Global Scenarios to 2025
Scenario building workshop

February 2008

Welcome

Mathew Burrows
National Intelligence Council

Jean-Pierre Lehmann
The Evian Group at IMD

Agenda and scenario building process

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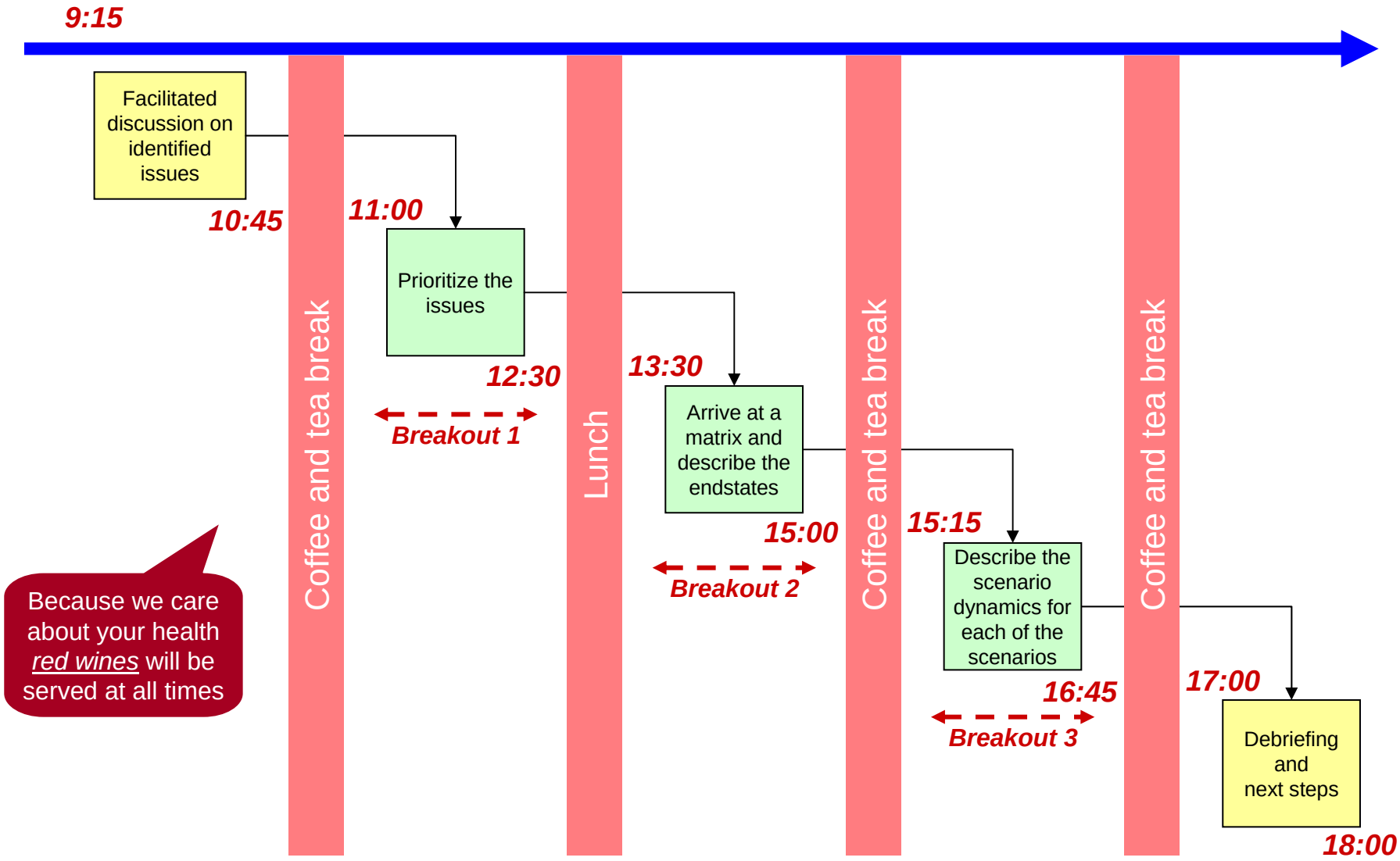
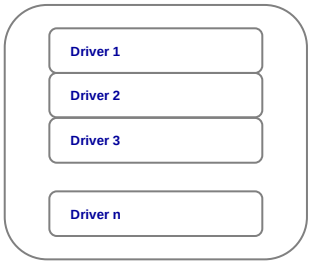
Today's agenda

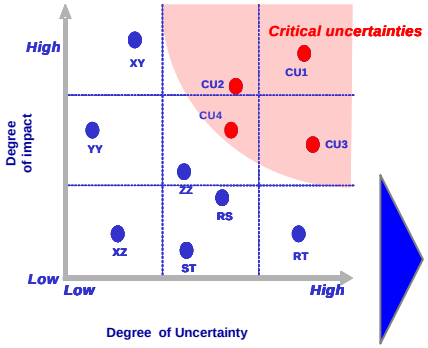


Scenario building process

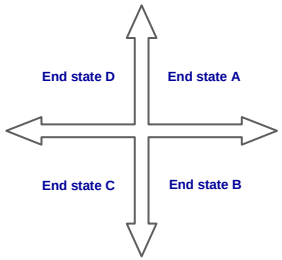
Long list of key drivers based on STEEP framework



Issue prioritization and identification of critical uncertainties



Focal questions, alternative scenarios end-states

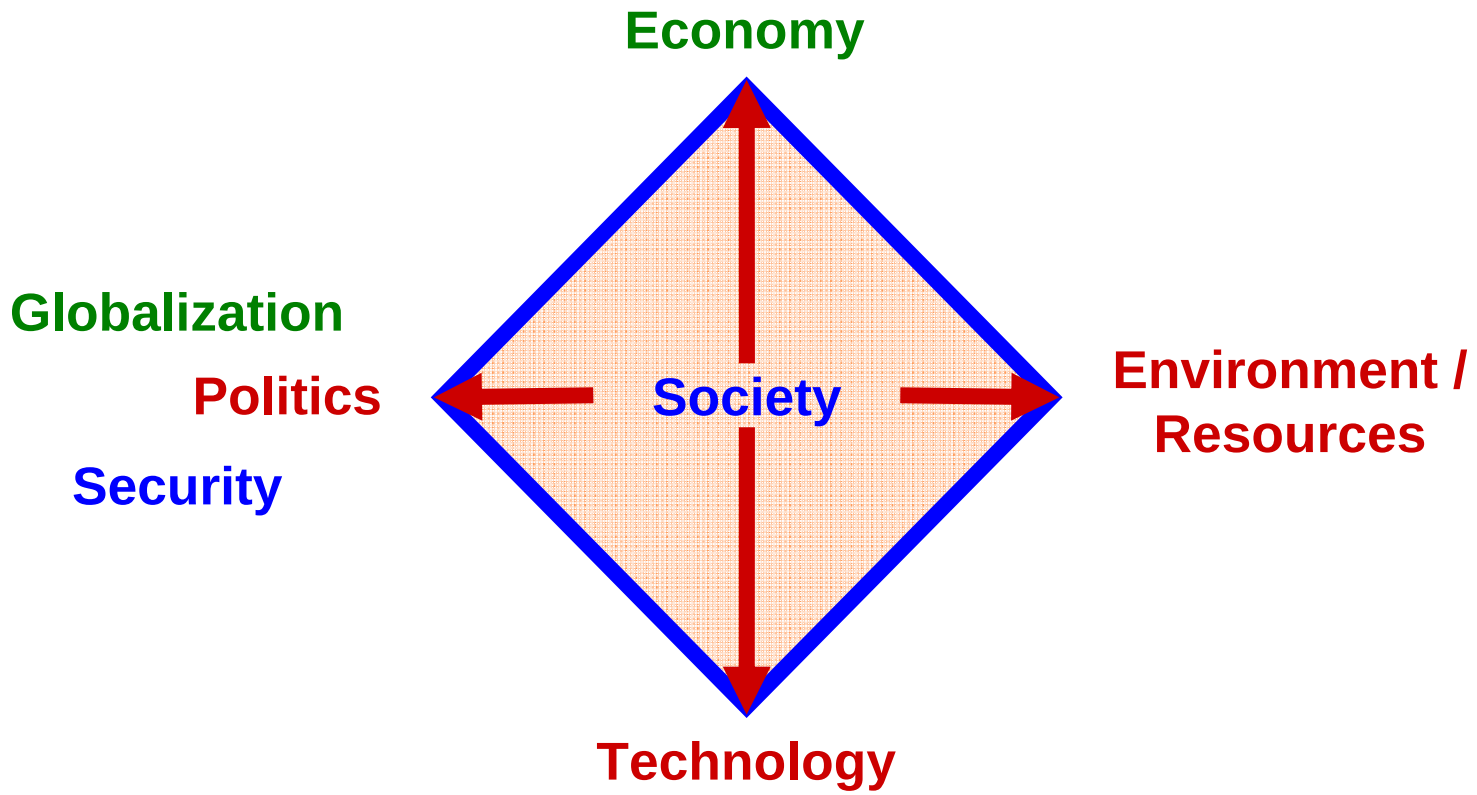


Focal questions, alternative scenarios end-states

For each scenarios	Period 1: 2009-2012	Period 2: 2013-2021	Period 3: 2022-2025
Regulatory context			
Economic growth			
Security			
Product, labor and capital markets			
Technology and innovation			
Climate change policies			
Population & Demographics			

The issue diamond framework

- **We use the ‘STEEP’ framework to identify the issues**

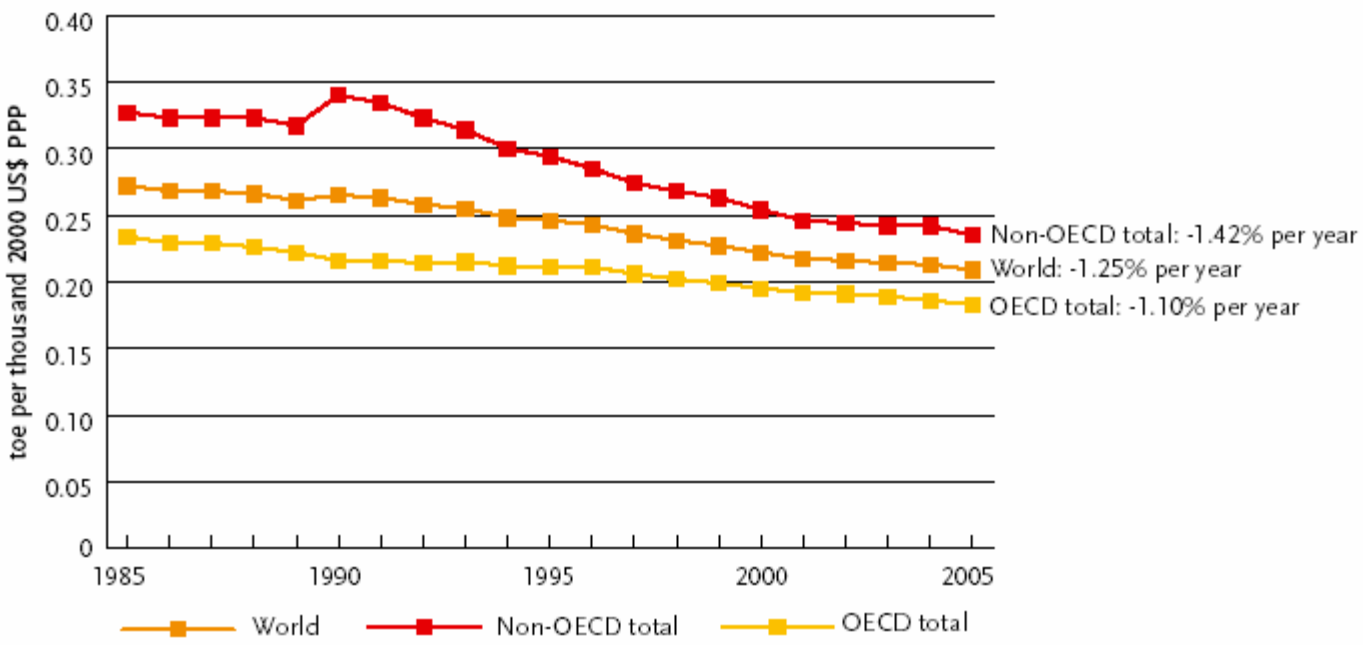


Environment and resources
Rising global energy demand – 1/3

- Global energy demand will continue to grow rapidly at about 1.9% per annum over the next 20 years (compared to 1.6% between 1980 and early 2000s). This is driven by a number of factors:
  - Rising but aging population levels: US population currently stands at 303 million, while the world's population has reached 6.6 billion (US Census Bureau). By 2025 the world population will be approaching 8.0 billion (UN).
    - Population is rising much faster in developing countries as compared to developed nations
    - The UN also observes that populations are aging in most countries, especially in OECD countries (expected to reach about 21% by 2025, compared to 8.5% in developing countries) but also in China.
  - Rising urbanization in developing countries: Since 1975, urbanization has accelerated in developing countries from about 25% to more than 40% today. This will continue and is projected to reach about 55% by 2025.
  - Rising levels of prosperity: Global economic growth has been strong over the last decade or so and this likely to continue, resulting in higher levels of prosperity. This particularly apparent in the BRIC nations

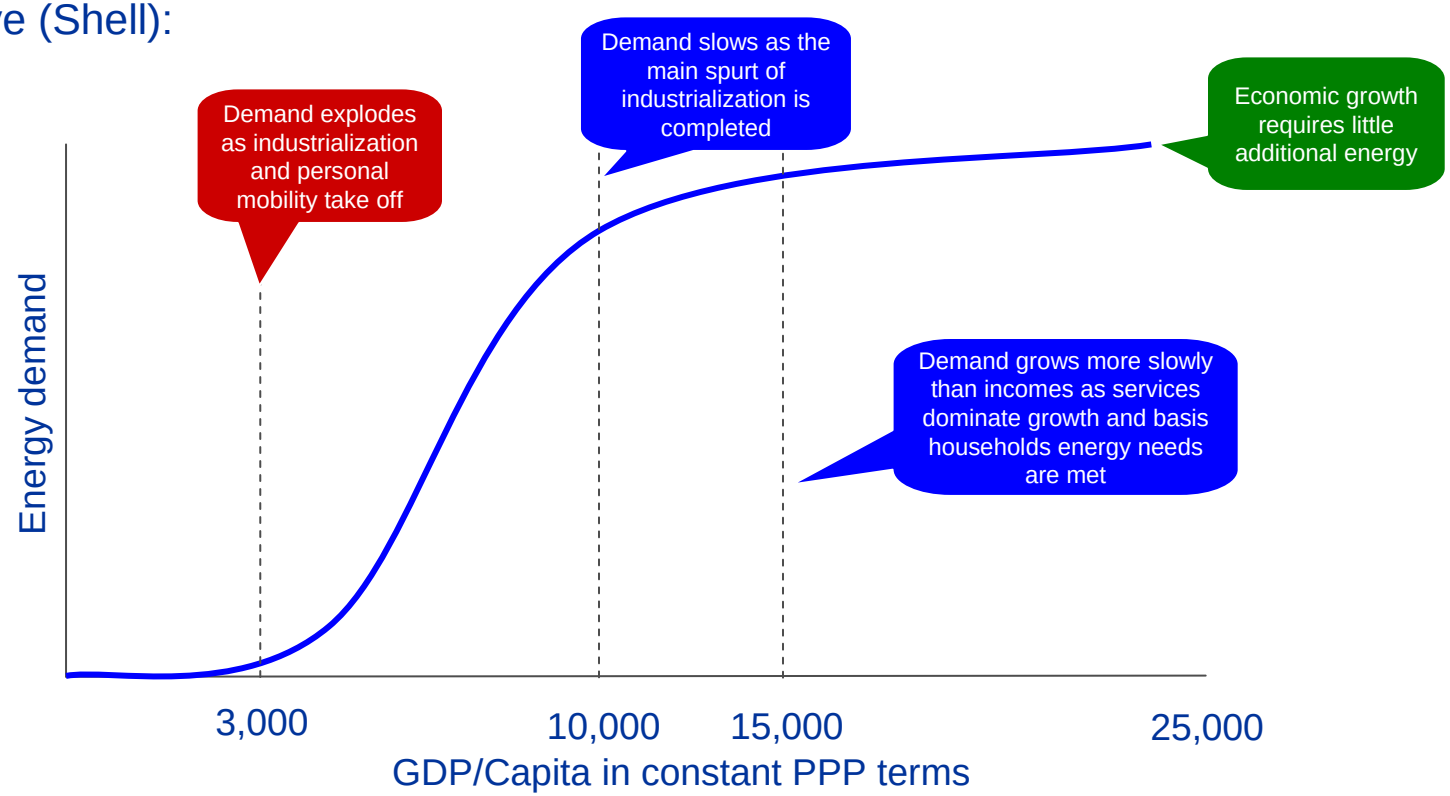
Environment and resources
Rising global energy demand – 2/3

- Global energy demand - continued
  - Declining energy intensity – Overall energy intensity has been declining, but results vary from country to country (InterAcademy Council, 2007).



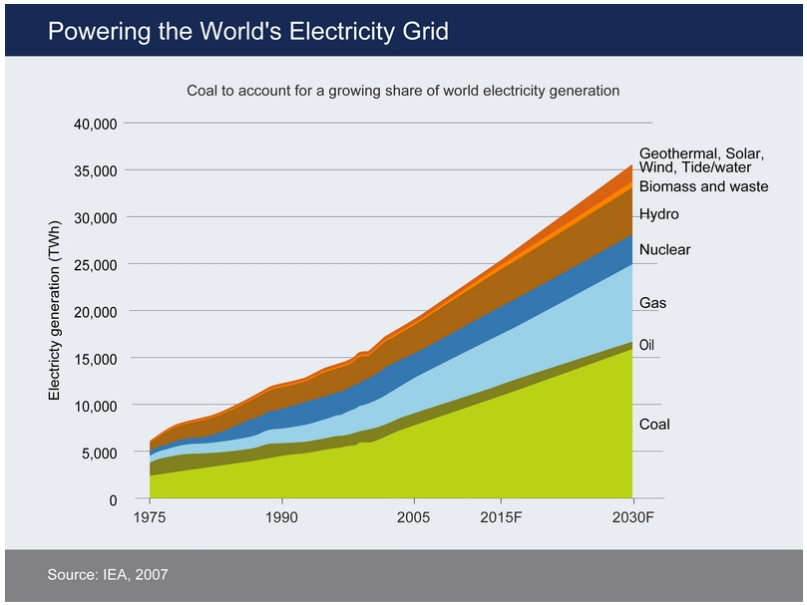
Environment and resources
Rising global energy demand – 3/3

- Global energy demand - continued
  - Non-linear energy demand growth – Historically (1980 – early 2000s, energy demand growth was quite predictable and grew about 1.6% per annum. Since the early 2000s, energy demand is growing much faster, driven by the economic rise of developing countries (especially China and India). The relationship between energy demand and economic growth is well understood and shows that it follows and S-curve (Shell):



Environment and resources
Changing supply – 1/6

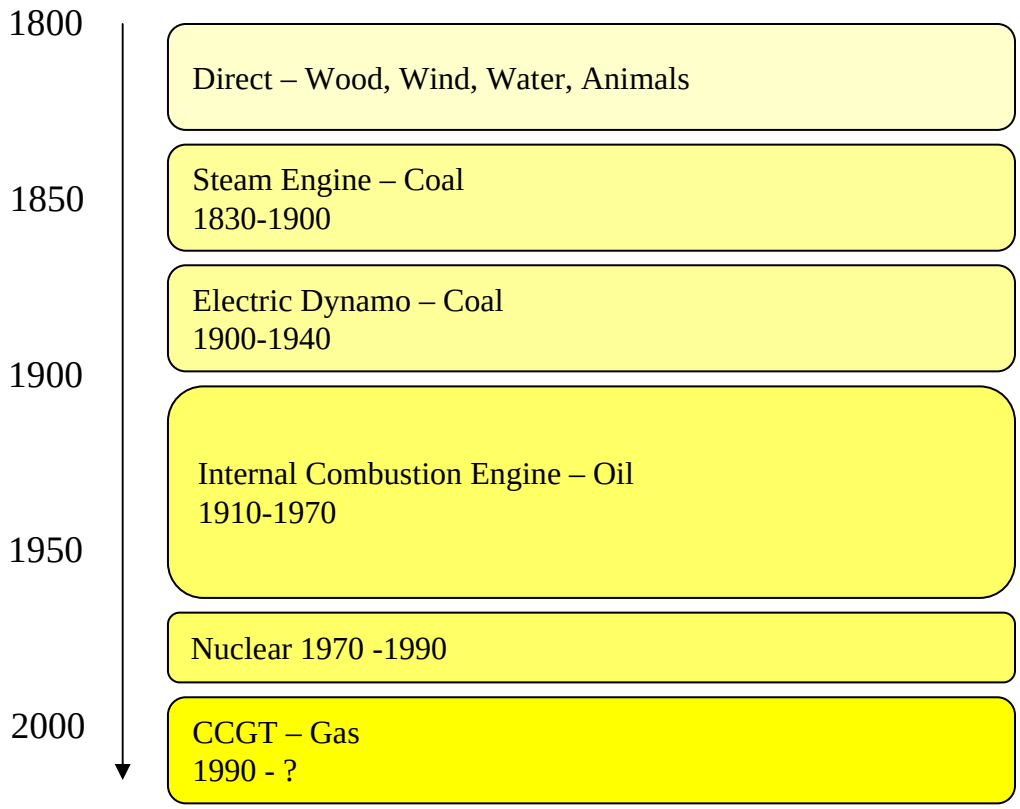
- Fossil fuels (80% of total energy needs today)
  - will continue to dominate over the horizon period, but a shift from oil to natural gas is already underway and coal (now that clean coal technologies are emerging) is returning
  - The fear that the world is running out of oil is not justified. At current production rates there are 41 years of oil, 63 years of natural gas and 147 years of coal left (BP, 2007)
  - However, by 2015 global demand for oil and gas will outstrip supply (Shell, 2008). In a letter to employees, Jeroen van der Veer said:



"We are experiencing a step-change in the growth rate of energy demand due to population growth and economic development, and Shell estimates that after 2015 supplies for easy-to-access oil and gas will no longer keep up with demand."

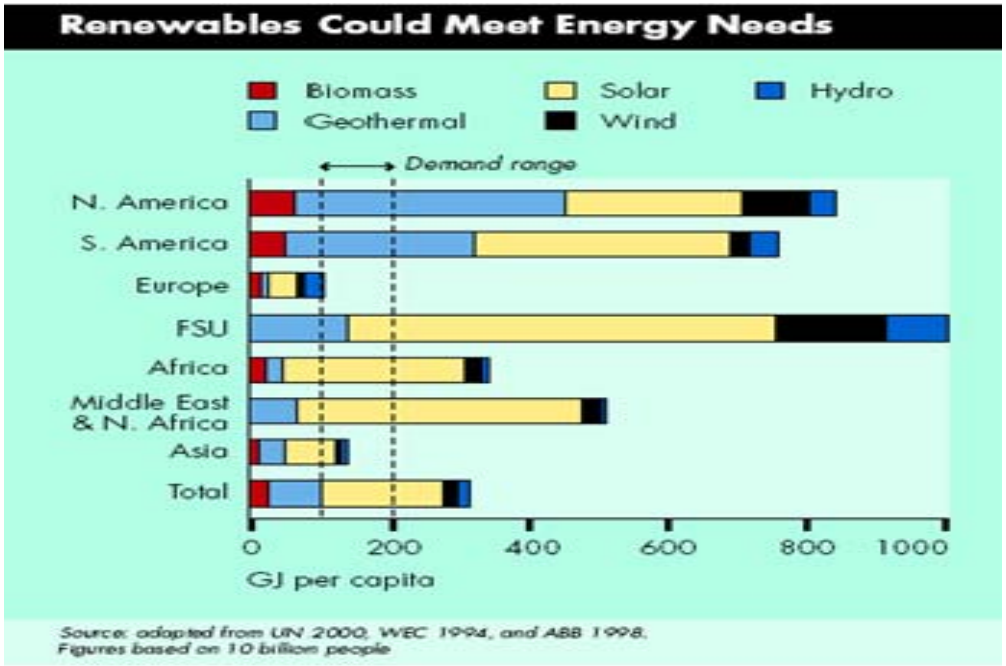
Environment and resources
Changing supply – 2/6

- Previous energy transitions were not driven by fuel scarcity but by energy technology discontinuities (Davis, 2001).
- Over a period of 200 years, five energy technology innovations have dramatically altered the global energy scene:



Environment and resources
Changing supply – 3/6

- Renewables are slowly gaining momentum and are plentiful (but it will take time): With the renewed focus on climate change, renewable energy technology investments are increasing:
  - The challenge is to scale up the roll-out and to apply renewable technologies for transportation.
  - The Shell energy scenarios to 2050 indicate that there is ample potential for renewable energy by 2050.



Environment and resources
Changing supply – 4/6

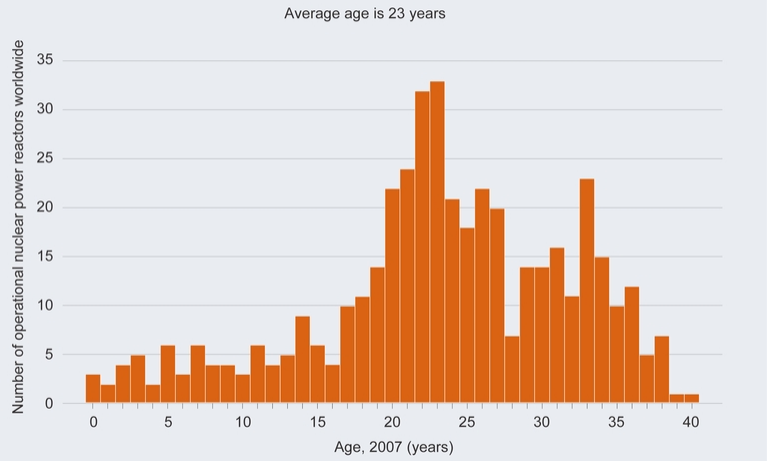
- Potential of solar power is plentiful but will take time to gain momentum:
  - Solar power plants could supply 69% of US electricity and 35% of its total energy by 2050 according to "A Solar Grand Plan"
  - Switching from coal, oil, natural gas and nuclear power plants to solar power would involve $420 billion in subsidies from 2011 to 2050 to develop infrastructure and make it cost-competitive
    - Solar plants consume little or no fuel (thus, significant savings)
    - US has at least 250,000 square miles of suitable available land in Southwest alone
    - Need for imported oil is effectively eliminated; reliance on Middle East lessened
    - Solar technologies are almost pollution-free thus GHG emissions from power plants would be reduced by 1.7 billion tons a year
    - Plug-in hybrid vehicles would account for a further reduction of 1.9 billion tons of GHG
    - Assumes energy demand grows by 1% annually
    - Envisions reducing US annual trade deficit by $300 billion per year
  - By 2050 US CO2 levels could be 62% below 2005 figures
  - If other renewable sources (i.e., wind, biomass and geothermal) are also developed, renewable energy could provide 100% of US electricity and 90% of total energy by 2050

Source: ("A Solar Grand Plan" by Ken Zweibel, James Mason, and Vasilis Fthenakis was published in the January 2008 issue of Scientific American)

Environment and resources
Changing supply – 5/6

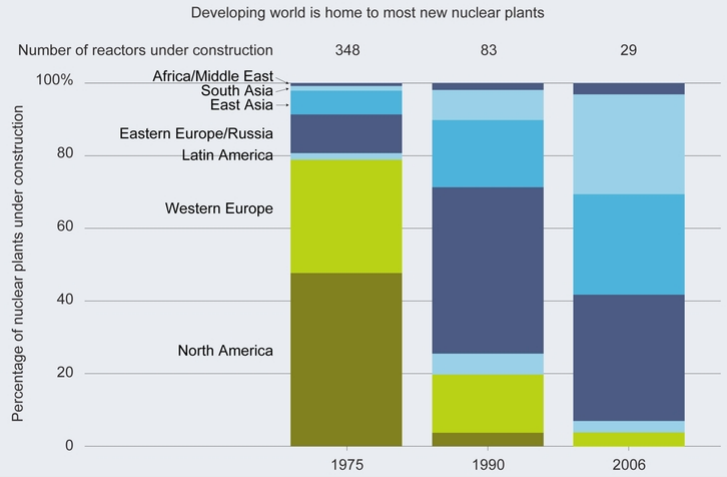
- The potential for nuclear energy is limited: Security of energy supply, anticipated electricity shortages, high fossil fuel prices, climate change and new emerging technologies, such as passively safe plants may lead to a renewed interest in nuclear technology for electricity generation. This renewed interest will most likely not have a significant impact on the global scene (PwC, 2008). Additional bottlenecks are:
  - Uranium mining capacity
  - Limited manufacturing capacity for critical parts
  - Shortage of qualified nuclear physicists

Ageing Nuclear Plants



Source: IAEA

Nuclear Plants Under Construction



Source: IAEA (2007)

Environment and resources
Changing supply – 6/6

- Global energy supply infrastructure investments will be large and are changing: Based on the International Energy Agency (IEA) reference scenario, the global energy supply infrastructure until 2030 will require an investment of $16 trillion or in excess of $500 billion a year. As these investments increasingly shift away from OECD countries, the risks – geopolitical, operational, economic, fiscal and security – faced by energy importing countries are both challenging and changing.

  The NOCs are today controlling the lion's share of hydrocarbon resources. Consequently, the IOCs have seen their share decline from 85% to less than 7% (PFC Energy)

Environment and resources
Climate change – 1/3

- Climate change is human induced: The fourth IPCC Assessment Report, completed in January 2007, concluded that

  "most of (>50% of) the observed increase in globally averaged temperatures since the mid-20th century is very likely (confidence level >90%) due to the observed increase in anthropogenic (human) greenhouse gas concentrations".

- The impact of climate change will be significant: The IPCC report, concludes that the impact will be large:

  "world temperatures could rise by between 1.1 and 6.4°C (2.0 and 11.5°F) during the 21st century, sea levels will probably rise by 18 to 59 cm (7.08 to 23.22 inches); there is a confidence level >90% that there will be more frequent warm spells, heat waves and heavy rainfall; there is a confidence level >66% that there will be an increase in droughts, tropical cyclones and extreme high tides".

Environment and resources
Climate change – 2/3

Carbon Emissions Source: EIA Territory	2004 Energy Intensity (BTU per $2000 GDP)	Per Capita CO2 Emissions From Fossil Fuels, 2004 (Metric Tons)	Total CO2 Emissions From Fossil Fuels, 2004 (Million metric Tons)	CO2 Emissions From Coal, 2004 (Million metric Tons)
North America		**15.99**	**6,886.88**	**2,232.26**
of which USA	9,336	20.18	5,912.21	2,089.95
Central & South America		**2.36**	**1,041.45**	**76.62**
of which Brazil	13,845	**1.83**	336.71	42.82
Europe		**7.96**	**4,653.43**	**1,348.27**
of which UK	6,305	9.62	579.68	139.59
of which France	7,957	6.71	405.66	49.49
of which Germany	7,764	10.46	862.33	327.44
Former Soviet Union		**8.88**	**2,550.75**	**714.52**
of which Russia	91,490	11.70	1,684.84	440.66
Middle East		**7.24**	**1,319.70**	**35.17**
Africa		**1.13**	**986.55**	**375.66**
Asia		**2.69**	**9,604.81**	**5,809.57**
of which China	39,760	3.62	4,707.28	3808.83
of which India	25,989	1.04	1,112.84	741.37
of which Japan	4,577	9.91	1,262.10	433.88
World		**4.24**	**27,043.57**	**10,592.07**

The US can also improve its position relatively painlessly by focusing upon improving energy efficiency

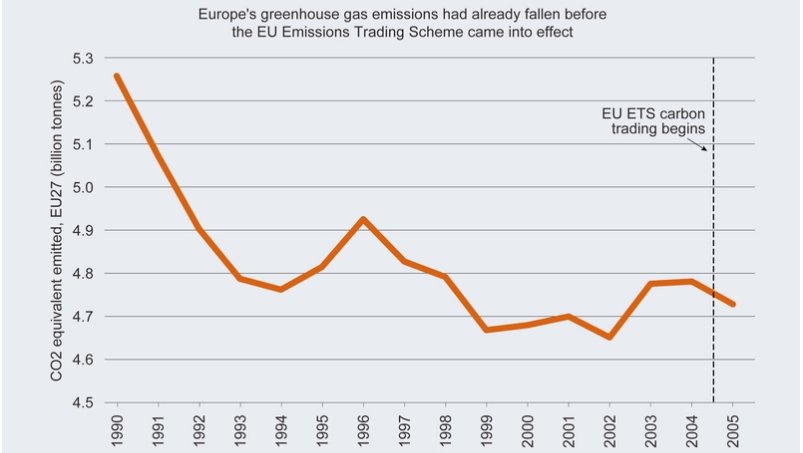
Environment and resources
Climate change – 3/3

- Climate change mitigation is possible: The Stern Report indicates that

  "the cost of mitigation of around 1% of GDP is small relative to the costs and risks of climate change that will be avoided".

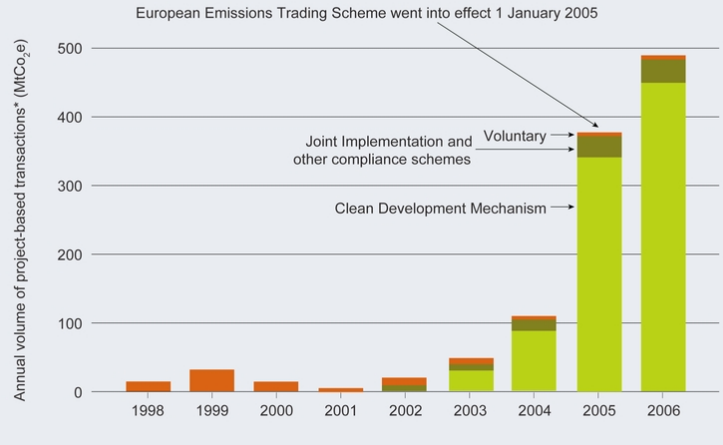
  Socolow and Pacala in their Scientific American 2006 article develop a framework, "the wedges" to stabilize and reduce carbon emissions based on 15 technologies.

Carbon Emissions in Europe



Source: European Environment Agency

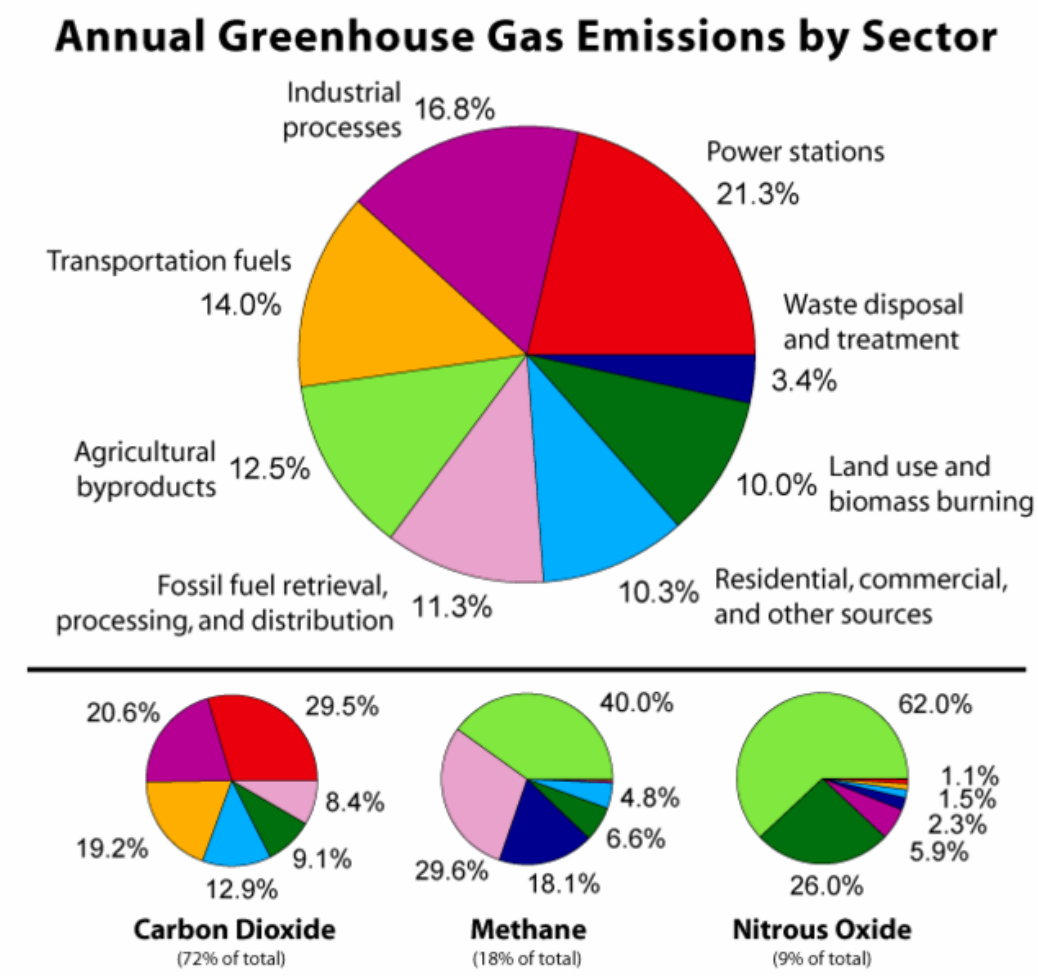
Carbon Markets Takeoff



* vintages up to 2012

Source: World Bank, State and Trends in the Carbon Markets 2007

Environment and resources
How do humans generate GHG?



Data from the Emission Database for Global Atmospheric Research, 2000

Coal power will be the first target of any climate change policy, but petroleum fuel will run a close second

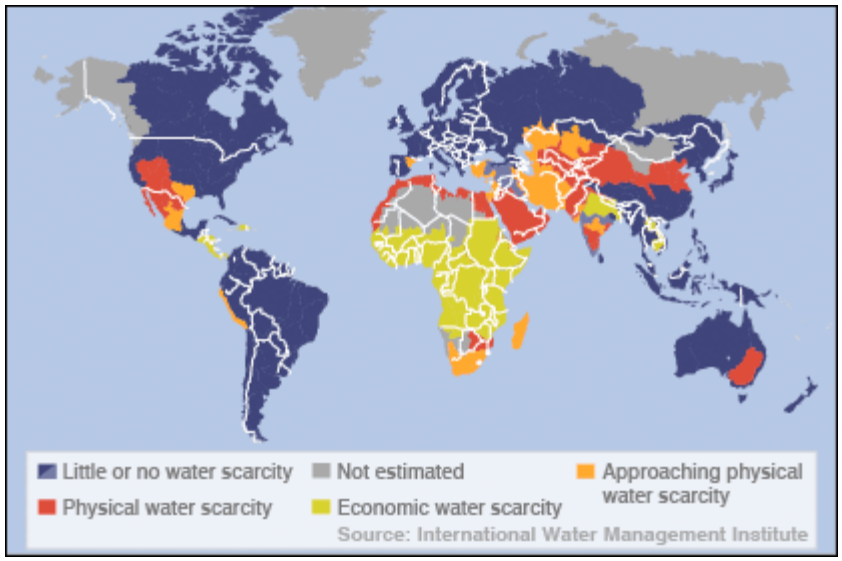
Environment and resources
Global water scarcity – 1/2

- Water scarcity facts:
  - 1.1 billion people in developing countries live without clean drinking water
  - 2.6 billion people, representing half of the developing world, lack toilets and other improved sanitation
  - Less than 1% of the world's fresh water (about 0.007% of all water on the planet) is readily accessible for direct human use
  - Millions of women and children spend several hours each day collecting water from distant, often polluted sources (which keeps children out of school)
  - 1.8 million children die each year from diarrhea and other diseases caused by unclean water and poor sanitation—4,900 deaths each day. Diarrhea is the 2nd biggest killer of children (after respiratory infections)
  - Every $1 spent on water and sanitation creates on average another $8 in costs averted and productivity gained (WHO estimate).

Source: UNDP, HDR 2006.

Environment and resources
Global water scarcity – 2/2

- Physical water scarcity: more than 75% of river flows are allocated to agriculture, industries or domestic purposes (accounting for recycling of return flows). This definition of scarcity--relating water availability to water demand--implies that dry areas are not necessarily water-scarce, eg Mauritania.
- Approaching physical water scarcity: More than 60% of river flows are allocated. These basins will experience physical water scarcity in the near future.
- Economic water scarcity: water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists. These areas could benefit by development of additional blue and green water, but human and financial capacity are limiting.*
- Little or no scarcity: Abundant water resources relative to use. Less than 25% of water from rivers is withdrawn for human purposes.



** Blue water = the water in lakes, rivers aquifers; green water = derived from rainfall in the unsaturated soil*

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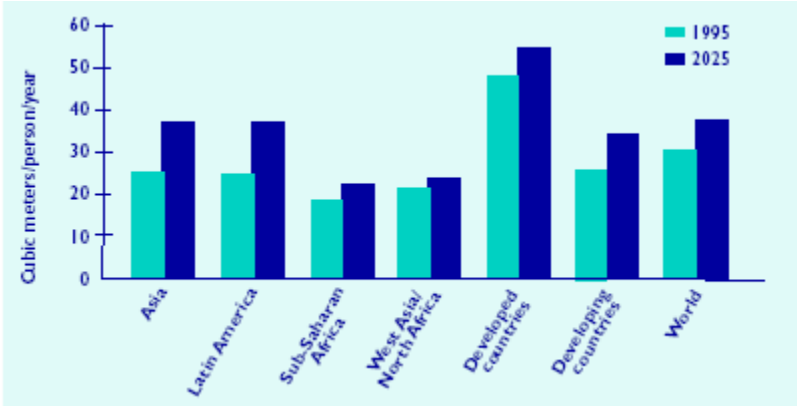
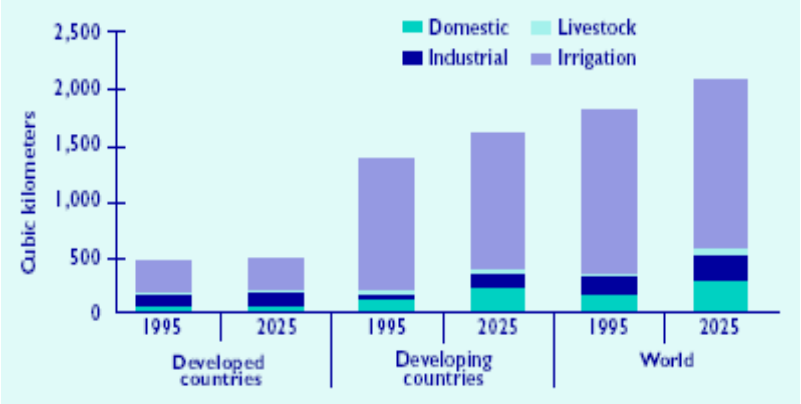
Environment and Resources
Water consumption

- Per capita consumption of water is on the rise in both developed and developing countries
- Demand for water for irrigation is far greater than household consumption. In developing countries agriculture currently consumes over 70% of the world's water.
- Virtual water used in the production of…
  - 1 kg wheat = 1,300 liters
  - 1 kg beef = 16,000 liters
  - 1 cup of coffee = 140 liters
  - 1 cotton t-shirt = 2,500 liters
  - 1 bed sheet = 9,750 liters
  - 1 liter of petrol = 2.5 liters
  - Crops grown for bioenergy need at least 1,000 liters of water to make 1 liter of biofuel

Per capita water consumption, 1995 and 2025



Water consumption by sector, 1995 and 2025



Source: International Food Policy Research Institute, Global Water Outlook to 2025.

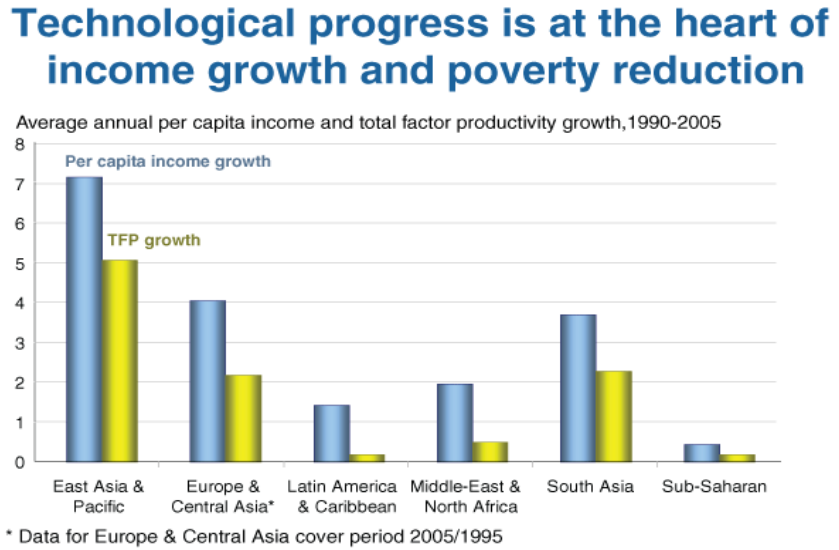
Environment and resources
Individual water use

- Minimum threshold is about 20 liters of water a day yet most of the 1.1 billion people lacking access to clean water use about 5 liters per day – one-tenth of the average daily amount used in rich countries to flush toilets
- Average daily water usage by people in Europe is over 200 liters and in the US it is 400 liters per person

"Dripping taps in rich countries lose more water than is available each day to more than 1 billion people." (UNDP HDR 2006, 14)

Technology
Technological progress

- Technological progress has gone hand-in-hand with income growth and reducing poverty in developing countries between 1990 and 2005.
- Rapid technological progress has reduced the share of people living in absolute poverty in developing countries from 29 percent in 1990 to 18 percent in 2004.
- Broadly, technological progress is what makes the difference between fast-growing developing economies and slow-growing ones.

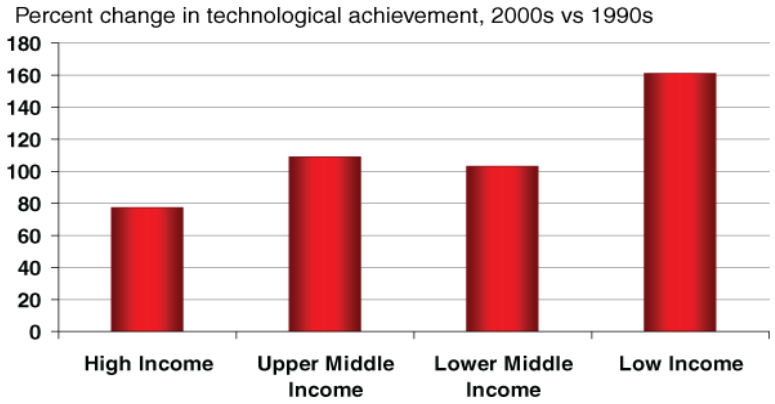


Source: World Bank, Global Economic Prospects, 2008

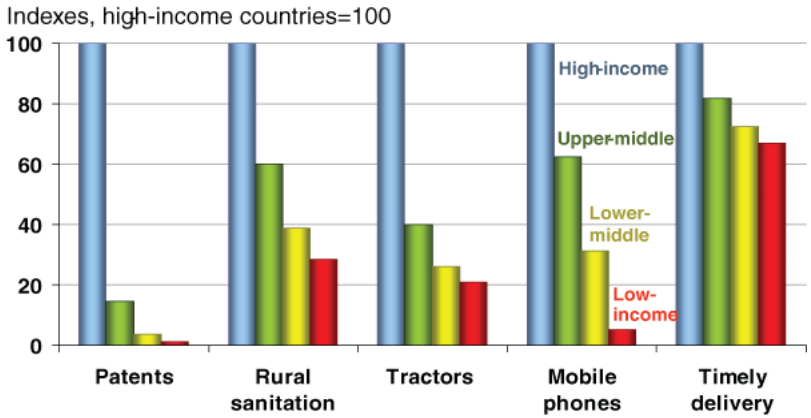
Technology
Technology gap between rich and poor

- Technological progress in developing countries between the 1990s and 2000s was very strong, outpacing that in developed countries by 40 to 60%, according to the World Bank but the gap between rich and poor countries is still very wide.
- Developing countries use only about a quarter of the level of technology used in rich countries.

Technological progress in developing countries has outpaced high-income countries



Wide gaps persist in the use of many technologies in 2004

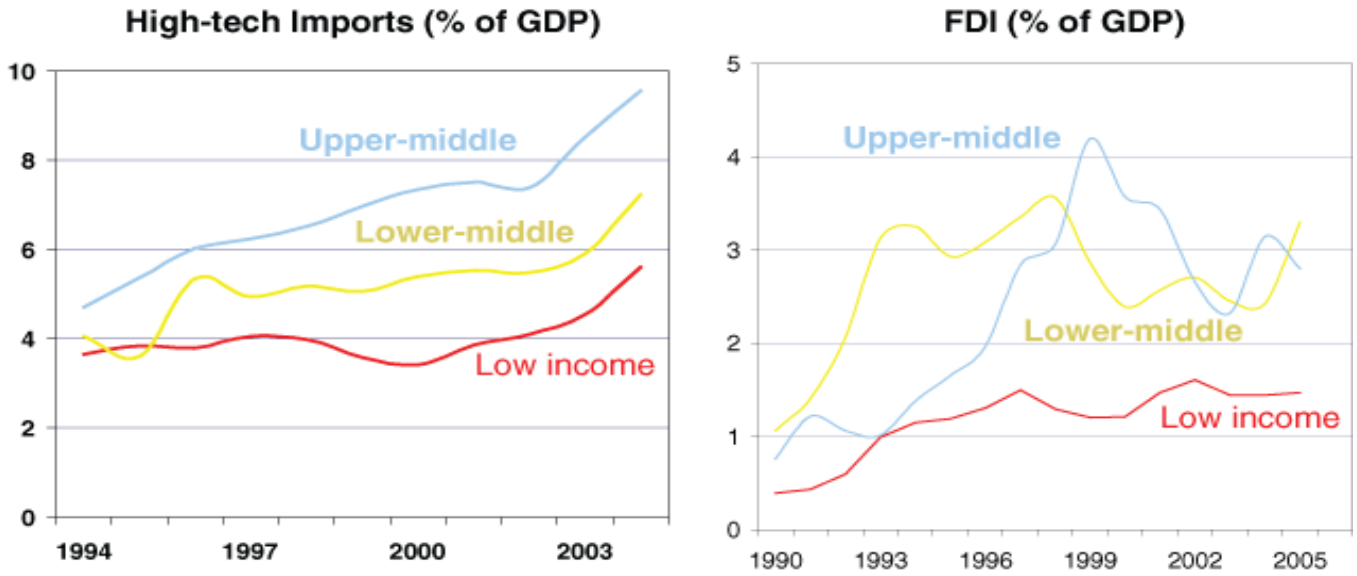


Source: World Bank, Global Economic Prospects, 2008

Technology
Enabling technology diffusion – 1/3

- High-tech business processes, products and services that enter a country via foreign trade, FDI, and contact with migrant populations living abroad provide the critical exposure needed to enable technological diffusion

Substantial increases in market openness have stimulated technology transfer

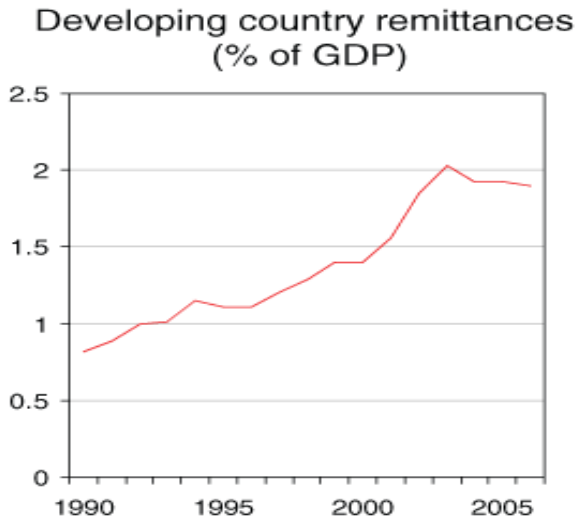


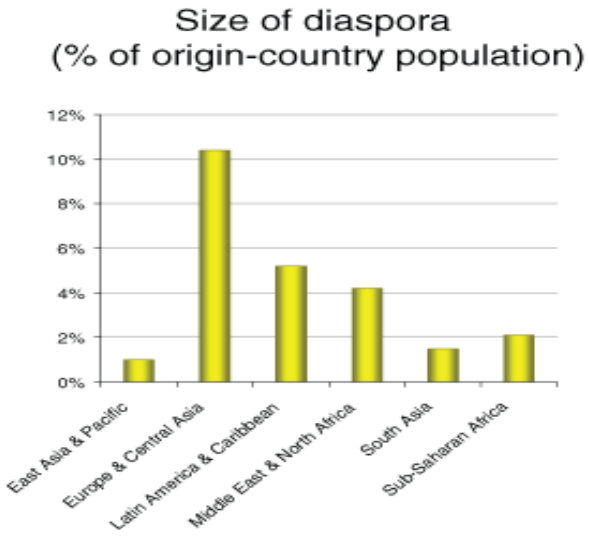
Source: World Bank, Global Economic Prospects, 2008

Technology
Enabling technology diffusion – 2/3

- Well-educated migrant populations living abroad are a *"brain bank"* for the home country and they enable technology diffusion by
  - strengthening trade and investment networks with wealthier countries
  - sending money home
  - providing resources (entrepreneurship, marketing know-how, for example) upon return to their home country

Highly-skilled migrant populations facilitate technology transfer





Source: World Bank, Global Economic Prospects, 2008

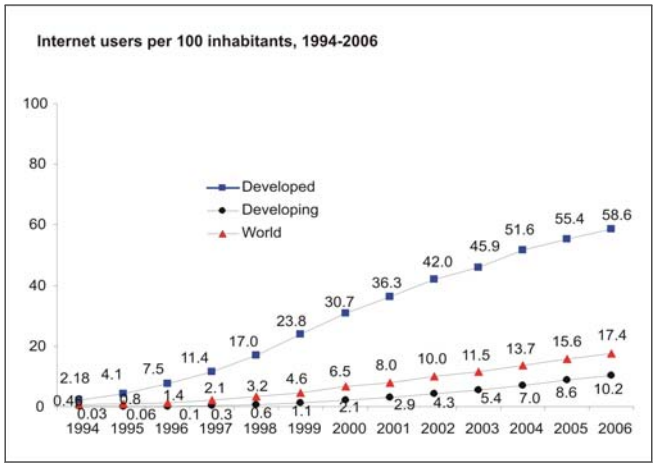
Technology
Enabling technology diffusion – 3/3

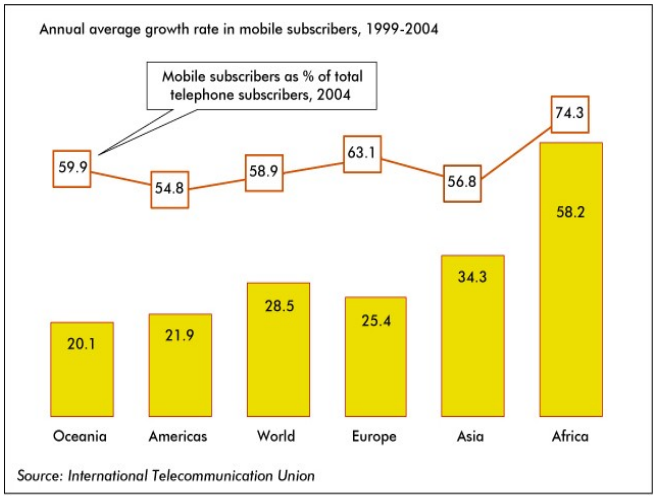
- But, developing nations also need the capacity to absorb technology which has been limited by
  - low technical literacy
  - the uneven spread of older technologies
  - low technology penetration in rural areas

- In November 2007 Brazil announced plans to invest $23 billion into a national science and technology plan.

Technology
Digital revolution

- The world is increasingly connected via information and communications technology (ICT).
- Internet:
  - At the end of 2007 there were more than 1.3 billion Internet users worldwide.
  - In 2006, less than 5 out of every 100 Africans used the Internet versus about 1 of every 2 G8 inhabitants.
  - There are roughly as many Internet users in the G8 as in the rest of the world (474 million in G8, 657 million in non-G8).
  - Home to 13% of the world's population, the G8 is home to 40% of the world's Internet users.
- Mobile phones:
  - The number of mobile phone subscribers passed the 3 billion mark in August 2007.
  - G8 accounts for 28% of mobile phone subscribers.
  - In 2006, Africa had 221 million telephone subscribers, 198 million of which were mobile.
- Research has shown a strong correlation between countries that are more competitive and those that are more ready to leverage and benefit from ICT.

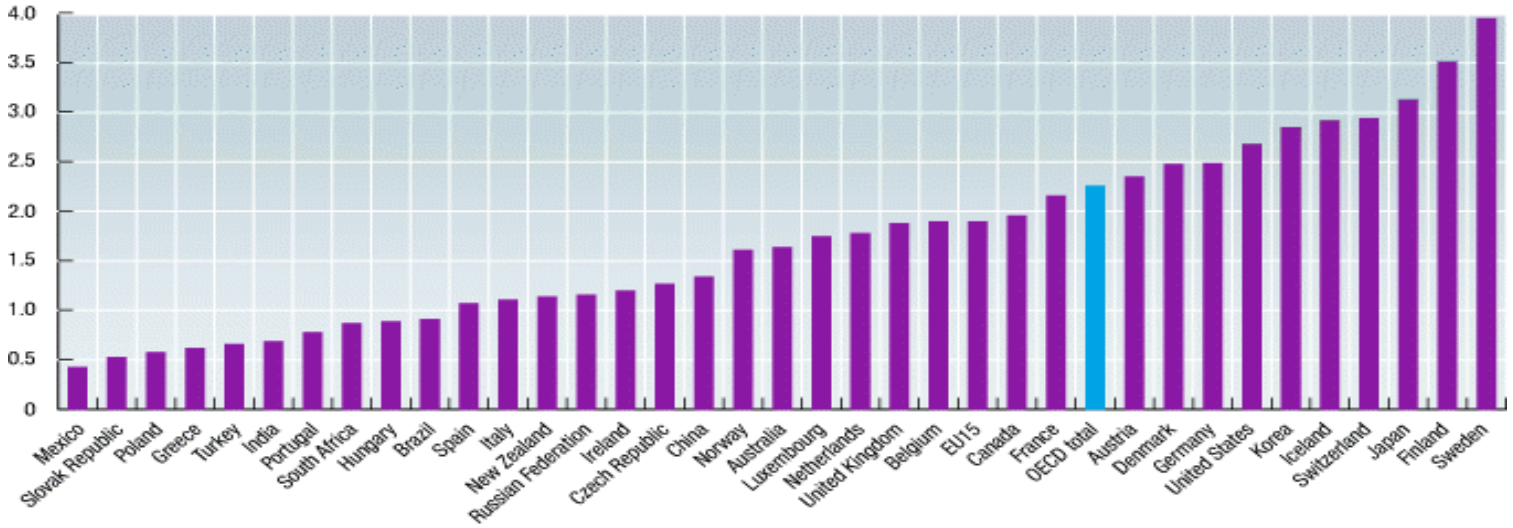




Source: International Telecommunication Union, "ICT levels around the world" for 2006

Technology
Research and development

- Expenditure on research and development (R&D) is a key indicator of government and private sector efforts to gain competitive advantage in science and technology. In 2004, R&D amounted to 2.3% of GDP for the OECD as a whole.
- Since 2000, R&D spending relative to GDP (R&D intensity) has increased in Japan and decreased slightly in the US.
- In 2003 and 2004, Sweden, Finland, and Japan were the only three OECD countries in which the R&D-to-GDP ratio exceeded 3%, well above the OECD average of 2.3%. Since the mid-1990s, R&D expenditure (in real terms) has been growing the fastest in Iceland and Turkey, both with average annual growth rates above 10%.
- R&D spending for China has been growing even faster than GDP, resulting in a rapidly increasing R&D intensity, growing from 0.9% in 2000 to 1.3% in 2005.



Source: OECD Factbook 2007

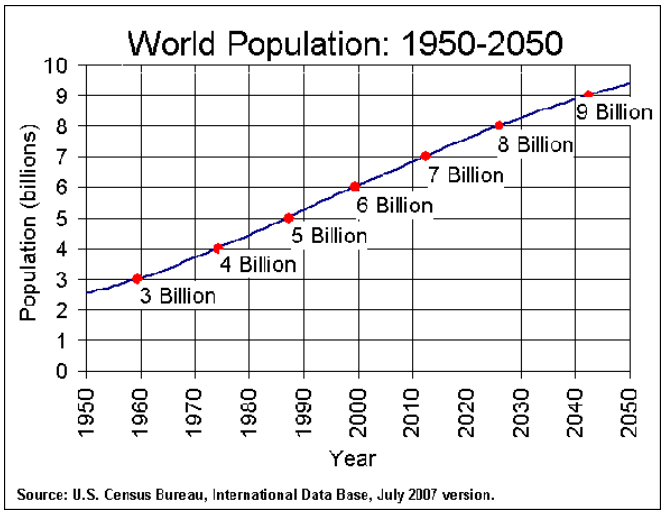
Technology
Advances in biology and biotechnology

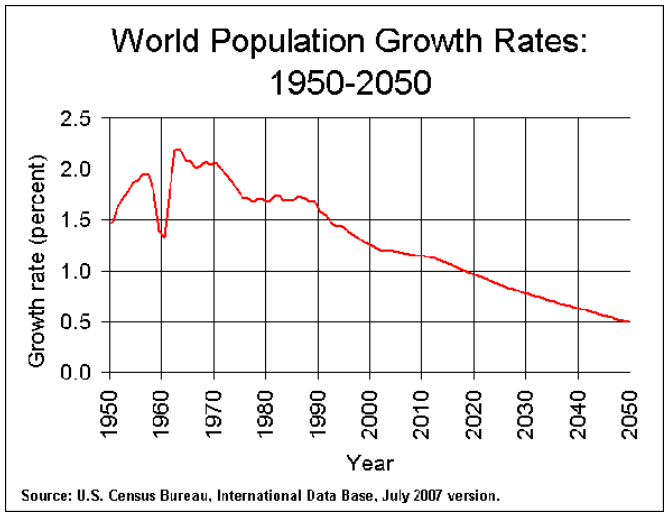
- Global biotechnology market: growing at about 14% annually
  - Biotechnology companies raised $27.9 billion and venture capital reached record $5.4 billion in 2006. In 2007, the companies raised $9.1 billion in venture capital.
  - Market capitalization was over $400 billion in 2006.
  - Public company revenues surpassed $70 billion; public company losses fell 37% in Europe, 43% in Canada.
  - US product approvals up from 33 in 2005 to 36 in 2006; applications and approvals in Europe grew from 21 to 25.
  - The biosciences, biotechnology plus all life sciences, employed 1.2 million people in the US in 2004 and generated another 5.8 million related jobs.
  - One of the most research-intensive industries in the world. The US biotech industry spent nearly $20 billion on R&D in 2005 with the top five companies investing an average of $130,000 per employee in R&D.
- The nature of the bioeconomy:
  - Affordability: the cost of biotechnologies has decreased markedly in the past decade.
  - Convergence and linkages drive innovation in a wide range of domains blurring traditional boundaries
  - Impact: applications flowing from developments in the life sciences will have far-reaching impacts on other economic sectors.
  - Rapid, discontinuous change: one of the most dynamic sectors of modern science. “Knowledge Churn” has become the motor.
  - The human factor: individual/societal values play an important role in decisions as to which technologies are explored and exploited.
  - Safety: the same technologies that improve human welfare can be used for harm.
  - Increased knowledge intensity as in bioinformatics.
  - High opportunity costs: innovation requires active support from government and industry. Countries able to muster resources to invest in R&D and human capital formation – and equipped with policies to meet the challenges posed by new products and processes – will prosper and become global leaders in innovation.
- Source: “Beyond Borders: Ernst & Young’s Global Biotechnology Report 2007”, OECD

Social
Demographics – 1/5

- World population:
  - Global population around 6.6 billion people today.
- Regional population distribution:

Asia: 3.7 billion	**North America: 335 million**
Africa: 941 million	**The Middle East: 193 million**
Europe: 802 million	**Oceania: 34 million**
Latin America / Caribbean: 569 million	





Source: US Census Bureau.

Social
Demographics – 2/5

- Asia and other developing economies account highest population levels:

	Population rankings						(10 millions)	
		2005			**2030**			**2050**
1	China	13.1		India	15.3		India	18.1
2	India	10.9		China	14.6		China	14.2
3	US	2.9		US	3.6		US	4.2
4	Indonesia	2.3		Indonesia	2.8		Nigeria	3.6
5	Brazil	2.2		Pakistan	2.3		Indonesia	3.1
6	Pakistan	1.6		Nigeria	2.3		Bangladesh	2.8
7	Bangladesh	1.4		Brazil	2.2		Pakistan	2.8
8	Russia	1.4		Bangladesh	2.1		Brazil	2.3
9	Nigeria	1.3		Mexico	1.4		Congo	2
10	Japan	1.3		Congo	1.3		Mexico	1.5

Source: US Census Bureau

Social Demographics – 3/5

- Aging population:
  - Proportion of world population aged 60 years and older:
    - 1950: 8%
    - 2007: 11%
    - 2050: 22%
  - Aging states: ‘old’ versus ‘ young’ states:
    - India is set to overtake China as the world’s most populous nation before 2030, reaching 1.4 billion. India also has a large demographic dividend and has one of the largest working age population ratios in the world.
    - By 2050, almost a quarter (24%) of China’s population will be aged 65 and older versus 8% today
    - In Europe: in EU10, CEE, lowest fertility ever recorded in the history of mankind; persistent below replacement levels; shrinking native populations

Source: US Census Bureau, UN Department of Economic and Social Affairs, 2007, The Population Reference Bureau

Social
Demographics – 4/5

- Rapid urbanization expected:
  - For the first time in history, more than half of the people on earth, 3.3 billion people, live in urban areas. In less than 25 years, the world's urban population will be almost 5 billion people
  - Expansion of global urban population:
    - 1900 = 13% (or 220 million people)
    - 1950 = 29% (or 732 million people)
    - 2005 = 49% (or 3.2 billion people)
    - 2030 = 60% (or 4.9 billion people)

	1950-2005	2005-2030
Total world	**1.71%**	**0.95%**
Urban	**2.62%**	**1.78%**
Rural	**1.12%**	**-0.03%**

  - By 2030, 80% of the world's urban population will live in the towns and cities of the developing world

Source: US Census Bureau, UN Department of Economic and Social Affairs, 2007

Social
Demographics – 5/5

- Concentrations of poverty:
  - 1 out of every 3 city dwellers or 1 billion people (i.e., one-sixth of humanity) are living in slums. More than 90% of slum dwellers are in the developing world.
  - Largest populations found in South Asia, then Eastern Asia, sub-Saharan Africa and Latin America. Almost 4 out of every 10 people living in slums are in China and India.
- Youth explosion in cities:
  - an estimated 60% of all urban dwellers will be under 18 years of age by 2030.
- Increasing vulnerability of cities:
  - According to the United Nations Environment Programme (UNEP), between 1980 and 2000, 75% of humanity lived in areas affected by natural disasters.
  - There were more than 700 major natural disasters in 1999 causing more than US$100 billion in economic losses and thousands of victims—more than 90% of the losses of life occurred in developing nation.

Source: UNFPA, State of the World Population, 2007

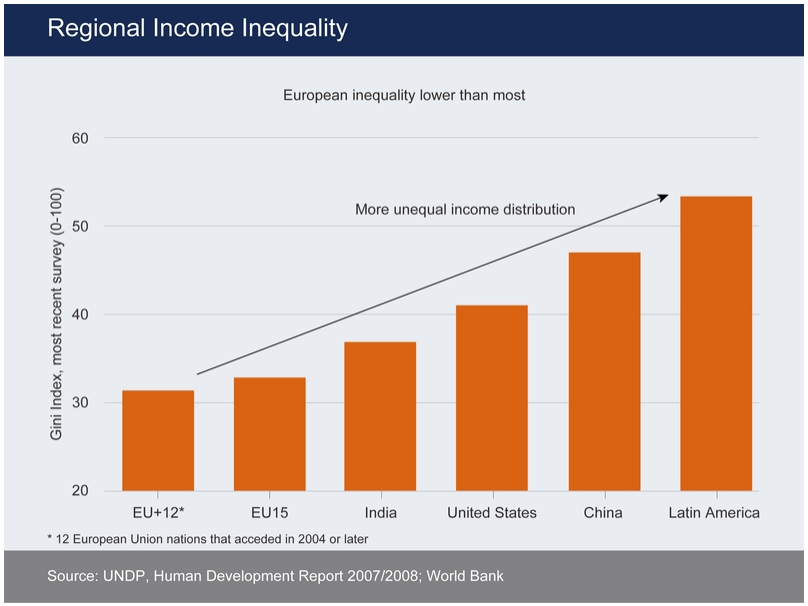
Social
Global health challenges

- HIV/AIDS:
  - Today about 33 million people live with HIV
  - Although percentage prevalence has stabilized, sub-Saharan Africa remains the most seriously affected region, with AIDS remaining the leading cause of death there.
  - Every day, over 6,800 people become infected with HIV and over 5,700 people die from AIDS
  - The HIV pandemic remains the most serious of infectious disease challenges to public health
- Malaria:
  - About 40% of the world's population, mostly those living in the world's poorest countries, risk contracting malaria.
  - Each year over 500 million people are affected by malaria. It accounts for an average loss of 1.3% annual economic growth in those countries most affected, consuming as much as 40% of their public health expenditure.
- Tuberculosis:
  - Over 1/3rd of the world's population has been exposed to the TB bacteria and new infections occur at a rate of 1 per second
  - There are a rising number of people who contract tuberculosis because their immune systems are weakened because of immonusuppressive drugs or HIV/AIDS
  - Drug- and multi-drug resistant TB is becoming an increased issues for treatment of TB patients.

Source: UNAIDS, World Health Organization

Social
Wealth / poverty gap

- According to the NIC, the share of the world's poor by 2030 is expected to decrease by 23%.
- Similarly, the World Bank predicts that by 2030, 1.2 billion people in developing countries – 15% of humanity – will belong to the 'global middle class' (up from 400 million today).
- However, high levels of income inequality remain:



Social
Climate change and human development

- Climate change and human development:

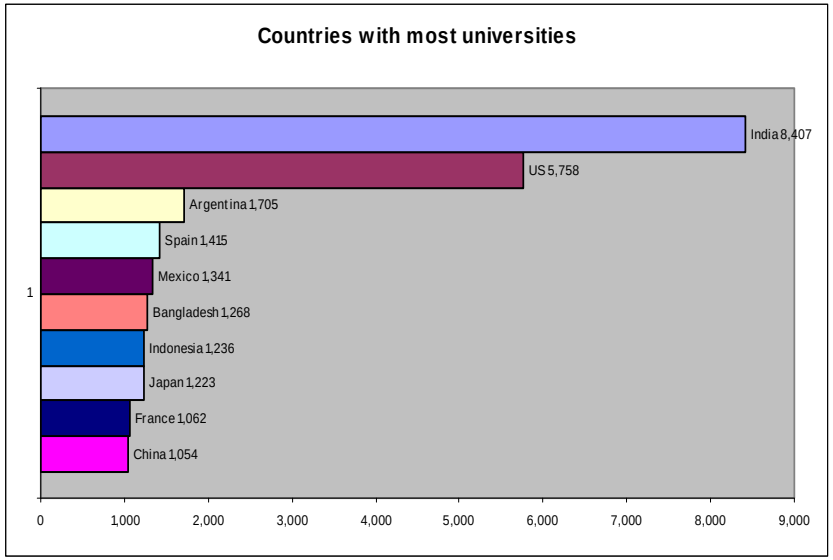
  Climate disasters are heavily concentrated in poor countries. Virtually all (98%) of the 262 million people affected by climate disasters from 2000 to 2004 were located in developing countries. In OECD countries 1 in 1,500 people were affected versus 1 in 19 in poor countries (a risk differential of 79).

- Five means through which climate change could hinder/reverse human development
  1. Agricultural production & food security
  2. Water stress & water insecurity
  3. Rising sea levels & exposure to climate disasters
  4. Ecosystems & biodiversity
  5. Human health

Source: UNDP, HDR 2007/2008.

Social
Education

- Higher education in emerging markets is on the rise:
  - In 2005, 5.7 million students graduated from universities in the 19 UNESCO World Education Indicators (WEI) program versus 5.2 million graduates in the 30 OECD member states.
  - In 2006, China produced twice as many university graduates than the top 3 OECD combined: the US (2.4 million), Japan (O.6 million), and France (0.3 million). Traditionally, the US has led this category.
  - India leads the world in number of universities with 8,407 followed by the US with 5,758



Source: UNESCO-UIS – World education indicators, 2007

Social
Higher education in science and engineering (S&E)

- Foreign students in US universities make up a much higher proportion of S&E master's degree recipients than they do of bachelor's/associate's degree recipients.
  - During the past two decades, the share of S&E master's degrees earned by temporary residents rose from 19% to 28%.
  - S&E master's degrees awarded to students on temporary visas rose from approximately 12,500 in 1985 to about 33,500 in 2005 and increased in most S&E fields during that period.
- S&E doctorates awarded by US academic institutions reached a new peak of almost 30,000 in 2005.
  - The largest growth in the number of doctorate awards was in engineering and the biological and agricultural sciences.
  - Virtually all of the growth reflected higher numbers of S&E doctorates earned by foreign students.
- Foreign students earned more than a third (36%) of all S&E doctorates awarded in the US in 2005:
  - A new peak of 10,800 doctorates earned by foreign students in 2005.
  - Foreign students earned half or more of all US doctorates in engineering, mathematics, computer sciences, physics, and economics in 2005.

Source: National Science Board, Science and Engineering Indicators, 2008.

Social
Skills/talent migration

- Skilled migrants from developing countries prefer the US, Canada and Australia to Europe
- High-skilled foreign workers as share of all workers:
  - Australia 9.9%
  - Canada 7.3%
  - US 3.5%
  - EU 0.9%

- Vast majority (85%) of unskilled workers from developing countries went to the EU versus only 5% to the US. Just over half (55%) of skilled workers went to the US compared with only 5% to Europe. (NYT, October 2007)
- 2.5 million of the 21.6 million scientists and engineers working in the US were born in developing countries (World Bank, 2008)

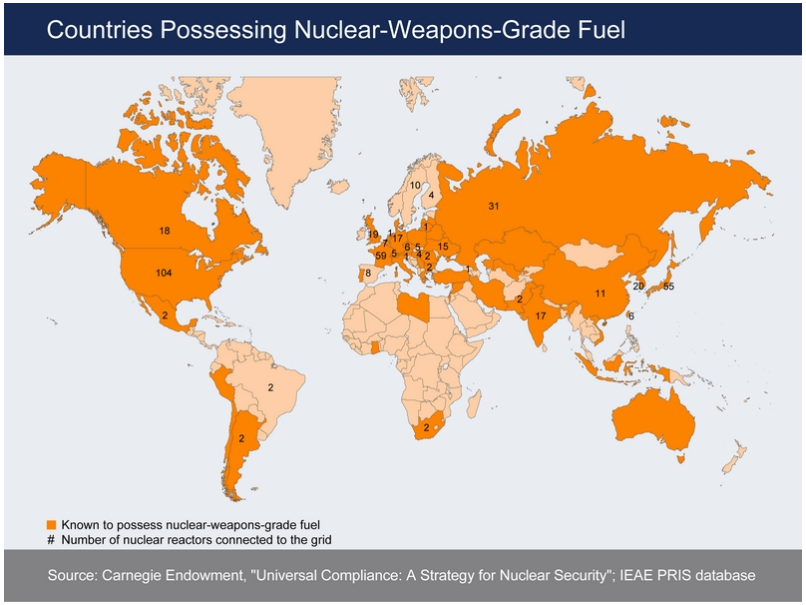
Social
Literacy

- The literacy challenge has absolute and relative dimensions, particularly affects the poor, women and marginalized groups, and is much greater than conventional measures indicate:
  - In absolute numbers, those without literacy skills are mainly in sub-Saharan Africa, South and West Asia, and East Asia and the Pacific. Prospects for meeting the 2015 goal hinge largely on progress in the 12 countries where 75% of those without literacy skills live.
  - In relative terms, the regions with the lowest literacy rates are sub-Saharan Africa, South and West Asia, and the Arab States, all with literacy rates around only 60%, despite increases of more than 10 percentage points since 1990.
  - Illiteracy is associated to a significant extent with extreme poverty.
  - Women are less literate than men: worldwide, only 88 adult women are considered literate for every 100 adult men, with much lower numbers in low income countries such as Bangladesh (62 per 100 men) and Pakistan (57 per 100 men).
  - 132 of the 771 million people without literacy skills are aged 15 to 24, despite an increase in this group's literacy rate to 85%, from 75% in 1970.
  - Direct testing of literacy suggests that the global challenge is much greater than the conventional numbers, based on indirect assessments, would indicate, and that it affects both developed and developing countries.

Source: UNESCO – The EFA Global Monitoring Report.

Security
Nuclear proliferation

- Efforts to prevent the proliferation of nuclear weapons will continue to be a major preoccupation of G8 leaders in 2008 and beyond. Challenges to deterrence in a multipolar nuclear future: the identity of any nuclear aggressor would not be immediately obvious; frequency of conventional wars in Middle East increases probability of conflict becoming nuclear; as the number of Islamic nuclear powers grows so does chance that Islamic terrorists acquire nuclear weapons:
  - Potential Israeli-Islamic state/entity nuclear arms race
  - Potential Asian nuclear arms race
- In addition to ongoing concerns about North Korean and Iranian programs, there is the growing threat of nuclear terrorism.
- Resistance to the revival of nuclear power centers on fears of a Chernobyl-style accident, and the difficulties of 'safely' disposing nuclear waste--that is, that it does not fall into the hands of terrorists.



Source: Rosen, 2006; WEF, 2008.

Security
Chemical and biological weapons (CBW) proliferation – 1/2

- CBW proliferation challenge in 2025 will be unique since it will occur within the context of a revolution in the life sciences and an increasingly complex and uncertain environment:
  - Not about what proliferators *have* but what they *know* and how they might try to use/misuse that knowledge, and how US/international community can affect those choices.
  - Shaping the challenge: advances in science and technology, and globalization.
- Impact of life sciences revolution:
  - Extremely rapid expansion of scientific knowledge: the "century of biology"
  - Increased capability to produce, package and deliver biological agents
  - Speed at which life sciences and related technologies become "commodities"
    - e.g., explosion in gene foundries. The cost of synthesizing a gene has fallen from about $30 per base pair to around $1, as productivity in DNA synthesis has jumped 700-fold in just a decade. Researchers and industries can now order online any gene they wish for delivery in just two weeks. Current estimates put the size of the rapidly growing gene synthesis market at between $50 and 75m globally. ("The gene makers: specialist gene foundries are helping to develop new production chains for chemicals based on engineered or entirely new genomes" by Anthony King, published in *Chemistry and Industry*, October 29, 2007.)
  - Innovation breakthroughs coming from unexpected sources (e.g., Cuba's meningitis vaccine).
  - Innovation not restricted to advanced technologies and is promoting "sidewise technology" (mature technologies applied to new areas).
  - Convergence of scientific disciplines (e.g., biology & chemistry, nanoscience & IT) and emergence of new fields (e.g., bionanotechnology) creating what the National Academies describe as "a transformation that will prove as powerful as the Industrial Revolution."
    - Ability to integrate and apply the new technologies will determine success of scientific convergence.
    - Convergence creates more options in terms of how proliferators can pursue their objectives.

Source: Michael Moodie in "Old Questions and New Dynamics: Biological and Chemical Weapons Proliferation in 2025" prepared for "Global Trends 2025"

Security
Chemical and biological weapons (CBW) proliferation – 2/2

- Impact of globalization:
  - More countries making long-term investments in life sciences
    - e.g., Korea expected to invest more than $4.7 billion in biotechnology between 2000 and 2007 and Brazil has pledged $ 479.5 million for future research.
  - More international collaboration
  - New patterns of industrial production (flatter organizations, empowered employees)
  - Emergence/influence of empowered non-governmental actors (operating beyond control of any single government)
- Implications for security: the risk spectrum is now exceptionally broad and continually evolving.
  - Diffusion of knowledge and skills throughout world
  - Lower entry costs to join proliferation process
  - More potential "dual-use" covers and pathways to create CBW-related capabilities
  - Increasingly difficult to monitor compliance with international norms
- Implications for proliferation:
  - Changing concept of CBW (from "bugs" to bioregulators) and delivery systems
  - Relationship between capability and intent: from "intent drives capability" to "capability shapes intention"
  - Changing views on CBW use by proliferators given climate of increased locally-based conflicts
  - Outsourcing
- Lessons for the future:
  - A change in thinking is required
  - Operationalizing and putting into action networking approach to respond to networked threats

Source: Michael Moodie in "Old Questions and New Dynamics: Biological and Chemical Weapons Proliferation in 2025" prepared for "Global Trends 2025"

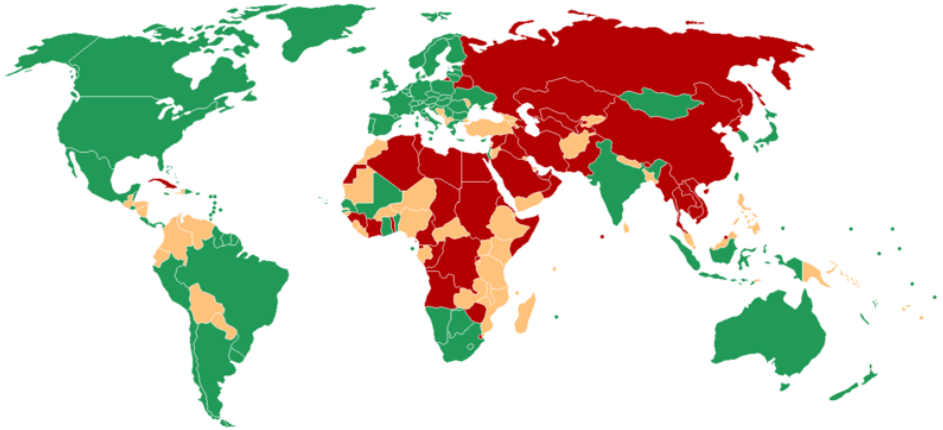
Security
Energy Security

- Dynamics of energy: energy security, climate change, new technology and price concerns.
- Costs of traditional hydrocarbons in terms of national security, the environment and economics are increasingly prohibitive.
- Challenges to energy transition are influenced by these trends:
  - growth in worldwide energy demand, nationalizations, increasing capital costs, and booming economic growth.
- 3 energy transition scenarios for the US that hinge on: type/amount of investment, infrastructure needs, environmental impacts, enabling technologies, public versus private led effort, response time and fuel selection.
  - "Energy security transition"
    - Main driver is to reduce energy dependence (esp. imported energy). Government led, environmental impacts are not primary concern.
  - "Environmental transition"
    - In response to public pressure for action on climate change; environmental impact issues paramount concern. Requires government action on regulations, R&D spending on alternative energies.
  - "Price-driven transition"
    - Occurs as result of a price event (price spike) and subsequent market/consumer reaction.
- Future of energy transition will most likely be a hybrid of all three scenarios.
- Must also consider energy transition of BRICOPs (BRIC and the oil producers)

Source: "The Future of Energy" by Saad Rahim for The National Intelligence Council

Security
Democracy around the world

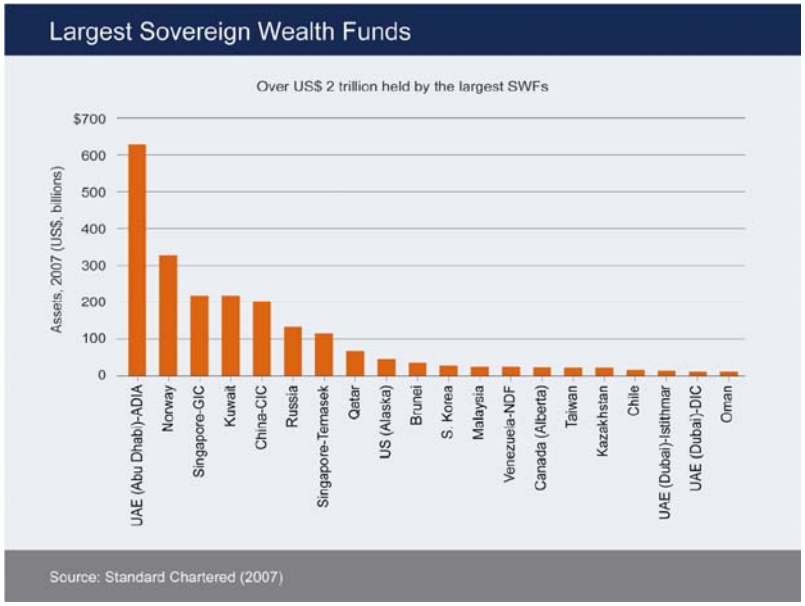
- Deterioration worldwide reflected in reversals in one-fifth of the world's countries. Erosion is particularly evident in South Asia but also in the former Soviet Union, the Middle East, North Africa and sub-Saharan Africa. The Middle East is still considered the world's most repressive region: significant setbacks in Egypt, Lebanon, the Palestinian Authority.
  - Free countries in 2007 remained at 90 (out of 193), or 46% of the world population World experiences "freedom stagnation" as the share of Free countries remained flat for almost a decade.
  - Partly Free countries numbered 60 (18% of world population) and reflect an increase of 2 (Thailand and Togo moved from Not Free to Partly Free).
  - Not Free countries totalled 43 (or 36% of world population) and declined by 2 from 2006. Previously classified as Partly Free, the Palestinian Authority is now considered Not Free.
  - Electoral democracies declined by 2 to a total of 121. Mauritania qualified to join this group while three were disqualified: Philippines, Bangladesh, and Kenya.

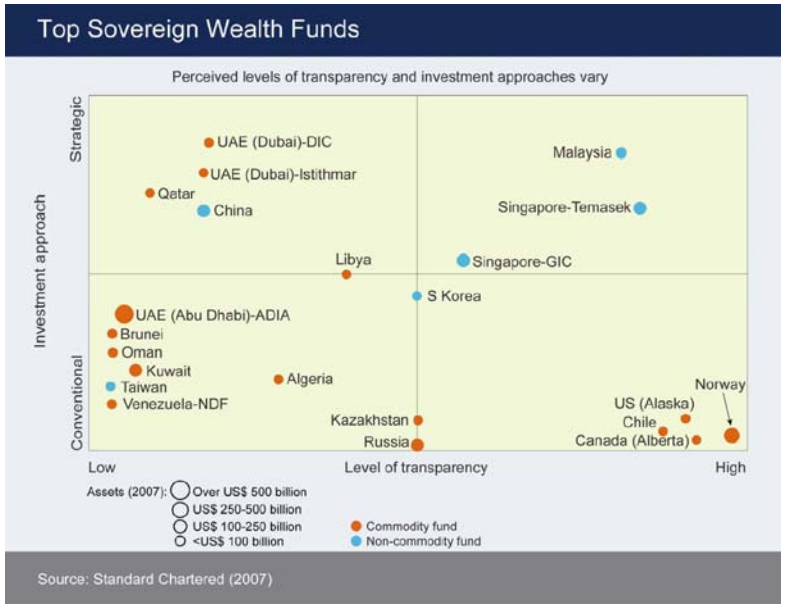


Source: Freedom House, Freedom in the World, 2008.

Globalization
Sovereign wealth funds

- Sovereign wealth funds manage the national savings for the purposes of investment:
  - There is over $2 trillion held by the largest SWFs combined and they are growing fast.
  - The largest SWFs are from oil-rich Gulf states and cash-rich Asian countries
  - Singapore, Kuwaiti and South Korean SWFs bailed out Citigroup and Merrill Lynch in the wake of the US housing credit crisis ($29 billion).
  - Strategic intent and level of transparency vary widely among SWFs.

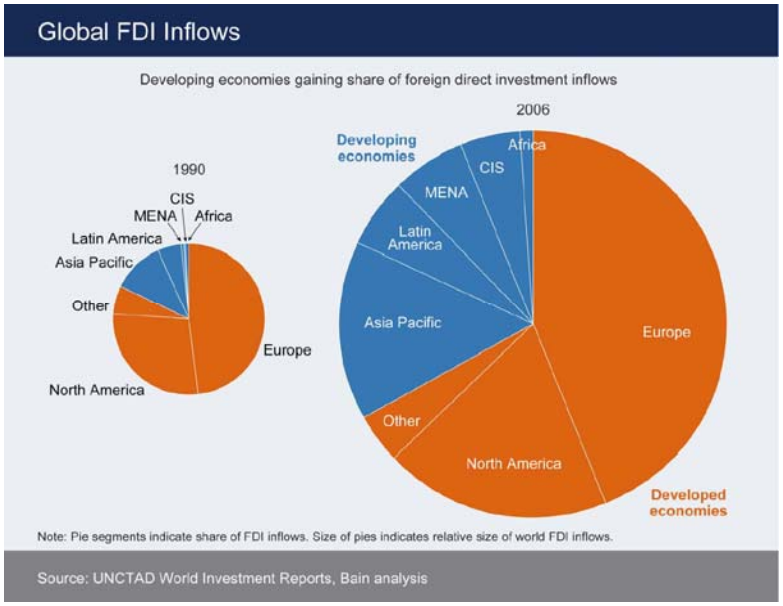




Source: The Economist, 2008; WEF, 2008.

Globalization
Global FDI flows

- Global FDI inflows soared in 2006 to reach $1,306 billion (38% over the previous year). This was driven by cross-border M&As with the increasing involvement of private equity funds.
- Inflows increased in all three groups of economies: developed countries, developing countries, and the transition economies of South-East Europe and the CIS.
- The geographical pattern of FDI is changing, with greater South-South FDI flows.
- Inflows to South, East and South-East Asia reached $200 billion, and outflows increased substantially.
- FDI inflows into West Asia continued to climb to unprecedented heights.
- Greenfield investments and reinvested earnings boasted FDI by 11% to $84 billion in Latin America and the Caribbean.
- Overall prospects for global FDI flows remain positive.

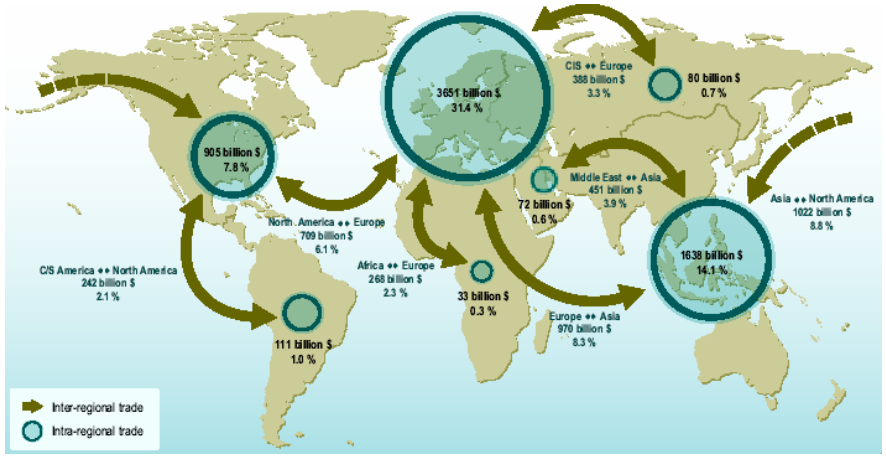


Source: UNCTAD World Investment Report, 2007; WEF, 2008.

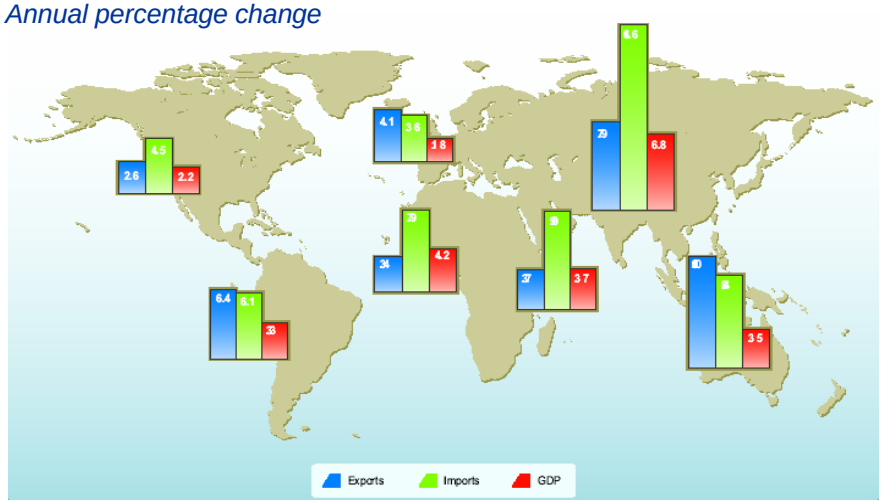
Globalization
Global trade – 1/2

- The objective of the Doha Round of the WTO, which started in 2001, is to lower trade barriers, allowing for free trade between all countries.
- The talks have collapsed over the divide between the developed nations and the major developing countries (the G20 developing nations)
- Despite the collapse of the Doha Round, the volume of world merchandise trade grew by 8%, while world GDP recorded an almost 4% increase.
- World merchandise trade is still characterized by intra-regional flows
- Asia and Europe recorded higher merchandize export growth than import growth in 2006.

Selected intra- and inter-regional merchandize trade flows, 2006
Billion dollars and percentage



Growth in the volume of merchandize trade and GDP by region, 2000-2006
Annual percentage change



Source: World Trade Organization.

Globalization
Favorable opinions of the US

- America's global image has slipped and support for the war on terrorism has declined even among close US allies, such as Japan.
- In 2005, anti-Americanism had shown signs of abating, in part because of the positive feelings generated by the US intervention to support tsunami victims in Asia
- However, the PEW survey shows that Americans and the population of major US allies share common concerns, including:
  - Opposition to Iran developing nuclear weapons is nearly unanimous in Germany, Japan, France, the UK and the US
  - Hamas triumph will be bad for the Palestinian people
- Divisions between the West and Muslim nations on these issues diverge however:
  - People in Egypt, Jordan and Pakistan are divided on the issue of Iran becoming a nuclear power
  - Most people in Pakistan, Egypt, Jordan and Indonesia believe that a Hamas party victory is good for the Palestinian people.

Favorable Opinions of the U.S.

	1999/ 2000	2002	2003	2004	2005	2006
	%	%	%	%	%	%
Great Britain	83	75	70	58	55	56
France	62	63	43	37	43	39
Germany	78	61	45	38	41	37
Spain	50	--	38	–	41	23
Russia	37	61	36	47	52	43
Indonesia	75	61	15	–	38	30
Egypt	--	--	--	–	--	30
Pakistan	23	10	13	21	23	27
Jordan	--	25	1	5	21	15
Turkey	52	30	15	30	23	12
Nigeria	46	--	61	–	--	62
Japan	77	72	--	–	--	63
India	--	54	--	–	71	56
China	--	--	--	–	42	47

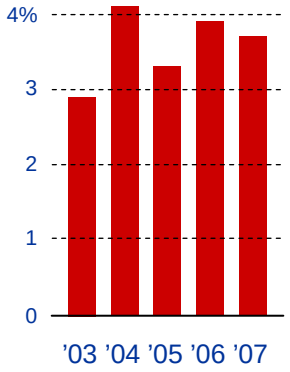
1999/2000 survey trends provided by the Office of Research, U.S. Department of State

Source: PEW Global Attitudes Project

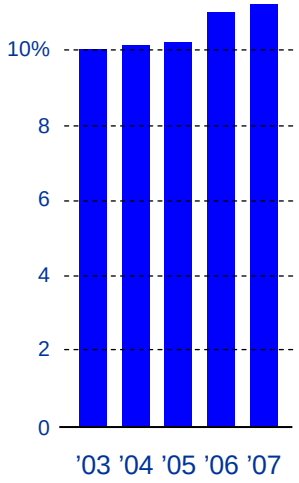
Economy
A two-speed world economy

- Under the combined impact of the housing market implosion and a credit squeeze, the US faces a significant slowdown this year, with probably a 50% chance of recession
- Europe and Japan will also slow, although not by as much – the greatest risks will come through the impact on financial markets
- In contrast, emerging markets seem likely to maintain the much faster growth rates of the past few years, with the chief risk to their benign outlook coming from inflationary pressures
- China, in particular, looks well-positioned to ride out 2008 comfortably – it would not be immune to a US/European slowdown, but some overseas help in restraining growth might actually be welcomed by a government struggling to control inflation

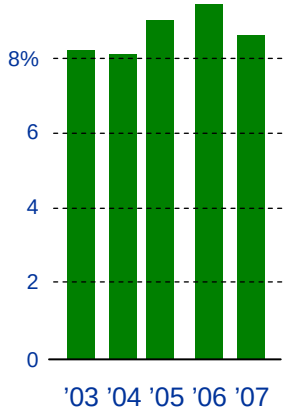
Global GDP growth



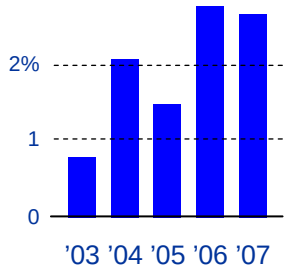
China GDP growth



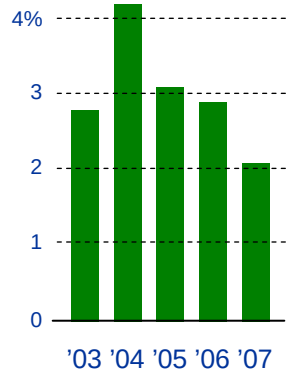
India GDP growth



Eurozone GDP growth



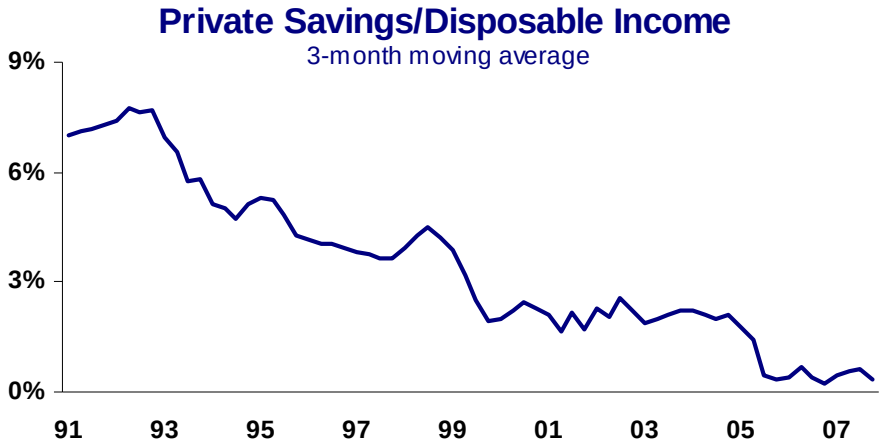
US GDP growth

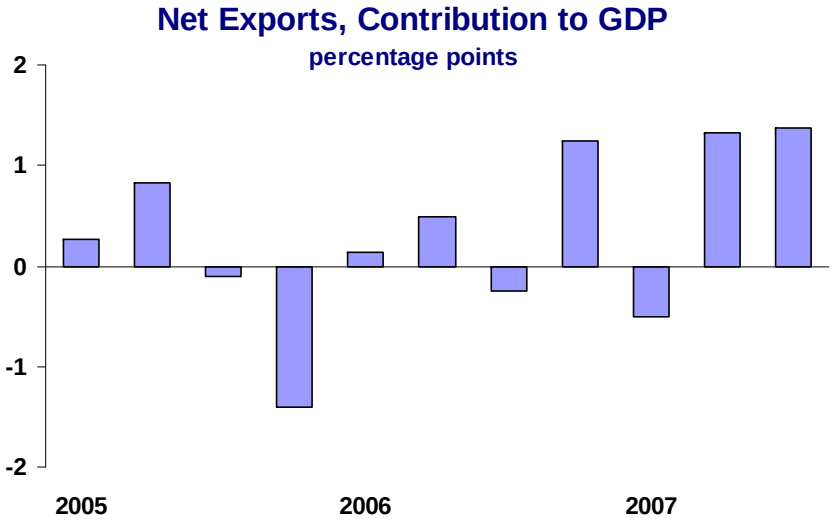


Source: Time, January 2008.

Economy
US economy – growth at risk

- Under the combined impact of the housing market implosion and a credit squeeze, the US faces a significant slowdown this year, with probably a 50% chance of recession
- Private consumption will be the critical factor—it has held up well so far, but consumers are under growing pressure from the housing crash, rising energy costs and tighter borrowing conditions
- For more than a decade consumption has outpaced income growth, as reflected in a declining savings rate—but this decline appears to have leveled off, and might be reversed as consumers react to falling home values
- Net exports have become the most important source of growth, thanks to the falling dollar and strong demand from the rest of the world
- But trade is too small a share of total GDP to drive the US economy on its own—and if consumers falter, there will be a recession





Source: PFC Energy, Markets and Countries Strategy Group

Economy
The world – decoupling or financial contagion?

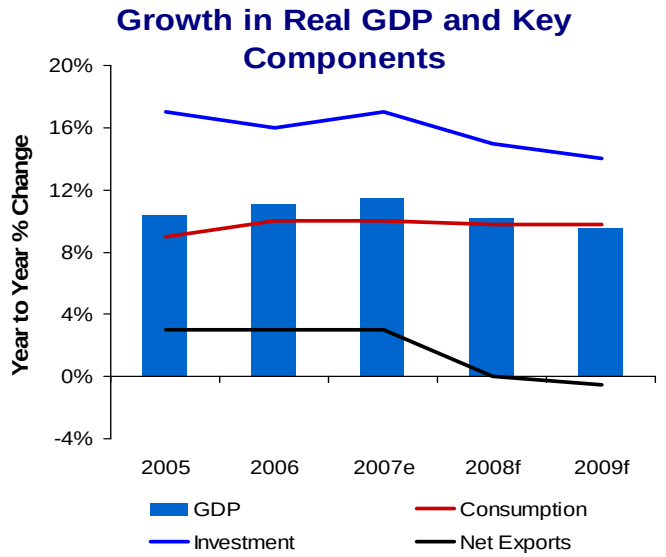
- On its own a US slowdown, or even a shallow recession, would not have more than a marginal impact on the rest of the world economy, which is still booming and has become less dependent on US-bound exports
- However, there is a much higher risk of contagion through the financial sector, where widespread losses stemming from US mortgage defaults have already led to a credit squeeze that threatens to grow worse in 2008
- In effect, this has become a banking crisis – as newly risk-averse investors have withdrawn from asset-backed bonds and commercial paper, banks have been obliged to take hundreds of billions of dollars worth of troubled assets onto their balance sheets, reducing their ability (and inclination) to undertake new lending
- This is not fundamentally a liquidity crisis; rather, it stems from insolvency (in US housing) and a loss of trust among banks and other financial intermediaries—which means that central banks and governments will struggle to remedy the situation
- Sovereign wealth funds have provided a welcome new source of capital to some of the largest banks in recent weeks, but they are unlikely to pile into financial sector investments on a large enough scale to make a difference—not least because of fears that there is worse news ahead for the sector

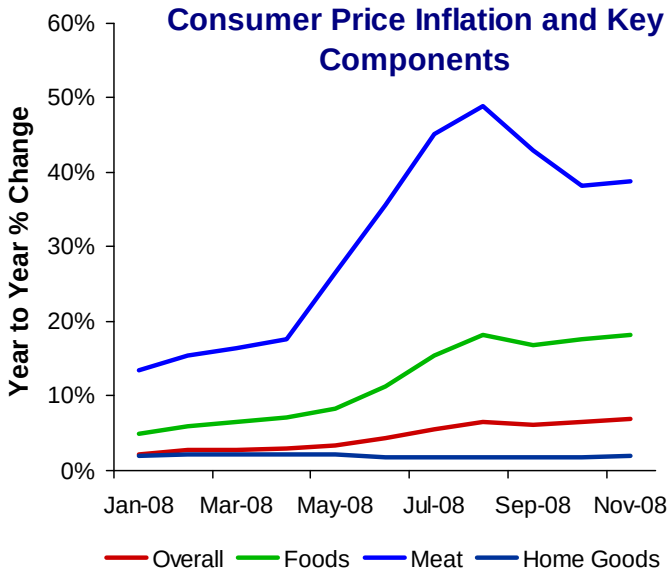
This is a European as well as a US crisis – it threatens to constrict the supply of credit by enough to produce a much deeper slowdown

Source: PFC Energy, Markets and Countries Strategy Group

Economy
China GDP growth likely to slow – to 10%

- 2007 real GDP growth is likely to come in at about 11.5%, and given the apparent strength of the economy at year end, GDP growth in 2008 is expected to be at least 10% for the 5th year in a row
- Growth will likely slow in part because of government efforts to control inflation and because of slower growth in the US and possibly Europe; government attempts to rein in export growth to counter protectionist sentiment in the West are likely to be another damper on near term prospects
- Consumer price inflation rose to nearly 7% in November, amid signs that higher food prices may be spreading to other goods and services
- Worryingly, there are indications that the government is contemplating steps to ease the impact on workers and pensioners by raising minimum wages and accelerating increases in pensions—potentially turning what is still a sector-specific problem into a more general one.
  - And equally worrying, as this is being finalized, there are reports that the government is about to freeze retail prices for fuel products, water and transportation. Given the root causes of the current inflation these latest initiatives would appear to be an over reaction and risk causing additional impediments to China's efforts to address its priorities in each of these areas.

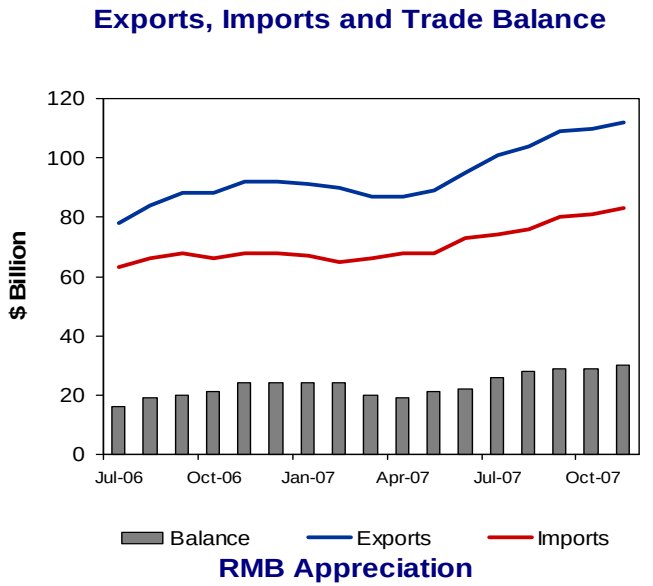


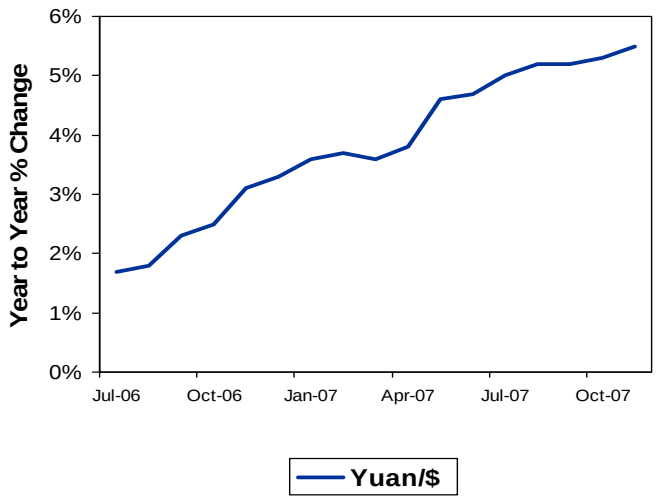


Source: PFC Energy, Markets and Countries Strategy Group

Economy
China exports continue to grow

- After narrowing for a time last spring / early summer China's exports and trade balance have again moved upward raising the risks of protectionist counter measures by the US and EU.
- In order to head off or at least temper protectionist initiatives China has taken a number of steps – mainly changes in taxes – to slow the growth of exports and to begin to shift the focus of industrial activity toward meeting domestic demand.To date however the effects of these steps have been modest and the the prospect of slower growth in both the US and Europe may lead the government to go slow until the extent of the slowdown are clearer.
- Allowing the yuan to appreciate is directionally consistent with these efforts – and is likely to continue and possibly even accelerate in 2008. To date however the effects have tended to make the challenge appear worse by increasing total exports and the surplus as measured in dollars.





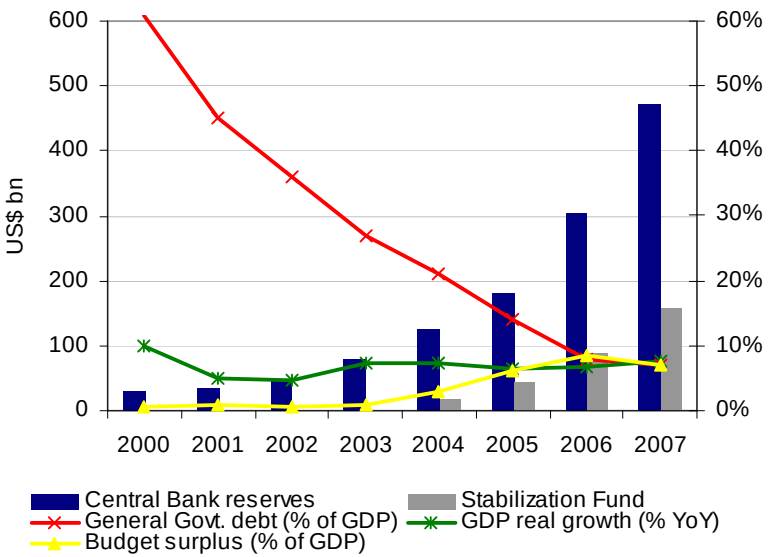
Source: PFC Energy, Markets and Countries Strategy Group

Economy
Russia – economy overview & outlook

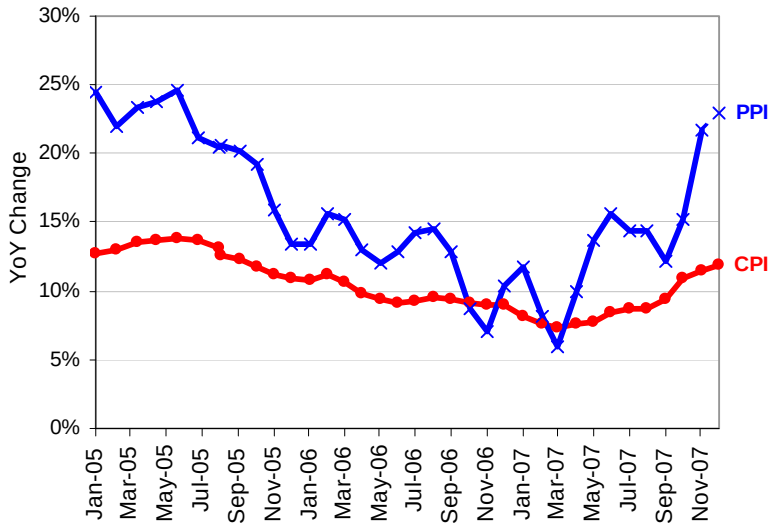
- Economic growth continues… Economic achievements in 2007:
  - Real GDP rose by 7.7%
  - Cumulative FDI increased by 55%
  - Central bank reserves and Stabilization Fund accumulated $450 bn and $156 bn, respectively
  - Budget surplus continued to rise – driven largely by high world oil prices
    - Which threatened to (11.9% in 2007 – vs. 9.2% in 2006)
- …but hurt by the accelerating inflation will likely slow down
  - Inflation reached 11.9% in 2007 (increased from 9.2% in 2006)
  - Kremlin's lavish spending threaten to further exacerbate already rising inflation
    - The government used of nearly $40 bn of the supplemented budget to fund state corporations and support the banking sector liquidity in late 2007
  - Consumer prices—especially food and energy—are growing exponentially in the past four months
- Inflation rapid growth will likely continue in 2008 and beyond – due to:
  - Additional pre-election federal expenditures
  - Much steeper than in 2006 increase for domestic gas prices, electric power and housing services
  - Liberalization of prices for oil products
  - Weakened fiscal sterilization tools

Source: PFC Energy, Markets and Countries Strategy Group

Russia: Macroeconomy Dynamics

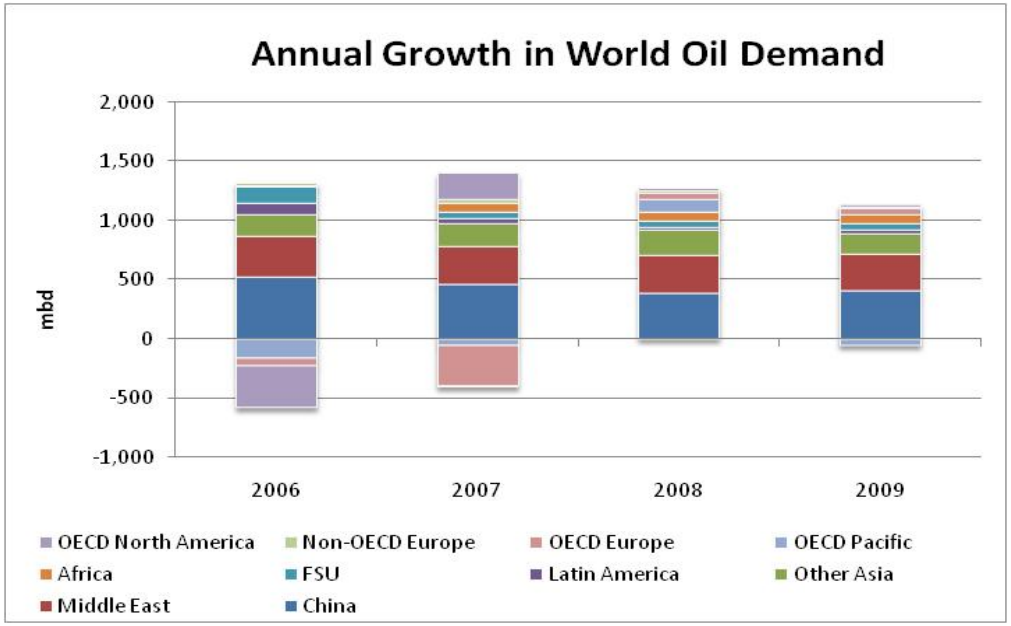


Russia: Inflation in 2005-2007



Economy
Slowing world oil demand

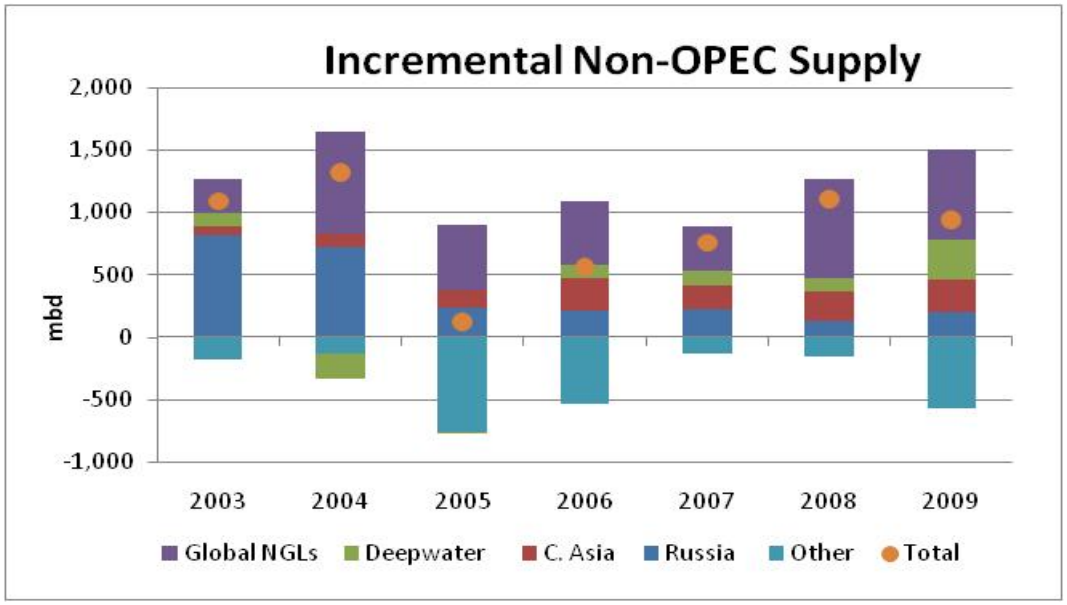
- Growth in oil product demand in 2008-09 will slow, reflecting lower economic output in the OECD, with some impacts on emerging market demand
- Growth will continue to be centered on the rapidly expanding markets in Asia and the Middle East
- Economic expansion largely immune from the impacts of slower growth in Europe and the US is key, aided by continued price subsidies
- Growing inflation worries and political risks to the economic stories in China and the Gulf remain additional risks to demand



Source: PFC Energy, Markets and Countries Strategy Group

Economy
Non-OPEC supply disappoints

- Growth in non-OPEC supplies led by NGL expansion (including OPEC NGLs), but falls short of meeting incremental demand in 2008-09
- Deepwater projects in the US Gulf of Mexico and Brazil (and West Africa for OPEC capacity expansions) continue to face delays—further project slippage could push some incremental 2009 volumes beyond the forecast period
- Global NGLs include bio fuels, with ethanol and bio diesel production set to increase from about 1.0 mmb/d in 2006 to 1.6 mmb/d in 2009—more ambitious expansion plans will be checked by growing concerns about the impact on food prices, particularly corn and palm oil



Source: PFC Energy, Markets and Countries Strategy Group