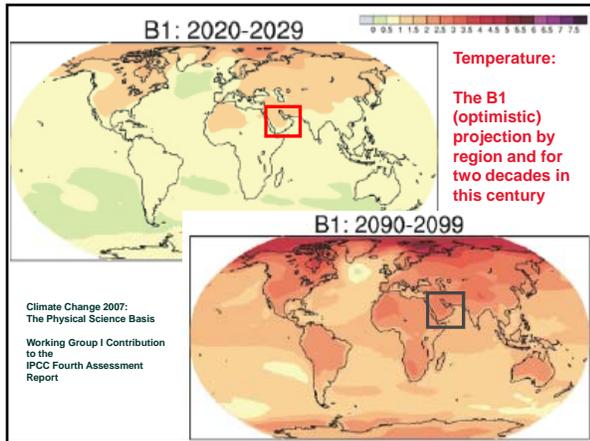
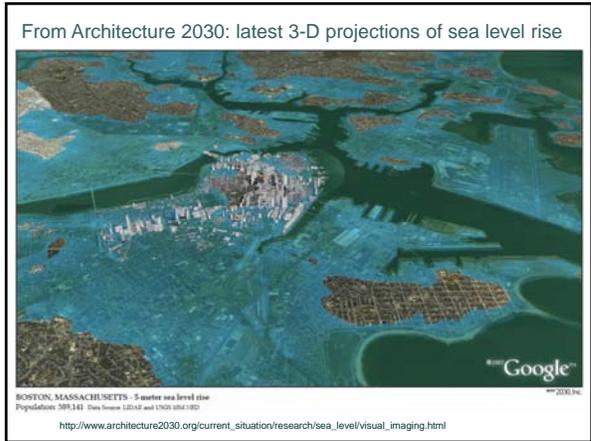


### Introduction

- The focus in this seminar is on the sustainable building and its links with the use of cement and concrete, but it may be useful to provide a picture of the 21st Century context that the whole construction industry will have to operate within;
- Climate change issues and resource scarcities are two main context factors;
- Such broad issues may at first seem to be too abstract to be relevant, but given the lifespan of most buildings, the buildings we plan and build today will certainly be affected by them;
- Not dealt with in this presentation are factors leading to high-performance buildings or the details on the assessment of performance.

Predicted climate change impacts: IPCC 2007

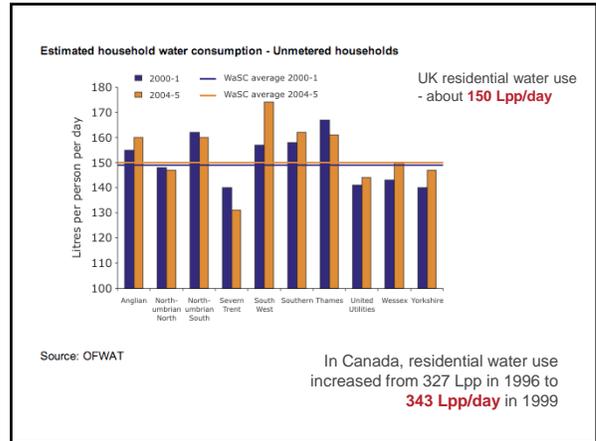
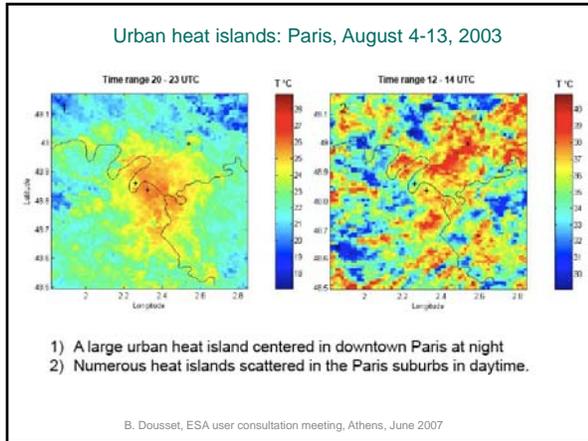
Phenomenon <sup>a</sup> and direction of trend	Likelihood that trend occurred in late 20th century (typically post 1950)	Likelihood of a human contribution to observed trend <sup>b</sup>	Likelihood of future trends based on projections for 21st century using SRES scenarios
Warmer and fewer cold days and nights over most land areas	Very likely <sup>d</sup>	Likely <sup>a</sup>	Virtually certain <sup>a</sup>
Warmer and more frequent hot days and nights over most land areas	Very likely <sup>d</sup>	Likely (nights) <sup>a</sup>	Virtually certain <sup>a</sup>
Warm spells / heat waves. Frequency increases over most land areas	Likely	More likely than not <sup>f</sup>	Very likely
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	Likely	More likely than not <sup>f</sup>	Very likely
Area affected by droughts increases	Likely in many regions since 1970s	More likely than not	Likely
Intense tropical cyclone activity increases	Likely in some regions since 1970	More likely than not <sup>f</sup>	Likely
Increased incidence of extreme high sea level (excludes tsunamis) <sup>e</sup>	Likely	More likely than not <sup>e,h</sup>	Likely <sup>i</sup>



### Specific impacts of high temperatures

- Higher temperature melts icefields and permafrost, and increases evaporation rates which aggravates water shortages;
- Generally, higher temperatures leads to more use of mechanical cooling which creates more demand for electricity, which creates more GHG emissions, which....
- Heat waves can cause higher death rates, especially in the older population. The estimated extra mortality in eight European countries from the 2003 heat wave was 34,897 \*;
- The same study reported that electricity demand rose significantly because of the intense use of cooling systems, and that hydroelectric production was reduced by 19% because of reduced river flow rates, and nuclear production was reduced by 4% because the water temperatures of river cooling water rose above acceptable levels.

\* J.-L. Salagnac, Building Research & Information, July/August 2007



### Some more specific links between climate change and the building sector

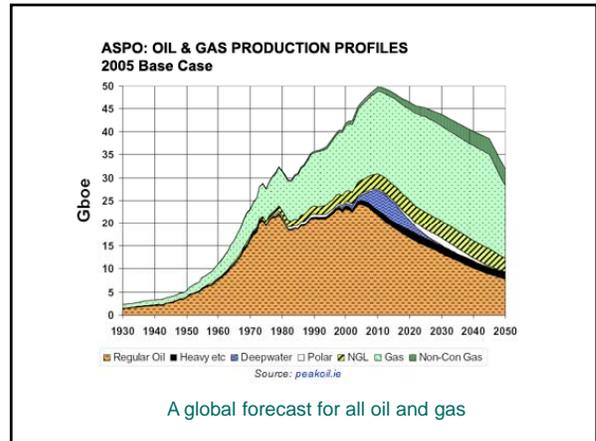
Cause	Intermediate effects	End Result
Higher global temps	Summer temps. Melting permafrost Need more AC  Insect population	Population health Methane, structural Operating cost More energy & GHG Repair / control
High winds	Wind damage	Repair / rebuild
Drought	Water supply  Soil instability Forest fires	Ration or import Prohibit new construction Repair / relocate Rebuild / relocate
Rain & Flood	Flood damage	Repair / relocate
Sea level rise	Vulnerable areas	Relocate

*Note that all end results also involve economic loss*

We have seen some of the impacts of climate change on the building sector.

But there will also be other issues facing us

- ### Possible context during the next century
- Energy prices will probably be high, with most analysts predicting long-term prices above \$50 per barrel for oil (currently at \$80+);
  - There may be a scarcity of affordable natural gas in some areas due to declining production from easily accessible fields - the wholesale price of natural gas in Europe tripled in the period 2003-2006;
  - The global production of oil may be close to peak or already past it;
  - This diminution of affordable fossil fuel supplies will have immense effects, only some of which can be foreseen clearly;
  - Fuel-dependent transportation will become very expensive, and so will the construction and operation of buildings;
  - But we also need fossil fuels for fertilizer and plastics.



### Resource consumption

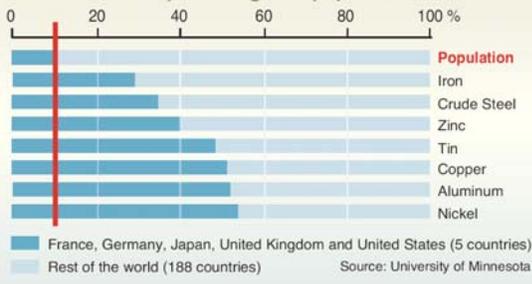
- The construction sector is a major user of resources, including metals, wood, plastics, and the constituent materials for cement, masonry and ...
- The production process for building materials require large amounts of energy and water, which feeds back into the central problem;
- The Club of Rome report was hasty in predicting shortages of resources, but in principle they were correct and there are clear signs that the increasing difficulty of extracting smaller amounts of some resources is now having an impact;
- And then consider the rate of growth in China, India and Brazil.

### Growth in the construction sector of China, Brazil and India is high, and is likely to remain so for many years



Davis & Langdon, World Construction Review 2005

### Consumption of selected industrial raw materials compared to global population

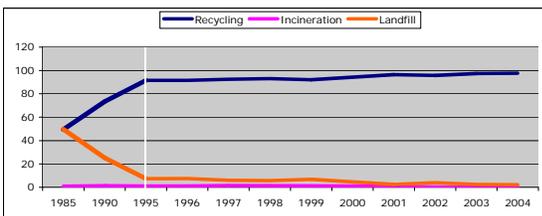


Consumption of a range of industrial materials in Western Europe and USA is much more than in the rest of the world: what happens when India and China join the party?

### Wastes

- The construction sector is responsible for 30% to 40% of municipal wastes;
- Materials taken to the dump means that new materials must be produced, with associated energy and emissions;
- Throwing things away does not work, because there is no "away";
- The goal must be zero waste.

### Reduction of C & D wastes in the Netherlands

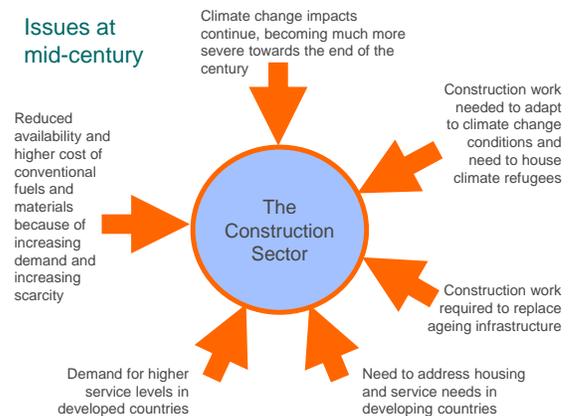


#### Important elements:

- Taxes on landfill since 1996
- Ban on landfill; partial since 1997, total since 2001;
- Obligation to sort C & D waste;
- Building materials decree (2001) - all materials certified regarding leaching, proper use, obligation to take back after use etc.

Info courtesy of Ronald Rovers

### Issues at mid-century



### Energy efficiency v. consumption and service levels

- Energy efficiency in operations is clearly a top priority in view of its central role in reducing GHGs;
- However, consider the following:
  - Construction undertaken for Olympics and World Expo events;
  - Buildings that are fully air-conditioned in even moderate climates;
  - Single family houses that are efficient but have areas of 500 m2 or more;
  - The proliferation of types and numbers of household appliances in even middle-class homes;
- In such cases, energy efficiency is not enough, and we must reduce expectations of service levels;
- But a reduction in expectation of service levels is much harder to achieve than efficiency improvements, since it requires changes in values and lifestyles;
- This will be the main issue to address during the next decades.

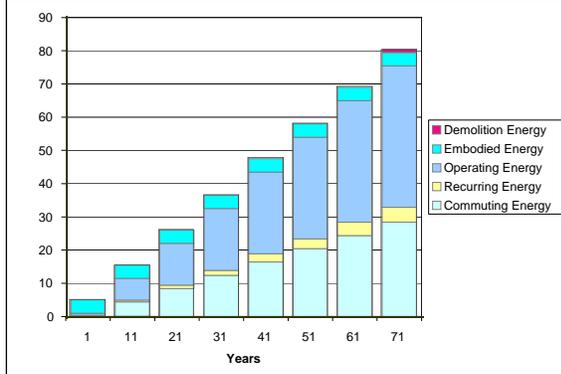
### Considerations for UAE

- UAE has oil and gas reserves for some years to come, but the global market is such that oil and gas scarcities in other countries will have an effect here;
- With some time lag, you are also likely to suffer from shortages and high prices;
- And that is clearly the case for other resources and materials;
- Therefore environmental efficiency is likely to take on strategic importance;
- And even wealthy foreigners may face problems in making frequent long-distance trips to the UAE from their countries of origin, which will affect the local economy;
- It is therefore in the long-term interest of UAE to set an example of environmental efficiency.

### Building performance issues

#### Set goals

	Community scale	Building scale
<b>Regenerative</b> Bring ecosystems back to full health	To be explored	
<b>Sustainable</b> No negative impact on ecosystems	High densities, mixed uses, mainly public transport & pedestrian oriented, green space	Very high performance, feed electricity to grid
<b>Green</b> Substantial improvement in environmental performance	Emphasis on higher densities, mixed uses, control of car, provision of public transport	Best practice performance - 75% reduction from norms
<b>Good Practice</b> Performance levels achieved by top 25%	Community planning follows conventional suburban path.	50% reduction from norms (probably top 25% of current).
<b>Regulation</b> Minimum performance according to regulation and/or industry practice	Transport, water, sewer etc. seen as quite separate	Some emphasis on energy performance, but not much else



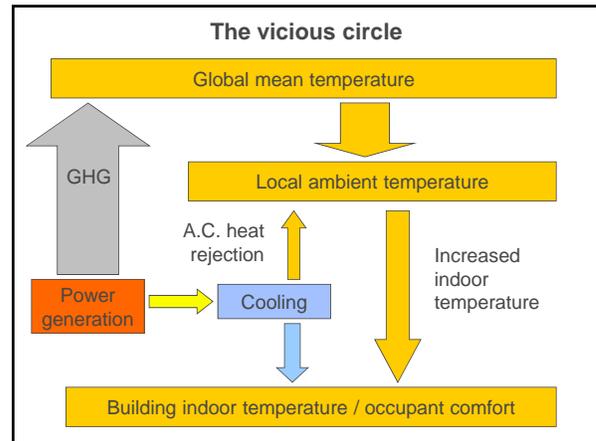
Energy consumption isn't only from operations

### Embodied energy and emissions

- Note that embodied energy and emissions becomes of increasing importance if the building life span is shorter or if the operating energy is very good;
- In any case, the embodied energy and emissions of structure, envelope and major equipment should be estimated;
- Reducing embodied energy now is especially important for a GHG reduction strategy;
- It becomes very important to build efficient structures and specifically to minimize the use of cement;
- Supplementing cementing materials should be seriously considered.

Electrical consumption is rapidly rising and presents the largest problem

Annual energy consumption, including cooling, ventilation, lighting and office appliances, according to Yi Jiang, Tsinghua University					
Country	China, large floor plate	China, narrow floor plate	France	Norway	USA
Typical annual electric power consumption, kWh/m <sup>2</sup>	100-150	20-60	165	226	356



Fuel Type	KgCO <sub>2</sub> /KWh
Grid Electricity	0.43*
Natural Gas	0.19
Gas/ Diesel Oil	0.25
Petrol	0.24
Heavy Fuel Oil	0.26
Coal	0.30

CO<sub>2</sub> emissions by fuel type in the UK; note the high rate of emissions for grid electricity

Source: UK Gov't.

### Why is high performance worthwhile?

- Climate change conditions will reward owners of high-performance buildings because of their lower operating costs and attractiveness to knowledgeable tenants;
- Design teams capable of producing such buildings will find their services in more demand;
- Put it another way: bad buildings that perform poorly in higher temperature regimes and that provide poor indoor environmental conditions will be heavily penalized by the market;
- Pursuing high performance strengthens corporate image and reduces risk;

### Performance Rating Systems

- Investors and tenants need to be able to distinguish high-performance buildings from the rest;
- Performance assessment systems, such as LEED, BREEAM, CASBEE and others can provide performance ratings and labels;
- It should be noted that most rating systems are developed within a specific region and contain assumptions about the relative importance of issues and performance benchmarks, so the relevance of rating results diminish greatly when such systems are used in other regions;
- For example, it may be difficult to reflect the priority for water conservation and, if the rating system contains criteria to assess the performance of carpeting, then application of such a system to regions where carpeting is not the norm penalizes the user;
- For regions other than North America, it therefore makes sense to adapt one of the existing systems, or else use a general framework, such as SBTool, that allows third parties to develop rating systems suited to any specific region.

### Things we should do....

- Government officials:**
  - Establish challenging performance goals, targets and regulatory requirements for urban areas and for existing and new buildings;
  - Establish carbon taxes and minimize taxes on renovation work;
  - Review planning regulations to ensure that they move the industry towards high-density and mixed-use development in areas served by public transport;
  - Provide support to R&D to ensure that high-performance technologies make their way to the market quickly;
- Universities:**
  - Support technical R&D;
  - Promote the growth of inter-disciplinary courses and studies.

## Things we should do....

- Investors:
  - Assess the financial viability of your projects using life-cycle costing approaches;
  - Can an existing building be renovated instead of building new?
  - Select development sites that are environmentally preferable.
- Architects and Engineers:
  - Use an integrated design process, working in an integrated team and ensuring that the implications of design decisions are clearly seen and assessed;
  - Establish clear and high performance goals;
  - Design and build lean and green;
- Tenants and purchasers:
  - Insist on proof of high performance in the form of a Performance Label - remember that you will pay the price of poor performance!

## Conclusions

- Energy efficiency and Greenhouse gas emissions are core factors, but more than operating energy is involved;
- Other key issues include water and resource scarcity;
- There are many obstacles to rapid take-up of new ideas in the building sector;
- Success will require action on a broad front, taking into account varying regional needs and preferences;
- Great advances in environmental efficiency can be expected, but it is not so clear that we will see the changes of lifestyles and values required to reduce the production volume of buildings and equipment or to reduce service quality expectations..
- **If we are to minimize the impacts of climate change we must act immediately!**

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