SB state of the art

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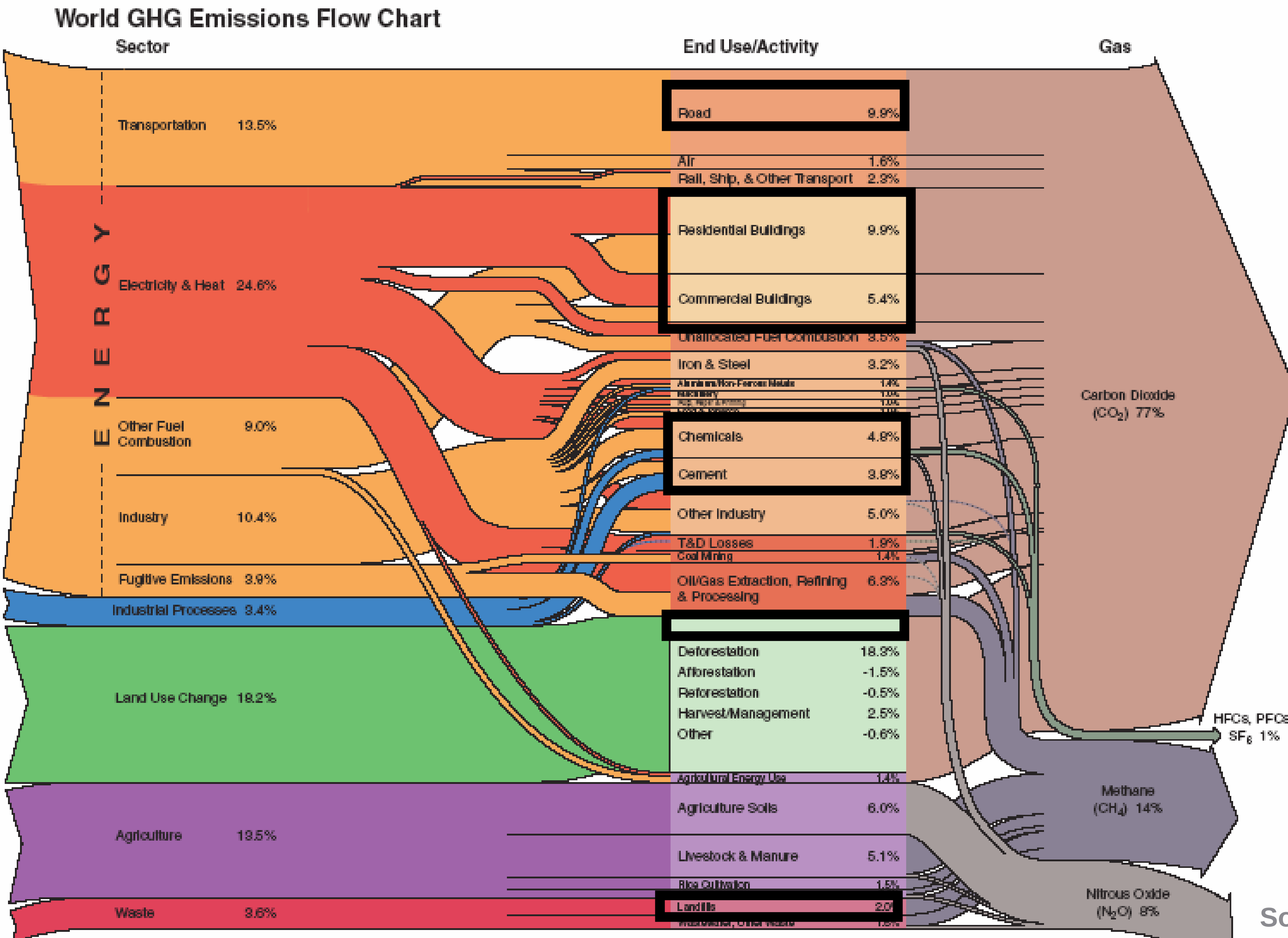
the International Initiative for a Sustainable Built Environment

September, 2009

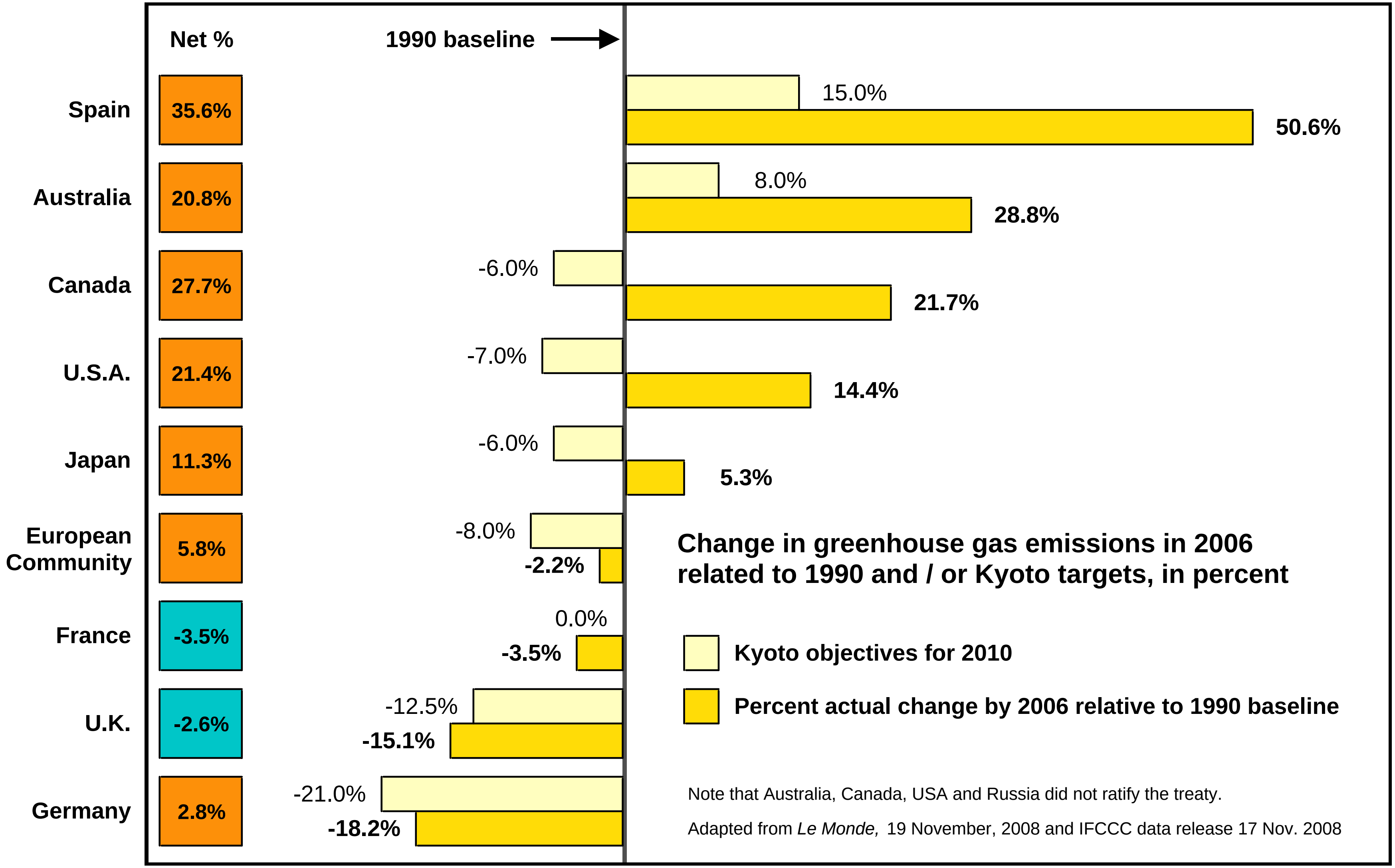
First, a few words on why we should care about high performance



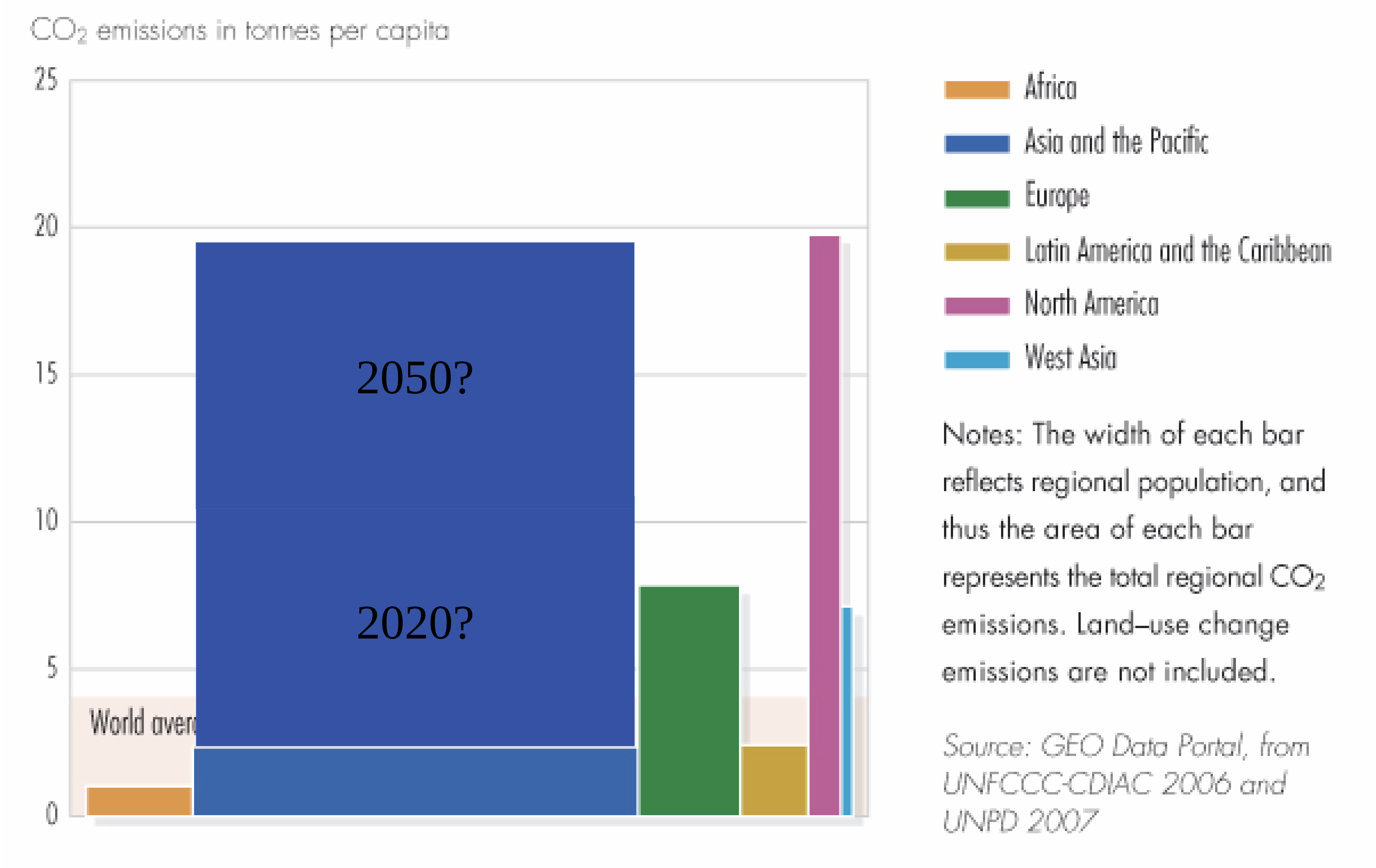
Sources & Notes: All data is for 2000. All calculations are based on CO_2 equivalents, using 100-year global warming potentials from the IPCC (1996), based on a total global estimate of 41,755 $MtCO_2$ equivalent. Land use change includes both emissions and absorptions; see Chapter 16. See Appendix 2 for detailed description of sector and end use/activity definitions, as well as data sources. Dotted lines represent flows of less than 0.1% percent of total GHG emissions.

Source: WRI

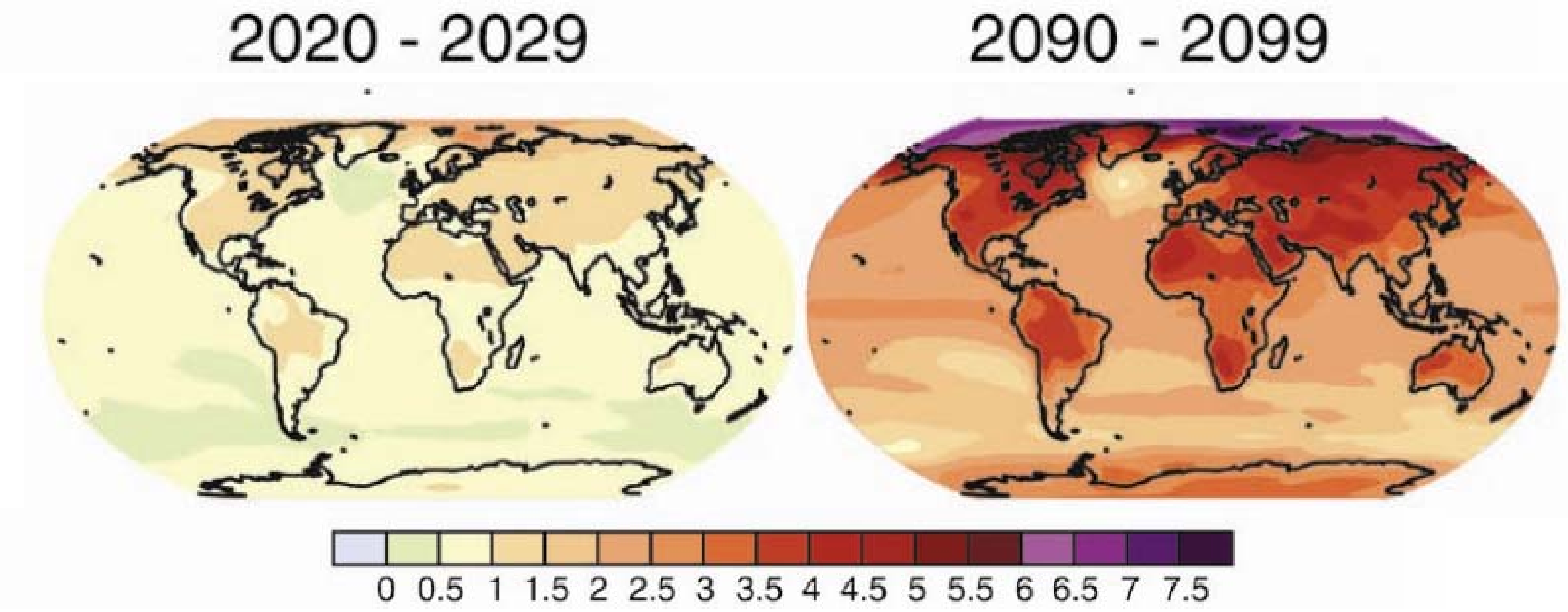
2006 emissions for selected countries, compared to 1990 baselines and/or Kyoto targets.



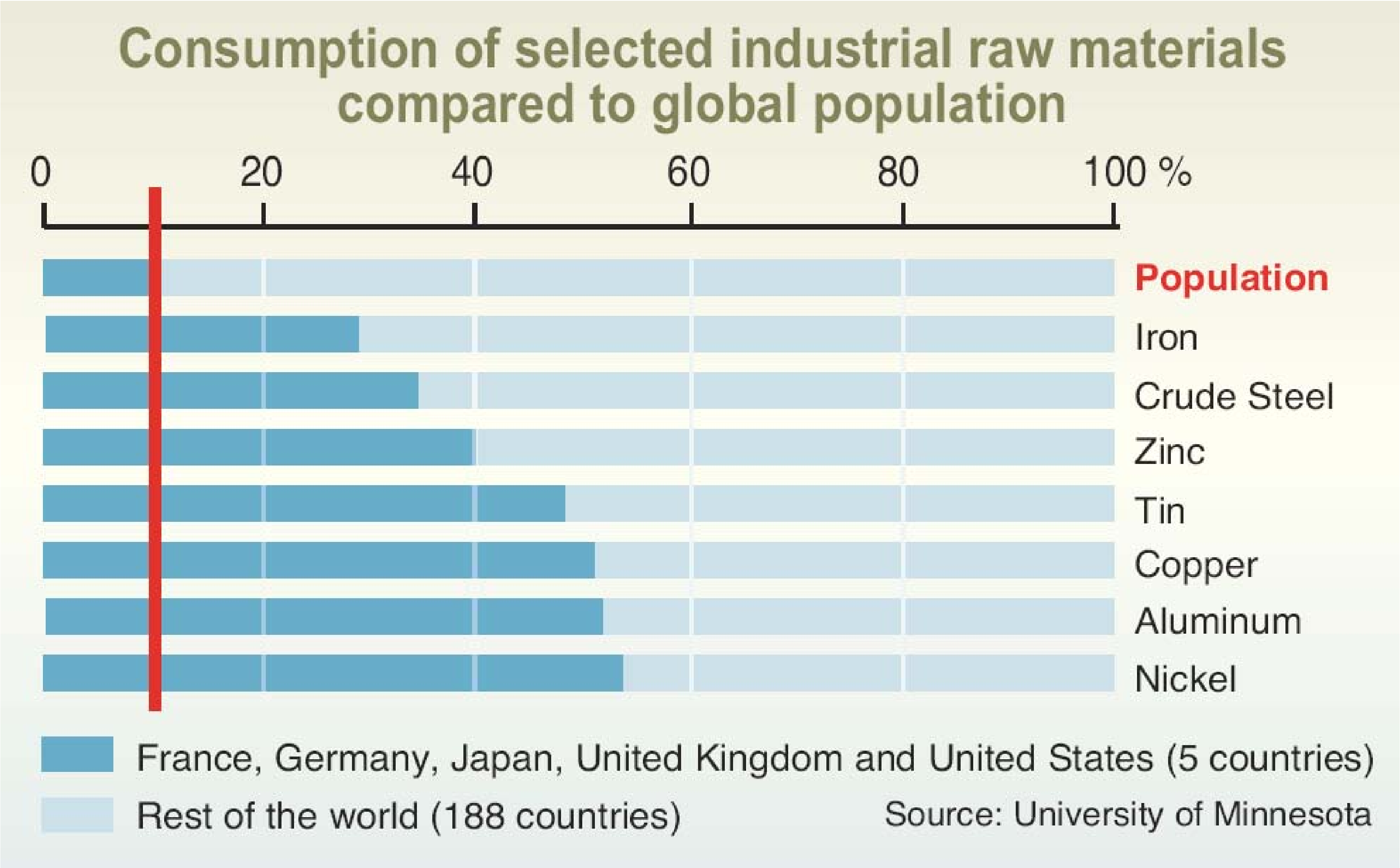
Per capita CO_2 emissions at the regional level in 2003



The A1B global temperature projection by region and for two decades in this century

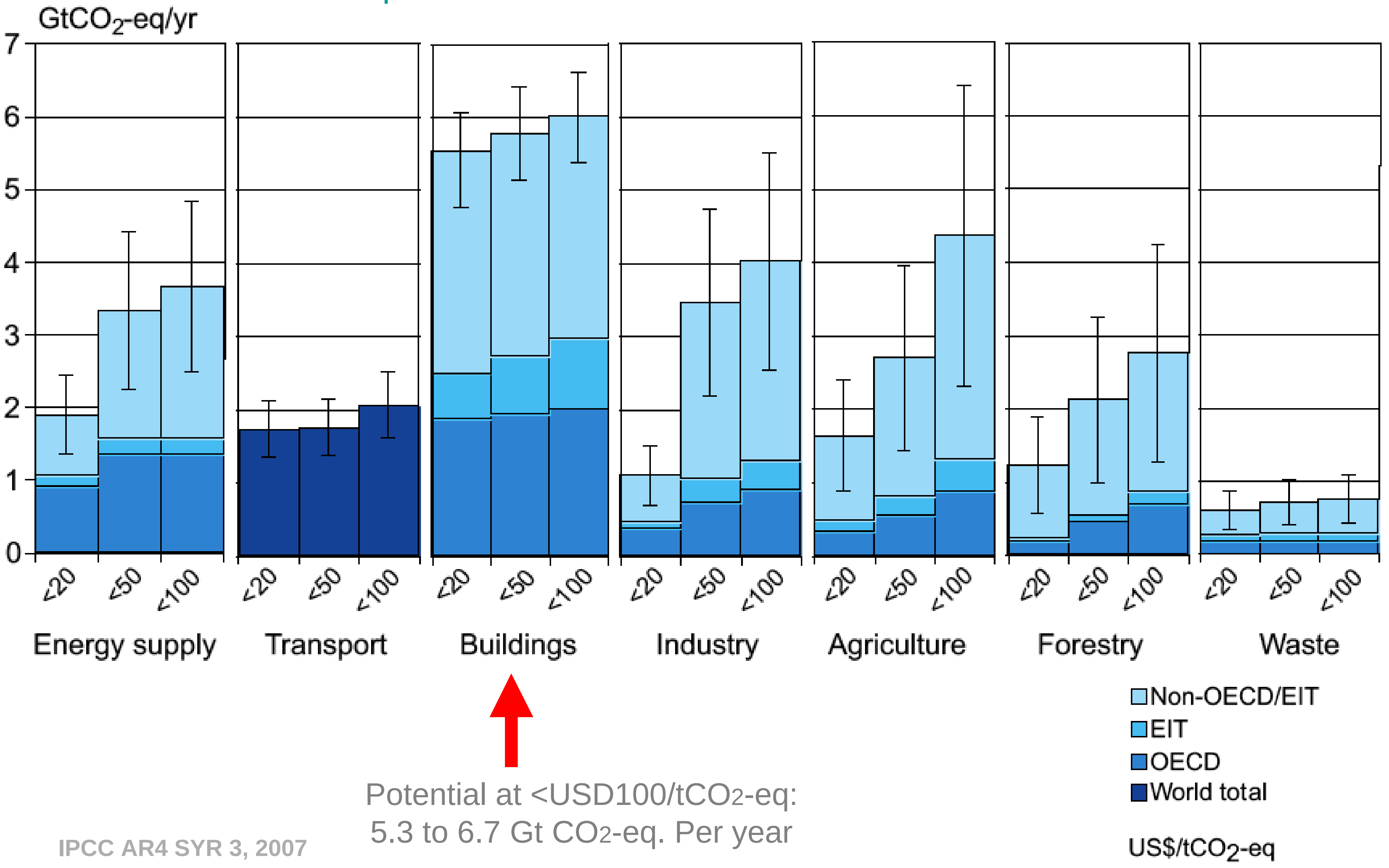


Climate Change 2007:
The Physical Science Basis
Working Group I Contribution to the
IPCC Fourth Assessment Report



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?

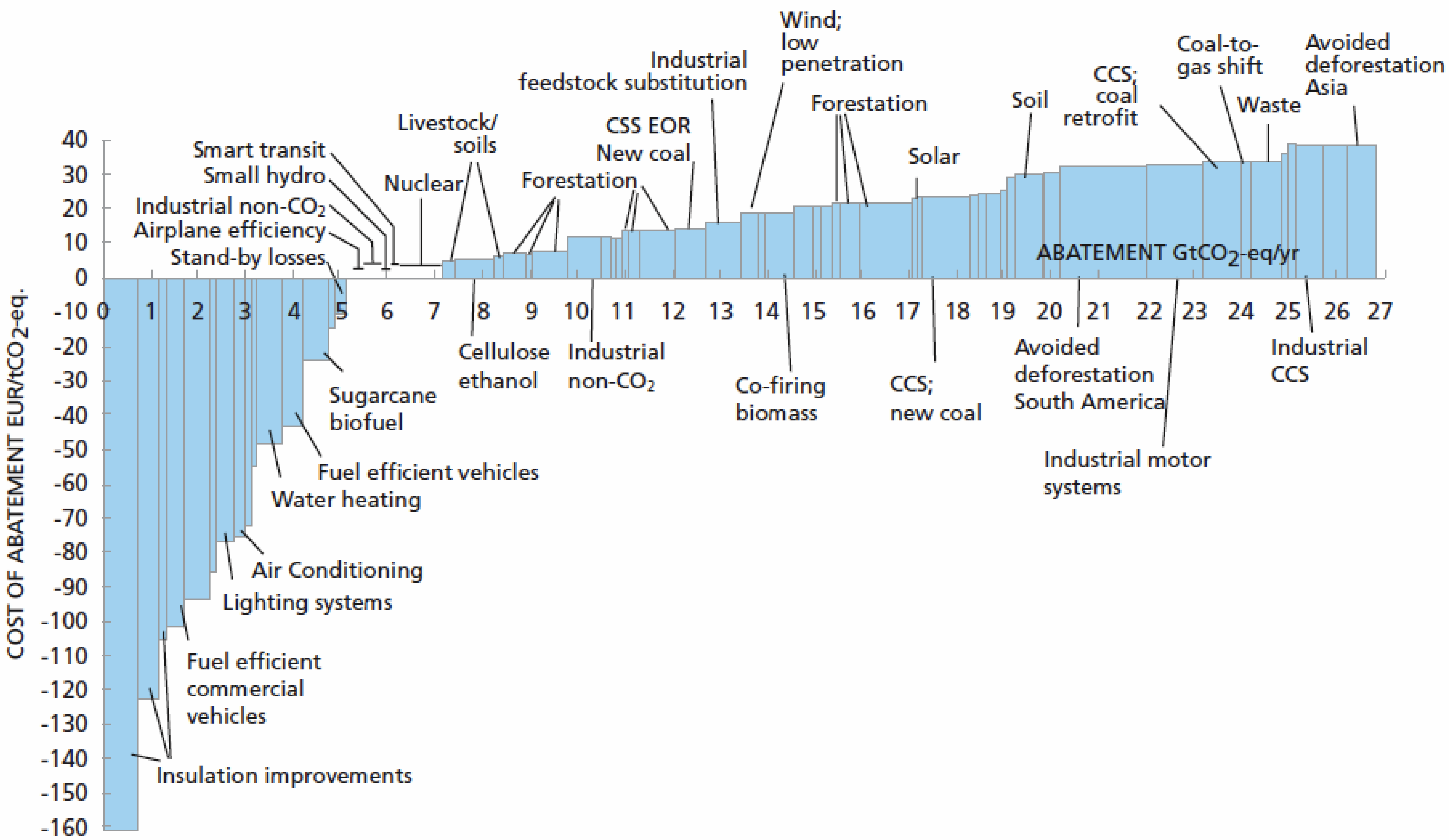
Some good news: economic mitigation potentials by sector as a function of carbon price in 2030 estimated from bottom-up studies.



Potential at <USD100/tCO2-eq: 5.3 to 6.7 Gt CO2-eq. Per year

IPCC AR4 SYR 3, 2007

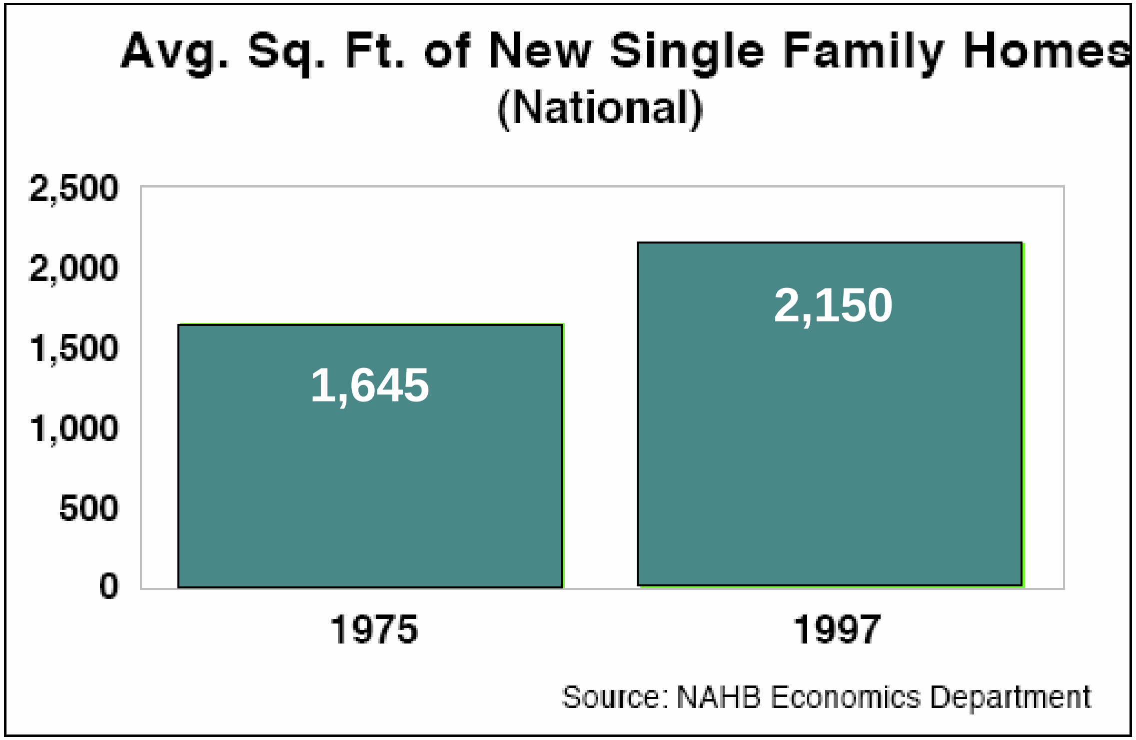
Some GHG reduction measures actually save money



Source: University of Copenhagen Synthesis Report, March 2009, pg. 29

But increasing efficiencies are matched by increases in consumption

The energy efficiency of houses in Canada improved significantly during the period 1995-2005, but house sizes increased from about 150 to 200 m2. The illustration below shows a similar pattern for house areas in the USA.

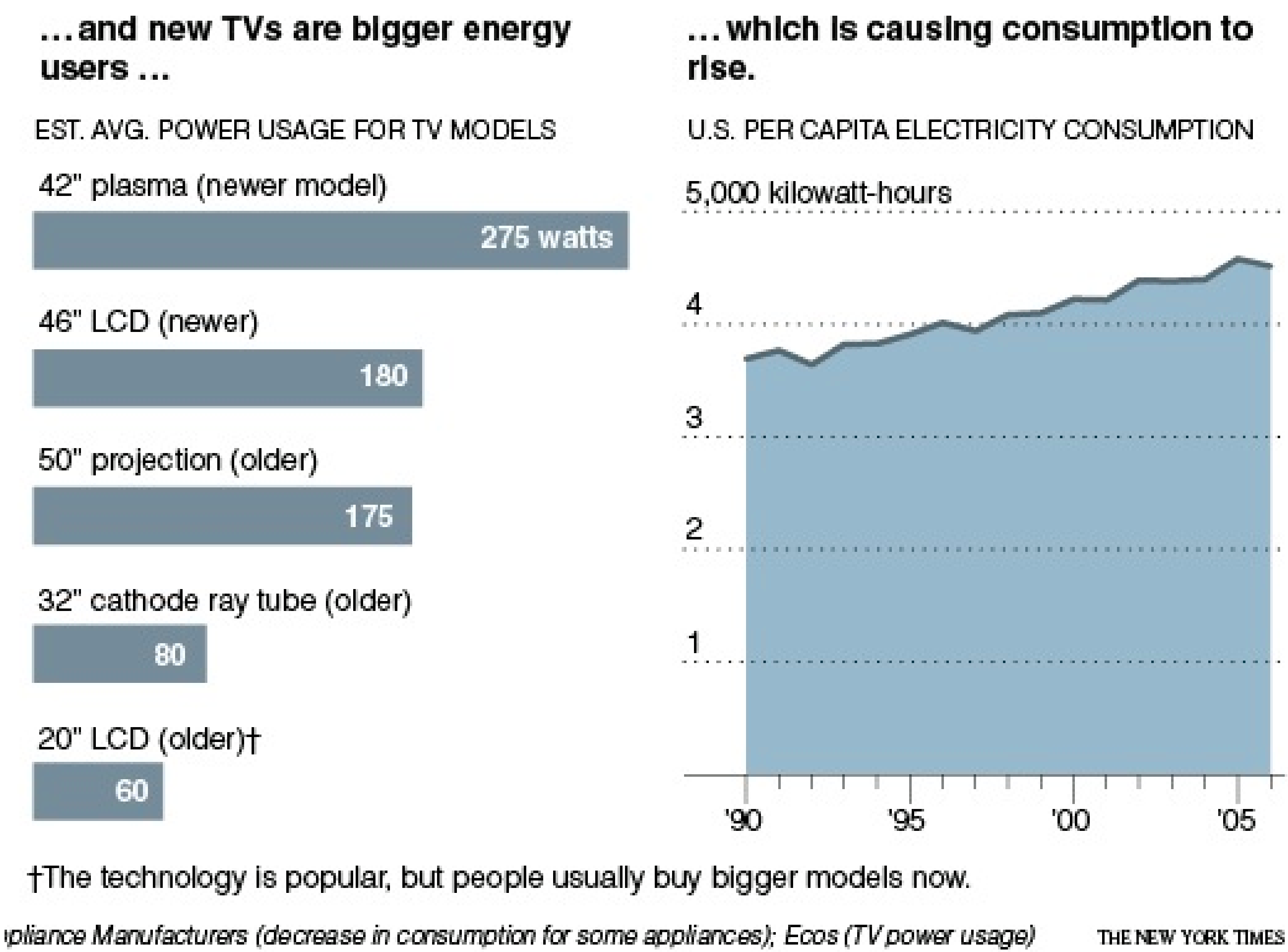


Not shown is the considerable growth in household appliances and equipment

Above: the Canadian Dream of 15 years ago; now the house is much larger and the garage has room for several cars;

All are influenced by such images

September 19, 2009



Energy efficiency v. demand and service levels

- We can conclude that energy efficiency is not enough, and we must reduce the level of demand and expectations of service levels;
- But a reduction in demand or service levels is much harder to achieve than efficiency improvements, since it requires changes in values and lifestyles;
- We need the general population to adopt this approach, but people will not be anxious to cooperate if they see continuing examples of waste by higher-income groups;
- So *everyone* must participate in reducing their material requirements that are carbon-based or use non-renewable fuels or materials;
- This also implies making better use of existing neighbourhoods through selective infill and upgrading of infrastructure and local public transportation systems;
- And better use of existing buildings through renovation and performance upgrading;
- These will be the main issues to address during the next decades.

Things we must do….

- Establish carbon taxes;
- Obtain a better understanding of global GHG emissions of various important building types in key regions, along with the potential for reductions through retrofits;
- Ensure that planning regulations move the industry towards high-density and mixed-use development in areas served by public transport;
- Undertake re-development triage programs in existing urban areas.
- Minimize taxes on new infill buildings and on renovation projects, except for second homes;
- Ensure that GHG performance requirements for new buildings are tough enough to make investors think twice about new construction – zero GHG in operations would be a good start;

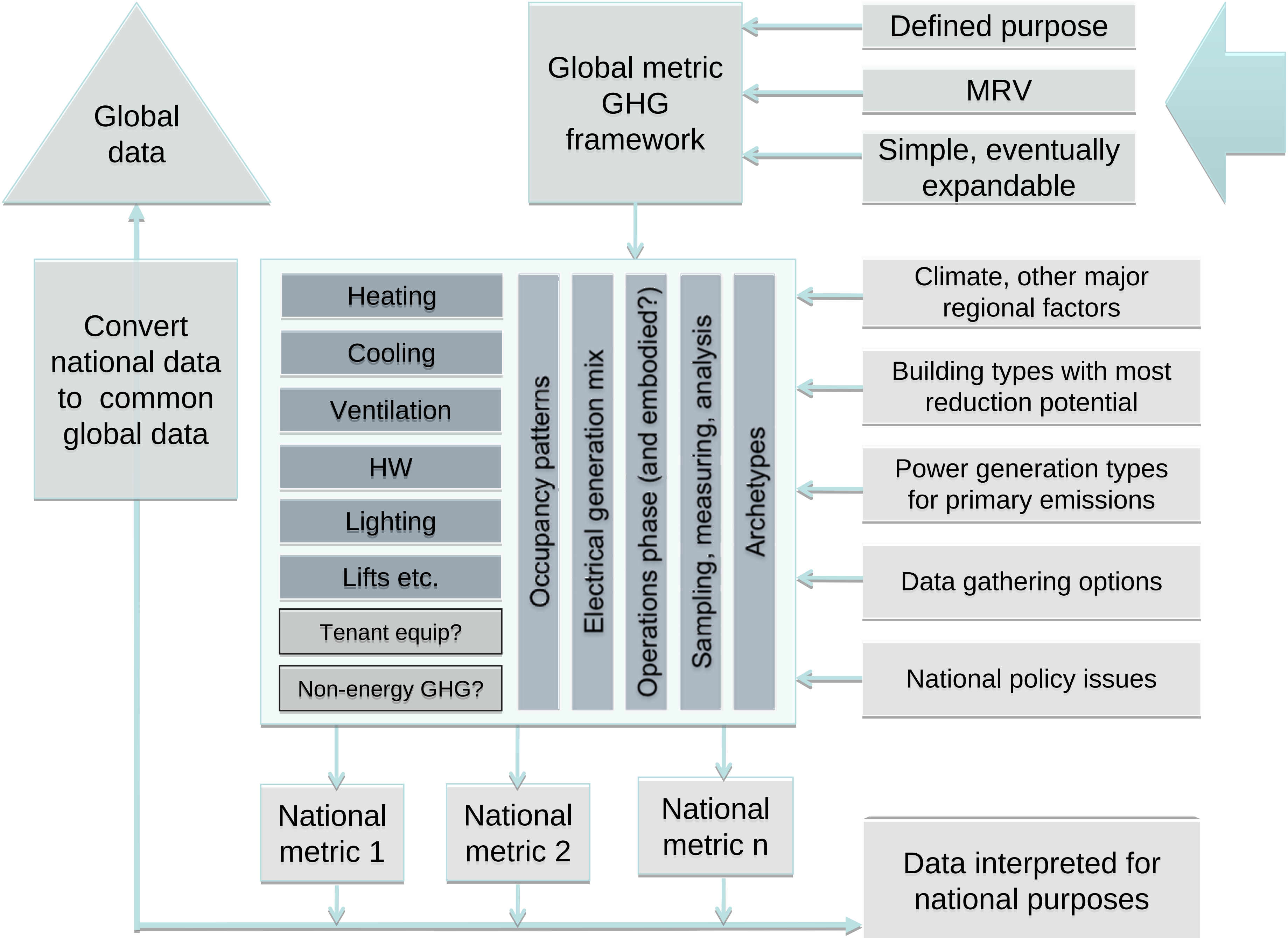
Things we must do….

- In N.A. and Asia we need to launch demonstration programs to make high-density areas attractive to families;
- Encourage (especially in North America) the spread of district heating and cooling systems;
- Provide support to R&D to ensure that high-performance technologies make their way to the market quickly;
- Require labeling to show core performance indicators, such as energy and emissions;
- Use some of the methods and tools that exist that help us reach high performance.

A few current
“soft” support mechanisms
for high performance

UNEP-SBCI

- The UNEP Sustainable Building and Climate Initiative (SBCI) was established in Paris to provide a forum for private sector organisations with a global interest to contribute to SB objectives;
- The group has, after a slow start, now hit its stride and is currently preparing proposals to table at Copenhagen, if the opportunity occurs;
- A document on the functional and cost effectiveness of various types of policy measures was completed last year, and a collection of international case studies is also being prepared;
- One of the problems is that the field of SB initiatives is currently crowded, but SBCI has an enormous advantage in that a UN body gains automatic respect and visibility;
- Another problem faced by SBCI is to avoid being captured by one or more of the participating groups that has a commercial interest in the field.


Global data
Global metric GHG framework
Defined purpose
MRV
Simple, eventually expandable
Convert national data to common global data
Heating
Cooling
Ventilation
HW
Lighting
Lifts etc.
Tenant equip?
Non-energy GHG?
Occupancy patterns
Electrical generation mix
Operations phase (and embodied?)
Sampling, measuring, analysis
Archetypes
Climate, other major regional factors
Building types with most reduction potential
Power generation types for primary emissions
Data gathering options
National policy issues
National metric 1
National metric 2
National metric n
Data interpreted for national purposes

Proposal for metric & process for multi-unit residential

Greenhouse gas emissions data during operations phase: multi-unit residential buildings			
Input data 1	**Input data 2**	**Supporting data and manipulation required**	**Output**
Building level			
From owner or operator records and utility records and for residential building types (within defined archetypes), the number of dweling units by type, location, annual metered electrical consumption and on-site fuel consumption by fuel type for a full 12 month period where the building has been operating for at least two years.		Archetype category; Date of initial occupancy; Gross area; Number of dwelling units; Typical and actual population; Energy consumed for heating, cooling, ventilation, hot water, equipment	Annual delivered energy consumption for the building within an individual building archetype, in total kWh, kWh per m2 of gross area and kWh per occupant at typical and actual occupancies.
Sub-regional or national			
Annual delivered energy consumption for the building within an individual building archetype, in total kWh, kWh per m2 of gross area and kWh per occupant at typical and actual occupancies.	Weather data for the study period; Number of buildings in archetype(s); For the sub-region or country, electrical generation mix and emissions by type of non-renewable fuel used; Annual on-site use of delivered electricity and of non-renewable fuels for all buildings by archetype.	Normalize energy consumption for weather conditions; Convert on-site non-renewable fuel use to eCO2 emissions; Convert delivered electrical consumption to primary non-renewable energy and consequent eCO2 emissions;	For the survey sample(s) and for each multi-unit residential archetype in the sub-region or country, the annual eCO2 emissions in total tonnes, eCO2 per m2 of gross area, and average eCO2 per occupant.
Global level			
For the survey sample(s) and for each multi-unit residential archetype in the sub-region or country, the annual eCO2 emissions in total tonnes, eCO2 per m2 of gross area, and average eCO2 per occupant.	Number of sub-regions or countries in and outside of the analysis; Number of buildings in each archetype being analyzed at a global level, including sub-regions or countries included and excluded in the analysis.;	Extrapolate data to cover sub-regions or countries not covered in analysis. Sum the GHG emissions per archetype per sub-region or country for all multi-unit residential buildings in all sub-regions or countries.	Total annual eCO2 emissions in tonnes, average eCO2 per m2 of gross area, and average eCO2 per occupant, for all multi-unit residential building archetype in all sub-regions or countries.

Proposal for metric & process for office buildings

Greenhouse gas emissions data during operations phase: office buildings			
Input data 1	**Input data 2**	**Supporting data and manipulation required**	**Output**
Building level			
From owner or operators or tenants, records and utility records and for office building types (within defined archetypes), location, annual metered electrical consumption and on-site fuel consumption by fuel type for a full 12 month period where the building has been operating for at least two years.		Archetype category; Date of initial occupancy; Gross area; Typical and actual population; Energy consumed for heating, cooling, ventilation, hot water, vertical transportation, fixed equipment	Annual delivered energy consumption for the building within an individual building archetype, in total kWh, kWh per m2 of gross area at typical and actual occupancies.
Sub-regional or national			
Annual delivered energy consumption for the building within an individual building archetype, in total kWh, kWh per m2 of gross area at typical and actual occupancies.	Weather data for the study period; Number of buildings in archetype(s); For the sub-region or country, electrical generation mix and emissions by type of non-renewable fuel used; Annual on-site use of delivered electricity and of non-renewable fuels for all buildings by archetype.	Normalize energy consumption for weather conditions; Convert on-site non-renewable fuel use to eCO2 emissions; Convert delivered electrical consumption to primary non-renewable energy and consequent eCO2 emissions;	For the survey sample(s) and for each office buildingl archetype in the sub-region or country, the annual eCO2 emissions in total tonnes,and eCO2 per m2 of gross area.
Global level			
For the survey sample(s) and for each office buildingl archetype in the sub-region or country, the annual eCO2 emissions in total tonnes,and eCO2 per m2 of gross area.	Number of sub-regions or countries in and outside of the analysis; Number of buildings in each archetype being analyzed at a global level, including sub-regions or countries included and excluded in the analysis.;	Extrapolate data to cover sub-regions or countries not covered in analysis. Sum the GHG emissions per archetype per sub-region or country for all office buildings in all sub-regions or countries.	Total annual eCO2 emissions in tonnes, average eCO2 per m2 of gross area, and average eCO2 per occupant, for all office building archetypes in all sub-regions or countries.

ISO

- Standards have an important and long-term influence on what is built;
- SubCommittee17 of Technical Committee 59 of ISO is developing standards for sustainability in building construction;
- WG1 is producing General Principles and Terminology;
- WG2 is responsible for Sustainability Indicators - Part 1 is for buildings;
- WG3 is developing a standard for the environmental declaration of building products (EPDs);
- WG4 is developing a standards framework for assessment methods - Part 1 is for buildings. It identifies issues to be taken into account when using methods, and by implication, factors to be considered in the design of such systems;

CEN

- The CEN TC350 committee is also developing indicators of performance in a somewhat parallel process;
- TC350 is placing more emphasis on social and economic indicators, but has little progress in this area so far;
- It is very difficult to develop social and economic indicators !

A workable set of performance impact indicators

Ecological systems

- Climate change
- Destruction of the stratospheric ozone layer
- Acidification of land and water resources
- Eutrophication of water bodies
- Photo-chemical ozone creation (POCP)
- Changes in biodiversity and other ecological systems

Resources

- Depletion of non-renewable primary energy
- Depletion of non-renewable resources other than primary energy
- Depletion of non-renewable freshwater resources
- Depletion of land resources with ecological or agricultural value
- Exhaustion of solid waste sites suitable for non-hazardous waste

Waste

- Pollution of water bodies by wastewater, other than eutrophication
- Hazards from disposal of non-radioactive hazardous waste
- Hazards from disposal or storage of radioactive waste
- *Health, society and culture*
- Ability of users with functional impairments to use the facility
- Personal safety and security of users
- Health, well-being and productivity for users of facility
- Health, security and well-being of off-site population
- Changes to social or cultural systems

Economy

- Financial risk or benefits for investors
- Housing affordability or commercial retail viability
- Changes in economic system (employment, economic stimulus)

Specific barriers to the widespread adoption of sustainable building practices

- Lack of meaningful regulations that are enforced;
- Limited market demand for high performance buildings;
- Actual or perceived cost of building to a high level of performance;
- Lack of simple funding mechanisms to pay for incremental performance;
- Difficulty of measuring environmental performance in an objective and reliable way;
- Increasing requirements for specialized skills and knowledge in the design process;
- Skills deficits in small design firms;
- Making bad decisions early in the design process.

Integrated Design Process

Integrated Design Process

- Experience indicates that changes in the design process can make major contributions to the performance of buildings;
- The *Integrated Design Process* (IDP), developed in Canada and Europe has shown this empirically;
- Primarily developed in the NRCan C-2000 program during the 1994-2003 period;
- International guidelines for IDP were also developed in IEA Task 23, led by Anne Grete Hestnes of NTNU;
- We are not claiming to have discovered something new, but have applied old principles that are not being widely used.

What is IDP

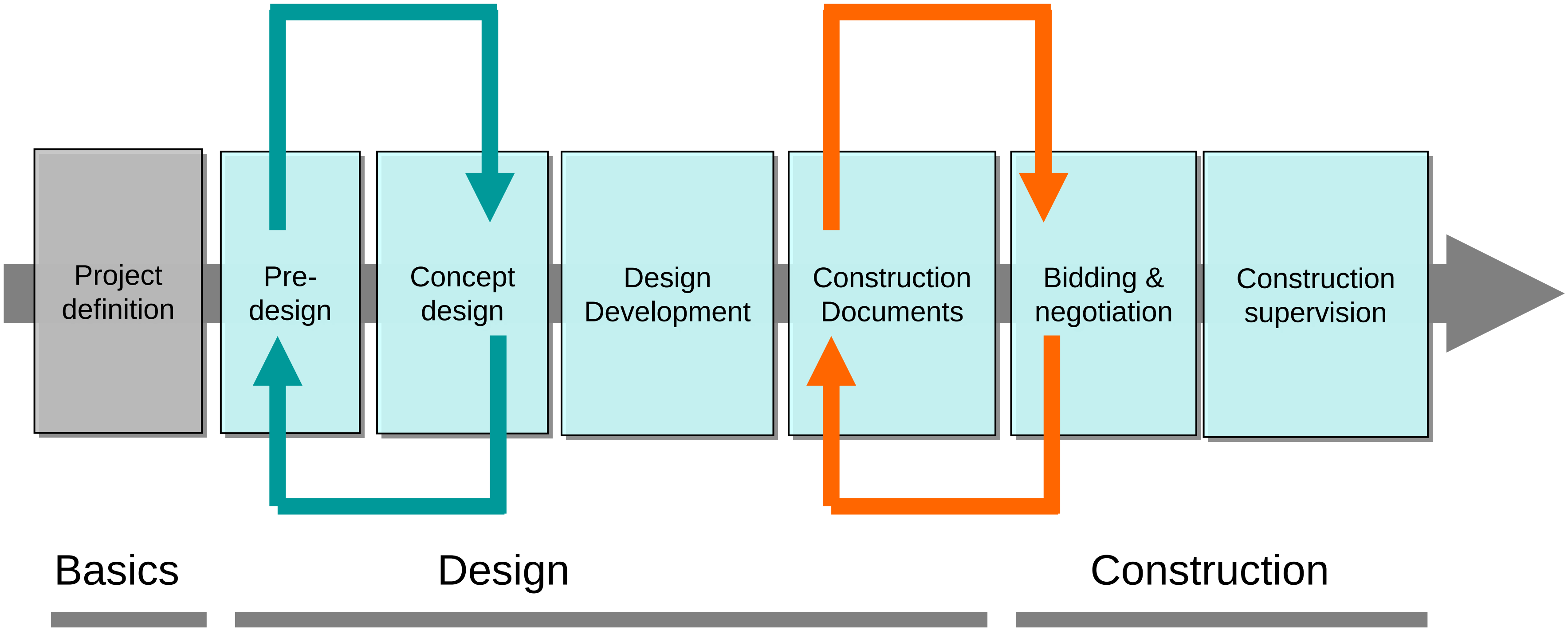
- IDP is a method to intervene in the design stage to ensure that all issues that can be foreseen to have a significant impact on sustainable performance are discussed, understood and dealt with at the beginning of the design process;
- IDP helps the client and architect to avoid a sub-optimal design solution;
- Integrated design process results in an integrated systems approach, and that can have many positive results;
- It enables the achievement of high levels of building performance through integrated systems design.

Problems in the conventional process

- The architect may develop a concept design that is agreed to by the client;
- After both parties are committed, then engineers and other key actors are brought in, to ensure that the chosen concept can perform as efficiently as possible;
- That is too late, and the design’s performance potential may be limited from its inception;
- There are also new specialties, such as daylighting, thermal storage etc. that require skills not often found in conventional design firms;
- At a later stage, there may be attempts to graft high-performance technologies on to the design, but that is usually an expensive failure.

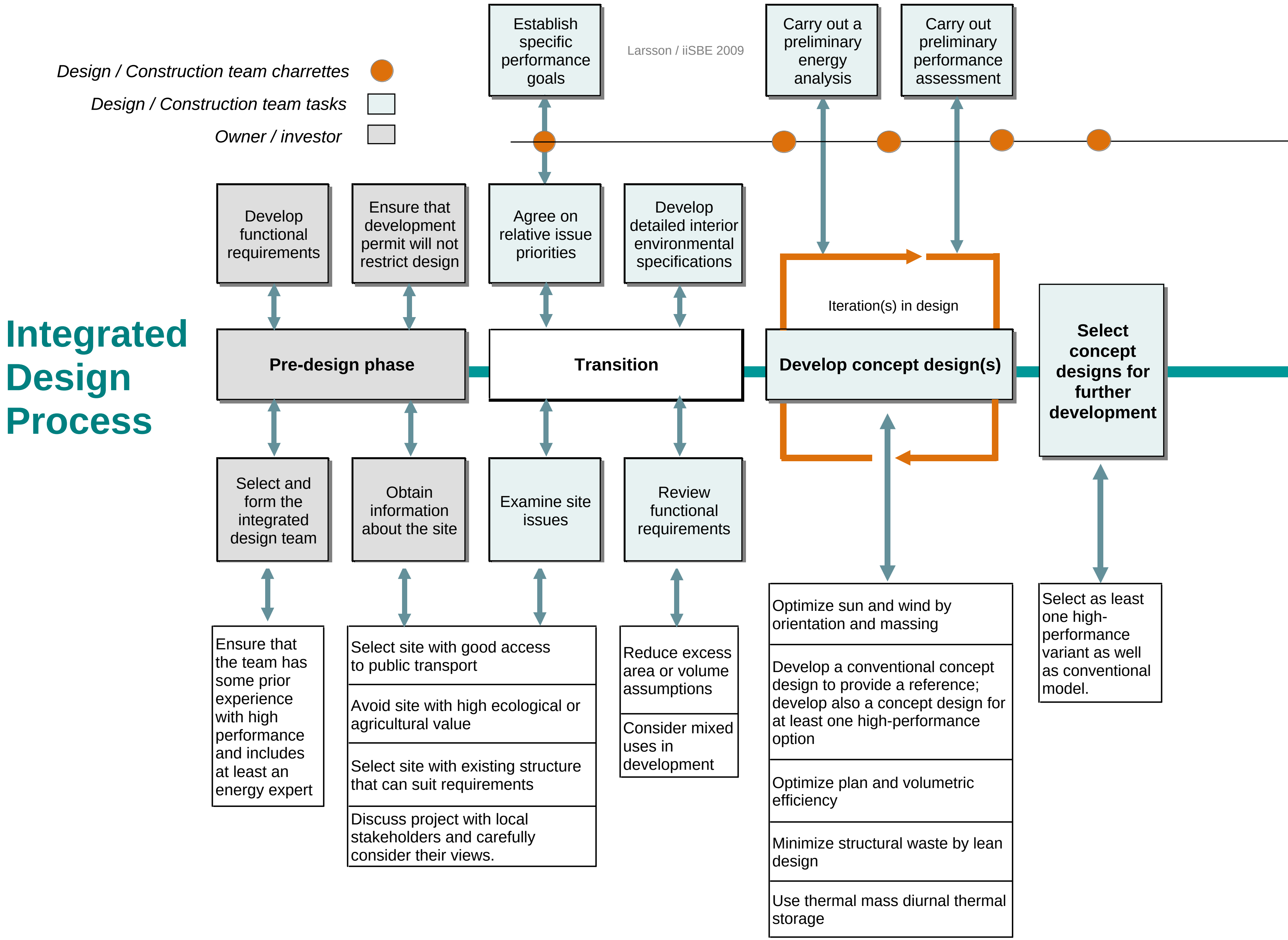
The Conventional Process

Design iterations are inevitable in any design process, but they only make a positive contribution if carried out early in the process.

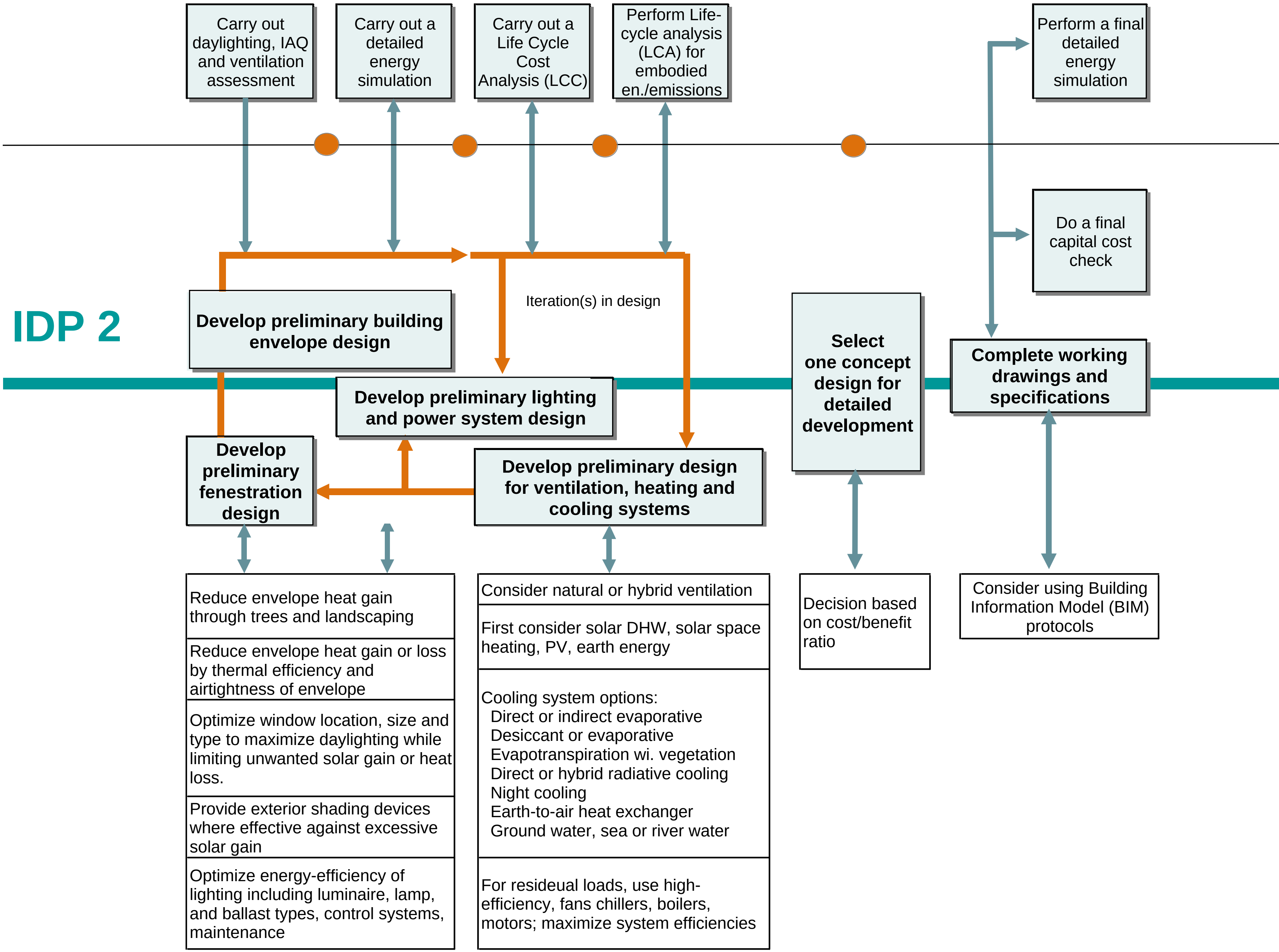


A different approach: What if…

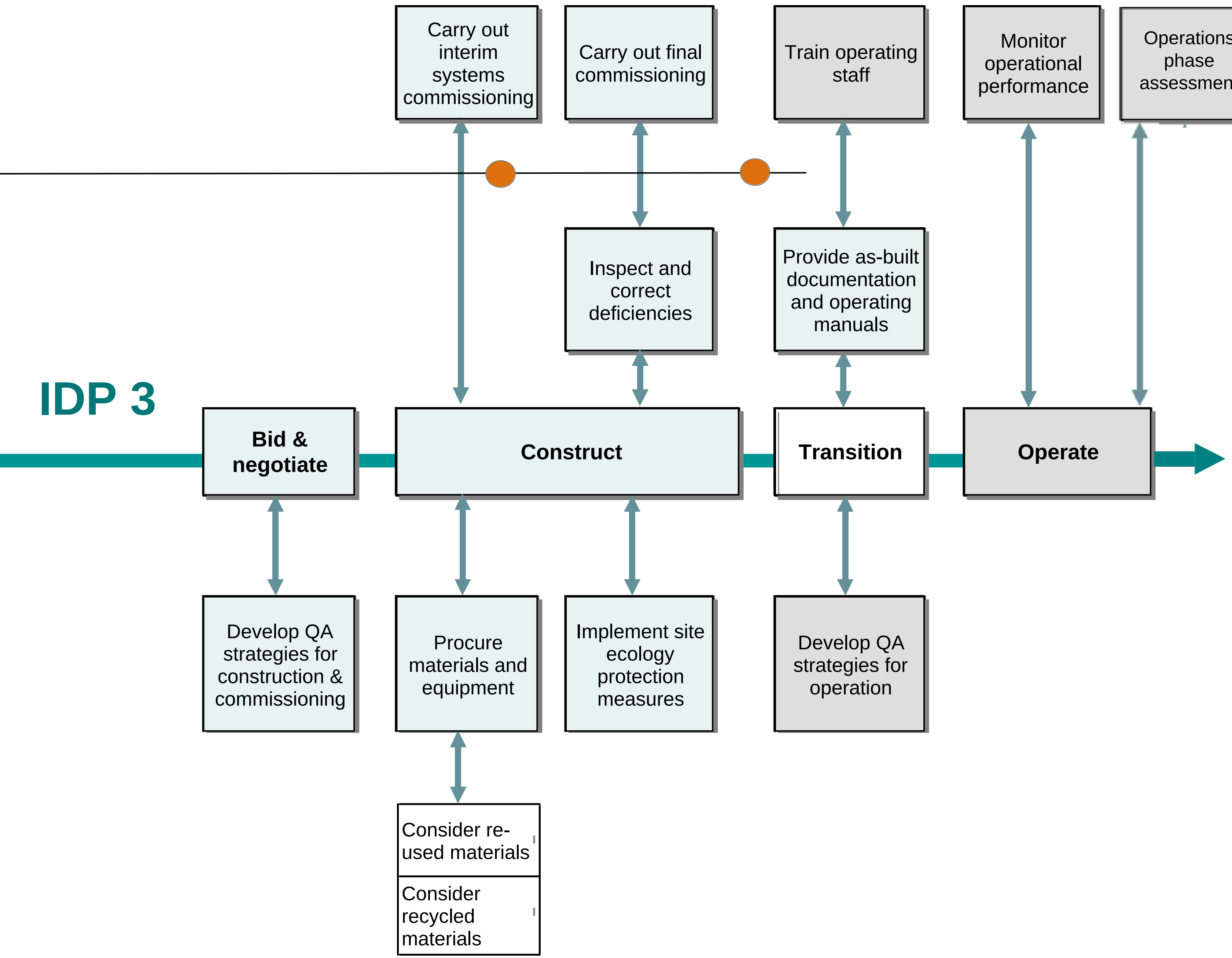
- …key actors sat around the table to discuss alternatives and objectives before the concept design is developed?
- …we could make use of the experience and knowledge of engineers, building operators and even users, early enough to influence the design?
- …we developed at least one alternative design?
- …we used simulation programs to predict how the designs will perform?
- All of this is common sense, but rarely followed.



Integrated Design Process
Larsson / iiSBE 2009
Design / Construction team charrettes
Design / Construction team tasks
Owner / investor
Establish specific performance goals
Carry out a preliminary energy analysis
Carry out preliminary performance assessment
Develop functional requirements
Ensure that development permit will not restrict design
Agree on relative issue priorities
Develop detailed interior environmental specifications
Iteration(s) in design
Pre-design phase
Transition
Develop concept design(s)
Select concept designs for further development
Select and form the integrated design team
Obtain information about the site
Examine site issues
Review functional requirements
Ensure that the team has some prior experience with high performance and includes at least an energy expert
Select site with good access to public transport
Avoid site with high ecological or agricultural value
Select site with existing structure that can suit requirements
Discuss project with local stakeholders and carefully consider their views.
Reduce excess area or volume assumptions
Consider mixed uses in development
Optimize sun and wind by orientation and massing
Develop a conventional concept design to provide a reference; develop also a concept design for at least one high-performance option
Optimize plan and volumetric efficiency
Minimize structural waste by lean design
Use thermal mass diurnal thermal storage
Select as least one high-performance variant as well as conventional model.



Carry out daylighting, IAQ and ventilation assessment
Carry out a detailed energy simulation
Carry out a Life Cycle Cost Analysis (LCC)
Perform Life-cycle analysis (LCA) for embodied en./emissions
Perform a final detailed energy simulation
Do a final capital cost check
IDP 2
Develop preliminary building envelope design
Iteration(s) in design
Select one concept design for detailed development
Complete working drawings and specifications
Develop preliminary lighting and power system design
Develop preliminary fenestration design
Develop preliminary design for ventilation, heating and cooling systems
Reduce envelope heat gain through trees and landscaping
Reduce envelope heat gain or loss by thermal efficiency and airtightness of envelope
Optimize window location, size and type to maximize daylighting while limiting unwanted solar gain or heat loss.
Provide exterior shading devices where effective against excessive solar gain
Optimize energy-efficiency of lighting including luminaire, lamp, and ballast types, control systems, maintenance
Consider natural or hybrid ventilation
First consider solar DHW, solar space heating, PV, earth energy
Cooling system options:
Direct or indirect evaporative
Desiccant or evaporative
Evapotranspiration wi. vegetation
Direct or hybrid radiative cooling
Night cooling
Earth-to-air heat exchanger
Ground water, sea or river water
For resideual loads, use high-efficiency, fans chillers, boilers, motors; maximize system efficiencies
Decision based on cost/benefit ratio
Consider using Building Information Model (BIM) protocols


Carry out interim systems commissioning
Carry out final commissioning
Train operating staff
Monitor operational performance
Operations phase assessment
Inspect and correct deficiencies
Provide as-built documentation and operating manuals
IDP 3
Bid & negotiate
Construct
Transition
Operate
Develop QA strategies for construction & commissioning
Procure materials and equipment
Implement site ecology protection measures
Develop QA strategies for operation
Consider re-used materials
Consider recycled materials

Assessment and rating systems

Rating systems: short country summaries

- The practice of performance rating and labeling of buildings is growing very quickly, but most systems focus on design-phase assessments of new buildings;
- In North America, most of action so far has been with the USGBC and CaGBC organizations, using the *LEED* system;
- *GreenGlobes* is an up-coming alternative in N.A. and is also being marketed in some other countries;
- *BREEAM* is well established in the UK, and several versions have been developed;
- BRE is now marketing consulting services for the development of similar systems in other countries;

LEED and BREEAM market penetration

- A USGBC document from 2009 indicates that by 2010, about 10% of commercial construction starts are expected to be green;
- However, the current total of LEED Certified projects is only 2,476, and this is a cumulative total since 2000, so it represents a miniscule proportion of total construction starts;
- A 2008 BREEAM document shows that 116,000 buildings are certified while 714,000 buildings have been registered, a higher level of penetration, but still small compared to total starts;
- The small proportion of certified v. registered projects probably reflects the high educational value of being registered v. the high cost of certification, which includes consulting fees for data preparation and also commissioning.

LEED	New Construction	Commercial Interiors	Existing Buildings	Core & Shell	Neighborhood Development	Schools	Retail	Total
Registered Projects	11,597	2,047	2,490	2,488	225	713	189	19,524
Certified Projects	1,600	479	200	157	13	4	36	2,476

Green Building Facts, USGBC, April 2009

More country summaries

- Australia has a very active organization which uses its own *GreenStar* system;
- *GreenStar* is also influential in New Zealand, but a domestic variant may be developed;
- Singapore has its own *GreenMark* labeling system;
- Hong Kong has *HK-BEAM* and *CEPAS*;
- Taiwan has a government system focusing on nine performance issues, and is rapidly issuing labels;
- The new SB Malaysia Council is trying to decide whether to use a version of LEED, a version of GreenMark, or SBTool;

SB Alliance

- SB Alliance is a consortium of mainly European agencies that are involved in the development and operation of assessment and rating systems;
- Key participants include BRE, CSTB, DGNB, VTT and ITC-CRN (Italy);
- Goals have included the harmonization of some key parameters related to energy and emissions;
- In the long term, the group may develop a unified and common system.

The options: Green and Sustainable Building

- Fuel consumption of non-renewable fuels
- Water consumption
- Land consumption
- Materials consumption
- Greenhouse gas emissions
- Other atmospheric emissions
- Impacts on site ecology
- Solid waste / liquid effluents
- Indoor air quality, lighting, acoustics
- Maintenance of performance
- Longevity, adaptability, flexibility
- Efficiency
- Earthquake & other forms of security
- Social and economic considerations
- Urban / planning issues

Green Building

Sustainable Building

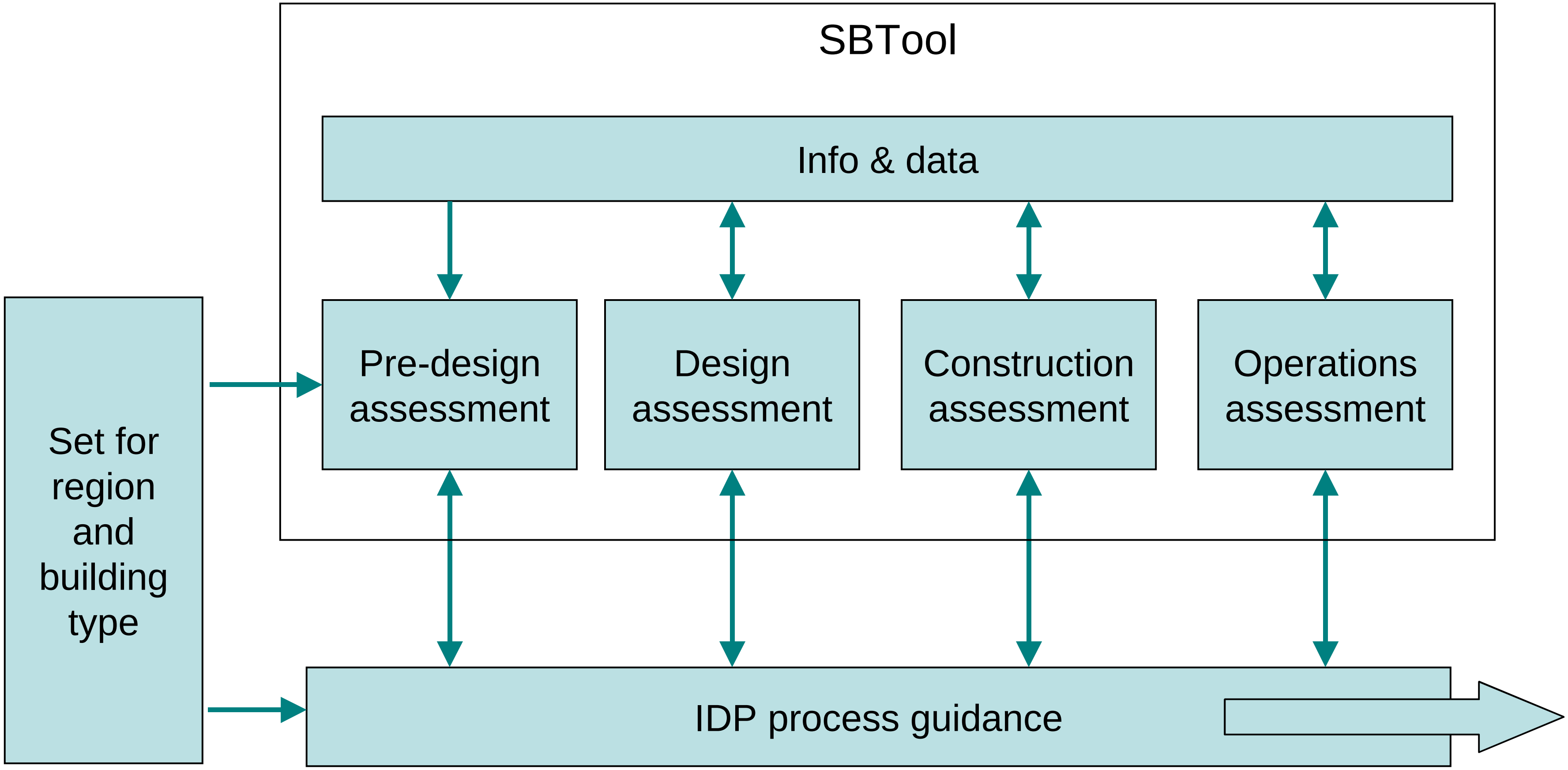
SBTool

- SBTool is a generic framework for rating the sustainable performance of buildings and projects. It may also be thought of as a toolkit that assists local organizations to develop rating systems;
- The system covers a wide range of sustainable building issues, not just green building concerns, but the scope of the system can be modified to be as narrow or as broad as desired, ranging from 120 criteria to half a dozen;
- SBTool takes into account region-specific and site-specific context factors, and these are used to switch off or reduce certain weights, as well as providing background information for all parties;

New…

- Provides quasi-objective weighting on one level only;
- Provides logical linkages between strategy and design guidelines, performance factors, loadings and impacts;
- Integrates IDP process guidance into the system.

Overview of SBTool integration with IDP



Cost and Risk

Costing

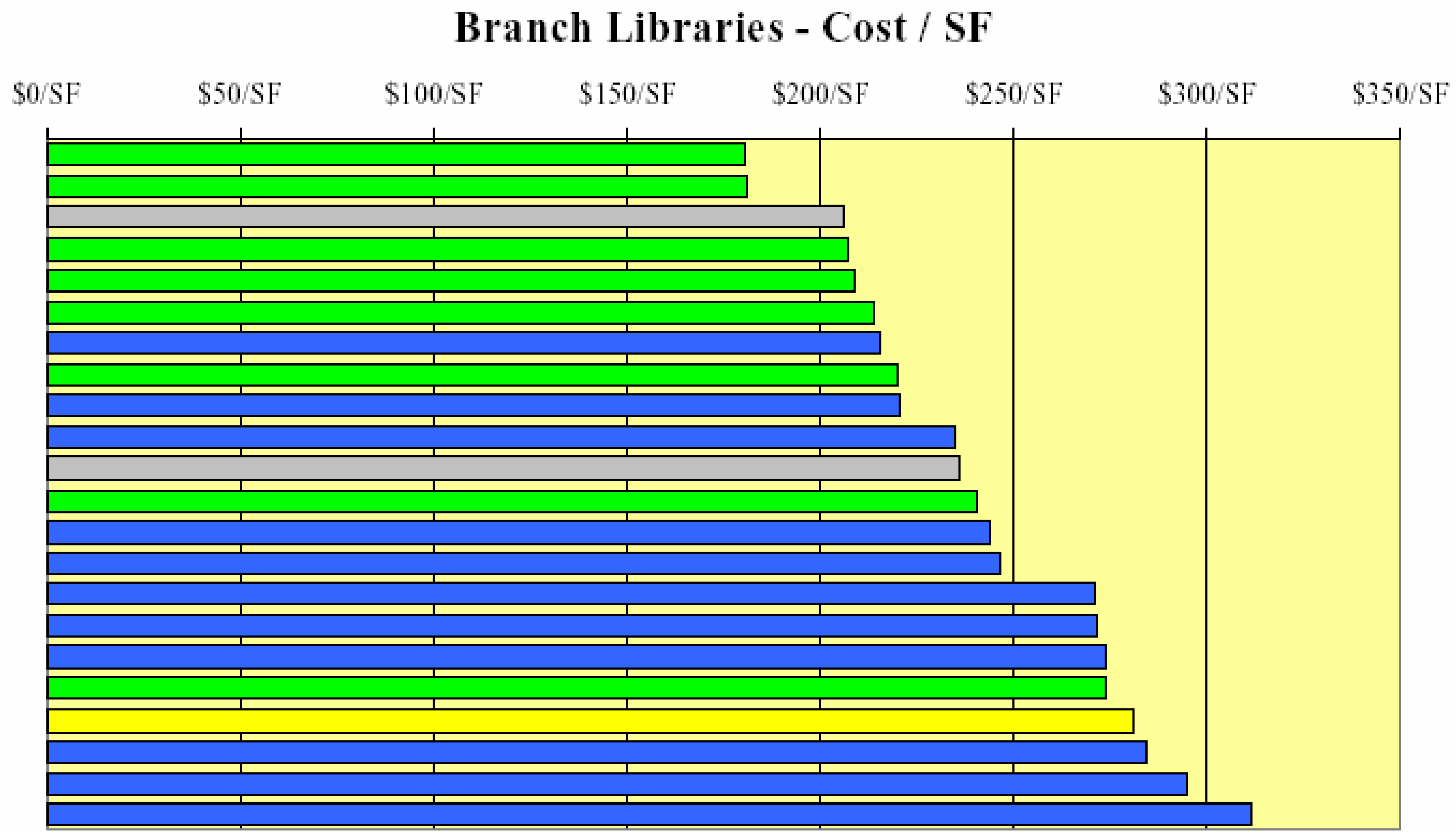
- The traditional measure has been land, design and construction cost;
- That evolved to become development cost, including also the short-term costs of financing;
- Developers reluctantly adopted the somewhat less crude measure of payback time - the number of years required for income from the property to pay back the investment, disregarding financing charges, energy cost changes or opportunity costs;
- Life-cycle costing (LCC) takes all these into account, but very few organizations use the approach;
- High performance building requires time to produce a payback, since the annual savings mostly come from savings in energy costs;

Costing

- Other environmental improvements, such as water savings or reductions in emissions, do not yet provide meaningful returns to the owner;
- However, if improvements in productivity or reductions in complaints can be factored in, there are major financial benefits;
- But these go directly only to owner-occupiers, otherwise one has to count on reductions in vacancies or higher leasing revenues.

The Capital Cost of LEED Buildings (Langdon & Davis)

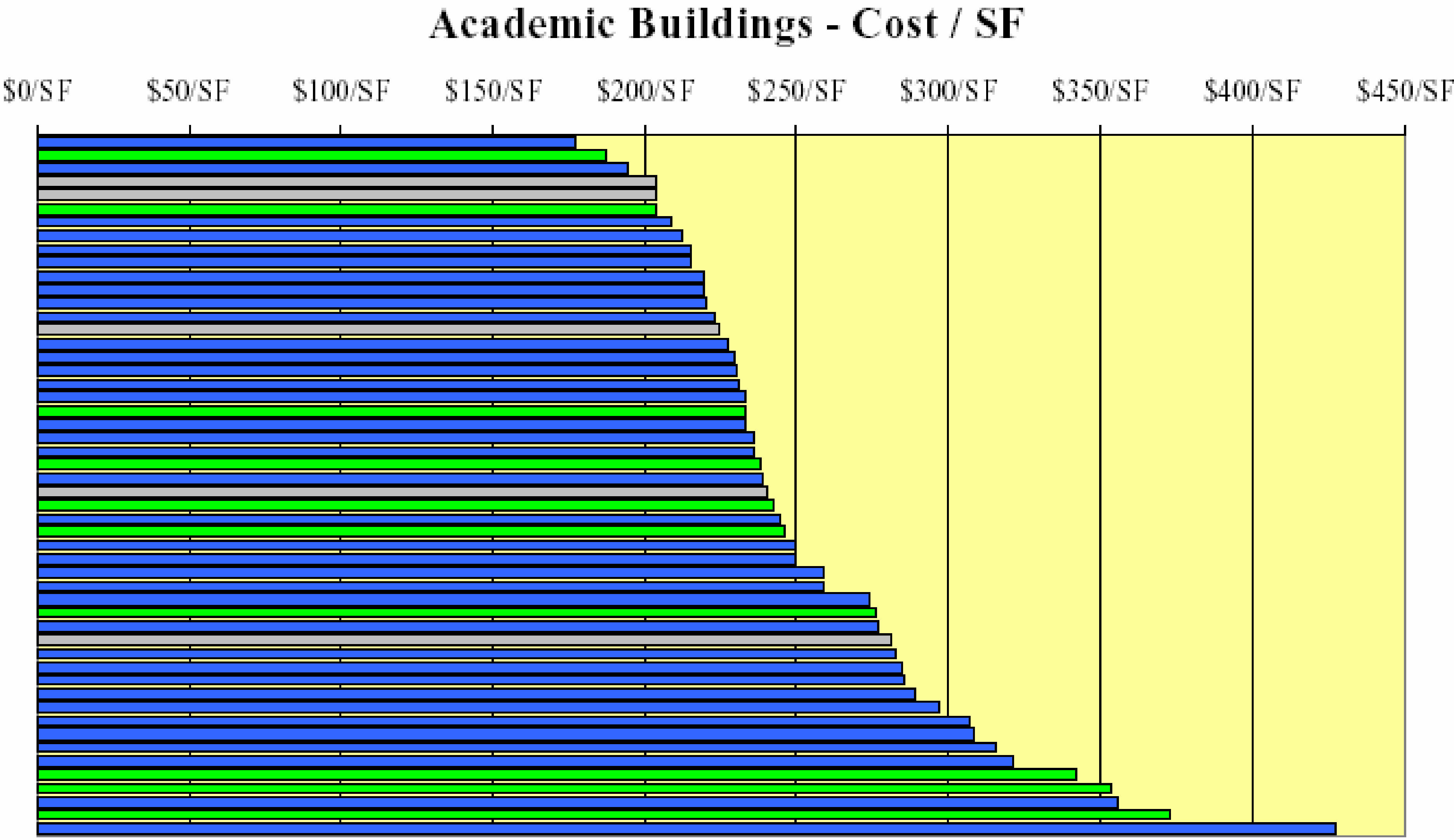
Note the lack of correlation between performance level attempted and the capital cost



Bar color denotes LEED level attempted – gold for LEED Gold, Silver for LEED silver, and green for LEED Certified.

The Capital Cost of LEED Buildings (Langdon & Davis)

Here also: high performance does not have to cost more.



Benefits to the Building Owner

Note that the financial benefits of health and productivity improvements can pay for any extra capital cost - if you can prove the benefits.

Figure ES-1. Financial Benefits of Green Buildings
Summary of Findings (per ft^2)

Category	20-year NPV
Energy Value	$5.79
Emissions Value	$1.18
Water Value	$0.51
Waste Value (construction only) - 1 year	$0.03
Commissioning O&M Value	$8.47
Productivity and Health Value (Certified and Silver)	$36.89
Productivity and Health Value (Gold and Platinum)	$55.33
Less Green Cost Premium	($4.00)
Total 20-year NPV (Certified and Silver)	**$48.87**
Total 20-year NPV (Gold and Platinum)	**$67.31**

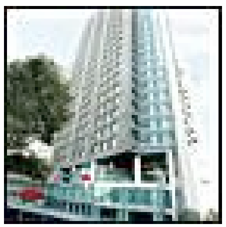
Source: Capital E Analysis

California Sustainable Building Task Force, 2003

Benefits to the Building Owner

W Mexico City — Lowest avg rate **C$243.94**

☆☆☆☆ Mexico, D.



Modern design and comfort in the Polanco district

- Located downtown in the trendy Polanco neighborhood, across the street from the ...

More hotel info

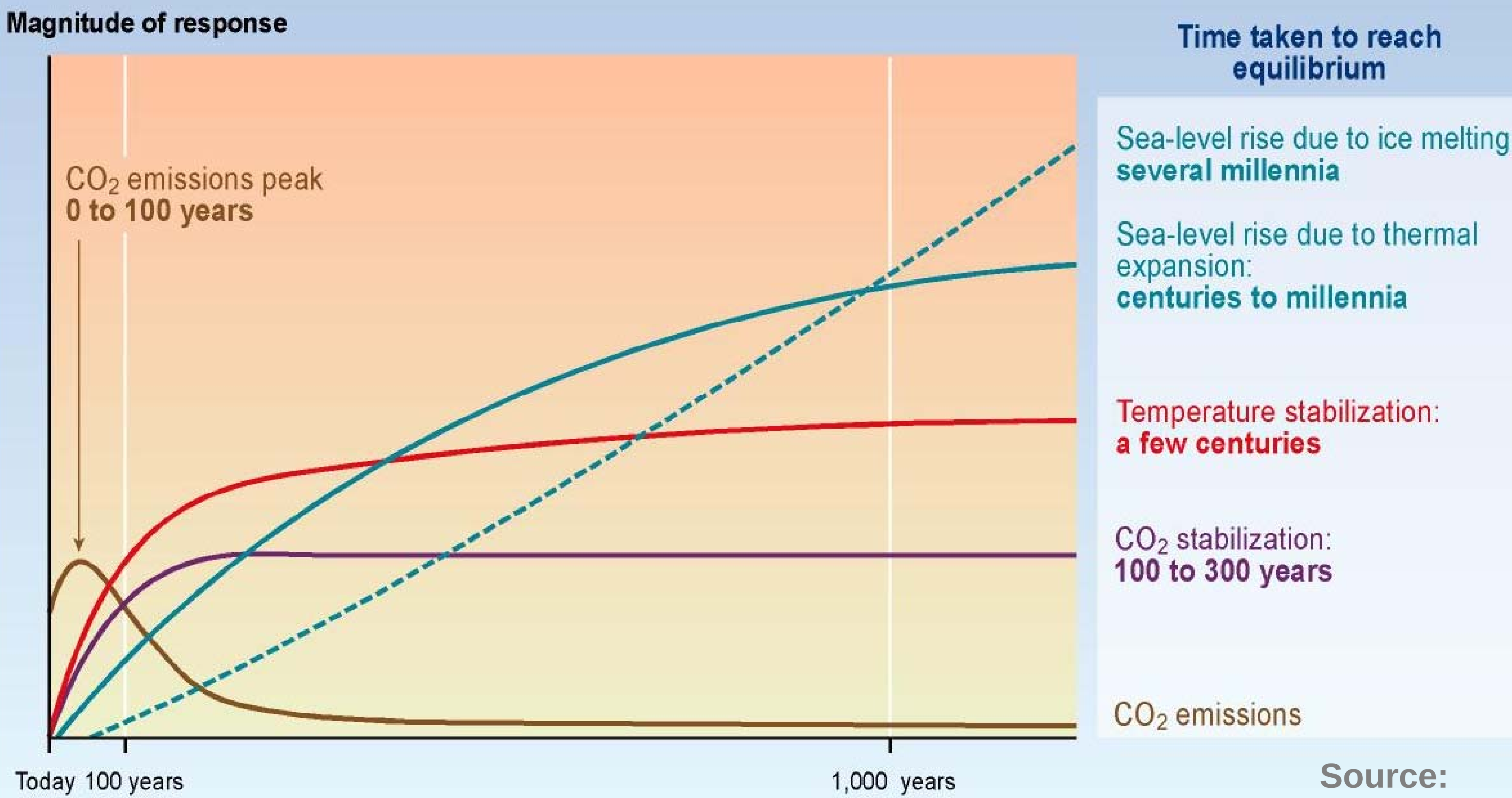
Availability request: 1 room | Expedia Special Rate | Sat 15-Apr-2006 to Wed 19-Apr-2006

Room type	Sat	Sun	Mon	Tue	Avg rate (per night)	
Deluxe room-European Plan	C$218	C$218	C$218	C$322	C$243.94	Book It
Superior View Room-European Plan	C$260	C$260	C$260	C$363	C$285.47	Book It
Cool Corner-European Plan	C$375	C$375	C$375	C$479	C$400.81	Book It

Accepting challenging performance targets

- If there considerable extra capital costs result from attempts to reach high performance, why should investors carry this burden?
- Because initial costs are not necessarily higher, if a smart development and design process is adopted;
- Because there may be a market niche for high performance buildings;
- Because regulations may force the market towards high performance in a few years, and then the value of the current investment would stand up to these requirements and new competition;
- That may be an unacceptable risk.

CO_2 concentration, temperature, and sea level continue to rise long after emissions are reduced



Source: IPCC

Contacts & Info

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