

Petroleum Industry Sustainability



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Petroleum Geoengineering

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Sustainable Development

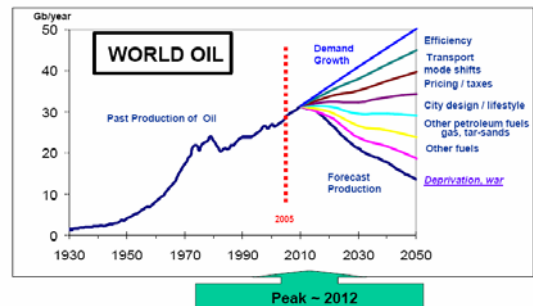
We humans have now coined a name for our survival instinct: its called "sustainable development"

Jonathon Porritt (Independent, Nov 2005)

Talk Outline

- Context
 - Peak Oil, Global Warming, Sustainability
- Industry Activity
 - IOR/EOR
 - CO2 and Clean Fossil
 - Solar, Wind, Marine, others
 - Biofuels
- Conclusions

A Chinese View on Peak Oil

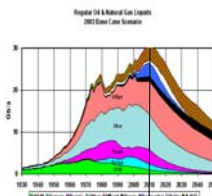
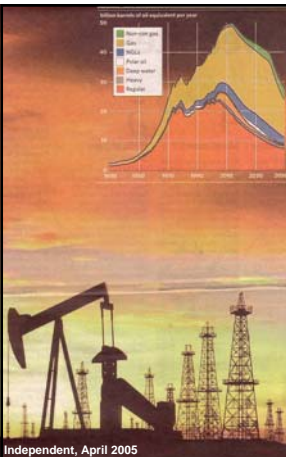


"The Chinese government is well aware of peak oil."

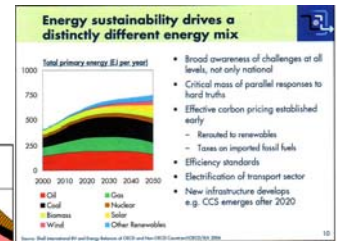
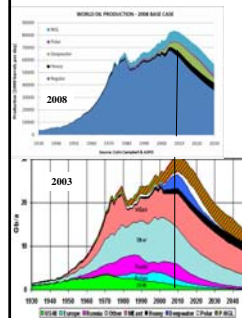
Pang Xiongqi, China University of Petroleum in Beijing

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Peak Oil



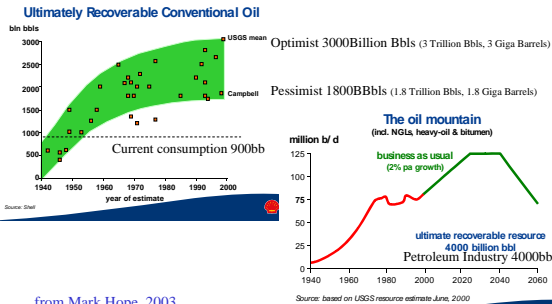
Future of Oil and Gas



Energy sustainability drives a distinctly different energy mix

- Broad awareness of challenges of oil levels, not only national
- Critical mass of parallel responses to hard truths
- Effective carbon pricing established early
 - Restricted to renewables
 - Taxes on imported fossil fuels
- Efficiency standards
- Electrification of transport sector
- New infrastructure develops e.g. CCS emerges after 2020

Future of Oil Supplies



Definition of Sustainability

- Meeting present needs without compromising the ability of future generations to provide for their own need (Brundtland)
- Apply knowledge and technology with reference to social, economic and environmental factors (Dresner)
- We humans have now coined a name for our survival instinct: its called "sustainable development" (Porrit)

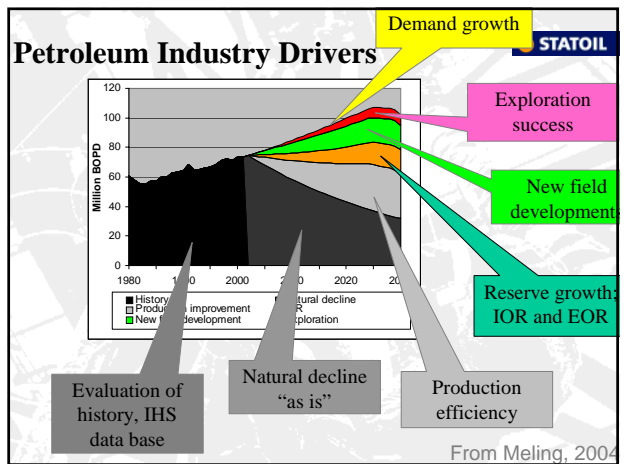
Industry Sustainability Principles

- Respect and safeguard people
- Engage and work with stakeholders
- Maximise benefits to the community
- Minimise impact on the environment
- Use resources efficiently
- Maximise profitability
- Integrate operations into local community
- Minimise the environmental impact
- Enhancing the value of hydrocarbon resources
- Develop new energy resources
- Improve products and their use

SHELL

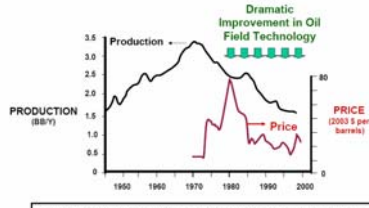
TOTAL

Petroleum Industry Drivers



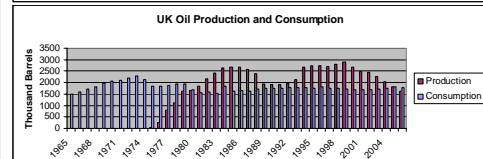
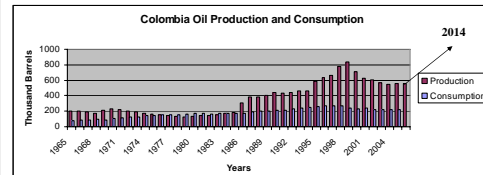
Need to show that new technology delays depletion

Experience: U.S. Lower 48 States Oil Production

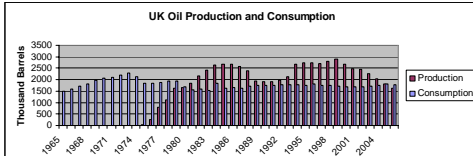
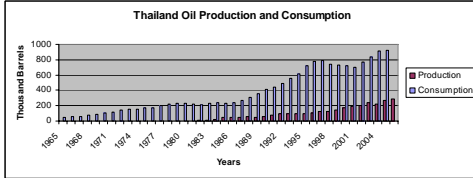


Hirsch, 2005

Where are we heading?

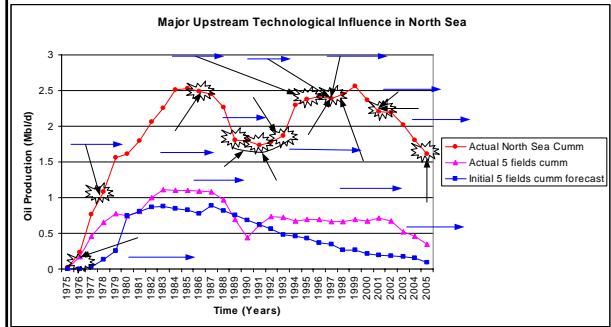


Where are we heading?



Source: BP Statistical Review (compiled by HWU)

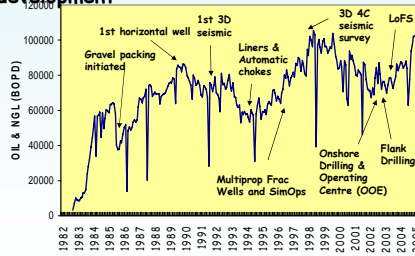
Upstream Technology Vs North Sea Production



Ahmed, 2006

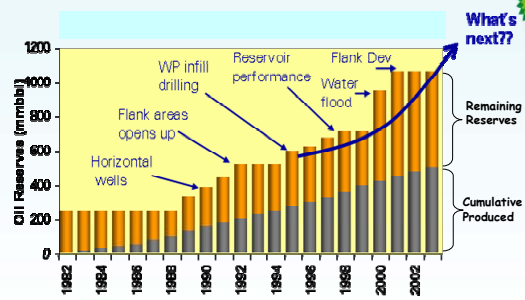
New technology can delay depletion

Valhall - a history of technology development



avimore 05
North Sea Subsurface Convention

Valhall - A history of increasing reserves



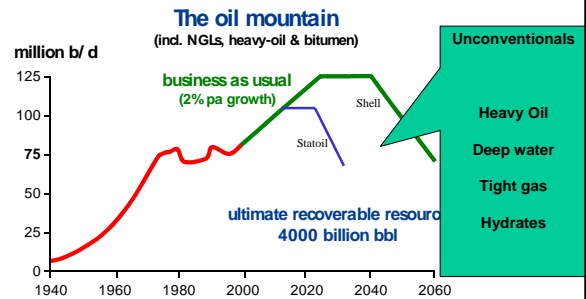
avimore 05
North Sea Subsurface Convention

Petroleum Geoengineering

- Less disintegration between disciplines
- More focus on improving World's recovery factor
- 1% increase in recovery factor = 10Bbbls
- 1% increase and efficiency could give up to 4yrs extra petroleum supply

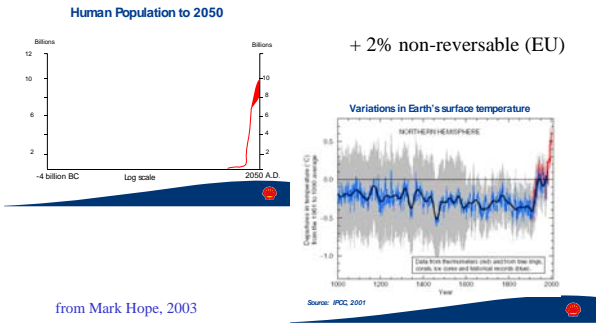


Unconventional Hydrocarbons

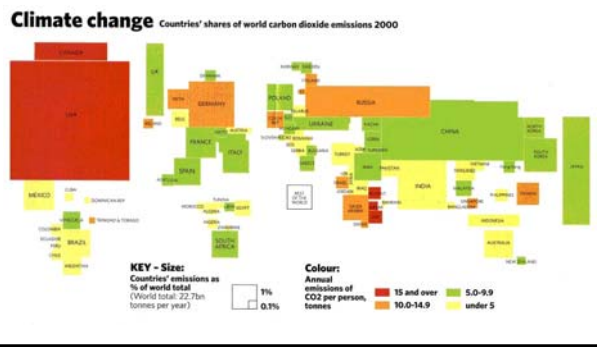


Source: based on USGS resource estimate June, 2000

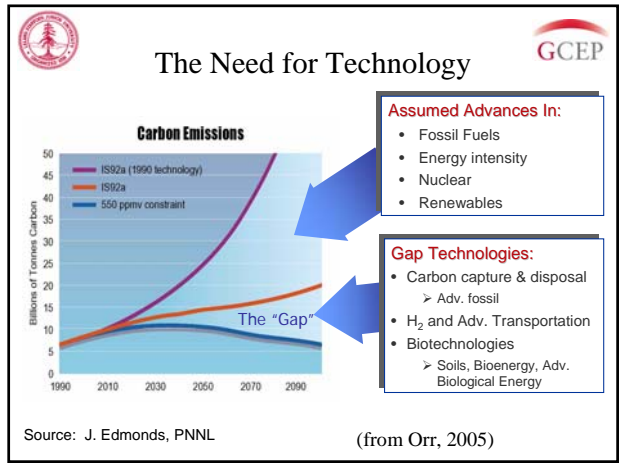
Society and Environmental Drivers



Global Emissions



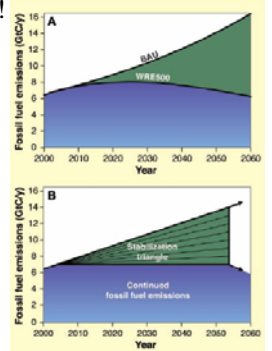
The Need for Technology



The challenge: find ways to reduce emissions or increase uptake by Gt quantities!

- Pacala and Socolow suggested thinking in terms of "wedges"
- A wedge is an activity that grows over ~50 yrs to equal 1 Gt C
- Partial wedges would work, too, but then more of them are required.
- Wedges are big!

Source: Pacala and Socolow, Science, Aug, 2004 (from Orr, 2005)



7 wedges of the stabilisation triangle

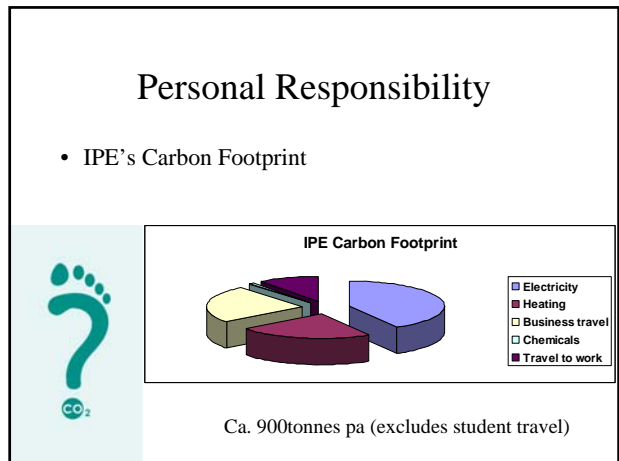
Wedges	Detail	Feasibility
Efficiency	Double fuel efficiency of 2 billion cars from 30 to 60 mpg	There are 600 million cars in the world today. Projection is 2 billion by 2054. 1 wedge • Double the average fuel efficiency of the fleet.
Fuel Switching	Replace 1400 coal electric plants with natural gas-powered facilities (Adding an amount in 2054 almost equal to today's world gas usage)	1 wedge • bringing one Alaska pipeline on line every year for 50 years; or 1 wedge • 50 large LNG tankers docking and discharging every day
Carbon capture and storage	Capture AND store emissions from 800 coal electric plants	1 wedge • 3500 In Salah developments (each need to last through to 2054)
Nuclear	Add double the current global nuclear capacity to replace coal-based electricity	400 nuclear plants today, 1 wedge • adding 700 more in the next 50 years
Wind	Increase wind electricity capacity by 50 times relative to today, for a total of 2 million large windmills	1 wedge • windmills on an area approx 4 times that of UK
Solar	Use 40,000 square kms of solar panels to produce hydrogen for fuel cell cars	1 wedge • solar panels covering area 230 times the area of London (1/12 size of UK)
Natural sinks	Eliminate tropical deforestation AND create new plantations on non-forested land to quintuple current	1 wedge • new plantations with a total area 25 times that of the UK

Carbon Capture

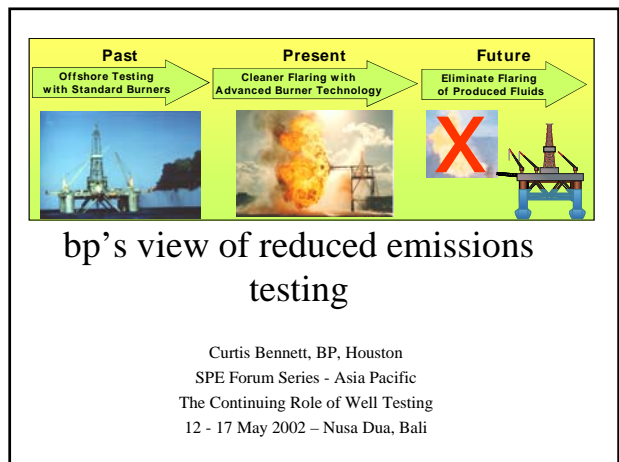
Project	Tonnes/year	
Global emissions	24000000000	Per planet
Shell's transport biofuels 350000 tonnes/yr		
Airline emissions	8800000	Per country (UK)
Statoil's Sleipner project (Norway)	1000000	Per field
Retrofitting carbon capture	450000	Per 600MW coal-fired power station
K12B project (Netherlands)	22000	Per field
Election Helicopters	100	Per party
Car pooling (Liftshare)	19	Per route (Saving)
Flight to SE Asia	12	Per flight
"Chelsea Tractor"	6	Per car
Renault Scenic	3	Per car
Flight to Europe	2	Per flight
Hybrid Car	1.5	Per car
Travelling by bus	1	Per passenger
Windmill	1	Per household (Saving)

THURSDAY 12 MAY 2005 THE INDEPENDENT
 791 MARSH WALK, LONDON E14 9RS
 tident.co.uk (NO ATTACHMENTS PLEASE)
 FAX: 020 7005 2056
 SEND YOUR FULL STREET ADDRESS AND
 NO NUMBER. LETTERS MAY BE EDITED

Nuclear power is not the magic answer
 Sir: Your article "Nuclear power may be the only way, says chief scientist" (12 May) overestimates the scope of nuclear power in fighting climate change.
 About a quarter of the UK's greenhouse gas emissions come from electricity. Nuclear power now provides around a quarter of this electricity. Even if we double nuclear generation, it would only reduce greenhouse gas emissions by at most 8 per cent - nowhere near the 60 to 80 per cent cuts which will be needed by 2050 to avoid dangerous climate change.
 The investment needed to replace our nuclear plants, let alone double the current number, would be far better spent elsewhere. **Energy efficiency, carbon capture and storage, energy generation and renewable energy all have huge potential.** Nuclear power is not a silver bullet that will kill the threat of climate change. It may simply be an expensive and ineffectual diversion.
TONY JONNER
 EXECUTIVE DIRECTOR
 FRIENDS OF THE EARTH
 LONDON SW1



- ## Petroleum Industry Trends
- Carbon Mitigation Initiative, Princeton Univ.
 - funded by BP and Ford in 2000
 - Economic, social, environment AND stewardship (UKOOA, 2001)
 - Oil industry genuinely trying to reinvent itself (Side, 2002)
 - Global Climate and Energy Project, Stanford University
 - Set up by ExxonMobil, Schlumberger 2002
 - Zero-emissions testing reducing carbon emissions (BP, 2002)
 - BP Solar records first profit (2005)
 - BP builds wind farm in Amsterdam (2005)
 - Total invest in Marine Energy (2005)
 - Total build biggest wind farm in France (2007)
 - Energy Biosciences Institute (Berkley, Illinois, Lawrence Berkley)
 - \$500M over 10 years invested by BP (2007)
 - Oil & Gas UK (formerly UKOOA) stakeholder meetings (2003-7)
 - UK Energy Technology Institute (2008)
 - £1B over 10years part-funded by BP and Shell



BP's Miller Field Project

- CO2 emissions down by 90%
- 1.3 M t/yr capture and stored
- Commence in 2009
- Delays abandonment beyond 2007
- Extend field life 10-20yrs
- Extra 40 MMBO

CANCELLED

Waiting on the post-combustion Competition (Marathon)

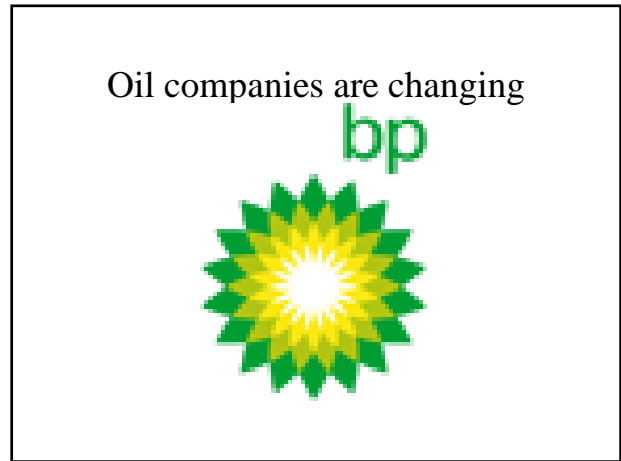
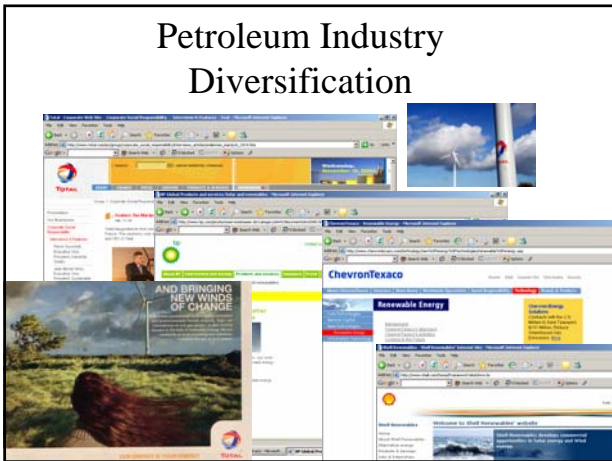
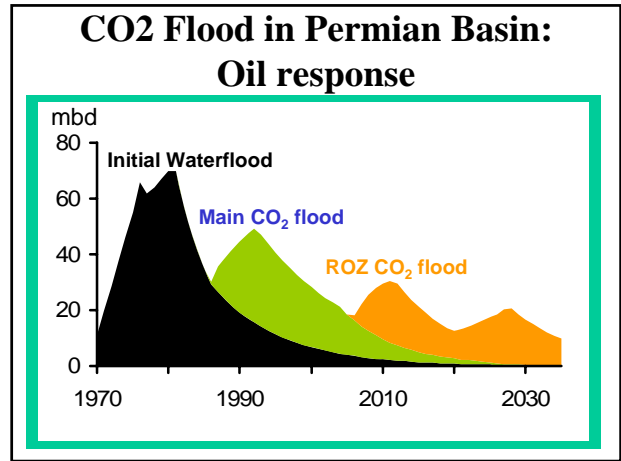
<http://www.bp.com/>

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**Recent UK
 Announcement of 4
 projects by 2014 – 2
 pre-combustion and
 two post-combustion**

<http://www.bp.com/>



To broad energy companies

“bp solar profitable in the last 2 years”

“bp alternatives – solar, hydrogen, wind and cleaner gas generation”

“bp want to remove 24 million tonnes CO₂ per year by 2015”

“bp will spend \$8billion over 10 years on alternatives”

“regional solutions important – local energy company”

“bp want to be world leader in low-carbon power generation”

But.... in 2009

“The mantra in BP today is ‘every dollar counts’”
Tony Hayward

Cuts in solar cell production in Australia
Ended wind power business outside US
Scrapped two CCS power station projects

“bp solar profitable in the last 2 years”

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Renewables and the Oil Industry

Web page search hits	2004	2006	2008
– Shell	1150	1182	963
– BP	150	200	890
– TOTAL	105	153	309
– ChevronTexaco	36	72	235
– ExxonMobil	-40	30	31
– ConocoPhillips	5	21	10
– HWU		17	32



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"Behind the spin, the oil giants are more dangerous than ever"
George Monbiot, Guardian 13 June 2006

Petroleum Industry and Solar

- BP Solar
 - 30yr History
 - Merger with Amoco (Solarex)
 - 7th largest PV company (3rd in 2000)
 - 5 technologies
 - Production in US, Spain, Australia
 - Recent projects in Germany, India, Angola, Australia, Philippines, USA, and China
- Shell Solar
 - 25 year history
 - 10th largest PV company (4th in 2000)
 - Thin film technology
- Total Solar
 - 23 year history
 - Teneosol (50:50 EDF)
- ENI Solar

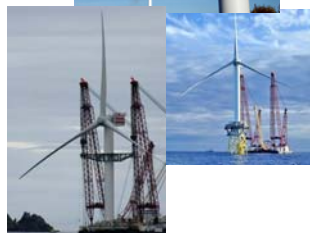


Solar latest

- BP
 - Employ 2200 staff in US – leading supplier of high quality solar. Closed plant in Spain with loss of 480 jobs as part of efficiency drive in March 2009
<http://www.solarbuzz.com/news/NewsNACO912.htm>
- Shell
 - Involved in thin film solar – but “are not the natural owner of glass” James Smith April 2009.

Petroleum Industry and Wind

- Shell WindEnergy
 - Onshore/Offshore
 - UK, Spain, Germany, France, US
- BP Wind
 - Two sites in Netherlands
- Total Wind
 - France (Mardyck Refinery and Aveyron, the largest in France)
- Talisman
 - Beatrice Wind Farm
- ChevronTexaco
 - Offshore - Gulf Coast
 - Onshore - Texas, Colorado
 - Netherlands



Wind latest

- Shell
 - Don't see Shell has any comparative advantage in wind
 - Generating electricity not core business
 - Don't plan new investment beyond 11 existing projects
 - James Smith April 2009.

Petroleum Industry and Marine

- Total
 - Iberdola, Spain
 - ScotRenewables
- StatoilHydro
 - Pelamis



Role for Oil Industry in Marine

- Focus of Marine Renewables Development in Scotland (MReDS) Project
- Focus of European initiatives
- Exploit a mature oil sector providing expertise in key elements needed for offshore renewables:
 - systems and reliability engineering
 - moorings and structures
 - offshore installation
 - operation and maintenance
 - project management



(Sutton, 2008)

Using Renewables

14 **EXPLORER** Recent Industry Article

Geo-Energy Powers Kansas Oil Field

Temps Fuel A New Breed of 'Rocking Donkeys'

Cutter Platform North Sea
Courtesy of Shell UK

Petroleum Industry and Other Fuels

- Total's Biofuels/Wind/Photovoltaics
- BP/Shell/Total's Biofuels
- Shell's Photovoltaics/BP Solar
- LPG
- Shell Hydrogen Car/Busses
 - ChevronTexaco (Unocal)
- Geothermal
 - Norsk-Hydro, Total
- Hydro-Electric

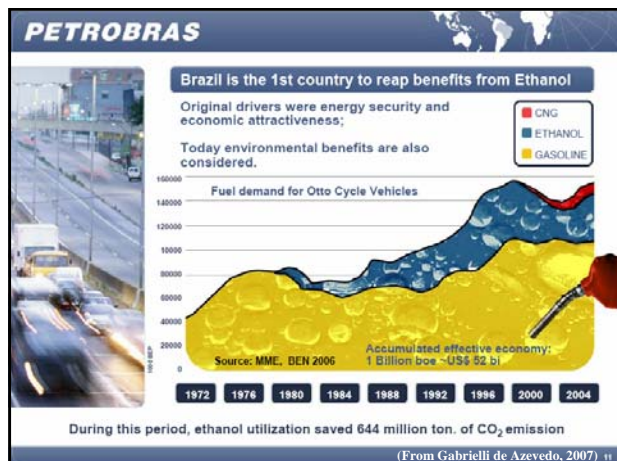


Shell are the World's largest supplier of transport biofuel
Total are the World's largest supplier of rape seed ethanol

Industry Activity

Company	Renewables	Biofuels
Shell	1182	195
BP	200	31
Total	153	36
Chevron Texaco	72	70
ExxonMobil	30	73
Petrobras	14	35

Web page search engine hits (2007)



World biofuel sources

Nearly half world sugar cane production



Brazil bioethanol supply (Petrobras, 2007)

Nearly 1/3 world main oil seed production



Second-generation Biofuels

- Non-competing feeds
 - Waste (straw, non-crop plants, sewage etc)
- Increased yields
- New enzymes (BTL)
- Biobutanol
 - Same crops as ethanol
 - Different bacterium
 - Higher Energy yield
 - Less miscible with water
- BP's Energy Biosciences Institute
 - \$500M over 10years
 - 3 US Universities



Fast growing lignocellulose From *Miscanthus* (BP, 2007)

PETROBRAS

Today : Sugar cane has the highest energy output/input ratio

Raw Material	Energy output / energy input
Wheat	1.2
Corn	1.3 - 1.8
Sugar Beet	1.9
Sugar Cane (under Brazilian Production Conditions)	8.3

Tomorrow
Lignocelluloses Biomass technology will double ethanol per ha. yield

1 metric ton of sugar cane

Molasses yields only 85 of ethanol,

But

Cane bagasse yields 185 L of ethanol
Basic calculation

(From Gabrielli de Azevedo, 2007)

Are biofuels the answer?

- Biofuels are carbon-reducing
 - Need to reduce rainforest destruction
 - Need to reduce competition with food production
 - Need to reduce energy required in production
 - Need to improve the energy content (for transport efficiency)
- First-generation Biofuels
 - Developing technology (Bioethanol is corrosive)
 - Developing Market (Shell are biggest supplier in the world)
 - Serious competition for land/food crops
- Second-generation Biofuels
 - Utilise biomass waste (wood chip, straw, bagasse)
 - Potentially more environmentally-friendly

Biofuel latest

- Shell
 - Working on the right kind of biofuels
 - Bioethanol from corn stalks
 - Biodiesel from marine algae
 - James Smith April 2009.

Who will engineer a sustainable future?

“Engineers prepared to challenge the historical orthodoxy of their profession”

Thinking out of the box

Side (2002)

“Imagination more important than knowledge” (Einstein)

Where will Sustainability lead the Petroleum Industry?

- Into Broad Energy Companies (subject to 2009 change of heart?)
- Becoming Social Enabling (CSR important)
- To be Rewarding (\$ and valued) Employers
- To further International and Multicultural Ethics/Standards

Clean Petroleum + Renewables Agenda

Petroleum Industry Sustainability

- IOR, Field regeneration, Exploration
 - Heavy Oil, Tight Gas, Shale Oil/Gas
- Commercial Renewables Subdivisions
 - Shell WindEnergy
 - BP Solar
- Reducing energy impact of operations
 - Cutter Platform (Shell/ExxonMobil)
- Reusing Offshore Infrastructure
 - Beatrice (Talisman)
 - Gulf of Mexico (ChevronTexaco)
- Developing Second Generation Biofuels
 - Total Bioethanol, BP Biobutanol, Petrobras BTL
- Corporate Social Responsibility
 - Norsk Hydro, Total investments in Marine Energy

Part of a “Cleaner Petroleum + Renewables” agenda