Building sector strategies for reducing GHG emissions under extreme conditions

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the International Initiative for a Sustainable Built Environment

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iiSBE at a glance

- An international non-profit organization;
- Focus on guiding the international construction industry towards sustainable building practices;
- Emphasis is on research and policy, with a special emphasis on information dissemination, building performance and its assessment;
- 450 members, Board members from 20+ countries;
- Offices in Ottawa and Maastricht;
- Local chapters in Canada, Czech Republic, Israel, Italy, Korea, Portugal, Spain and Taiwan;
- Andrea Moro is President, Nils Larsson is XD.
- Very active network.
The cause of the problem

World Greenhouse Gas Emissions in 2005
Total: 44,153 MtCO₂ eq.

End Use/Activity
- Road: 10.5%
- Air: 1.7%
- Rail, Ship, & Other Transport: 2.5%
- Residential Buildings: 10.2%
- Commercial Buildings: 6.3%
- Unallocated Fuel Combustion: 3.8%
- Iron & Steel: 4.0%
- Aluminum/Non-Ferrous Metals: 1.2%
- Machinery: 1.0%
- Food & Tobacco: 1.0%
- Chemicals: 4.1%
- Cement: 5.0%
- Other Industry: 7.0%
- T&D Losses: 2.2%
- Coal Mining: 1.3%
- Oil/Gas Extraction, Refining & Processing: 6.4%
- (tropics only)
  - Deforestation: 11.3%
  - Afforestation: -0.4%
  - Harvest/Management: 1.3%
- Agricultural Energy Use: 1.4%
- Agriculture Soils: 5.2%
- Livestock & Manure: 5.4%
- Rice Cultivation: 1.5%
- Other Agriculture: 1.2%
- Landfills: 1.7%
- Wastewater, Other Waste: 1.5%

Waste: 3.2%

Carbon Dioxide (CO₂) 77%
Methane (CH₄) 15%
Nitrous Oxide (N₂O) 7%
HFCs, PFCs, SF₆ 1%
Influence of CO₂ emissions on CO₂ concentration, temperature and sea level

- **Time taken to reach equilibrium**
  - Sea-level rise due to ice melting: several millennia
  - Sea-level rise due to thermal expansion: centuries to millennia
  - Temperature stabilization: a few centuries
  - CO₂ stabilization: 100 to 300 years

Source: IPCC
The A1B global temperature projection by region and for two decades in this century
IPCC Precipitation Projections 2090-2099 enlarged

Those who have lots will get much more...

December-February

Climate Change 2007: The Physical Science Basis
Working Group I Contribution to the IPCC Fourth Assessment Report
And those who have little will get less...

change in recurrence of 100-year droughts, 2020-70, compared to 1961-90, business as usual model.
<table>
<thead>
<tr>
<th>Global effects</th>
<th>Likelihood of future trends</th>
<th>Examples of major projected impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmer and fewer cold days and nights over most land areas</td>
<td>Virtually certain (99% probability)</td>
<td>Reduced energy demand for heating; increased demand for cooling, declining air quality in cities</td>
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<tr>
<td>Warmer and more frequent hot days and nights over most land areas</td>
<td>Virtually certain (99% probability)</td>
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<tr>
<td>Warm spells / heat wave frequency increases over most areas.</td>
<td>Very likely (90% probability)</td>
<td>Reduction in quality of life for those people in warm areas without appropriate housing; impacts on the elderly, very young and poor.</td>
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<td>Area affected by droughts increases</td>
<td>Likely</td>
<td>Water shortages...reduced hydro generation, potential for population migration.</td>
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<tr>
<td>Heavy precipitation events. Frequency (or proportion of rainfall from heavy falls), increases over most areas.</td>
<td>Very likely (90% probability)</td>
<td>Disruption of settlements, transport and societies due to flooding; pressures on urban and rural infrastructure; loss of property.</td>
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<tr>
<td>Intense tropical cyclone activity increases</td>
<td>Likely</td>
<td>Disruption by flood and high winds, loss of insurance, population migration, loss of property.</td>
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<tr>
<td>Increased incidence of extreme high sea level (excludes tsunamis).</td>
<td>Likely (long term)</td>
<td>Costs of coastal protection v. relocation, loss of insurance, population migration, loss of property.</td>
</tr>
</tbody>
</table>
Demand and resource depletion
It isn’t only climate change effects: global forecast for all oil and gas demand from China, India, Brazil and SE Asia.
Implications

- The ratio of energy input to output in conventional oil fields has been in the order of 1 to 15 or 20;
- In the Oil Sands of Alberta, the ratio is 1 to 3 or 4;
- Greater difficulties of extraction for both oil and gas will lead to higher prices;
- Remember that we need oil and gas for other purposes, such as fertilizers, plastics and lubricants;
- Herman Scheer: using oil and gas to the last drop is pyromania, and the long chain between the few sources and the many end users is fragile, so it is far wiser to focus on local sources of renewable energies.
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?
Commodity prices – steel and copper

- Resource depletion of key materials will surely continue to drive up construction prices, since most form part of a global market.

- **Iron ore prices are headed as much as 35 percent higher this year and will likely pressure the profit margins of steel companies…** Spot market prices for iron ore surged more than two-fold in the last 12 months on strong demand from China and recovery in Europe, and the United States…. the company continues to hunt for more sources of iron ore and coal for the European unit. *

- **Martin (BHP Billiton) calculates that there will be a copper supply gap of 10-million tons in 2020...** Martin reports that China's per capita copper growth is rising to 4 kg, and he expects this to more than double by 2025. He sees power distribution as a major demand driver owing to copper being preferred as underground distribution cable, and replacing overhead aerial transmission cables - which are made mainly from aluminium - in the process.**

* www.reuters.com  
** www.miningweekly.com, 16 May 2010
World consumption of cement is forecast to continue to increase throughout the next 15 years, taking the annual volume up from the 2283mt of 2005 to around 3130mta by 2015, and 3560mta by 2020, representing overall forward expansion of approximately 56% *

...consumption trends (in USA) appear to spell trouble, with both short- and long-term production shortfalls expected. Climate change legislation, plant emissions regulations, and sustained high oil prices are likely to result in the elimination of wet process cement production, which accounts for approximately 15 percent of all U.S. powder, and could force the closure of a significant portion of domestic mill capacity. Add to that the likely growth in cement usage even in the next five years (consumption levels are expected to hit 122 million metric tons by 2015), the potential for a 100 million-metric ton domestic supply gap may materialize by 2035.**
What lies behind greater resource consumption

Las Vegas, USA, 1973

Las Vegas, USA, 2000

Source: UNEP, 2005
Example: housing in North America

- Between 1950 and 2004, the size of the average new house in the US expanded by 135%, from about 1000 square feet (93 m²) to 2349 square feet (218 m²);

- One in five new houses now comes in at more than 5000 square feet (465 m²). (The US National Association of Home Builders’ ‘showcase home’ for 2005 was 5950 square feet (553 m²) or 15% bigger than the 2004 model.)

- Forty-three per cent of new construction features 9-foot ceilings compared with 15% in the 1980s.

- Meanwhile, between 1950 and 2003, average US household size fell from 3.7 to 2.6 people.

- This means that floor space per capita increased by over 230% from 270 square feet (25 m²) to 903 square feet (84 m²).

J.R.’s ranch on the Dallas TV show:

The TV show was watched by 300 million people in 57 countries. Many viewers perceived the Ranch as the kind of house that most Americans have, and a lifestyle that they also should aspire to.
A major emerging problem

Many appliances are more energy efficient...

CHANGE IN ENERGY CONSUMPTION SINCE 1990

-10%

-20%

-30%

-40%

-50%

-60%

-70%

Air conditioners*

Refrigerators*

Clothes washers

*1998 data unavailable

... but homes have more gadgets than before ...

AVG. U.S. RESIDENTIAL CONSUMPTION, 2005

Other, including clothes washers

Air conditioning

Computers 1%

Cooking 2%

Freezers 2%

Dishwashers 2%

Clothes dryers

Space heating

Water heating

Refrigeration

Lighting

TVs and set-top boxes

Sources: International Energy Agency (per capita consumption and energy use by appliance); Association of Home App...
A major emerging problem

... and new TVs are bigger energy users ...

<table>
<thead>
<tr>
<th>EST. AVG. POWER USAGE FOR TV MODELS</th>
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<tbody>
<tr>
<td>42&quot; plasma (newer model)</td>
</tr>
<tr>
<td>46&quot; LCD (newer)</td>
</tr>
<tr>
<td>50&quot; projection (older)</td>
</tr>
<tr>
<td>32&quot; cathode ray tube (older)</td>
</tr>
<tr>
<td>20&quot; LCD (older)†</td>
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</tbody>
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... which is causing consumption to rise.

U.S. PER CAPITA ELECTRICITY CONSUMPTION

<table>
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<tr>
<th>5,000 kilowatt-hours</th>
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<tr>
<td>'90</td>
</tr>
<tr>
<td>4</td>
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<tr>
<td>3</td>
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<tr>
<td>2</td>
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†The technology is popular, but people usually buy bigger models now.

Appliance Manufacturers (decrease in consumption for some appliances); Ecos (TV power usage)

THE NEW YORK TIMES
An unavoidable factor in consumption: 90% of urban growth is taking place in the developing world

Urban populations in Africa and Asia will double in the next 20 years
Summary of likely issues at mid-century

Reduced availability and higher cost of fuels, materials, labor and capital

Water scarcity and/or drought in some areas

Demand for higher service levels in developing and developed countries

Retrofitting and new construction to meet climate change adaptation needs

New construction to house climate change refugees

Construction work required to replace ageing infrastructure in the West

Housing and service demand to meet current deficits and future urban growth in developing countries
**Things we must do.... key points**

- Be ready to relocate large populations and their supporting infrastructure and building stocks;
- Be prepared for repair and reconstruction efforts;
- Adapt our buildings and infrastructure to cope with new conditions;
- *Most important, we must not let the coming problems divert us from the vital need to reduce GHG emissions much more rapidly than we are currently doing, to prevent the problem from worsening.*
The implications of the current gradual approach to mitigation
Deferred action on climate change

- Key industry and government leaders don’t want to face the facts about climate change and have hesitated too long about implementing adequate long-term mitigation measures;

- Measures that are implemented tend to be of the no-regrets and painless variety, but these are not sufficient to make the rapid reductions that are needed;

- Some countries, especially in Europe, have announced aggressive plans for GHG reduction, but it remains to be seen if their populations will accept the consequences;
Deferred action on climate change

- Considering the long lag times in the climate system, it therefore seems that GHG reductions will *not* come rapidly enough to avoid severe climate change impacts;

- We therefore face a distinct probability that global temperature increases will be considerably more than the target 2 °C;

- This would lead to massive long-term disruption of agriculture, industry, living and working conditions, as outlined by IPCC and others.
Climate change effects may come in such a gradual form that we will not take action until it is too late;

However, we should not be surprised if the first announcements of serious climate change arrive in the form of major weather events such as cyclones, other wind storms, flash floods, droughts, or a combination of some of these;

We may not be able to have absolute proof that recent droughts in Australia, heat waves in Russia or floods in China or Poland are linked to climate change, but is it wise to ignore the strong possibility?

The consolation is that, if series of major weather events were to occur within a short period of time, and if they strike close to regions of wealth and power, they will focus attention on climate change in a way that logic and scientific proof never will;
These are only two of the many impacts on the horizon - precipitation and wind.
The likely scenario

- Let us assume that a series of major weather events, causing billions in damage and thousands of deaths, does occur within in First World locations during the next decade, and that the imminence of climate change is finally accepted;

- Based on the history of catastrophic events of other types, we can assume that the shock effect will open the minds of the public and elites to radical measures;

- But such openness will last only for a few weeks, and desperate leaders will grab whatever plans are available;

- The result is likely to be hasty, ad-hoc and poorly considered action;

- We have unfortunate examples of this kind of reaction from the collapse of the USSR, the 9/11 event, SARS, the recent recession, and even the current Gulf of Mexico oil spill.
Possible reactions

- In the case of the forthcoming weather shocks from climate change effects, we may unfortunately face a similar situation, but the consequences may be even more serious;
- The immediate concern will be to care for injured populations and to carry out immediate repairs, and this is likely to push the need for adaptation and mitigation measures to the back burner;
- Undoubtedly, there will be some immediate proposals for quick adaptation and mitigation measures, but all will be hastily prepared and some of them will have side effects of excess profits and social dislocation;
- But if they are the only plans on the table they will be accepted, because, in the panic, nobody will have the time or the will to develop well-considered plans;
- So, what might be the effects in the building sector in such a disorderly situation?
Governments might be led to announce that, in addition to urgent rebuilding efforts, national emissions must be reduced by large amounts over a very short period (say 80% by 2025 instead of 2050), along with promises of massive fines if targets are not met;

Reaching such performance requirements would be very difficult, because strategies for such a rapid and deep reductions would have to be invented on the fly;

We can foresee that such actions might be achievable in, for example, in the automotive or the consumer goods sectors, but the building industry is very large and complex, with a few large players and very many small ones on the production side, and with control even more dispersed on the demand side;

And the building industry is highly regionalized, so it is very unlikely that we can suddenly implement rapid improvements in this sector.
Likely effects

- First, we would expect a surge in demand for labor and materials to carry out urgent repair, re-building and re-location needs;
- This would, within weeks, deplete the supply of skilled and firms in the region;
- Manufacturers of building materials will be faced with urgent production requests, but will face greatly increased power costs, and may also have to cope with a disrupted labor force and plant conditions;
- Prices for materials and services would therefore reach astronomical levels;
- Owners or managers of existing commercial buildings would have to reduce operating hours to meet GHG reduction targets;
- Residential tenants will face mandatory energy cuts;
- The value of buildings with poor energy efficiency will plummet;
... effects

- Suburban building land values will also face massive drops because of controls on new building and stringent limits on private vehicle emissions, which will bring new construction in outer suburbs to a halt.

- Standards for good design and operations, such as adequate lighting levels, indoor comfort conditions, and work to preserve heritage buildings will fall by the wayside, at least temporarily (say for 20 years);

- Social tensions will rise to very high levels when those who want to pursue their normal paths (commercial building development, building your dream home) are faced with permit refusals, while climate refugees and families suffering from energy poverty are given priority;

- And the need to deal with repair and remedial work will lead governments to say that they cannot afford more GHG mitigation measures;

- So climate change will continue unabated.
The likely scenario
An alternative scenario: specific contingency plans prepared now, ready for implementation when needed
Contingency planning scenario

- Our assumption is that pressures for immediate action will be very great in the aftermath of major weather events, if developed countries are affected;

- We will therefore need to have contingency plans available for immediate implementation to achieve deep cuts in GHG emissions, to be implemented in parallel with urgent repairs and assistance to affected populations;

- For mitigation, such plans must support very rapid reductions in GHG emissions over a short time-frame – something like 75% over 5 years – but varying with the sector and specific cases;

- To be available when the time comes, plans must be voluntarily developed now by a variety of public- and private-sector organisations so they will be ready when needed;

- A large number of contingency plans will need to be prepared by individual governments and private-sector organizations, and these must cover most key sectors of the emission-producing economy;
Reactions, likely and preferable

- Shocks
- Panic
- Search for instant solutions
  - Ad-hoc disaster relief action
  - Weak plans for GHG mitigation
    - Ad-hoc adaptation action
  - Ad-hoc disaster relief action
    - Strong plans for GHG mitigation
      - Adaptation action

- Preparation of many specific contingency plans
- Partial implementation
- Many specific plans ready to implement
Contingency planning scenario

- Most plans should be developed by national or local governments;
- Such plans could be versions policies currently in place, but made more specific and geared towards more rapid GHG reductions;
- Others would be developed by non-government organisations for assets or services that are under their own control; e.g. the owner of a large portfolio of office, hotels or residential buildings would develop a strategy to suit their portfolios;
- Some of these plans will have to remain confidential, because they will require restrictions on the actions of individuals that are totally unacceptable today;
- Here are some diverse examples of the kind of rapid reduction plans that might be useful in a contingency plan scenario:
Proposals for 20 key contingency plans

1. Immediately introduce carbon taxes, to reduce the carbon intensity of building-sector related goods and services; and simultaneously reduce existing income taxes;

2. Immediately ban the construction of new coal-fired generation power plants and the extension of existing plants, unless significant GHG sequestration is provided;

3. Rapidly reduce peak loads in electrical networks through the rate structure and through load ceilings;

4. Rapidly implement measures to facilitate feed-in tariff policies from decentralized renewable power sources;
Proposals for 20 key contingency plans

5. Develop strategies to minimize speculative price rises for construction materials;

6. Prepare risk assessment studies of existing urban areas and building stock with regard to possible climate change impact events, such as floods, wind storms, heat waves etc. Such work is a necessity for post-disaster recovery.

7. Develop alternatives to deal with power outages and other service interruptions (water, food and other supplies, communications etc.);

8. Ensure that facilities of critical importance, such as hospitals, public transportation systems, water and sewage treatment and pumping systems, remain provided with electrical power, heat, water and other vital services;
Proposals for 20 key contingency plans

9. Make realistic plans for the rapid relocation of key facilities such as docks and airports, and of large populations in areas vulnerable to flooding or fire;

10. Develop strategies to rapidly implement passive survivability including food security; support the transition of large urban and suburban milieux to localized, small urban areas and communities with greater self-reliance;

11. In areas with housing shortages, rapidly identify empty non-primary dwellings, and develop measures to ensure that they are more fully utilized;

12. Develop measures to prevent the proliferation of secure and gated communities as a disaster response, unless these are socially balanced;
Proposals for 20 key contingency plans

13. Introduce an immediate triage program for urban areas, to determine zones that will be targeted for performance upgrades or, if the potential is limited, targeted for dismantling and replaced by high-performance re-development;

14. In areas designated for performance upgrading, establish immediate programs of urban infill to increase densities and renovation of existing buildings to greatly reduce GHG emissions (by at least 80%) and to improve water performance;
15. In developed countries, impose a freeze on new construction in unserviced or low-density areas or potential flood areas; …and for new construction that is permitted, impose a zero operating GHG emissions requirement and then, a zero impact requirement.
Proposals for 20 key contingency plans

16. Ensure a rapid reduction in operating emissions of public buildings, private office, hotel and multi-unit residential buildings, through implementation of “hammer-ready” energy reduction retrofit plans and better operating practices, all while minimising disruption or reduction in service levels to occupants;

17. Operators of manufacturing plants and service-sector facilities should have plans ready to rapidly reduce peak loads and emissions in their facilities, by means of changes in industrial processes, operating hours or other relevant means;

18. Prohibit the sale of appliances and equipment that do not meet certain operating efficiency criteria (e.g. "A" label in Europe), and establish a program for rapidly scaling up of equipment efficiencies;
Proposals for 20 key contingency plans

19. Establish crash training programs for regulators, renovation contractors, simulation specialists and others needed to upgrade performance in new and existing buildings;

20. Rapidly implement public education programs to promote conservation in energy, water and materials, for office tenants and residential owners or tenants.
Conclusions

- Some governments, especially in Europe, have launched ambitious plans to reduce GHGs, but it is not yet clear whether their voters will agree with the changes in lifestyle that will be necessary to meet these targets;
- Excessive consumption will not easily be reduced, and is likely to lead us into global temperature increases that will be considerably greater than the desired target of 2 deg.C;
- It is not unreasonable to assume that it will require several climate-induced disasters of major proportions to shock governments and their populations into real action, especially in North America;
- When that happens, there will be an immediate demand for repair and reconstruction efforts, but we must also deal with the causes;
- This will require that we have contingency plans at the ready to reduce GHGs in a very rapid way and to implement urgent measures for climate change adaptation;
- We must develop such plans now and keep them ready.
Contacts & Info

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- www.iisbe.org