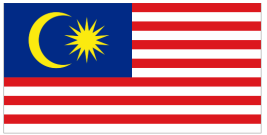


HYDROGEN ECONOMY: PERSPECTIVE FROM MALAYSIA

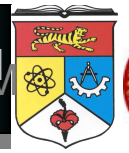
Prof. Wan Ramli Wan Daud

National Fuel Cell Research Program Malaysia

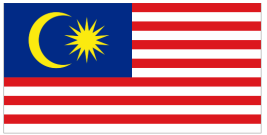
Presented at

International Seminar on the Hydrogen Economy for Sustainable Development

28 -29 September 2006, Reykjavik, Iceland



INTRODUCTION



- Malaysia
- Population: 25.58 million people
- GDP of RM 250 billion in 2004
- GDP per capita of RM9,732
- Committed to sustainable development to become a developed country by 2020
- Energy development: significant part of sustainable development
- Crucial to success of industrialization process

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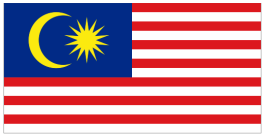
MALAYSIAN ENERGY DEVELOPMENT



- Conventional Energy Reserve:
- Oil reserve: 4.83 billion barrels in 2004
- Gas reserve: 2.46 trillion cu m 2004
- Coal reserve : 1,483 million tonnes
- Hydropower reserve: 27,000 MW
- Renewable energy resources reserves:
- Biomass: 2 million tonne of oil equivalent
- Mini-hydro: 1,640 MW
- Net exporter oil & natural gas
- Net importer of coal

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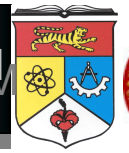

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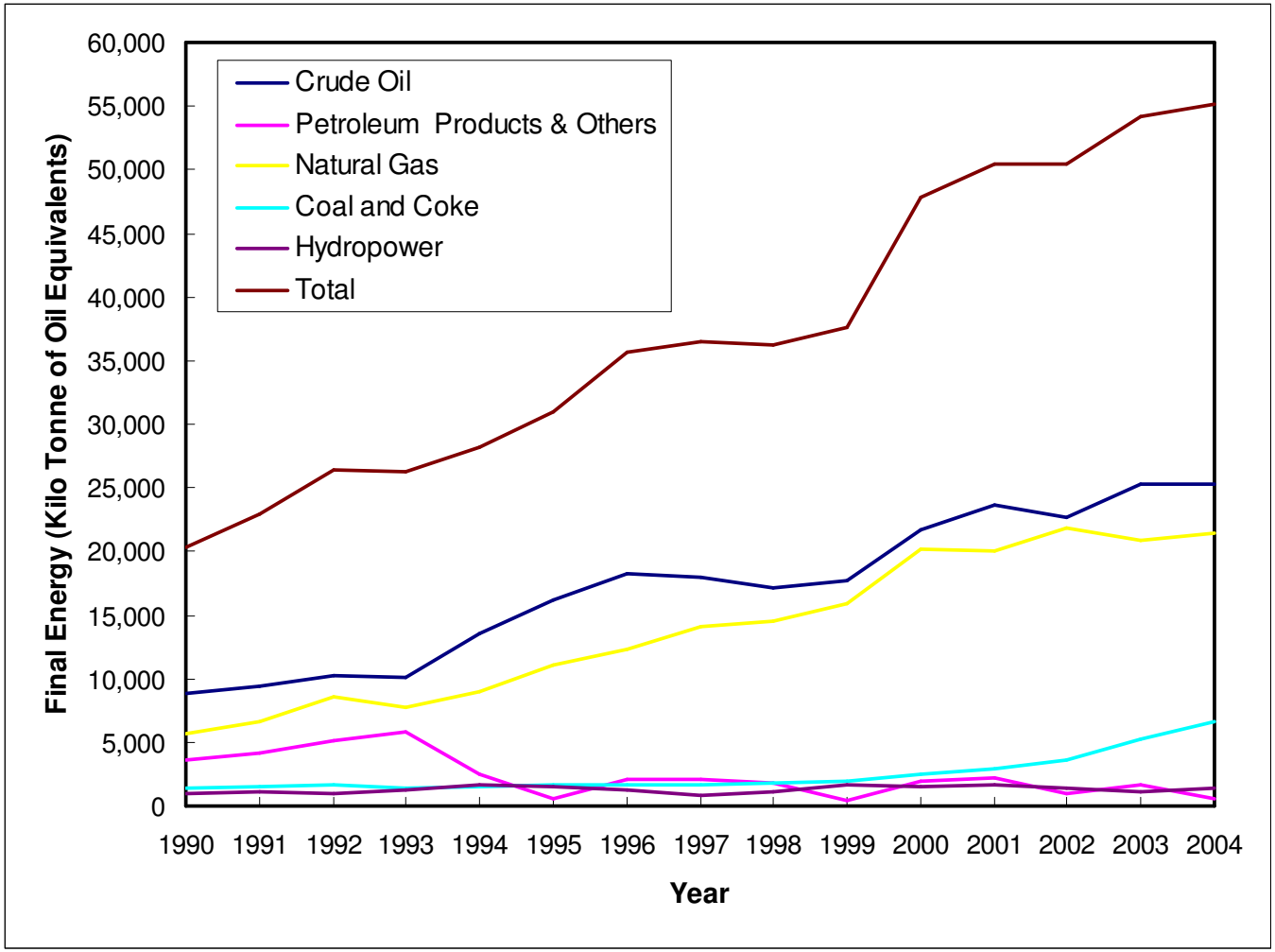
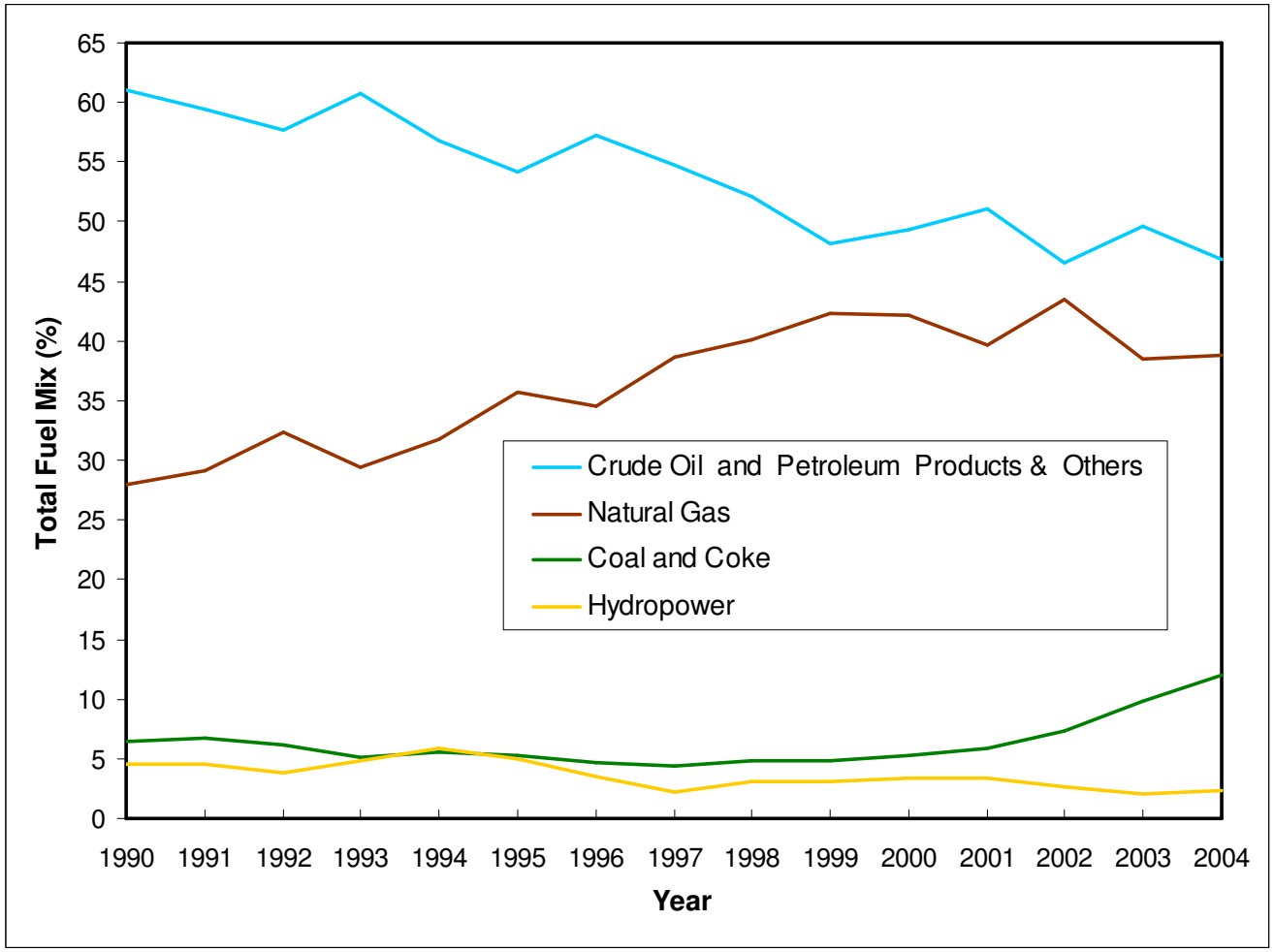
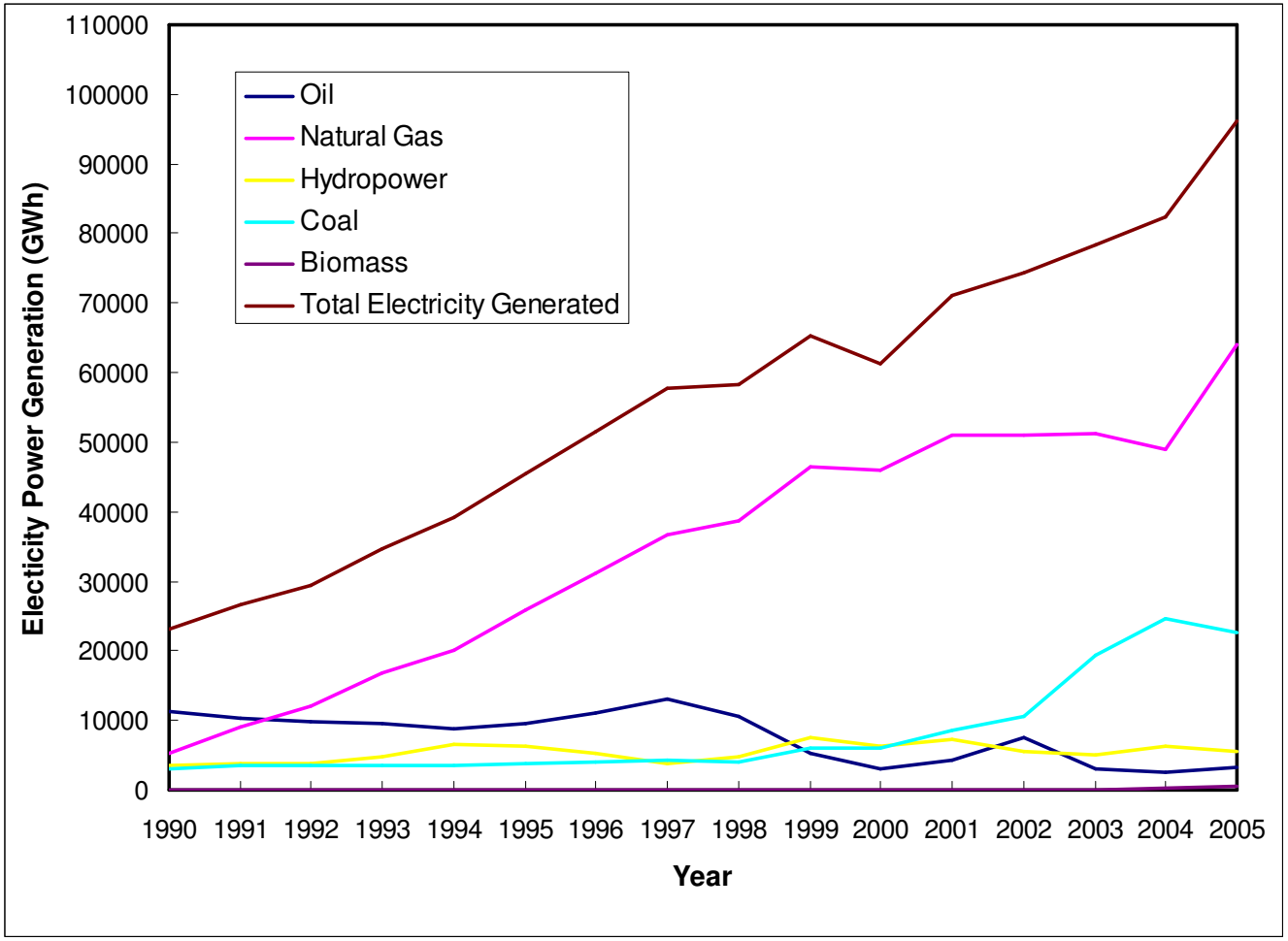


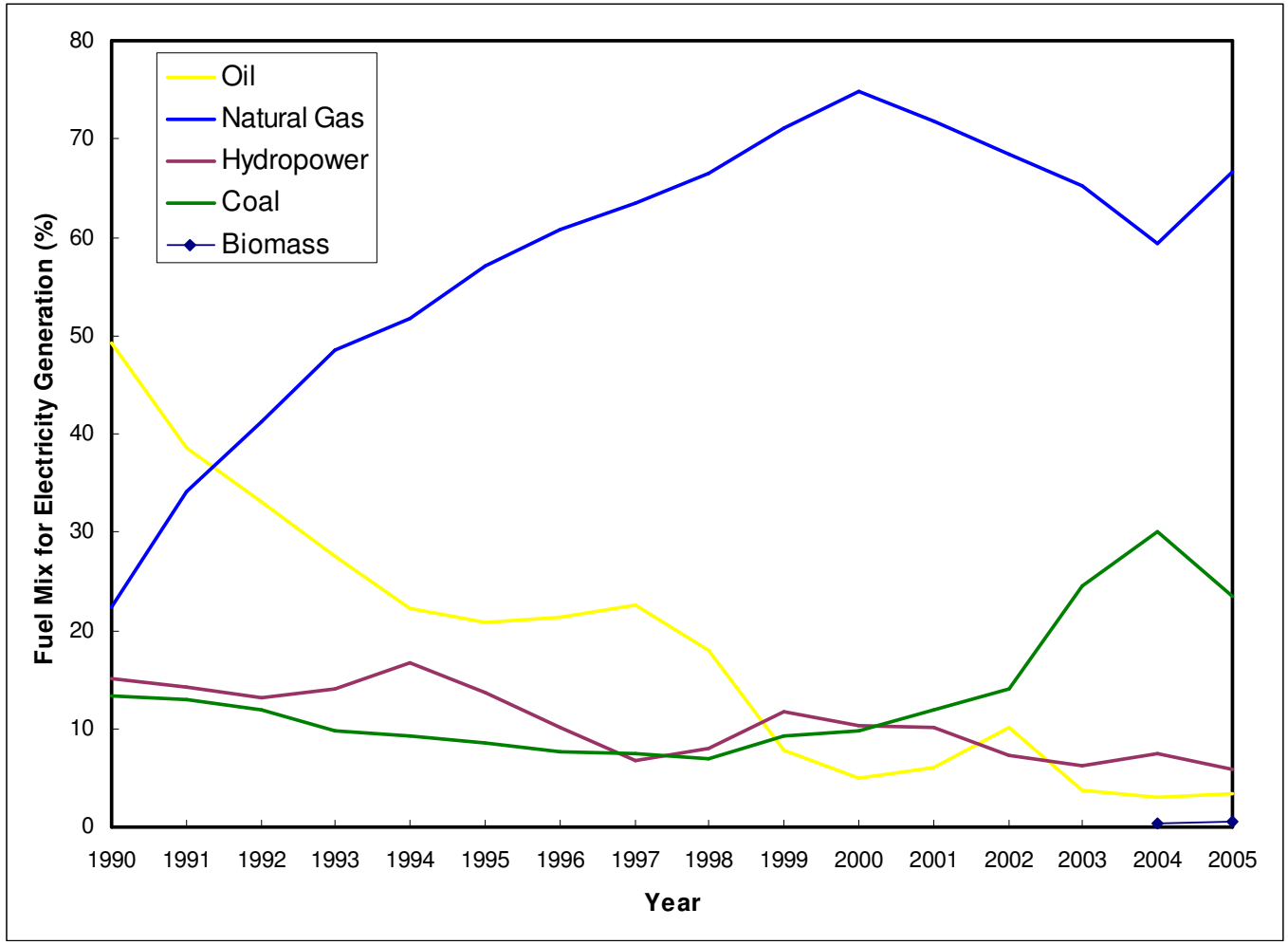
MALAYSIAN ENERGY DEVELOPMENT



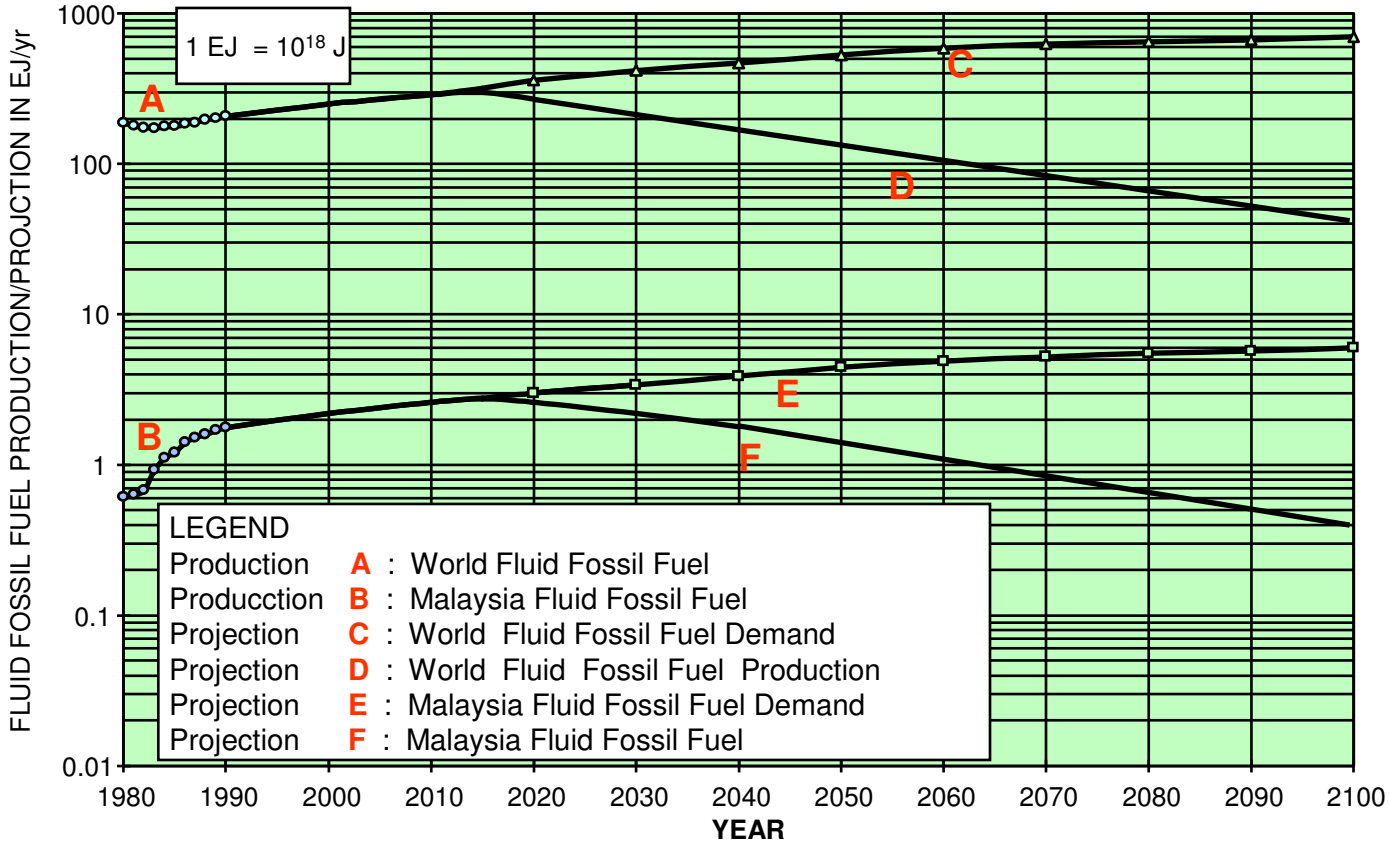
MALAYSIAN ENERGY DEVELOPMENT



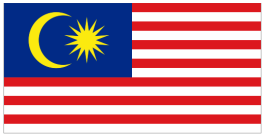
MALAYSIAN ENERGY DEVELOPMENT



MALAYSIAN ENERGY DEVELOPMENT



MALAYSIAN RENEWABLE ENERGY DEVELOPMENT



- Many palm oil mills utilized oil palm residues for production of electrical energy & heat in co-generation for their own use
- In 1990's EC-ASEAN COGEN built 5 Full-Scale Demonstration Projects (FSDP) in in Malaysia utilizing wastes in wood industries using cogeneration systems
- In 1980's national electrical utility company developed many mini-hydro plants supplying electricity to remote communities

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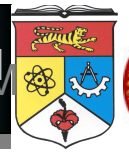
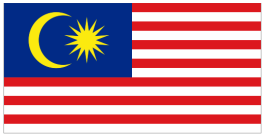


MALAYSIAN RENEWABLE ENERGY DEVELOPMENT



- Third Outline Perspective Plan (OPP3) 2001-2010 and the 8th Malaysia Plan 2006-2010 forcasted That Malaysia may net oil importer by 2008
- Air pollution reduction in transportation &industrial sectors using natural gas and clean coal technology
- Sustainable energy development through secure cost-effective supply
- Efficient utilization & minimization of environmental effects of energy
- Introduction of renewable energy as the fifth fuel
- Promotion of energy efficiency

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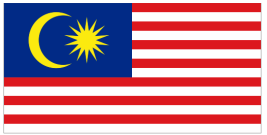
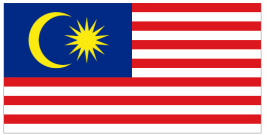
MALAYSIAN RENEWABLE ENERGY DEVELOPMENT



- In 1999, renewable energy added as fifth “fuel” in additioan to oil, coal, gas & hydropower with target for renewable energy 5% by 2005 & 10% by 2010
- Fuel mix in 2010 is targeted to 40% gas, 40% coal, 10% hydropower and 10% renewable energy
- Biomass resources utilized for electricity generation and connection to the national grid
- The total generating capacity of oil palm based biomass for own use in 2002: 150 MW
- Total capacity oil palm biomass: 2400 MW

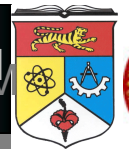
MALAYSIAN NATIONAL FUEL CELL RESEARCH & DEVELOPMENT PROGRAM

SMALL RENEWABLE ENERGY POWER PROGRAM (SREP)

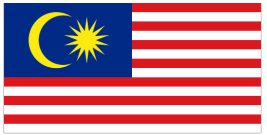


- After DANCED report in 1999, Small Renewable Energy Power Program (SREP) started in 2001
- Target 500 MW by 2005 of renewable energy for connection and sale to national grid
- Not viable for solar energy because capping of the electricity tariff to RM 0.17 per kWh
- Oil palm biomass now become more expensive to third party SREP because competitive use in making mattresses, medium density boards, paper pulps and animal feed

MALAYSIAN NATIONAL FUEL CELL RESEARCH & DEVELOPMENT PROGRAM



SMALL RENEWABLE ENERGY POWER PROGRAM (SREP)



- 115 applications mainly oil palm biomass
- 65 projects approved in 2004 : 368.9 MW
- 27 oil palm biomass projects: 214.7 MW
- 2 rice husks projects : 12 MW
- 1 wood residue project 6.6 MW
- 1 municipal solid wastes project 5 MW
- 3 mixed biomass projects : 19.2 MW
- 5 landfill gas (biogas) projects: 10.2 MW
- 26 mini-hydroelectric projects 101.6 MW

BIOGEN

- **UNDP & Malaysian Government implemented Biomass-based Power Generation and Cogeneration in the Malaysian Palm Oil Industry (BIOGEN)**
- **Main objective is to reduce the growth rate of green-house gas emissions from fossil fuel by utilizing excess oil palm biomass residues**
- **To develop and exploit the energy potentials of other biomass wastes.**

BIOGEN

- BIOGEN facilitate development of the grid-connected biomass fuelled small power systems
- Disseminating awareness information in palm oil industry
- Capacity building and technical assitance in policy formulation
- Facilititation of financial assistance through favourable bank loans and tax exemption
- Establishment of real live demonstration plants and development of biomass energy technology

BIOGEN

- Target of Phase 1 (2 years) of BIOGEN 15% of palm oil mills (50 palm oil mills) to implement biomass power generation & cogeneration
- Target of phase 2 (year 5), green house gas emissions from power generation reduced by 3.8%
- Up to 2004 there was only 1 major BIOGEN project 14 MW oil palm residues mitigate 40,000 to 50,000 tonnes CO2

BIODIESEL

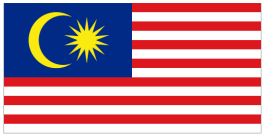
- Long history of interest at Palm Oil Research Institute of Malaysia (PORIM) now Malaysian Palm Oil Board (MPOB)
- Early 80's, PORIM developed biodiesel using transesterification technology that was used 100% on special engines from Germany
- Lack of interest from transportation & automobile industry
- No clear policy from government
- High price of palm oil & low price of oil

MALAYSIAN NATIONAL FUEL CELL RESEARCH & DEVELOPMENT PROGRAM

BIODIESEL

- Recent revival of interest due to increasing oil prices and falling palm oil prices
- Palm biodiesel is viable when crude oil price reaches above USD 43
- German-based train operator Prignitzer Eisenbahn (PE) Arriva tested 50 tonnes of Malaysia's biodiesel & ordering additional 100 tonnes of the fuel
- Legislation to require oil companies to sell biodiesel at their petrol stations

BIODIESEL



- Three biodiesel plants are planned for 2006 each with capacity of 60,000 tonne/yr
- Total capacity by next year is 180,000 tonne/yr biodiesel mainly for export only
- Raw material is refined, bleached and deodorised (RBD) palm oil
- Biodiesel composition: 5% processed palm oil blended with 95% petroleum diesel for diesel engine vehicles and industrial and power generation

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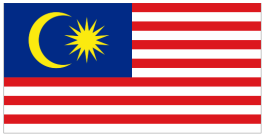
HYDROGEN, SOLAR & FUEL CELLS



- Hydrogen energy & solar energy at a smaller extent identified as most viable long term renewable alternative to fossil fuel
- Fuel cell as most viable energy conversion device for hydrogen especialy in transportation
- Malaysia taking steps to prepare itself for eventual diffusion of solar, hydrogen energy & fuel cells technologies to developing countries
- Solar, hydrogen energy and fuel cells identified as priority research by MOSTI

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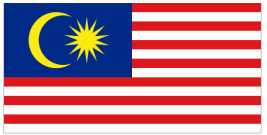
HYDROGEN, SOLAR & FUEL CELLS



- Potential capacity of grid connected building integrated photovoltaic (BIPV) in Malaysia is 11 GWp or 12 TWh: 20% of national energy demand
- Potential capacity of solar thermal 75 GW
- Presently, solar energy applications oriented towards domestic hot water systems, water pumping, drying of agricultural produce
- Photovoltaic for remote applications, building integrated photovoltaic systems and products, and daylighting

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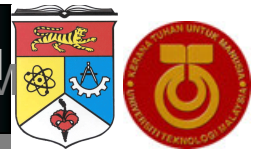
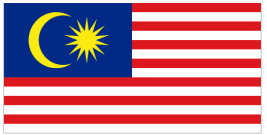


HYDROGEN, SOLAR & FUEL CELLS



- R&D in solar energy funded at RM27 million by the MOSTI 1996 – 2006.
- Photovoltaic & photovoltaic-wind hybrid hydrogen production system, photoelectro chemical cell, photovoltaic-biomass hybrid system, thin film technology, and material and cell fabrication, grid connected photovoltaic and BIPV, stand alone photovoltaic system & photovoltaic system components
- Development of BIPV in Malaysia funded by the Global Environment Facility (GEF) RM16 million

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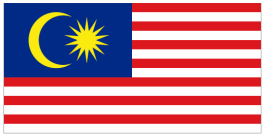
HYDROGEN, SOLAR & FUEL CELLS



- R&D program funded by MOSTI of RM7 million on hydrogen production and storage technologies 2002-2007
- Auto-thermal steam reforming catalysts for both gas and liquid fossil fuels, gasification/pyrolysis thermochemical cycle,
- Solar photovoltaic-electrolyser splitting of water, photoelectrochemical and photobiological splitting of water and carbon nanotube hydrogen storage from

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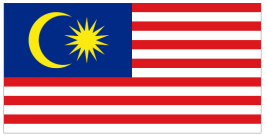
HYDROGEN, SOLAR & FUEL CELLS



- The national fuel cell research and development programme sponsored by the MOSTI RM34 million from 1996-2007
- Collaboration between Universiti Kebangsan Malaysia (UKM) & Universiti Teknologi Malaysia (UTM)
- Developed PEMFC prototypes, hydrogen production and storage technology as well as PEMFC powered motorcycle and bus air conditioning demonstrator system

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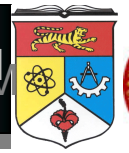
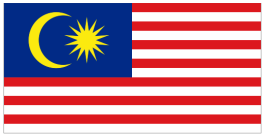


HYDROGEN, SOLAR & FUEL CELL ROADMAP



- Malaysia currently develops roadmap for hydrogen, solar and fuel cell
- Stake holders: industry: power generators & distributors & fuel producers, government, R&D institution & academia
- Expansion use of solar energy
- Introduction and utilization of renewable hydrogen energy
- Application of fuel cells as one of the more important energy conversion devices in the future

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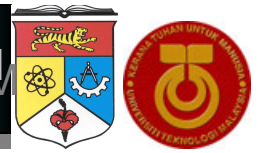
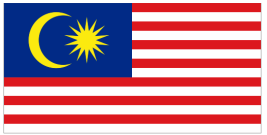


HYDROGEN, SOLAR & FUEL CELL ROADMAP



- Five major strategies:
- Cost competitiveness and market enhancement
- Technology research & development
- Standards and policy development
- Awareness and capacity building
- Financial incentives and funding

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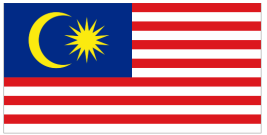
SOLAR ENERGY ROADMAP FOR MALAYSIA



2030 – Increase of solar energy installed capacity (PV - 40MW, Thermal – 75 GW)

2030 SOLAR IS COMPETITIVE TO FOSSIL FUELS

Technology cost lower or on par than other energy sources

2025

LONG TERM

Commissioning of 10MWp solar PV power plant

2020

Inverter and BOP equipments for BIPV locally manufactured

2015

Incorporation of 20MWp BIPV installed capacity in generation mix, Reduce Technology Cost by 30%

2010

MEDIUM TERM

•Solar thermal market enhanced to 50%

•PV market enhanced to 4.5MWp

2009

Availability of 10 solar demonstration projects and gazetted by laws, Technology efficiency improved by 2-5%, Increase BIPV capacity to 1.5MW and technology cost reduction of 20%

Design, fabrication and manufacturing of local inverters

Locally made charge controllers for standalone applications, mounting structure, innovative architecture integration, and social acceptance studies of the public perception of the BIPV

Cost competitive and locally made thin films and organic cell

Increased thermal installed capacity to 200MWth

Increased PV rural installed capacity to 6MWp

2008

2007

Joint Industries – Universities Research Projects implemented

SHORT TERM

PV association established

2006

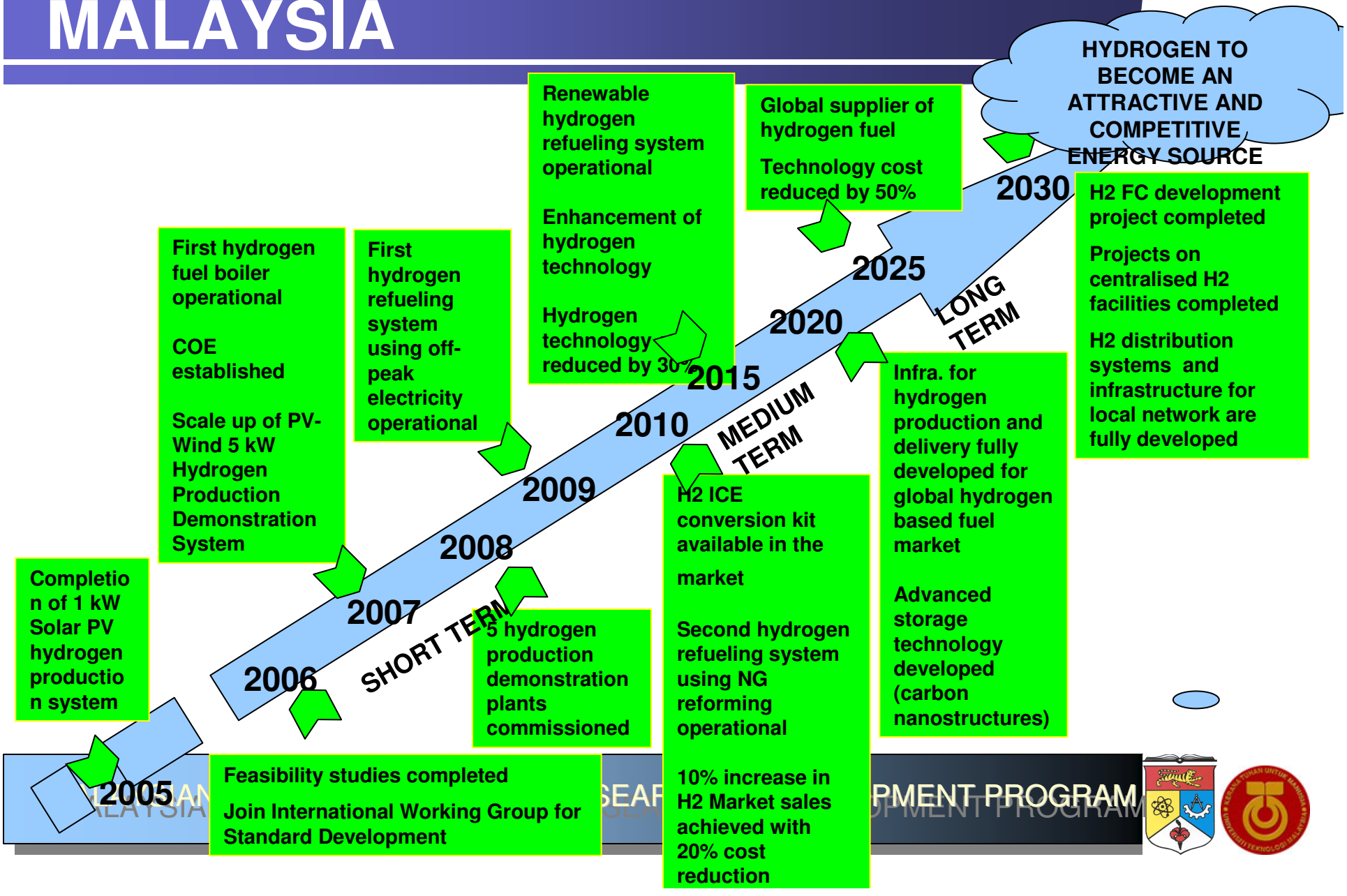
Set up of working groups for solar thermal standard development

Set up of Solar demonstration projects

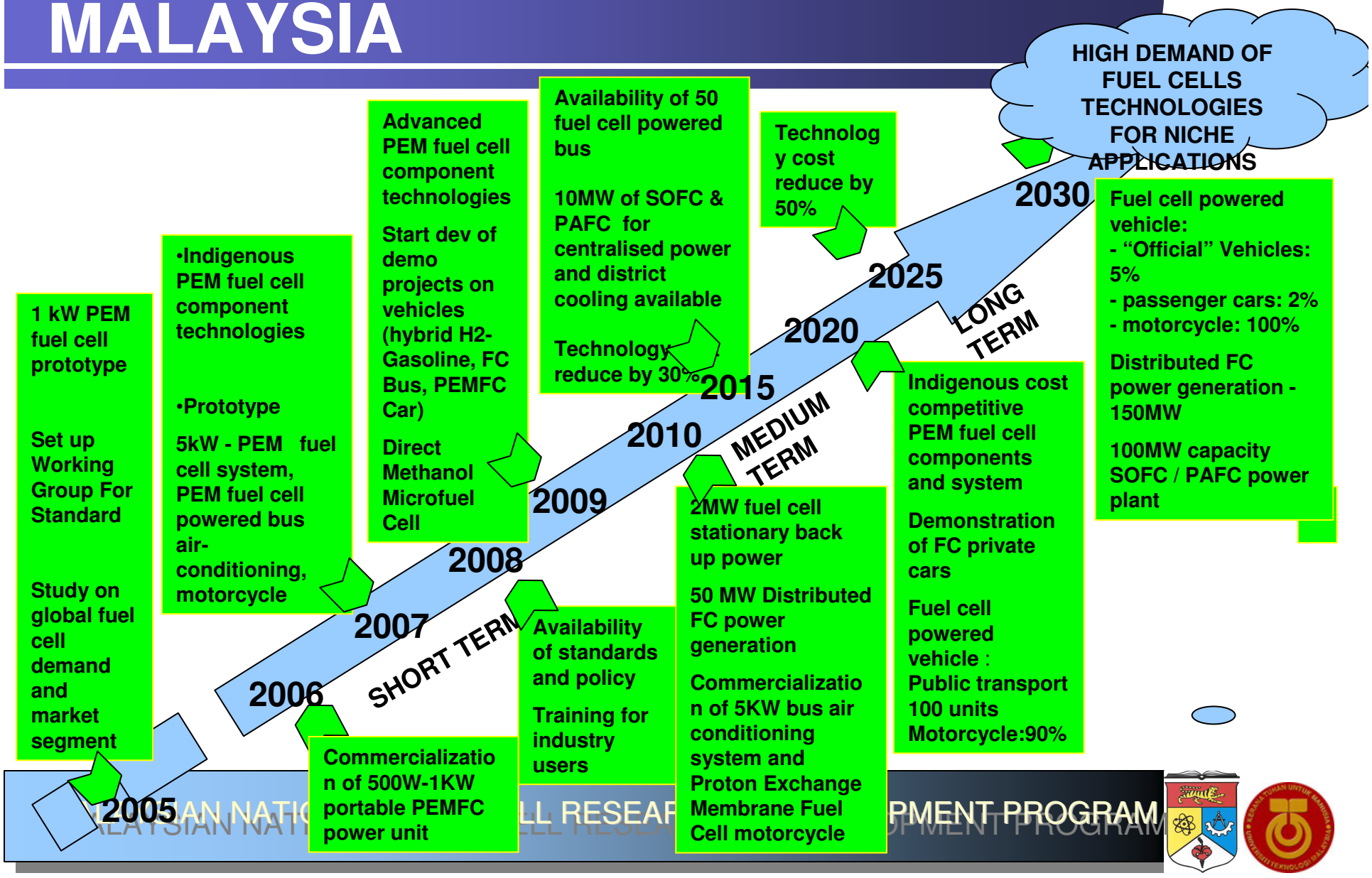
Start Implementation of National PV programme "Suria 1000"

2005

HYDROGEN ROADMAP FOR MALAYSIA



FUEL CELLS ROADMAP FOR MALAYSIA



Thank You