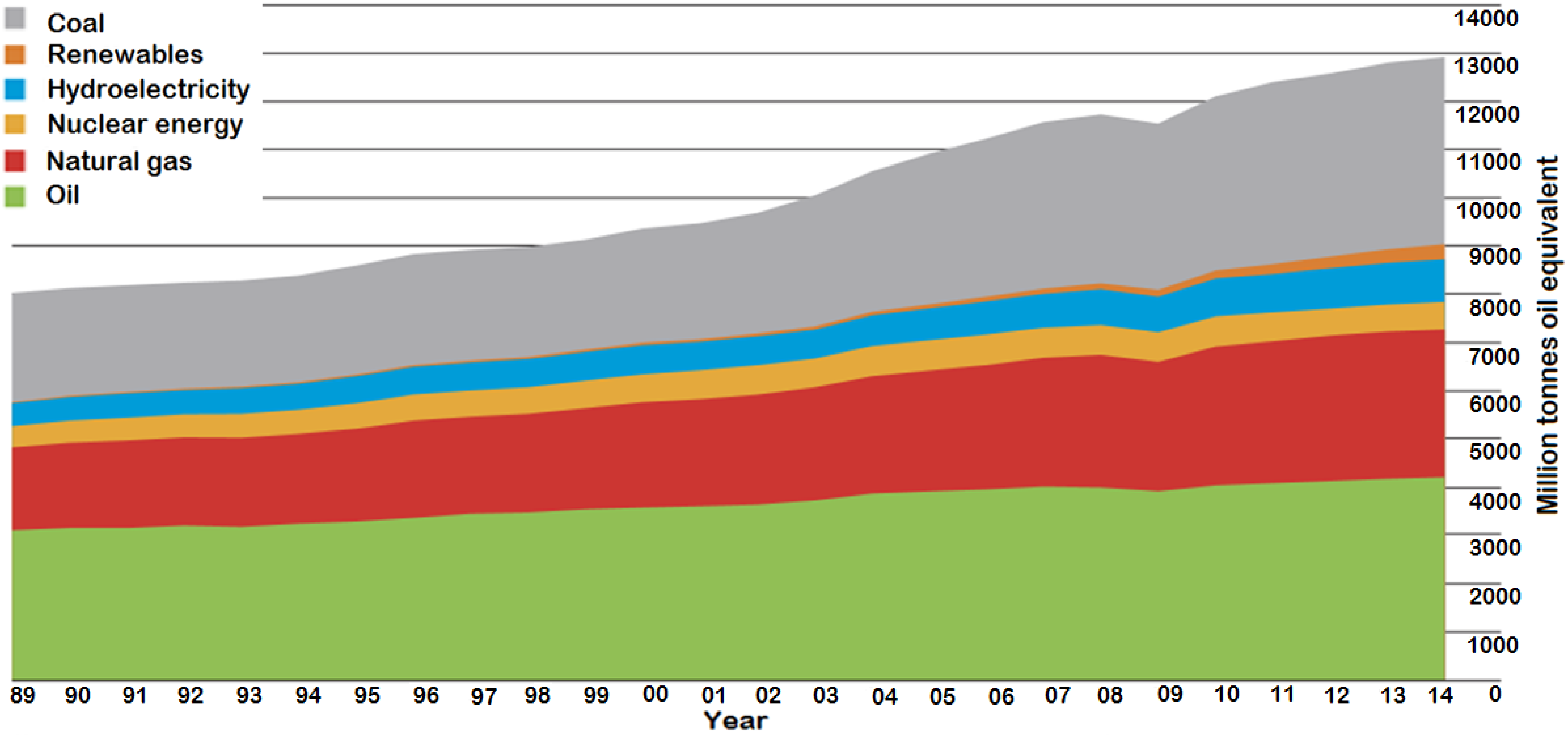
Faculty of Engineering

University of Malaya

Kuala Lumpur, Malaysia

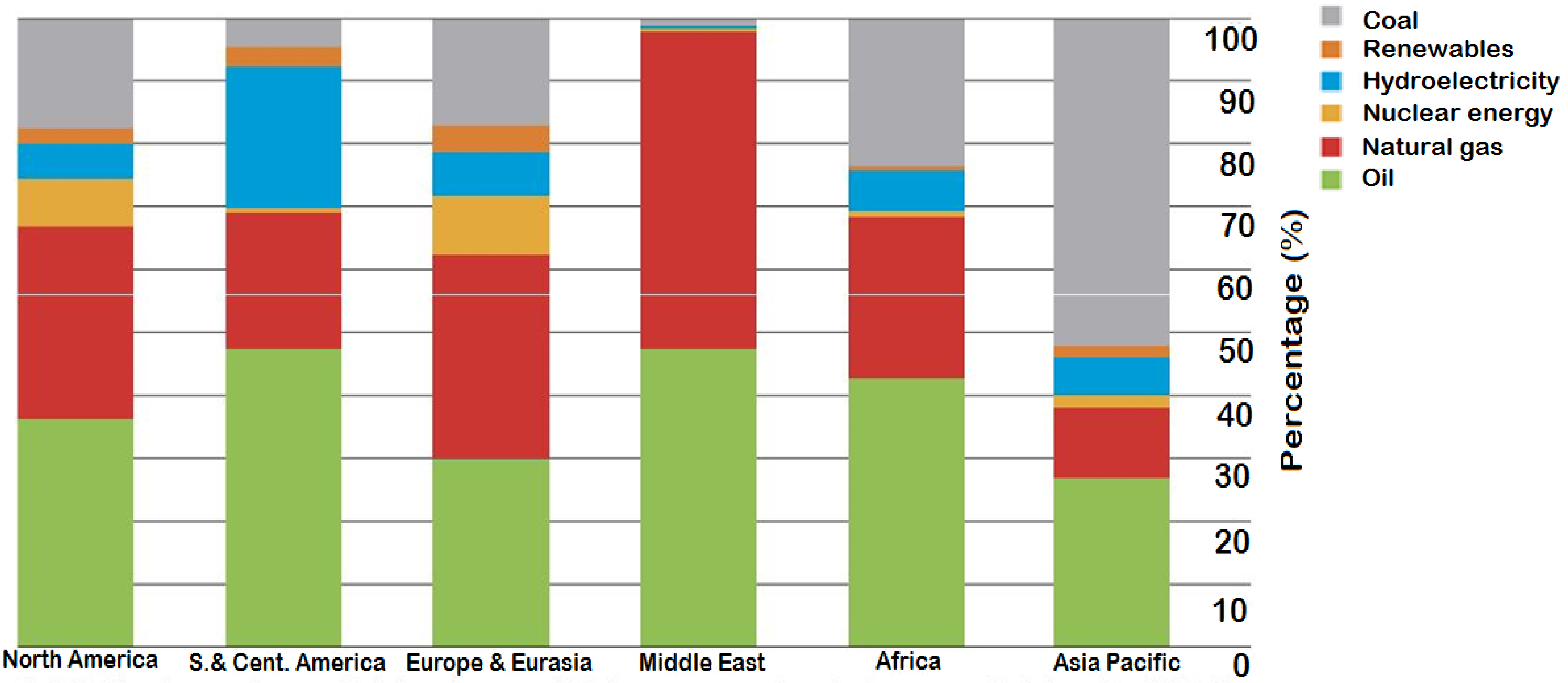
UNIVERSITI MALAYA
KUALA LUMPUR

World energy consumption



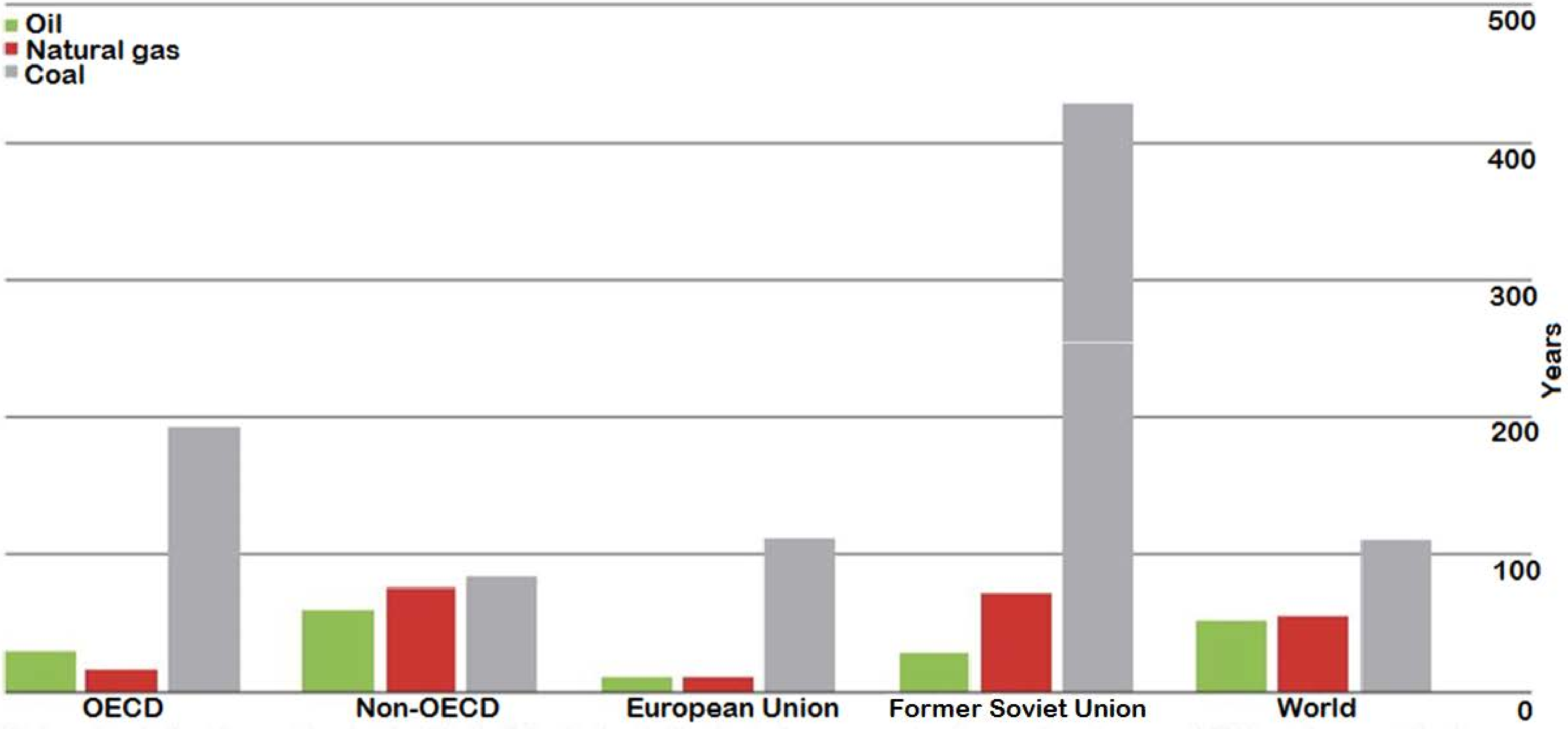
BP Statistical Review of World Energy June 2015 *bp.com/statisticalreview*

Regional consumption pattern



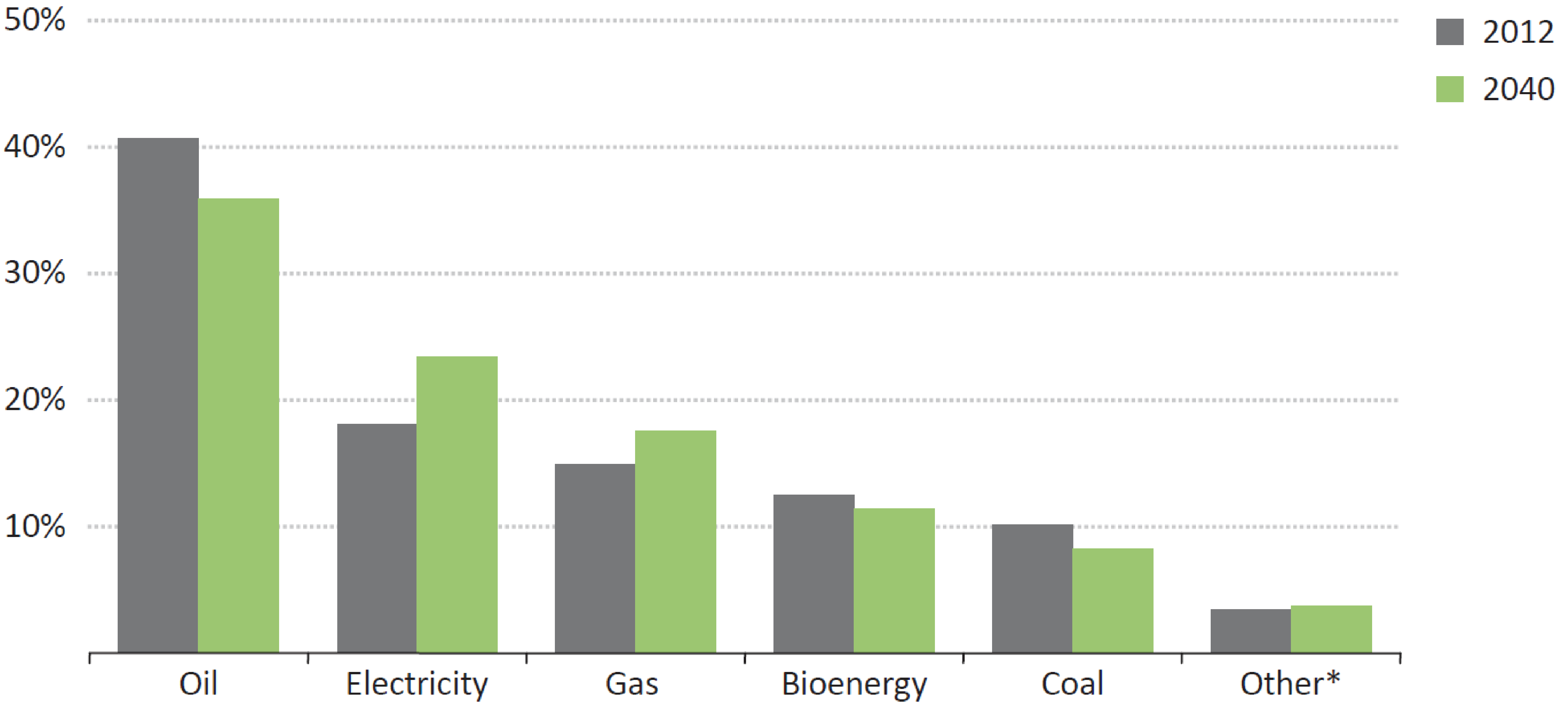
BP Statistical Review of World Energy June 2015 *bp.com/statisticalreview*

Fossil fuel reserves to production (R/P) ratios at end 2014



BP Statistical Review of World Energy June 2015 *bp.com/statisticalreview*

Fuel shares in global final energy consumption

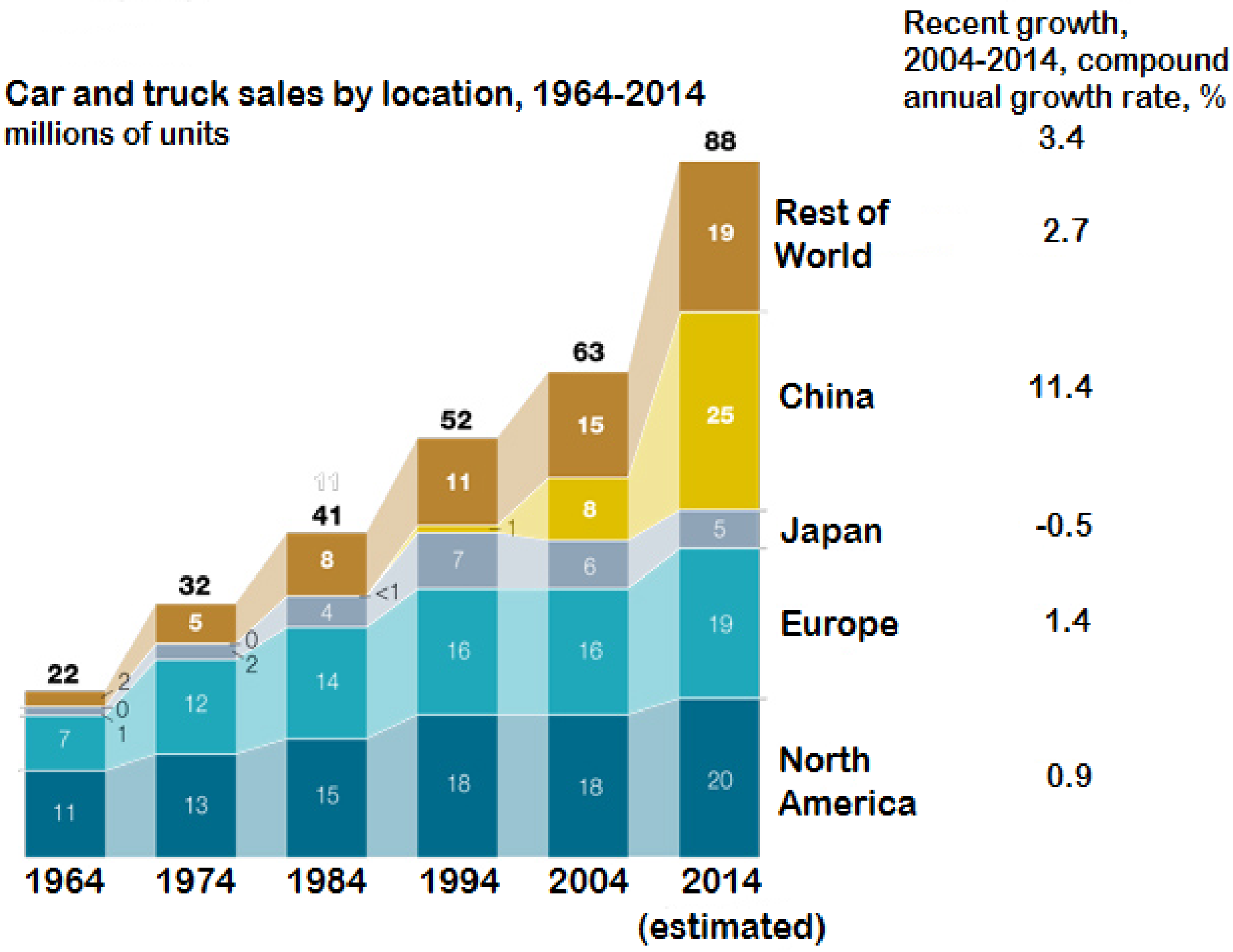


* Includes heat and renewables except bioenergy.

Source: OECD/IEA, 2014, World Energy Outlook 2014

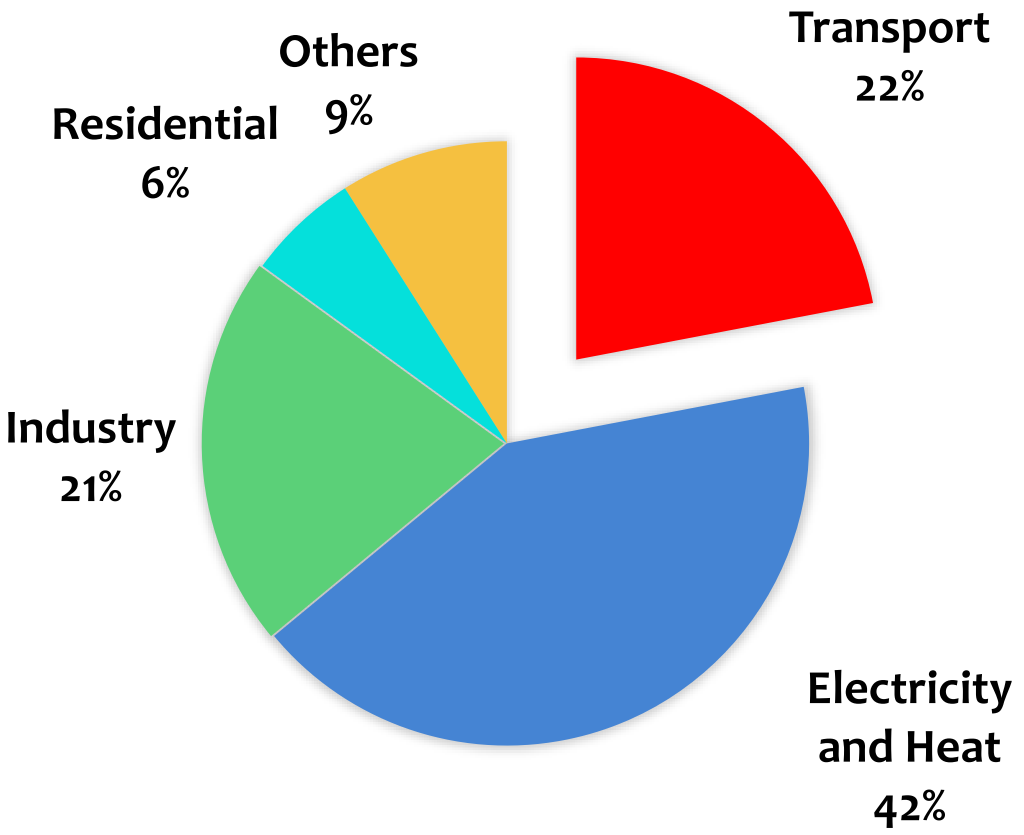
Worldwide vehicle sales and CO_2 emission

Worldwide vehicle sales (1964-2014)



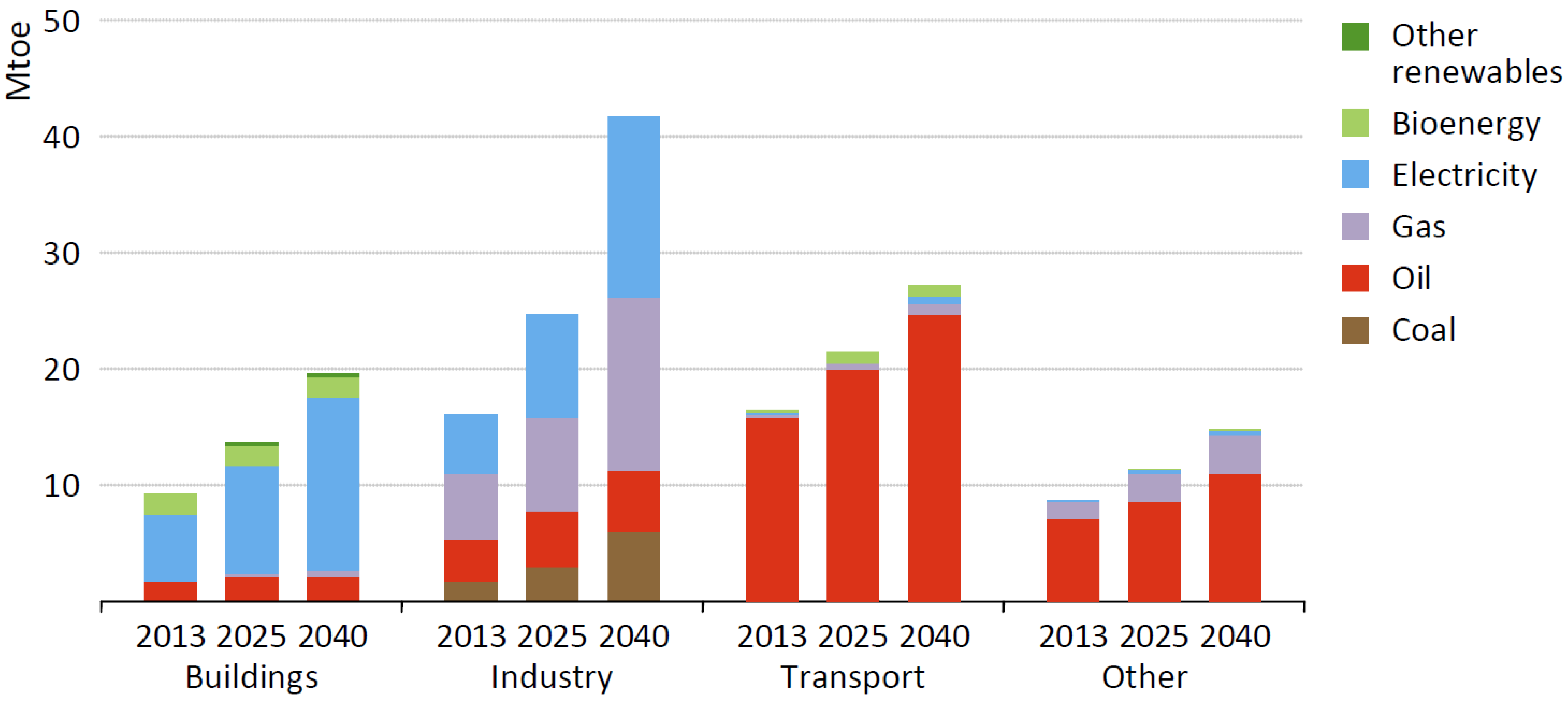
Source: IHS Automotive/Polk; Ward's Auto InfoBank; McKinsey analysis

World CO_2 emission by sector



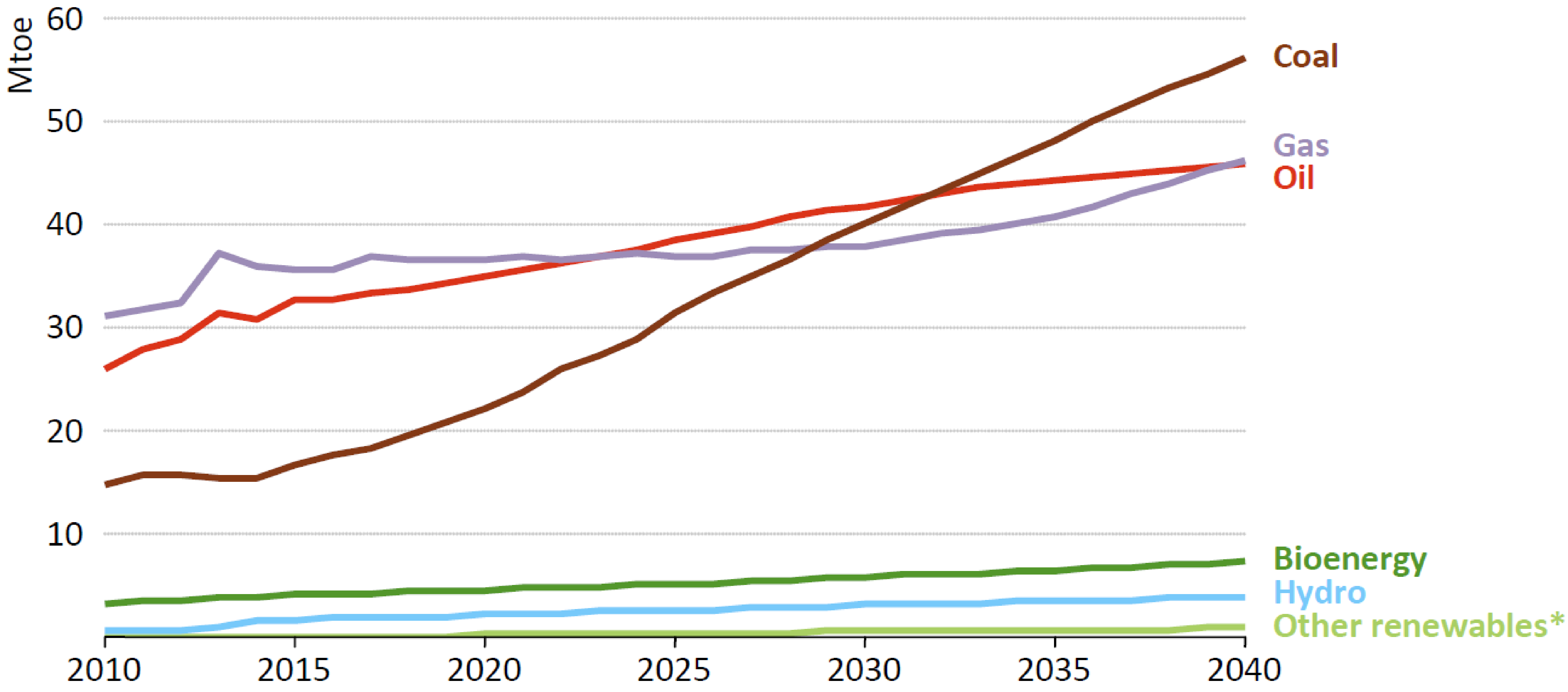
Source: CO_2 emission from fuel combustions highlights

Total final energy consumption by fuel in Malaysia



Source: OECD/IEA, 2015, *World Energy Outlook, www.worldenergyoutlook.org*.

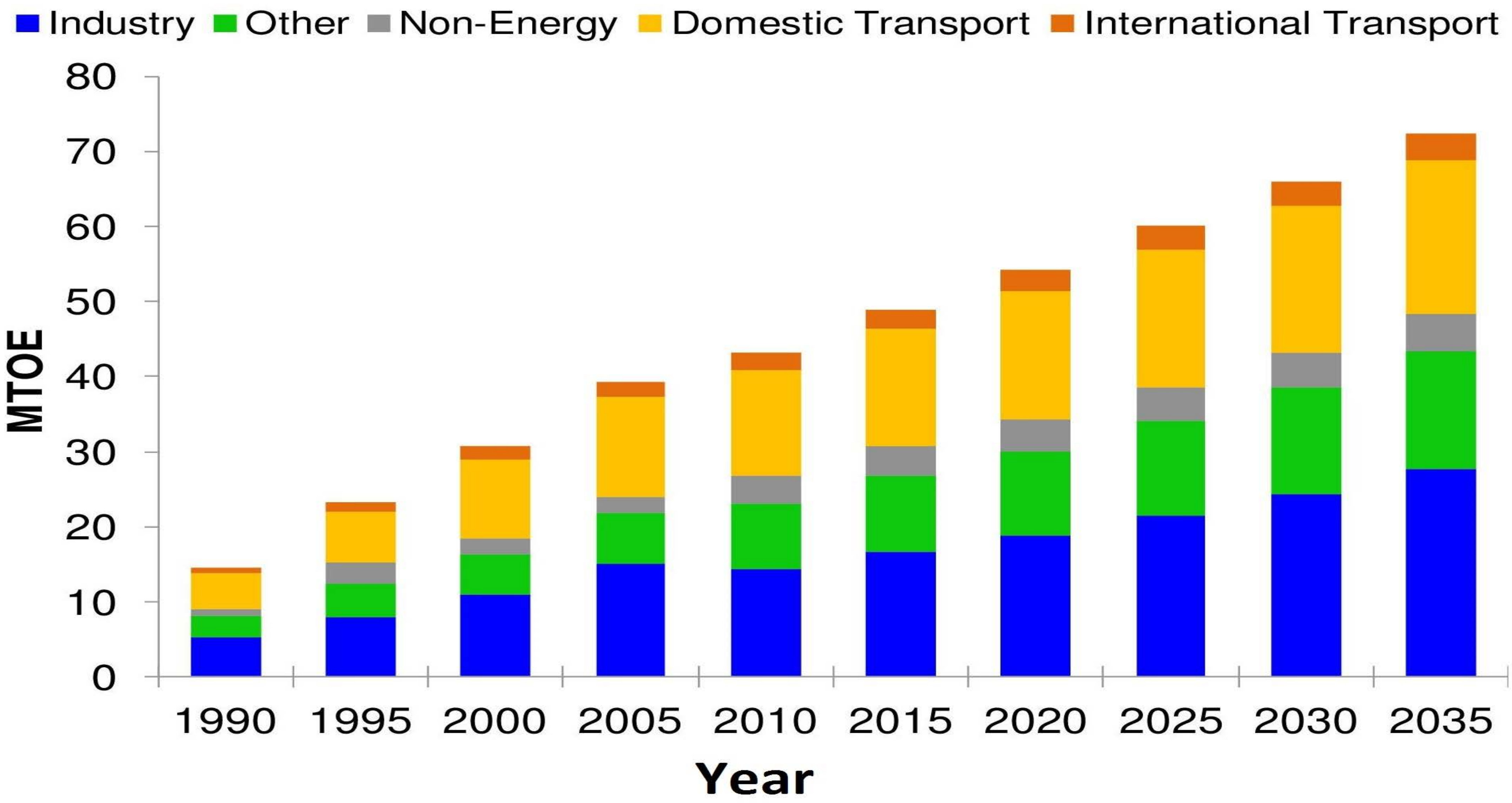
Primary energy demand by fuel in Malaysia, 2010-2040



*Includes solar PV and wind.

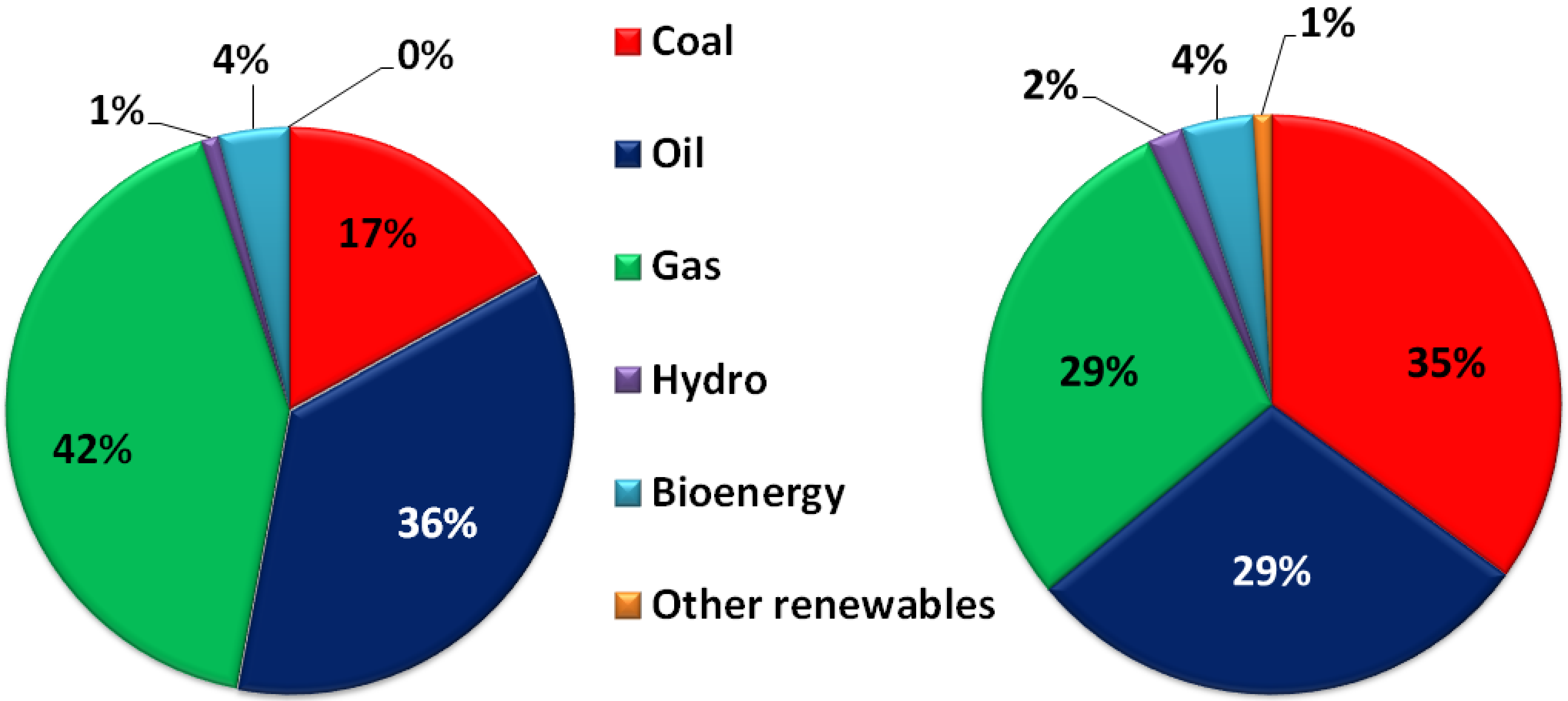
Source: OECD/IEA, 2015, *World Energy Outlook*, *www.worldenergyoutlook.org*.

Malaysia energy demand by sectors



Source: MALAYSIA ENERGY STATISTICS HANDBOOK, 2014, http://meih.st.gov.my/documents/10620/adcd3a01-1643-4c72-bbd7-9bb649b206ee

Fuel shares in primary energy demand in Malaysia

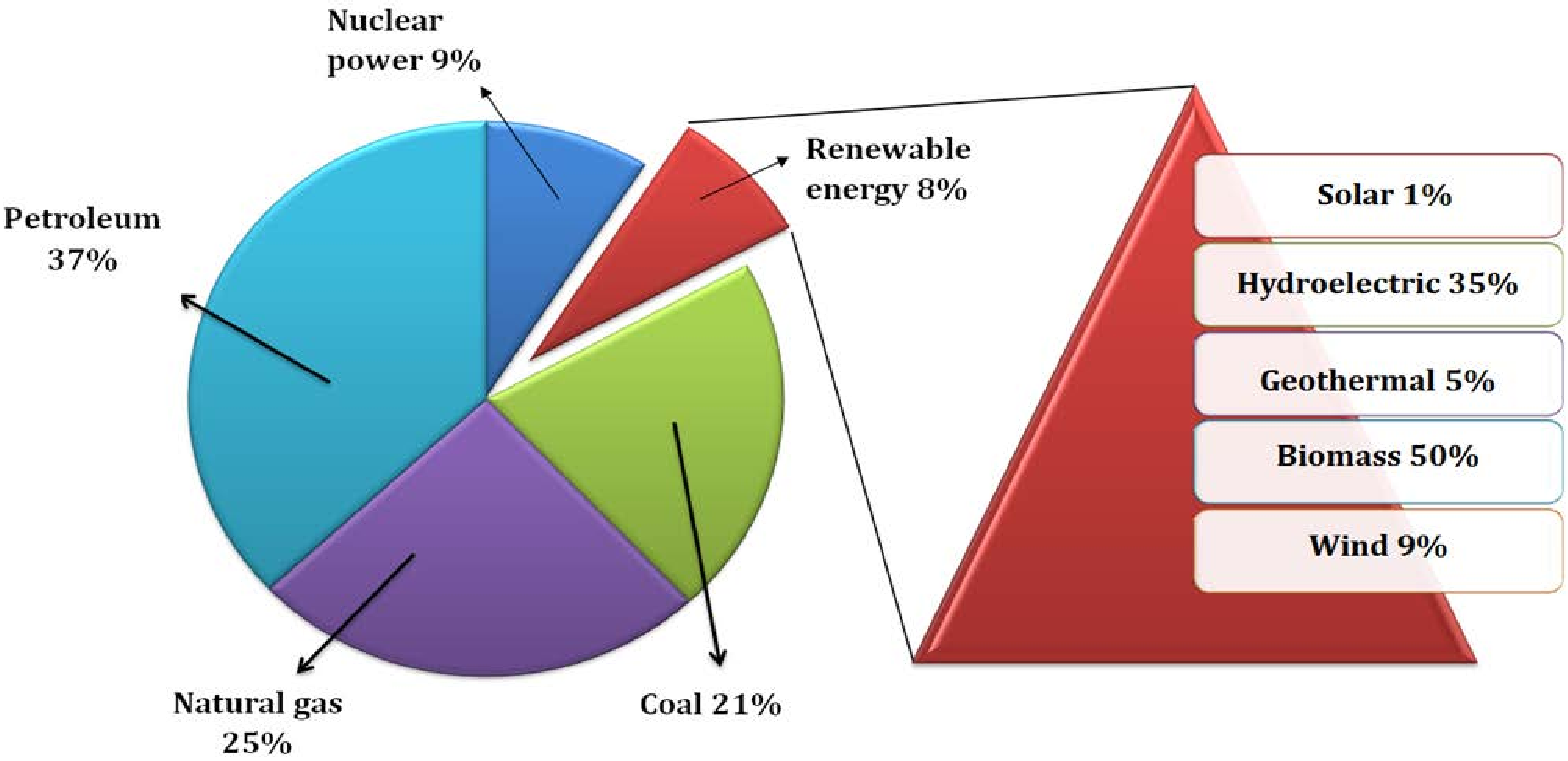


2013: Total 89 Mtoe

2040: Total 160 Mtoe

Source: OECD/IEA, 2015, *World Energy Outlook*, *www.worldenergyoutlook.org*.

Malaysia renewable energy shares in 2015



Source: https://www.eia.gov/beta/international/analysis.cfm?iso=MYS

Energy security in Malaysia

Energy Crisis is Economic Crisis

- Growing Economy, Growing Consumption of Energy

Ever-growing demand vs. low supply

- Raising Gap between Demand and Supply of Oil

Petro-dependency

- Energy-consuming Structure

Alternatives to Short Supply of Oil

- Renewable Energy

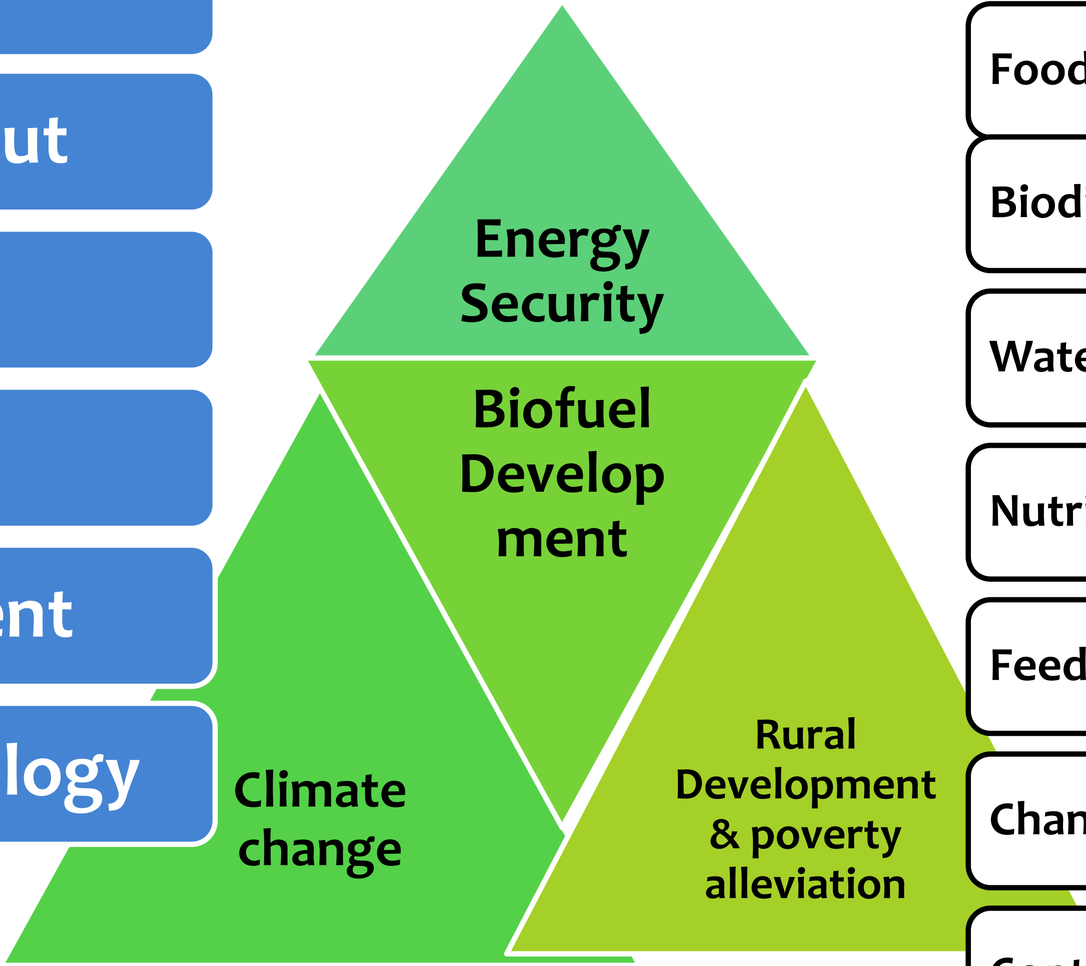
Regional Cooperation and/or Competition

- Petro-diplomacy

Courtesy: Won-Ho Kim, Director, KIEP

Factors of biofuel development in Malaysia

- Renewable
- Net Energy Output
- GHG reduction
- Job Creation
- Rural development
- Conversion Technology



- Food security
- Biodiversity
- Water Resource
- Nutrient and pesticides
- Feedstock and soil
- Change in land use
- Contamination and air quality

Main challenges of biofuels In Malaysia

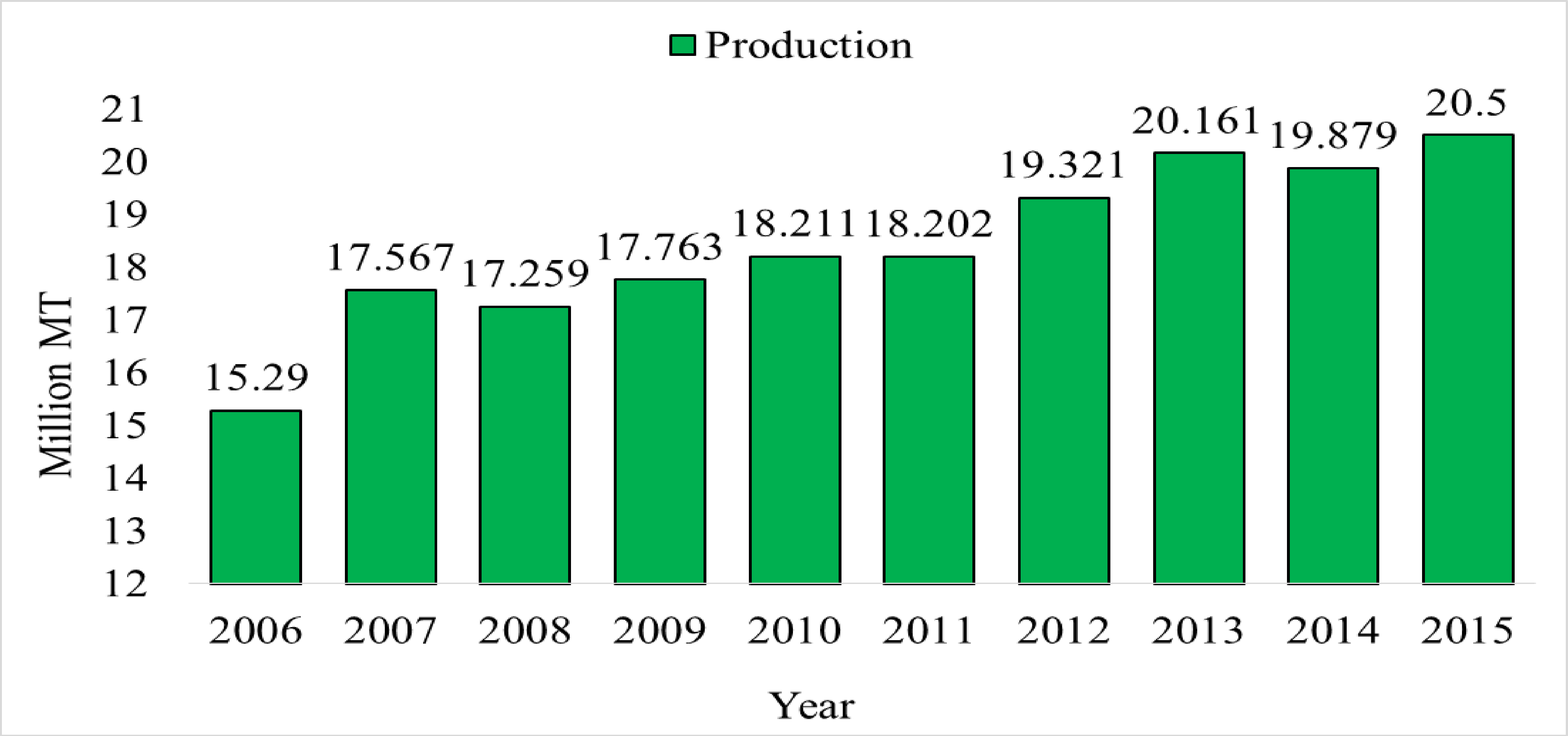
- Supply cost
- Supply volume
- Dependency on specific feedstocks
- Compete with food
- Technology
- Infrastructure
- Policy
- Public acceptance

Biodiesel Standards In Malaysia

Source: MPOB, http://www.palmoilworld.org/biodiesel.html

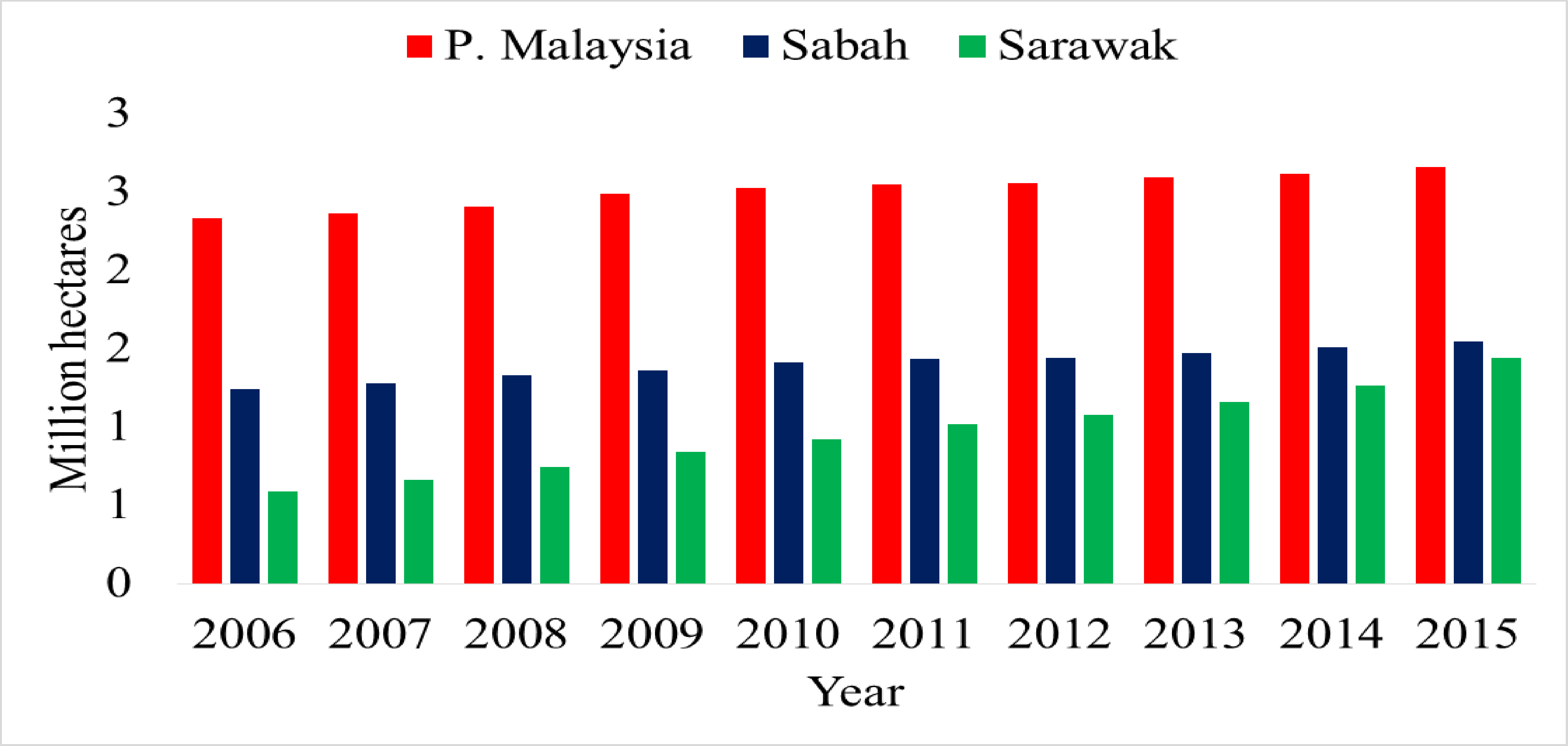
Parameters	USA (ASTM)	Malaysia
Density at 15 °C g/cm³	0.8-0.9	0.878
Viscosity at 40 mm²/s	1.9–6.0	4.4
Flash point (°C)	130	182
Pour point (°C)	-	15
Cetane number	≥47	56
Conradson carbon residue (%)	0.05	-
Sulphur Content (% mass)	-	<0.001
Iodine number	–	58.3
Methanol/ethanol (mass %)	–	<0.2
Ester content (mass %)	–	98.5
Monoglyceride (mass %)	–	<0.4
Diglycerides (mass %)	–	<0.2
Triglyceride (mass %)	–	<0.1
Free glycerides (mass %)	≤0.02	<0.01
Total glycerol (mass %)	≤0.24	<0.01

Sustainable production of palm feedstock in Malaysia



Source: MPOB, http://www.mpob.gov.my/

Palm planted area in Malaysia



Source: MPOB, http://www.mpob.gov.my/

Chronology of Biodiesel development in Malaysia (2001-2007)

Year	Milestone
2001	• Low pour point palm Biodiesel research work initiated. • Crude palm oil and fuel blend are used power generation
2002	Liquid palm oil and petroleum diesel blends (B2,B5 and B10) are used in MPOB selected vehicles began
2004	Refined, bleached and deodorized (RBD) palm oil and petroleum diesel blends (B5) using MPOB selected vehicles began.
2005	• PME Biodiesel production technology transfer from the MPOB to Lipochem(M) Sdn Bhd and Carotino Sdn Bhd • Design of commercial low-pour-point PME Biodiesel plant. • National Biofuel Policy drafted.
2006	• National Biofuel Policy launched • First commercially Biodiesel production • Envo Diesel launched. • The Government approved 92 Biodiesel licences with combined installed capacity of 10.2 million tonnes.
2007	Surge in the price of CPO (the main feedstock for Biodiesel production) resulted in many Biodiesel projects to be suspended or cancelled.

Source: MPOB, http://www.mpob.gov.my

Chronology of Biodiesel development in Malaysia (2008-2013)

Cont.… …

Year	Milestone
2008	• Malaysia Biofuel industrial Act 2007 came into force
	• Envo Biodiesel was replace with B5 (blending 5% PME and 95% fossil fuel) Biodiesel blend
	• Only 14 palm Biodiesel plants in operation and there total plants capacity 1.68 million tonnes.
2009	B5 blend are used government vehicles from selected agencies.
2010	Initial plan for the B5 mandate is set on January 1, but the government had to defer it to June 2011.
2011	B5 mandate commercially used began.
2012	Big drop in CPO prices and record high palm oil inventory prompted government to reconsider Biodiesel programme seriously as a safety net to cushion the commodity price and reduce stocks
2013	The government lunched B10 programme had considered nationwide implementated by mid 2014 upon agreement from parties involved.

Source: MPOB, http://www.mpob.gov.my

Status of Biodiesel Industry in Malaysia (2015)

Implementation Phase	No. of Plants	Biodiesel Production Capacity (Tonnes/Year)
Commercial Production*	22	3,198,000
Completed Construction**	7	582,400
Produced from Used Cooking Oil	4	107,800
Construction	6	905,000
Pre-Construction / Planning	19	1,691,400
Terminate Biodiesel Project***	2	350,000
Total	59	6,714,600

Note:
* On / Off production
**Completed construction covers the biodiesel plants which have completed but yet to commence production and also includes those undertaking production trials.
*** Company which had decided not to proceed with biodiesel project, however, its biodiesel manufacturing license under MPIC is still valid.

Source: Ministry of Plantations Industries and Commodities (MPIC)

Development of biodiesel industries in Malaysia

No	Name of Biodiesel Production company	Location	Plant capacity (Mtoe/year)	Production Technology
1	SPC Bio-Diesel Sdn.Bhd.	Lahad Datu, Sabah	0.1	Esterification
2	Global Bio-Diesel Sdn. Bhd.	Lahad Datu, Sabah	0.2	Esterification
3	Carotech Bio-Fuel Sdn.Bhd.	Ipoh, Perak	0.15	Esterification
4	Lereno Sdn.Bhd.	Setiawan, Perak	0.06	Winterized Technology
5	Mission Biotechnology Sdn.Bhd.	Kuantan, Pahang	0.2	Crown's trans-esterification process
6	PGEO Bioproduct Sdn.Bhd.	Pasir Gudang, Johor	0.1	Esterification
7	Carotino Sdn.Bhd.	Pasir Gudang, Johor	0.2	Esterification
8	Malaysia Vegetable Oil Refiney Sdn.Bhd.	Pasir Gudang, Johor	0.11	------------
9	Vance Bioenergy Sdn.Bhd.	Pasir Gudang, Johor	0.2	trans-esterification
10	Golden Hope Biodiesel Sdn.Bhd.	Selangor	0.15	Esterification

Source: MPOB, http://www.mpob.gov.my

Consumption of B5 Biodiesel in Malaysia in 2013

Consumption	B5 (in tons)
Subsidized transport sector for whole Malaysia	320,000
Non subsidized commercial sector – Manufacturing & Logistic	180,000
Potential consumption throughout Malaysia	500,000
Actual current consumption in Peninsular Malaysia – 8 states where B5 Biodiesel available	155,000
Additional potential Consumption throughout Malaysia inclusive non-subsidized commercial sector if fully implemented	345,000
CPO production in 2013	19,216,459
Actual current % of biodiesel used in 2013	0.8%
Potential possible % of biodiesel used throughout Malaysia in 2013	2.60%

Source: Malaysian palm oil Board, http://www.mpob.gov.my

Malaysian biofuel policy 2006

National Biofuel Policy 2006

Strategies
- Biofuel technologies
- Biofuel for transport
- Biofuel for industry
- Biofuel for export
- Biofuel for a cleaner environment

>>Short-term strategies
- Establish Malaysian standard specifications for B5 diesel
- Utilizing B5 diesel by selected government department vehicles
- Establish B5 diesel pumps for the public
- Voluntary trials B5 diesel in the industrial sectors
- Promotional and motivation programme for the public

>>Medium term strategies
- Establish Malaysian standard specifications for PME biodiesel for domestic use and export
- Pass government rule to mandate the use of B5 diesel
- Encourage private sector to establish of commercial biodiesel plants

>>Long-term strategies
- Gradual increases palm oil percentage in the diesel fuel blend
- Upgrade biofuels production technology by Malaysian and foreign companies.

Source: Biofuels in Malaysia: An analysis of the legal and institutional framework, http://www.cifor.org/nc/online-library/browse/view-publication/publication/3470.html

Carbon Free Energy: Roadmap for Malaysia

Key technologies for Bioenergy towards 2050

Technology Development	Policy	Time frame
➢ Enhancement the 1st and 2nd generation technologies ➢ Technology scanning and upgrading by home grown expertise ➢ Pursue the gasification of solid waste ➢ Maximum resource utilization efficiency ➢ Implementing energy efficiency measures ➢ Bio gasoline/Bioethanol: To make the technology more cost competitive for larger scale ➢ Modify Engine design to effective utilize biofuel without damage ➢ Development of integrated bio-refinery	➢ More promotion and awareness raising programmes from the governments ➢ Development of standards ➢ Train more skilled/semi skilled manpower ➢ Establish a platform for public & private partnership ➢ Industrial based R&D project ➢ Engagement of industry and universities and research institutes at the early development stage ➢ Establishing international collaboration and networking for technology and knowledge transfer (JAPAN ?)	By 2020

Carbon Free Energy: Roadmap for Malaysia

Cont.....

Technology Development	Policy	Time frame
➢ Enhancement of bio refinery concept ➢ Development of entire value chain of bio-refinery (Utilization, Storage and distribution)	➢ Continuous efforts on nurturing and enhancing the local talents	By 2030
➢ Locally produced enzyme ➢ Strengthening fundamental knowledge related to process and material development	➢ Continuous efforts on nurturing and enhancing the local talents	By 2040
➢ Practices related to the technology improvement	➢ Continuous efforts on nurturing and enhancing the local talents	By 2050

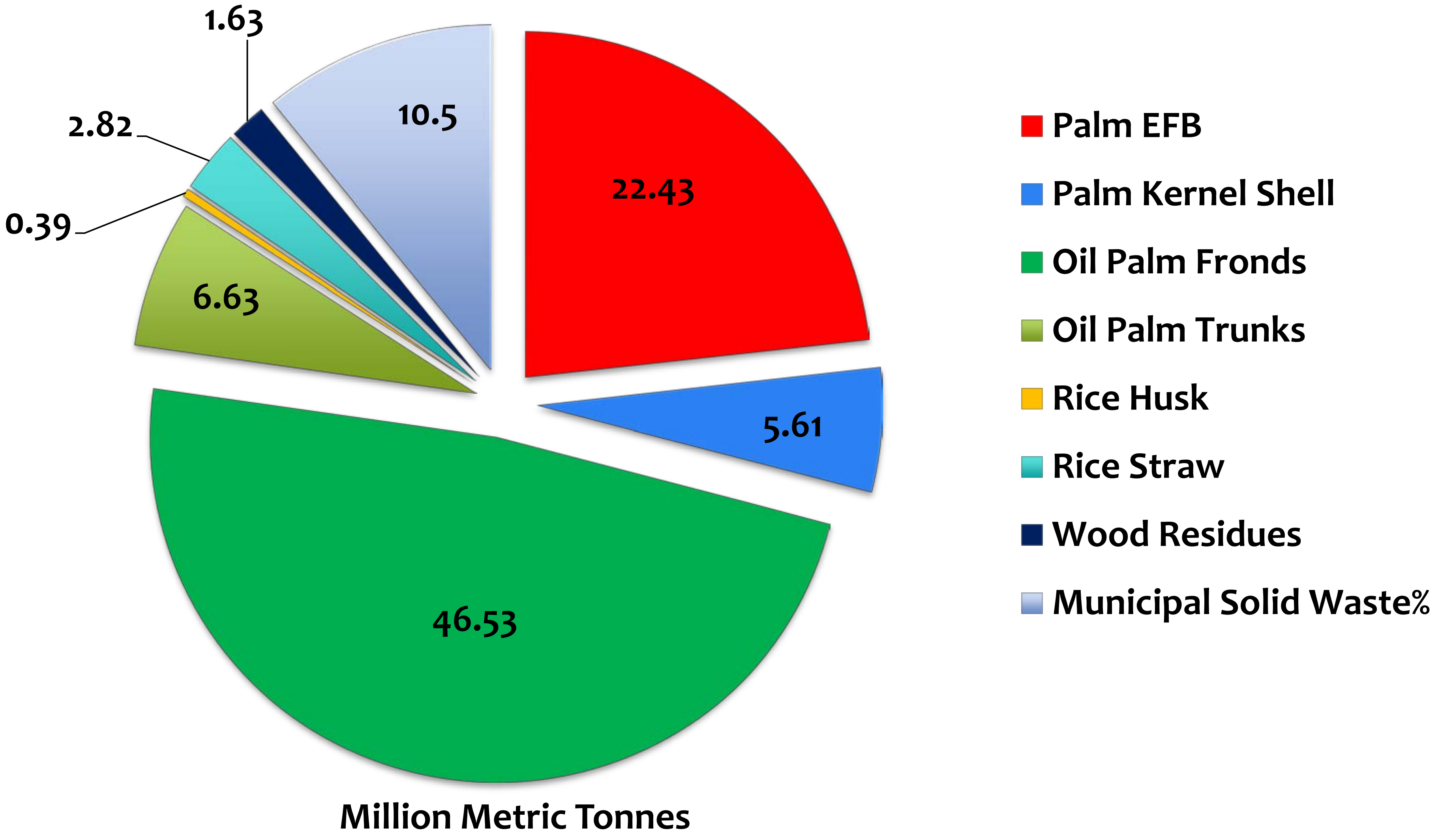
Implementation of Biodiesel Programme

Region	State	Implementation Date	% of blend
Central	WP Putrajaya, Melaka, Negeri Sembilan, WP Kuala Lumpur & Selangor	June - November 2011	5% (B5)
Southern	Johor	July 2013	5% (B5)
Eastern	Pahang, Kelantan & Terengganu	February 2014	5% (B5)
Northern	Pulau Pinang, Kedah, Perak & Perlis	March 2014	5% (B5)
	Peninsular Malaysia	November 2014	7% (B7)
	Sarawak, Sabah & Labuan	December 2014	7% (B7)

Note: Implementation of biodiesel programme for transportation & fishery sector only

Source: MPOB, http://www.palmoilworld.org/biodiesel.html

Total Projected Annual Biomass Availability in Malaysia



Source: Malaysian Industry-Government Group For High Technology, www.might.org.my

Malaysian biomass industry action plan 2020

Feedstock

- Palm biomass
- Rice Husk & straw
- Municipal Solid waste
- Kenaf
- Wood biomass

Products

- Bio-energy
- Green chemical & Bio-polymers
- Bio-fertilizers
- Bio-composites

Applications

- Steam
- Electricity
- Heat
- Transport fuel
- Packaging
- Livestock feed
- Agriculture
- Green building materials

Substitution Targets

- Oil & gas
- Diesel
- Petrol
- Natural gas
- Chemicals
- Polymers
- Mining
- Minerals
- Forestry
- Timber
- Plywood
- Fuel pellets

Source: Malaysian Industry-Government Group For High Technology, www.might.org.my

Biofuels upgrading technologies

There have been intensive studies on biofuels upgrading research and various technologies have been developed for biofuels upgrading.

- Hydrotreating /hydrofining
- Hydro-cracking /hydrogenolysis /catalytic cracking
- Supercritical fluid
- Solvent addition (direct add solvent or esterification of the oil with alcohol and acid catalysts)
- Emulsification /Emulsions
- Steam Reforming
- Chemical extracted from the bio-oils

Solvent addition for biodiesel upgrading

Solvent addition / etherification

Most environmental catalysts applied in bio-fuels upgrading are heterogeneous catalysts. Solid acid catalysts, solid base catalysts ionic liquid catalysts, HZSM-5, and aluminum silicate catalysts are investigated for esterification of bio-oils. Considering the simplicity, the low cost of some solvents such as methanol and their beneficial effects on the oil, this method seems to be the most practical approach for bio-oil quality upgrading.

University Of Malaya biodiesel production plant

Current solvent technology research in Malaysia

University/ Research Institute	Objective of Research	Feedstocks used	Outcome
International Islamic University of Malaysia (IIUM) And University of Malaya Malaysia, (UM)	A green technology of biodiesel production focuses on the use of enzymes as the catalyst. Addition of tert-butanol at 2:1 tert-butanol to SPO molar ratio into the ethanol-solvent system	Produced ethanol based biodiesel from a low-cost sludge palm oil (SPO) using locally produced candida cylindracca lipase from fermentation of palm oil mill effluent based medium	The optimum levels of ethanol to SPO molar ratio and enzyme loading were found to be 4:1 and 10 U/25g of SPO respectively with 54.4% w/w SPO yield of biodiesel and 21.7% conversion of free fatty acid into biodiesel
University Technology PETRONAS (UTP), Perak, Malaysia And Kumamoto University, Japan	Characterize the natural low transition temperature mixture (LTTMs) as promising green solvents for biomass pretreatment with the critical characteristics of cheap, biodegradable and renewable, which overcome the limitations of ionic liquids (Ils)	The pretreatment of oil palm biomass was consistence with the screening on solubility of biopolymers. This work provides a cost effective alternative to utilize microwave hydrothermal extracted green solvents such as malic acid from natural fruits and plants	The thermal properties of the LTTMs were not affected by water while the biopolymers solubility capacity of LTTMs was improved with the increased molar ratio of water and treatment temperature.

Current solvent technology research in Malaysia Cont..

University/ Research Institute	Objective of Research	Feedstocks used	Outcome
University Technology PETRONAS, Perak, Malaysia (UTP) And National metal and materials Technology Centre, Thailand Science Park, Thailand	The aim of this research was to select the ideal condition for accelerated aging of bio-oil and the consequences of additive in stabilization the bio-oil	The bio-oil was produce from the catalytic pyrolysis of empty fruit bunch. And A 10 wt% of solvents including acetone, ethanol and ethyl acetate were used to study the bio-oils stability.	The results of Gas chromatography Mass Spectrometry (GC-MS), it could impede the chain of polymerization by converting the active units in the oligomer chain to inactive units. The solvent reacted to form low molecular weight products which resulted in lower viscosity and lessen the water content in bio-oil. Addition of 95 vol% ethanol also inhibited phase separation.
University of Malaya, Kuala Lumpur, Malaysia (UM)	A low cost quaternary ammonium salt-glycerin based ionic liquid is proposed as a solvent for extracting glycerin from the transesterification biodiesel product.	The separation technique was tested on palm oil based produced biodiesel with KOH as a reaction catalyst.	The viability of the separation technique with a best DES: biodiesel molar ratio of 1:1 and a DES molar composition of 1:1 (salt:glycerin)

Current Solvent technology research in Malaysia Cont….

University/ Research Institute	Objective of Research	Feedstocks used	Outcome
University Putra Malaysia (UPM)	The use of enzymes as catalyst in organic synthesis such as the use of lipase in esterification and oxidation	In esterification, the method is used to synthesize sugar esters, biodegradable surfactants, and the reaction is also carried out in ionic liquid.	They are trying to achieve a Green process in using biocatalysts and minimize use of volatile organic solvents.
University Putra Malaysia (UPM)	Development of heterogeneous catalysts for biodiesel production, dry reforming of methane and biomass conversion to syngas and bio-oil. Modification of Vanadium Phosphate Catalyst for n-Butane and Propane Oxidation to Oxygenate Products.	Biomass Conversion of Empty Fruit Bunch to Syngas and Bio-Oil.	Investigation on Reactivity of Oxygen Species and the Mechanism for Partial Oxidation of n-Butane. Development of Solid Heterogeneous Catalysts for Higher Grade Biodiesel.

Strategic recommendations and actions

- Identify mechanisms to incentivize isolated plants such as easing transmission costs for long-distance connections or exploring other sustainable applications for biogas like biofuel for on-site transport utilization.
- Regulate environmental laws to enhance biomass/biogas production and incentivize plants to achieve excellent environmental performance.
- Stimulate the co-firing of biogas/biomass in boilers of new and upgraded facilities.
- Promote local content to improve technological self-dependency.
- Provide research funding and incentivize commercial pioneering for second generation technologies.
- Distribute benefits of RE to the local community to ensure continued public support.
- Explore potentials of other forms of organics.

Conclusions

- Government should formulate environment and energy policies favourable for future development of renewable energy.
- Government should encourage planting more biofuel plants, implementation and development of biofuel policy and proper utilization of biodiesel in various sectors, which would reduce the dependency of non-renewable energy.
- Malaysian government must endeavor to reinforce palm oil based biodiesel industry and likewise develop other feedstocks to maintain the development and competition of biodiesel industry without focusing and dependent on one feedstock.

Thus, the ability of biodiesel industries in Malaysia to shift from the current palm oil source to multi-feedstock sources, will play an important role in ensuring security and sustainable development in the future.

Thank you
for
your attention

The Policy is underpinned by five strategic thrusts

- **Thrust 1: Biofuel for transport**

Diesel for land and sea transport will be a blend of 5% processed palm oil and 95% petroleum diesel. As this sector is the main user of diesel which is highly subsidized, it will be given priority in this policy

- **Thrust 2: Biofuel for industry**

B5 diesel will also be supplied to the industrial sector including for firing boilers in manufacturing, construction machinery, and generators

- **Thrust 3: Biofuel technologies**

Research, development and commercialization of biofuel technologies will be effected and adequately funded by both the government and private sectors including venture capitalists to enable increased use of biofuel

- **Thrust 4: Biofuel for export**

Worldwide interest reflects the important role of biofuels in energy for sustainable development. Malaysia will have an edge to supply the growing global demand for biofuel. The establishment of plants for production biofuel for export will be encouraged and facilitated.

- **Thrust 5: Biofuel for cleaner environment**

The use of biofuel will reduce the use of fossil fuels, minimize the emission of green house gases (carbon dioxide), carbon monoxide, sulphur dioxide and particulates. Increased use of biofuel will enhance the quality of the environment.

Source: MINISTRY OF PLANTATION INDUSTRIES AND COMMODITIES MALAYSIA, http://www.kppk.gov.my

Advantages and Disadvantages of Solvent technology

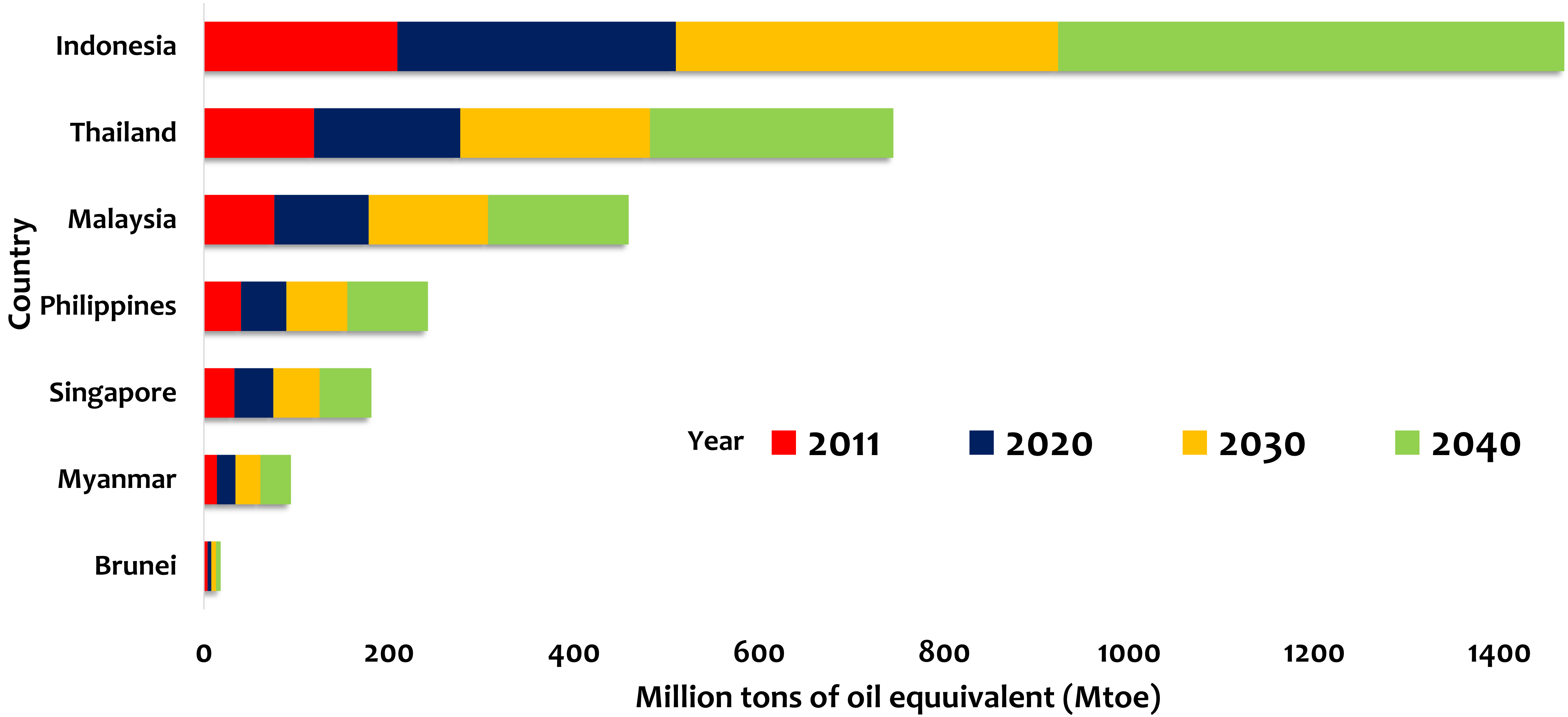
Advantages

- Better solubility of substrates and product.
- Shifting of thermodynamic equilibria (synthesis takes place instead of hydrolysis).
- Simpler removal of solvent (most organic solvents have lower boiling point than water).
- Reduction in water-dependent side reactions such as hydrolysis of acid anhydrides or polymerization of quinines.
- Removal of enzyme after reaction since it is not dissolved.
- Better thermal stability of enzymes since water is required to inactivate enzymes at high temperatures.
- Elimination of microbial contamination.
- Potential of enzymes to be used directly within a chemical process.

Drawbacks

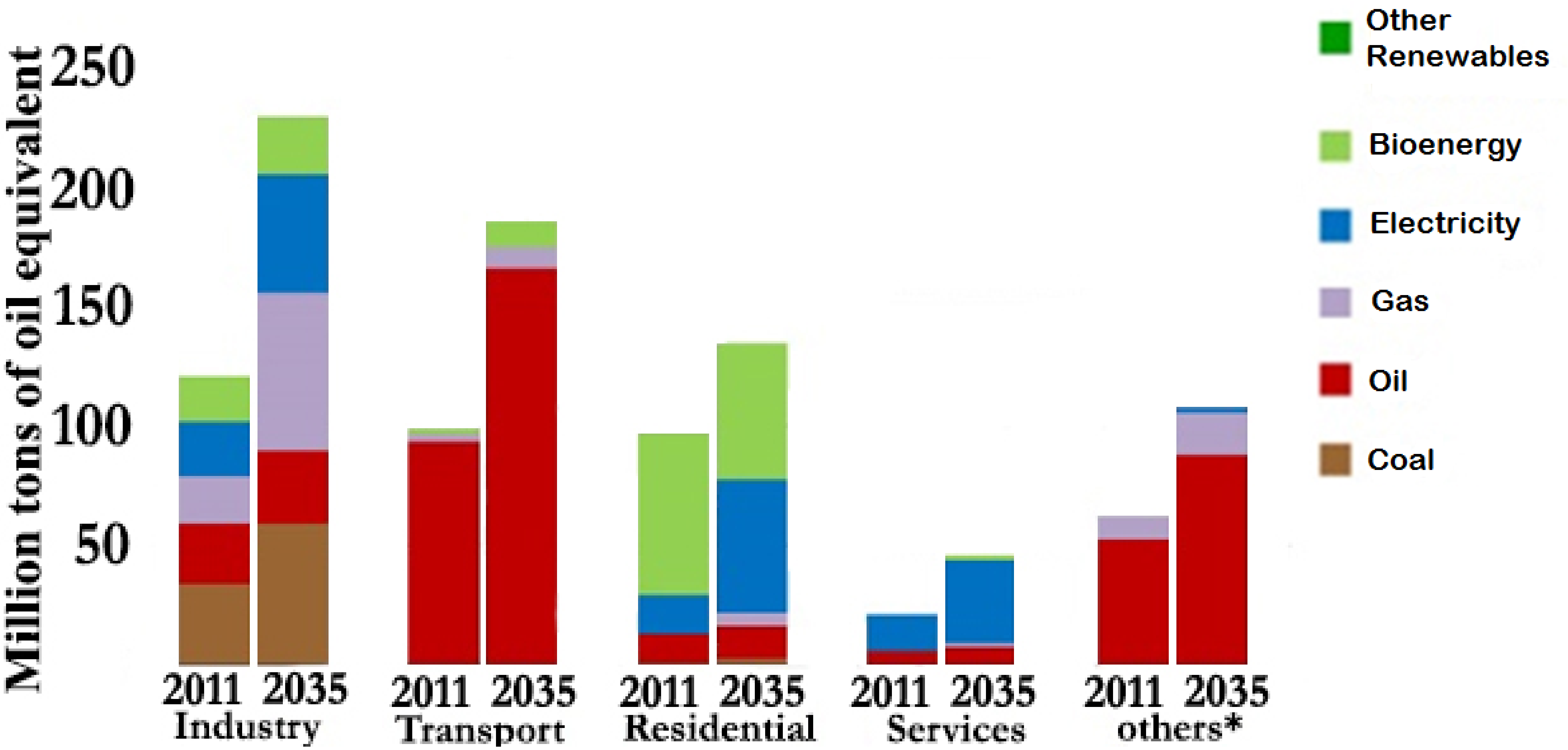
- High viscosity (a serious limit to mass and phase transfer)
- Toxicity and corrosivity to be better considered
- Expensive and only large scale production

ASEAN primary energy consumption (2011-2040)



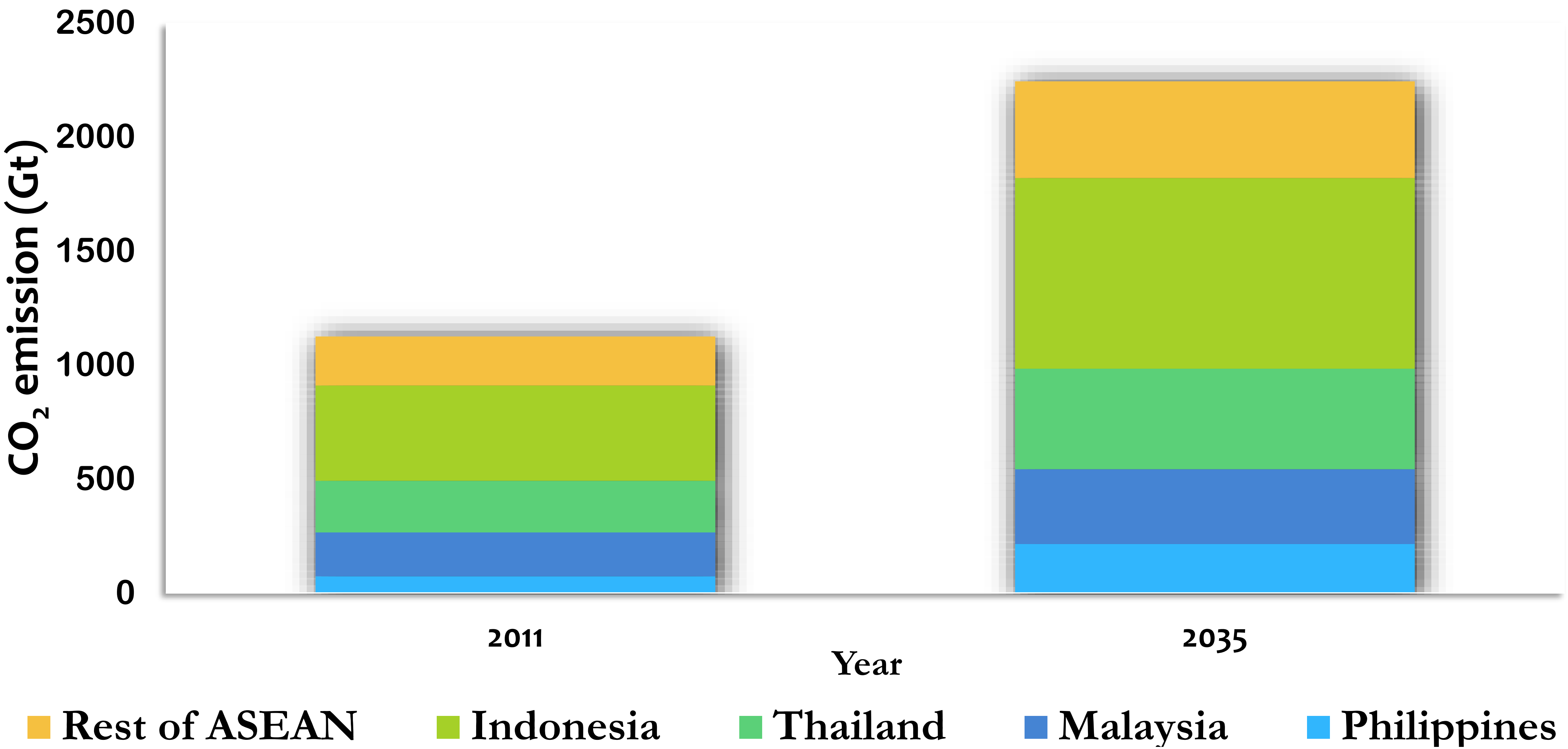
Source: Energy scenario and biofuel policies and targets in ASEAN countries, M Mofijur, HH Masjuki, MA Kalam, SMA Rahman, Renewable and Sustainable Energy Review, 2015 - Elsevier

ASEAN energy demand by sector



Source: Energy scenario and biofuel policies and targets in ASEAN countries, M Mofijur, HH Masjuki, MA Kalam, SMA Rahman, Renewable and Sustainable Energy Review, 2015 - Elsevier

Energy related CO_2 emission of ASEAN



Source: Energy scenario and biofuel policies and targets in ASEAN countries, M Mofijur, HH Masjuki, MA Kalam, SMA Rahman, Renewable and Sustainable Energy Review, 2015 - Elsevier

Key biodiesel policy of major ASEAN countries

Indonesia

20% of total energy mix within 2025

Malaysia

- Successful implementation of B5 within 2014
- Considering introduction of B7
- Evaluating prospect of B10

Philippines

- 2007-2009: 1% (B1) biodiesel blend sold in all gasoline stations
- 2009-2013: 2% (B2) biodiesel blend

Thailand

- Implementation of B10 within 2012

Vietnam

- Targeted annual production of 50,000 tons of B5 by 2010

Source: Energy scenario and biofuel policies and targets in ASEAN countries, Renewable and Sustainable Energy Review, 2015 - Elsevier