Combustion Strategy - UK

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Government Funding Sources for Universities

HERIOT WATT UNIVERSITY

The UK Research Councils are:

Arts and Humanities Research Council (AHRC);

Biotechnology and Biological Sciences Research Council (BBSRC);

Engineering & Physical Sciences Research Council (EPSRC);

Economic & Social Research Council (ESRC);

Medical Research Council (MRC);

Natural Environment Research Council (NERC);

Science and Technology Facilities Council (STFC).

EPSRC – Combustion

EPSRC Currently Support 65 Grants worth £30.5M this is roughly £10M p.a.

EPSRC Support by Classification - Combustion.mht

Development of a laser induced incandescence high vacuum system for the measurement of soot or nanoparticulate, size, mass and morphology.htm

Industry – Combustion

- **This is dominated by three main players of which one is by far the largest:**
- **Rolls-Royce** Rolls-Royce.mht
- **JLR** Jaguar Land Rover.mht
- **Doosan Babcock** Current Projects - Doosan Babcock.mht

Industry & Government

- **This includes:**

- **BIS** BIS Technology Strategy Board.mht

- **TSB** Technology Strategy Board Our strategy Technology areas.mht

& Technology Strategy Board Our strategy Application areas Energy generation and supply.mht

Energy Security and the IEA ExCo on Combustion

Prof Phil Hutchinson

24 Sept 2009

31st TLM on Combustion

The Purpose of the Discussion

- Should we launch a task or set of tasks on Combustion Research related to Energy Security?
- If so what should be the structure?
- Which topics are of interest?
- Who would wish to participate?
- Who will lead the collaboration?
- What are the next steps?

Energy Security

- Energy security is an issue for those nations which consume more energy than is available from indigenous sources.
- The affected group includes the present member countries of this IEA collaboration.
- A failure to secure adequate energy supplies at an acceptable price prejudices both national and economic security.
- Energy security is thus a major policy issue.

Energy Security

- A proper understanding and analysis of energy security involves interactions between at least:
- International politics
- Defence
- Economics and economic development
- Present and future technologies
- National infrastructure
- Resource distribution
- Environmental science and politics

Energy Security

- The issue is not simply driven by an energy shortage, but rather depends on the ability to effectively utilise and control available sources of supply.

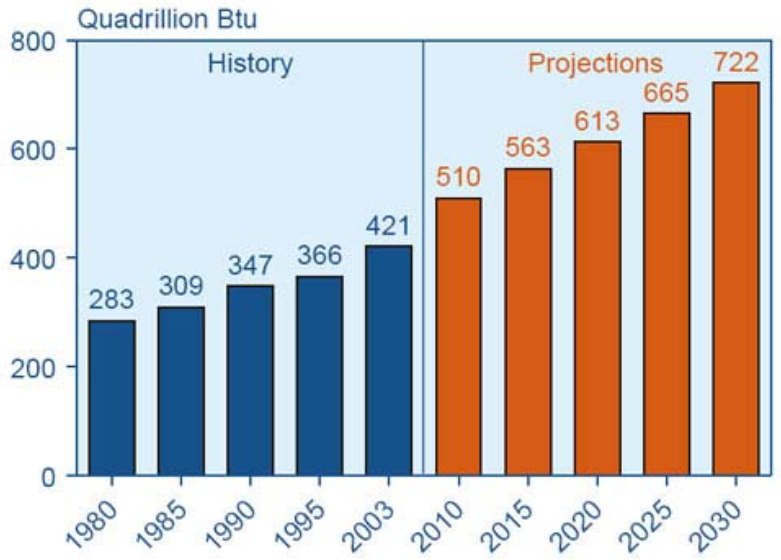
- It is noteworthy that the global supply of solar energy massively exceeds present human consumption.

Energy Security

- In the near to medium term the primary energy source will remain hydrocarbon fuels as the energy infrastructure is centred around it as a source.
- This is particularly true in the road and air transport sectors.
- This infrastructure and vehicle fleet have lifetimes of 10 to 20 years and are built around liquid hydrocarbon fuel.

EIA **Forecasts**: World Energy Consumption

Figure 7. World Marketed Energy Consumption, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

Figure 10. World Marketed Energy Use by Fuel Type, 1980-2030

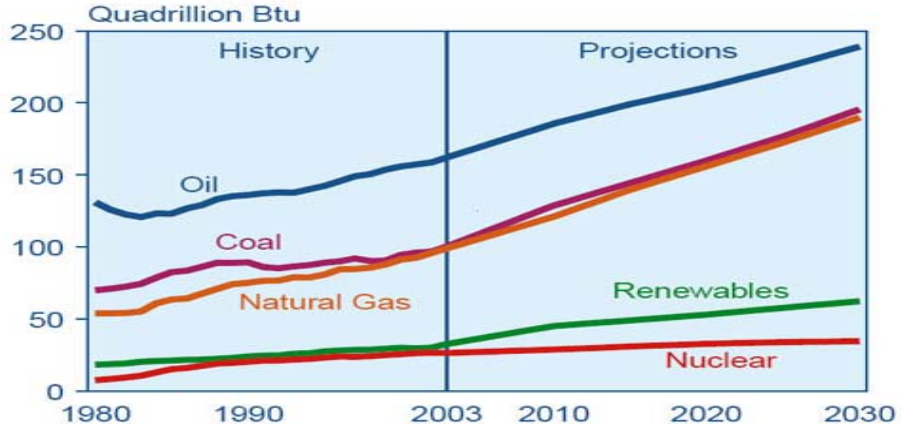
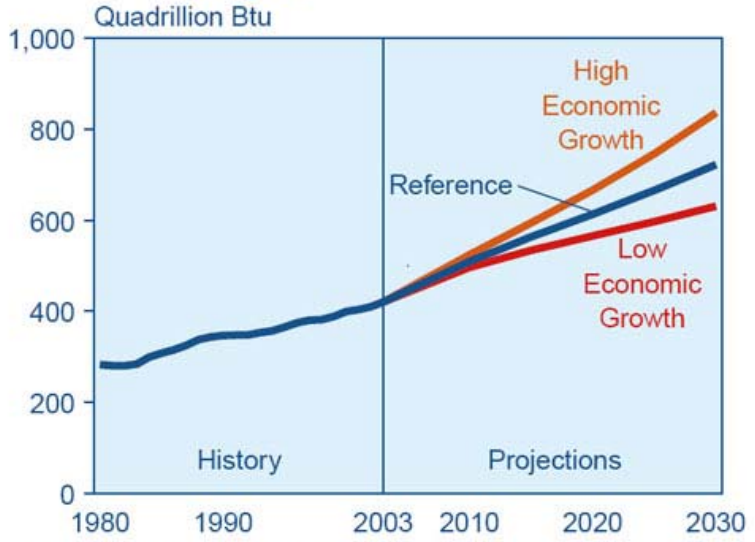


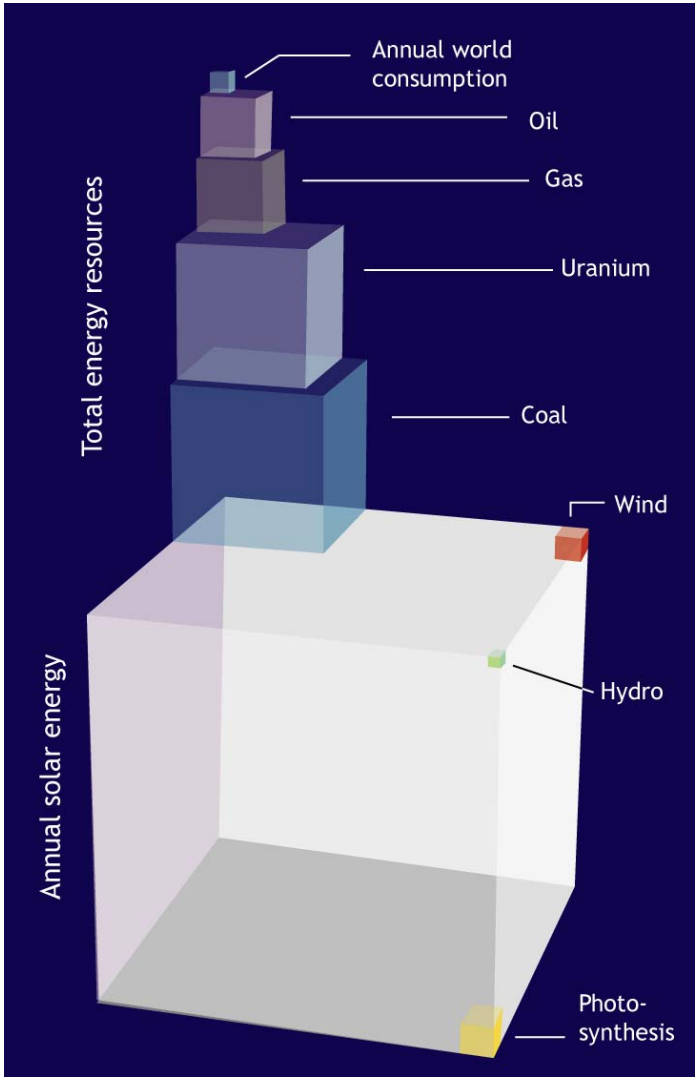
Figure 14. World Marketed Energy Consumption in Three Economic Growth Cases, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

Source: U.S. Energy Information Administration (EIA), International Energy Outlook 2006 http://www.eia.doe.gov/oiaf/ieo/world.html

Is there a shortage of energy?



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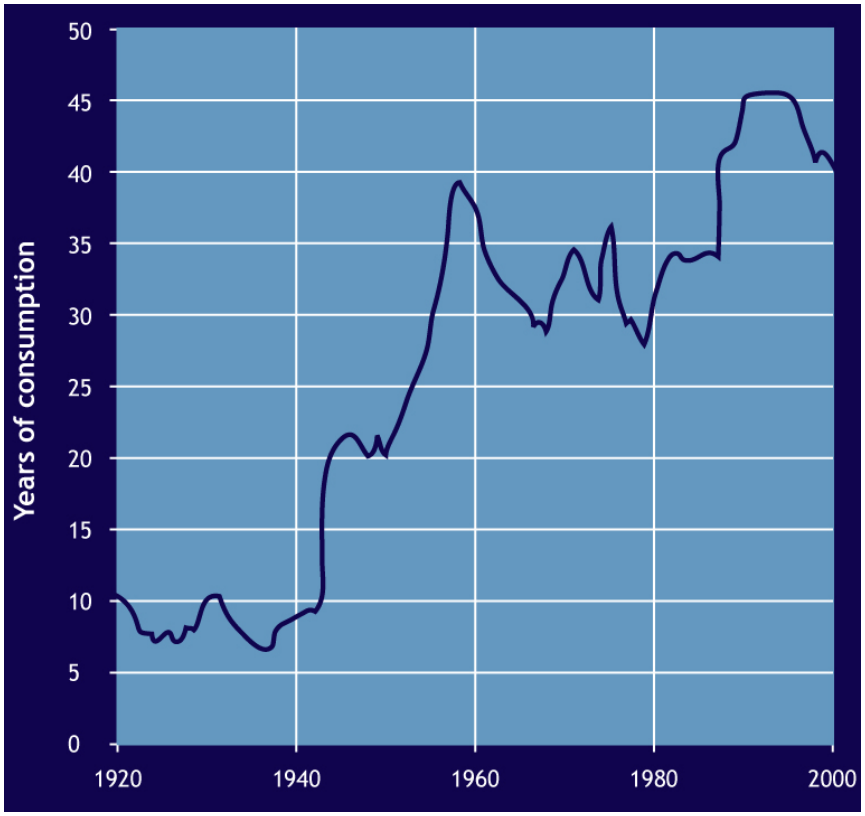

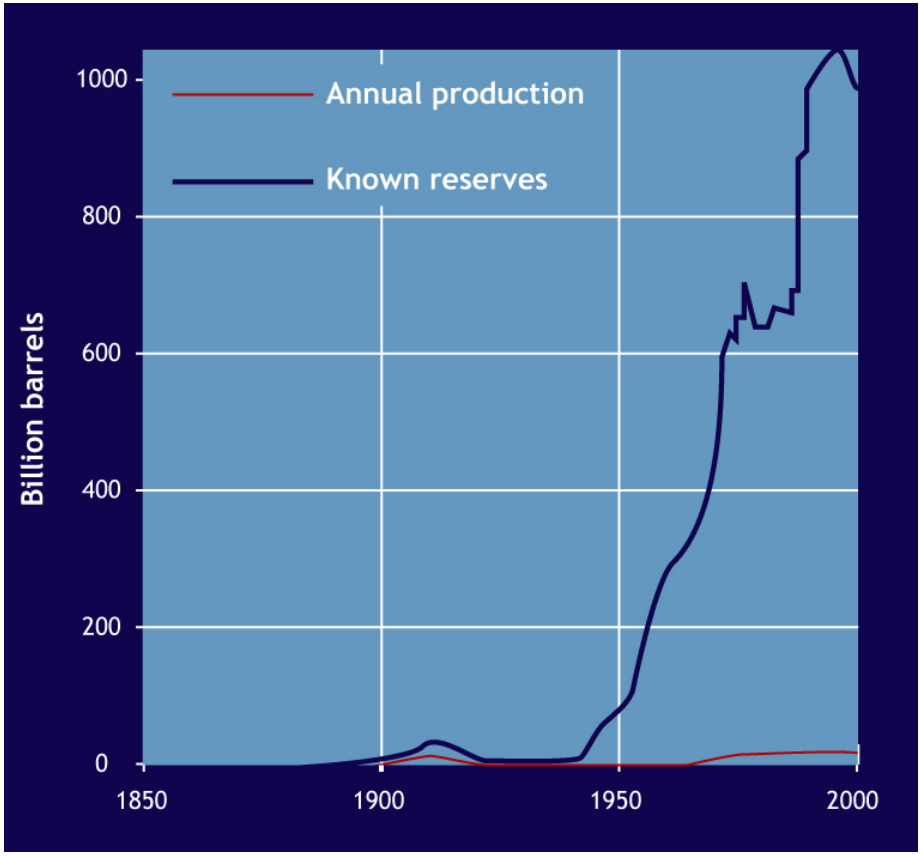

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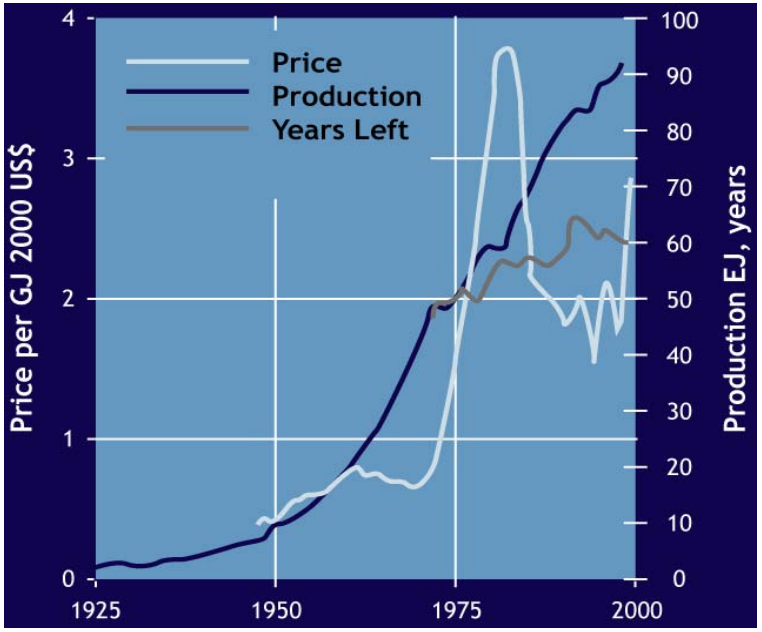
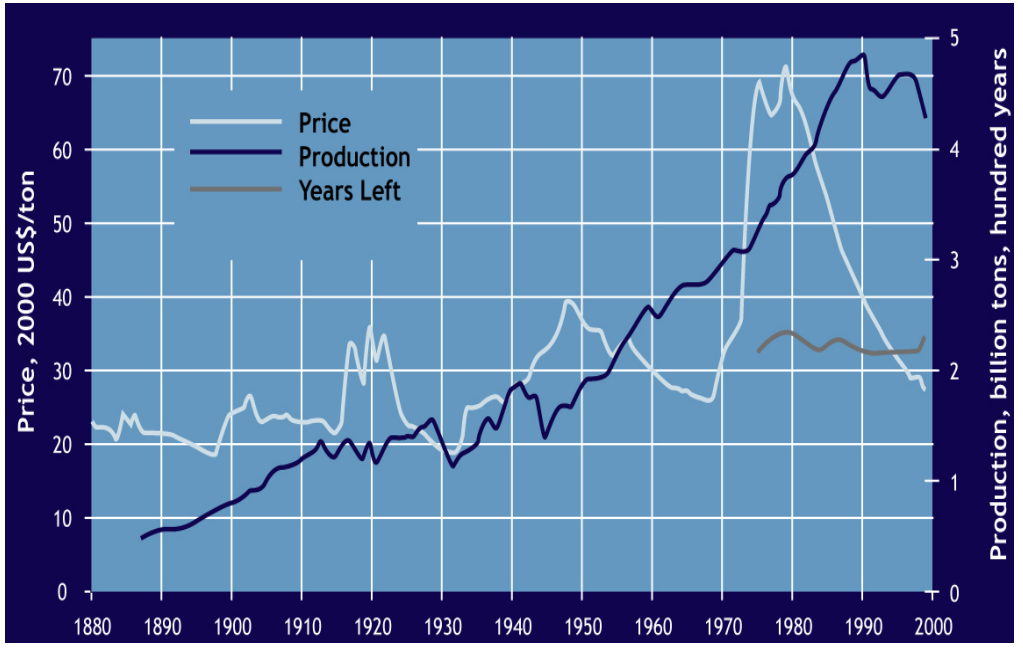
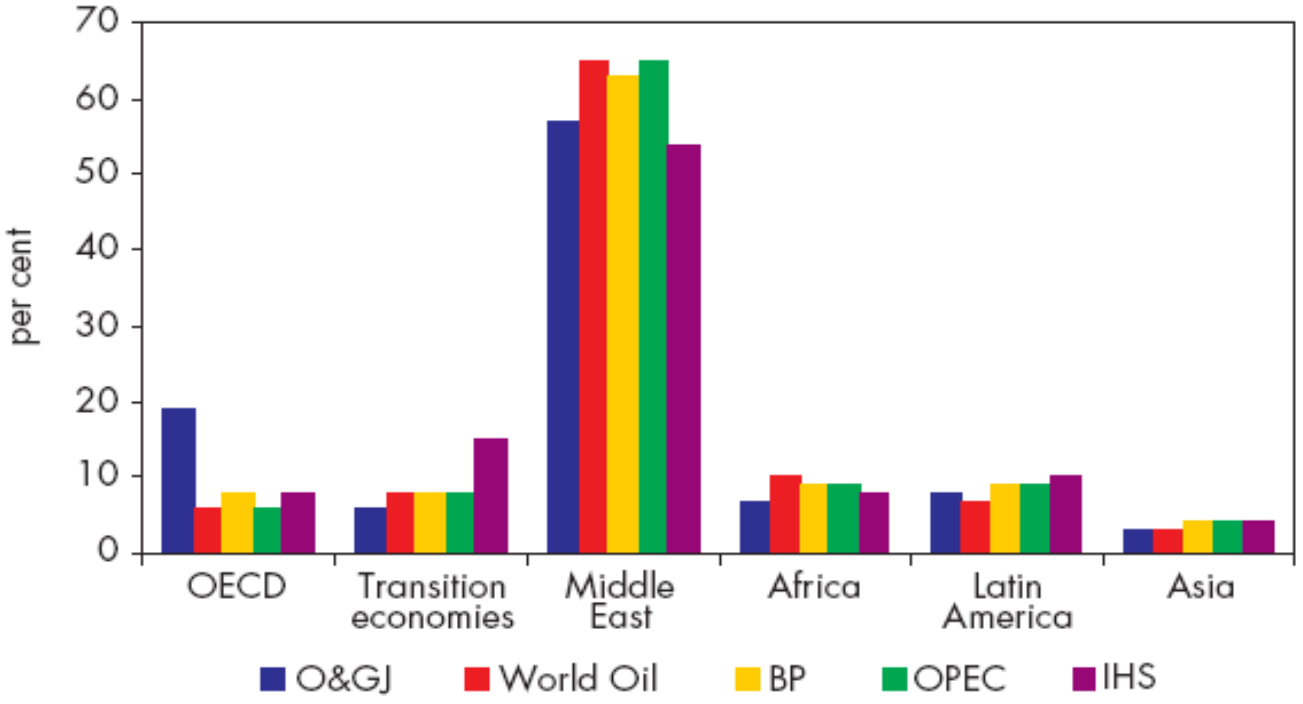




World Proven Oil Reserves by Region



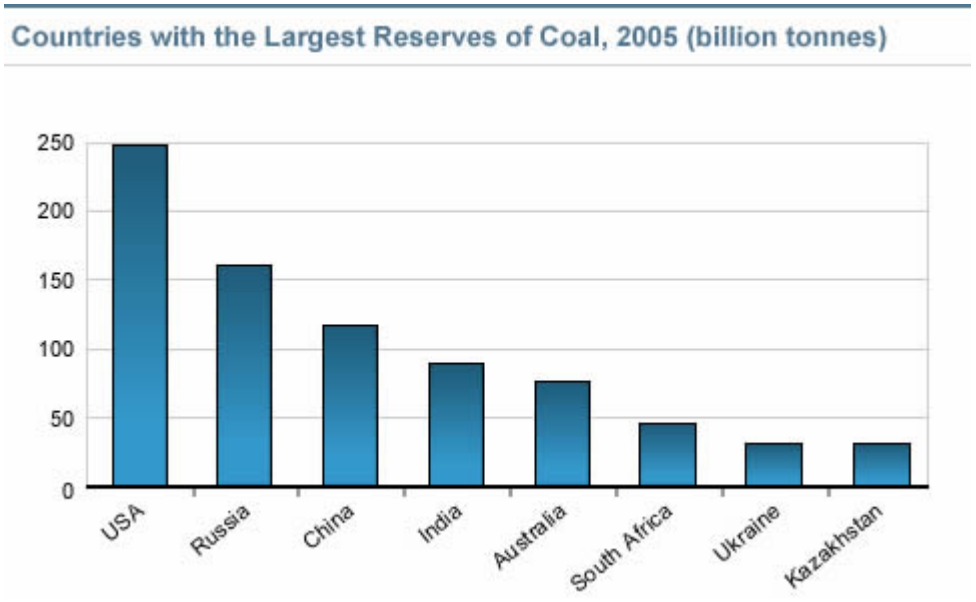
Producers, exporters and importers of crude oil

Producers	Mt	% of World total
Saudia Arabia	409	11.5
Russia	378	10.7
United States	350	9.9
Mexico	178	5.0
Islamic Rep of Iran	176	5.0
People's Rep of China	169	4.8
Norway	156	4.4
Venezuela	153	4.3
Canada	133	3.7
United Kingdom	115	3.2
Rest of the World	1,331	37.5
World	3,548	100.0

Exporters	Mt
Saudia Arabia	303
Russia	162
Norway	151
Islamic Rep of Iran	119
Venezuela	109
Nigeria	105
Mexico	93
Iraq	90
United Kingdom	87
United Arab Emirates	79
Rest of the World	663
World	1,961

Importers	Mt
United States	526
Japan	209
Korea	119
Germany	105
Italy	91
France	86
India	79
Netherlands	61
People's Rep of China	60
Spain	58
Rest of the World	663
World	2,057

World Coal Reserves



World Hydrocarbon Reserves

- Oil Reserves are concentrated in the Middle East.
- Gas Reserves are concentrated in the Middle East and Russia.
- Coal Reserves are widespread and large.

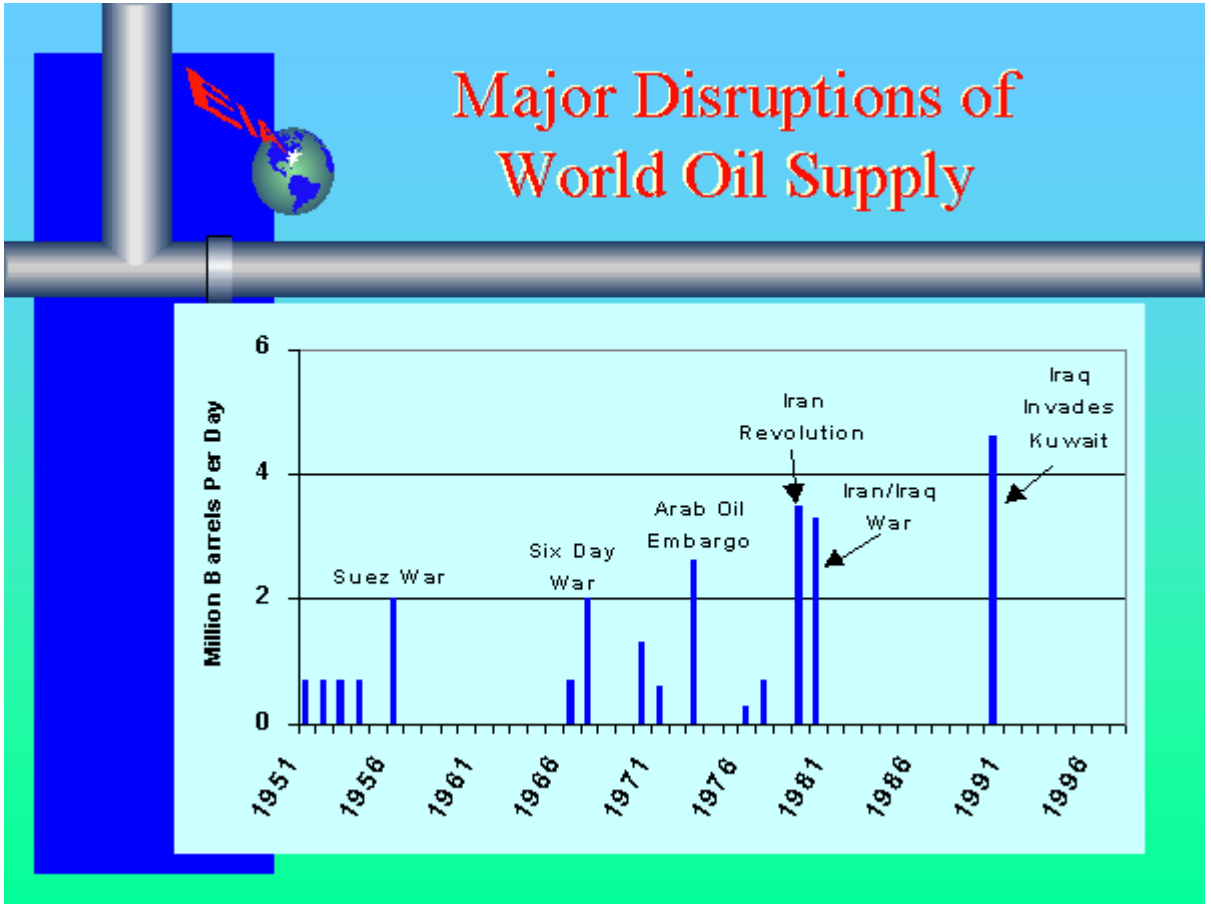
Energy Security

- In the near to medium term hydrocarbon fuels will continue to be the primary energy source as the energy utilisation infrastructure is built around them.
- As long as markets work a sound Energy Security Policy is to be able to afford the prevailing price, but….
- The regional concentration of oil and gas reserves poses a threat to orderly markets.

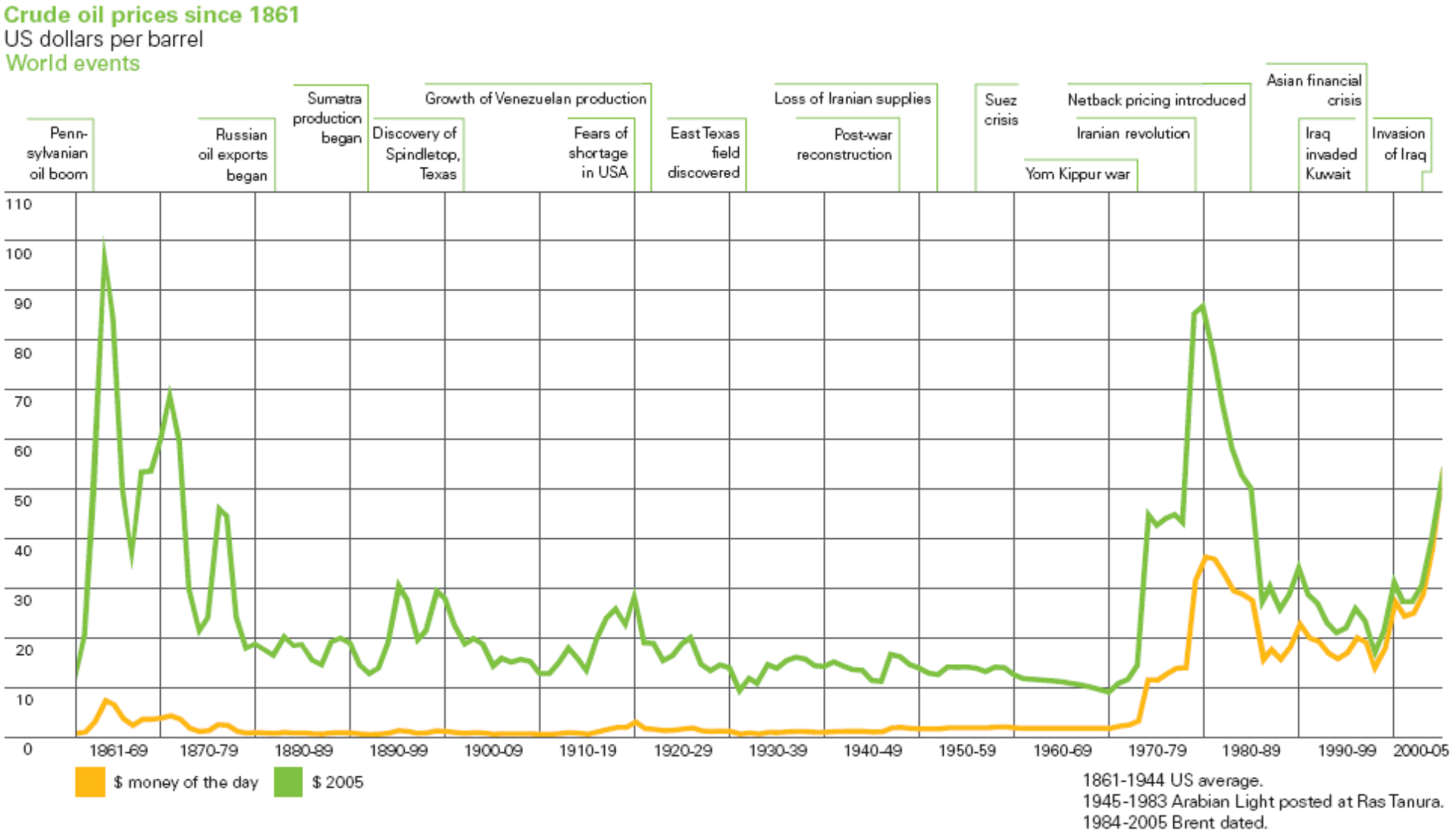
Oil Supply Disruptions

- The 1973 Arab Oil Embargo was the first oil supply disruption to cause major price increases and a worldwide energy crisis.
- In Fifteen years during the last half of the 20th century major disruptions in world oil supplies have occurred. Six of those instances decreased the world oil supply by at least 2 million barrels per day.
- In 1950, the United States provided 52 percent of the world's crude oil production; by 1997 that figure had dropped to 10 percent.
- Virtually all spare oil production capacity was in the Middle East when the Arab Oil Embargo began in October 1973.
- Supply disruptions increased in severity as world oil production increased and production shifted to less secure areas of the Middle East.
- Source: Energy Information Administration, Interagency Database and Projections Working Group.

Major Disruptions of Oil Supply



Nominal & Real (Yr2005) World Oil Prices, 1861-2004, ($/bbl)



Source: Peter Davies London, June 14, 2006 - BP Statistical Review of World Energy, 2006

Energy Security – What to do?

- Increase the energy intensity of the economy (GDP per unit of energy), for example by rational conservation measures.
- Use a wide range of different fuels including coal (fuel flexibility and substitution).
- Ensure adequate access to guaranteed minimum supplies in the event of supply disruption by creating reserves.
- Develop indigenous supplies including renewables.
- Stimulate oil and gas prospecting.
- The security problem will be significantly exacerbated if we do not use some fuel sources such as Coal and Oil Shale.
- Develop a reliable long life energy source.

Energy Security and Combustion 1

Most energy still comes from burning things ranging from wood to gas and is likely to continue so to do for the foreseeable future (25 years).

Thus combustion technology has a substantial role to play in setting the scene and defining options for policy makers.

Energy Security and Combustion 2

The first and most obvious contribution of combustion technology must be to improve device efficiency at acceptable emission levels so as to facilitate rational conservation.

We already have this in hand, though we might wish to highlight some elements of our present program in this new context.

Sectors -Stationary Combustors

The Boiler and Furnace Sector already has well developed fuel flexibility and multi-fuel capability.

It also has a wide range of options for substitution of energy from combustion by energy from nuclear, solar, wind, wave and other renewables.

Therefore I conclude that there will be few possibilities for new combustion research in this area.

Sectors – Transportation.

Most new railways are electrified and, therefore, powered by stationary sources.

Road and air transport are built around the use of liquid hydrocarbons and given the long life of the fleet and infrastructure pose interesting opportunities for combustion research.

Air transport is likely to provide the most challenging problems.

The remaining possibilities factor into new fuels, new devices and their interplay.

New Fuels

If imports of energy can be reduced then energy security improves.

This implies development of indigenous sources which will include renewables and the substitution of oil by alternative fossil fuels such as coal and oil shale.

Given the size and longevity of the present fleet, the transport sector, and particularly air travel, is likely to require liquid hydrocarbon fuels for the foreseeable future.

The alternatives to imported oil are likely to be bio fuels, and oil from coal, tar sands or oil shale.

New Devices

As the future fuel market diversifies combustion devices with fuel flexibility will offer important advantages.

This might be particularly important in a Defence context.

An initiative on multi fuel or fuel flexible combustion systems would be relevant.

The issues will differ according to the application.

Interplay Between New Fuels and New Devices

Both new fuels and new devices can be designed to new specifications.

Both manufacture and use require energy.

An interesting question is “Where does the optimum lie between these two areas?”.

For example, Which combination of biofuel and engine would be the most energy efficient?

Questions and Discussion

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