Plan B: Global and Regional Strategies for the Built Environment Under Climate Change

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iiSBE

The first version of this presentation was developed 12 years ago. It has been updated every year, but contains the same central message.

The following persons made substantial contributions:

Gregor Herda (UN Habitat), Richard Lorch and Fionn Stevenson (UK), Stella Bezerra and Roberto Lamberts (Brazil), Teresa Coady, Jean Cinq-Mars, John Crace, Gary Martin and Mark Gorgolewski (Canada), Teresa Parejo-Navajas (Spain), Ann Edminster and Giancarlo Mangone (USA), Norman Goijberg (Chile), Wynn Cam (Singapore), Andrea Moro (Italy),

Global Context

International developments

There are too many things happening to provide a single coherent overview of what is happening, but here is a partial view:

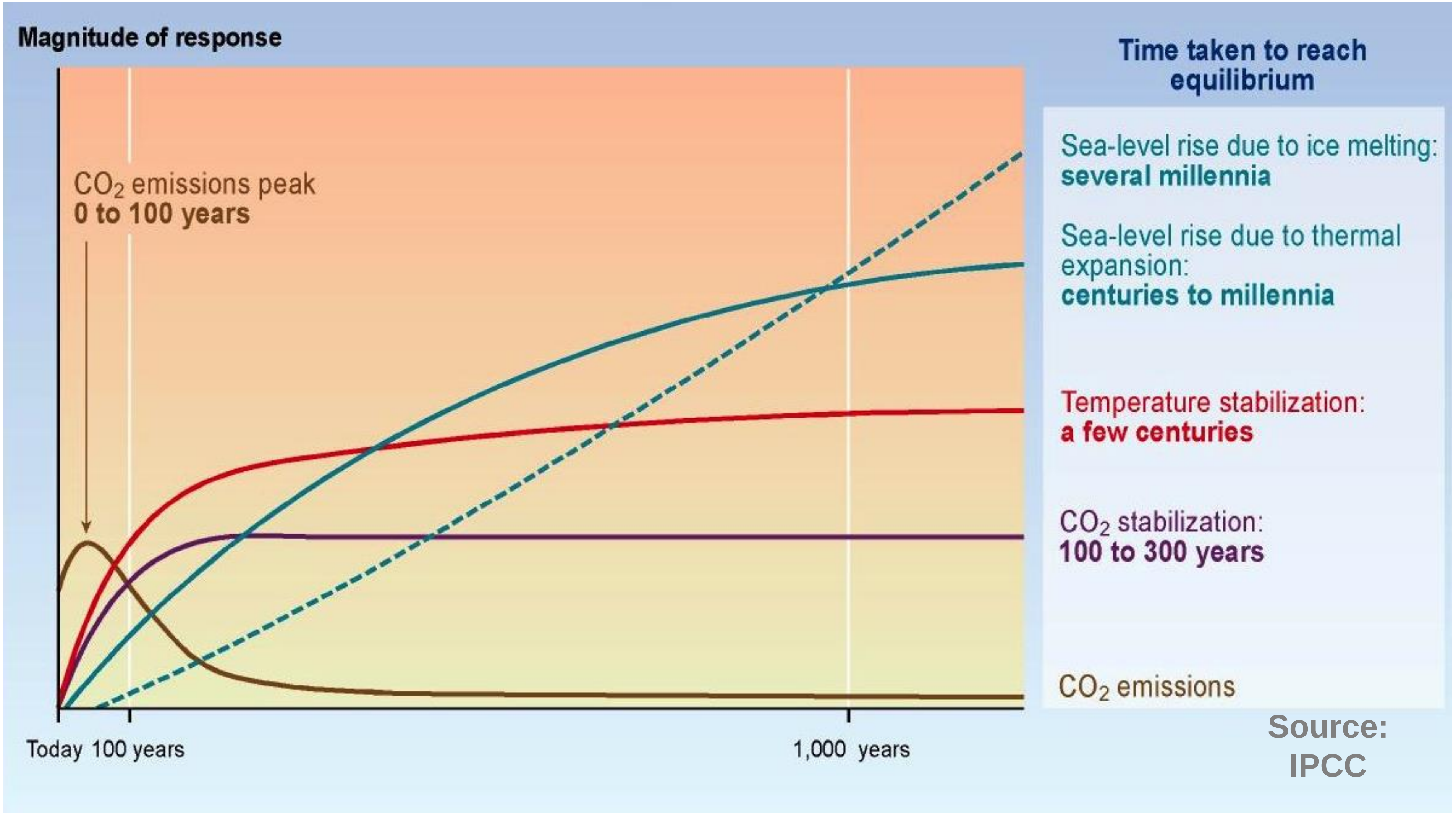
- At COP21, delegates reached an agreement for voluntary measures that will, hopefully, lead to action;
- At COP21 Buildings Day, the Global Alliance for Building (GABC) and Construction was launched;
- Europe is pursuing strong policies related to targets for 2030 and 2050;
- COP 22, COP23 and COP 24 have taken place but the position taken by USA is problematic, and take-up by some key countries is slow and partial, while others are reluctant to move away from fossil fuels or are playing games with interpretation of the rulebook.

International developments

- In October 2018, the IPCC released SR1.5, their new special report focusing on a global temperature rise of 1.5 deg. C.
- It had been known for some time that, even if we can maintain a global temperature rise of less than 1.5ºC, many South Pacific states will face major problems;
- The new SR1.5 report makes it clear that there are significant impacts around the world with that extra ½ degree temperature;
- The report also points out that there is much scope for positive action, although the emphasis on CO_2 sequestration seems overly optimistic;
- Unfortunately, COP25 has not led to more definite action and COP26 has recently been delayed by one year, because of Covid-19..

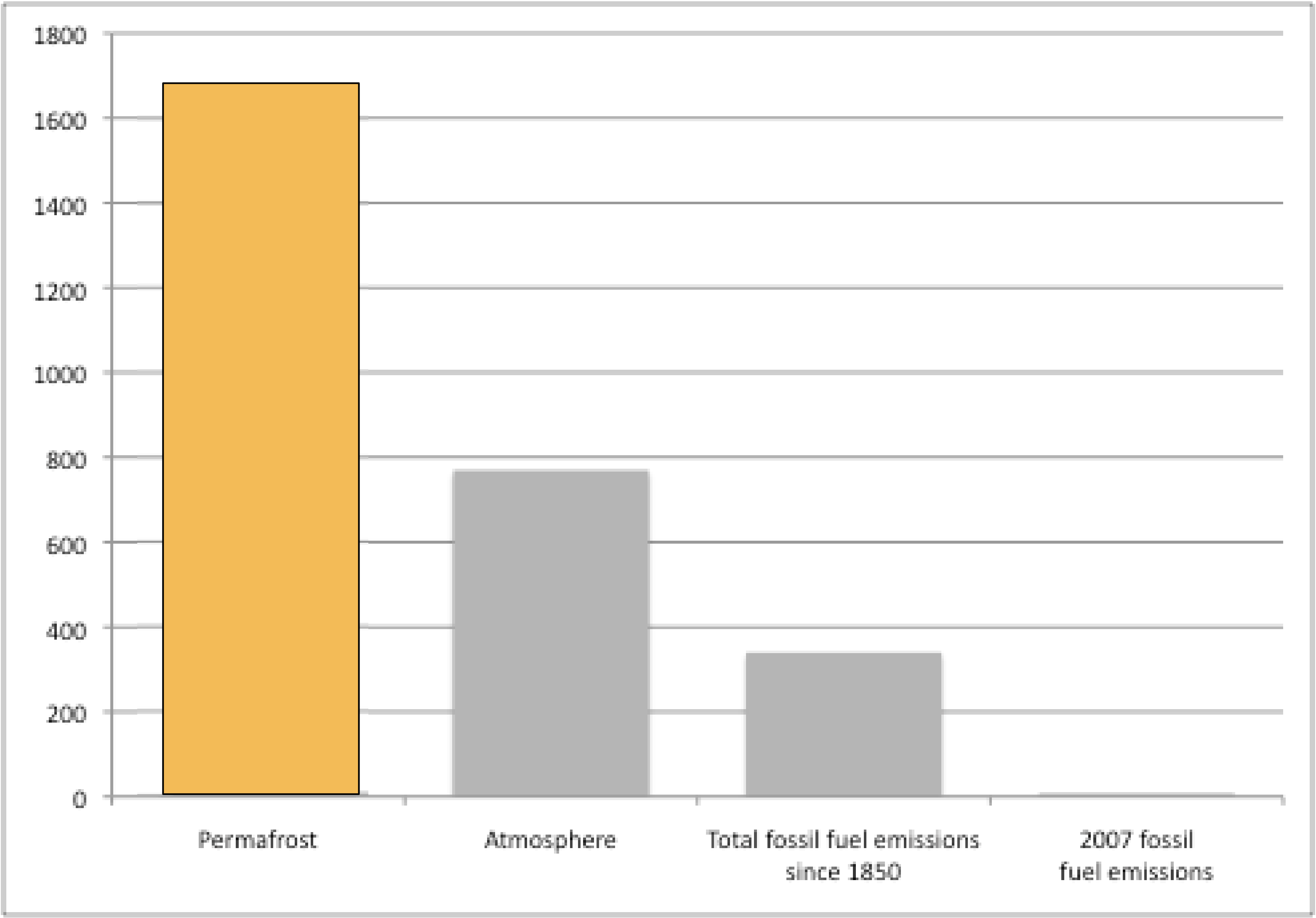
Climate change mechanisms

CO_2 emissions have very long-term effects on global temperature and sea level



Source: IPCC AR5

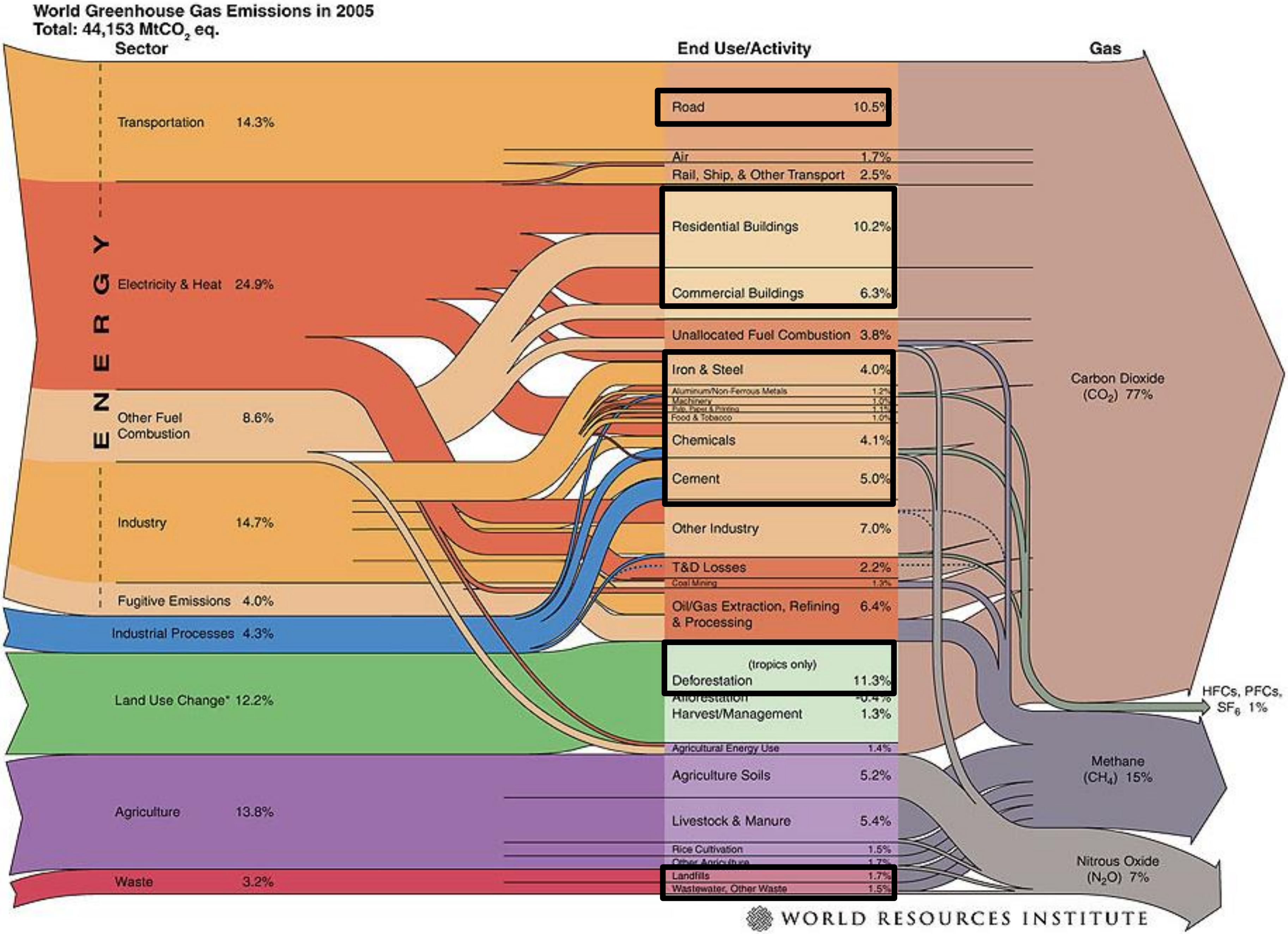
The nightmare scenario:
total global carbon content estimated in billions of tonnes



Sources: Schuur et al., UNEP, CDIAC, in *Climate Safety*, Public Interest Research Centre, UK, 2008

Buildings’ share of GHG emissions

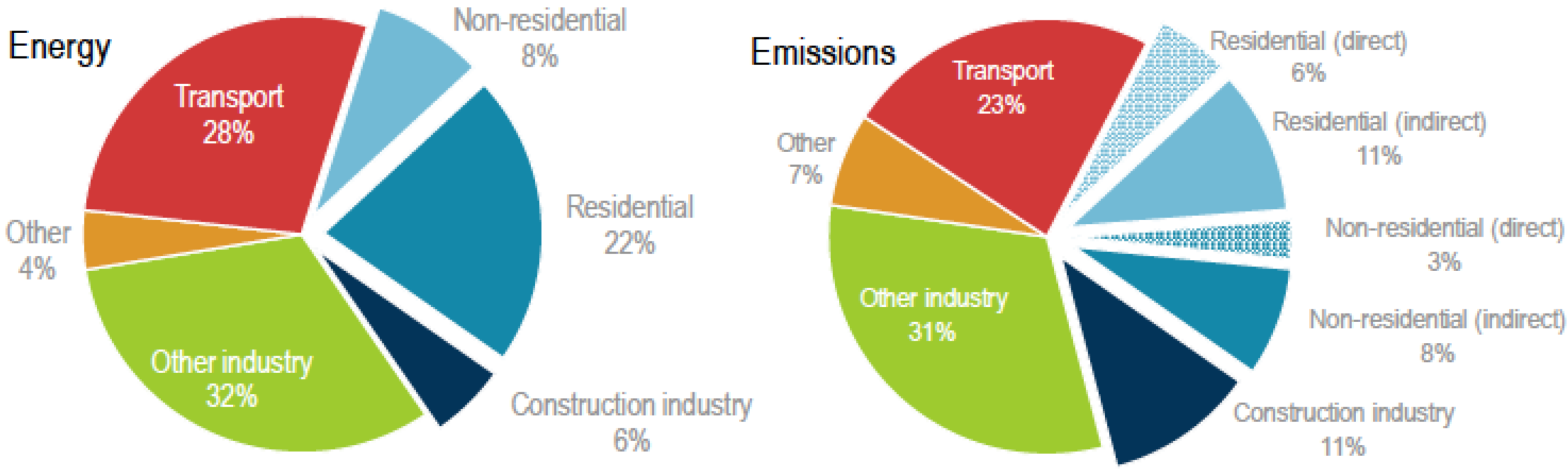
The built environment is implicated in many sectors of GHG emissions



Energy and emissions in the buildings and construction sector

Building construction and operations accounted for the largest share of both global final energy use (36%) and energy-related CO_2 emissions (39%) in 2018 (Figure 2).

Figure 2 • Global share of buildings and construction final energy and emissions, 2018

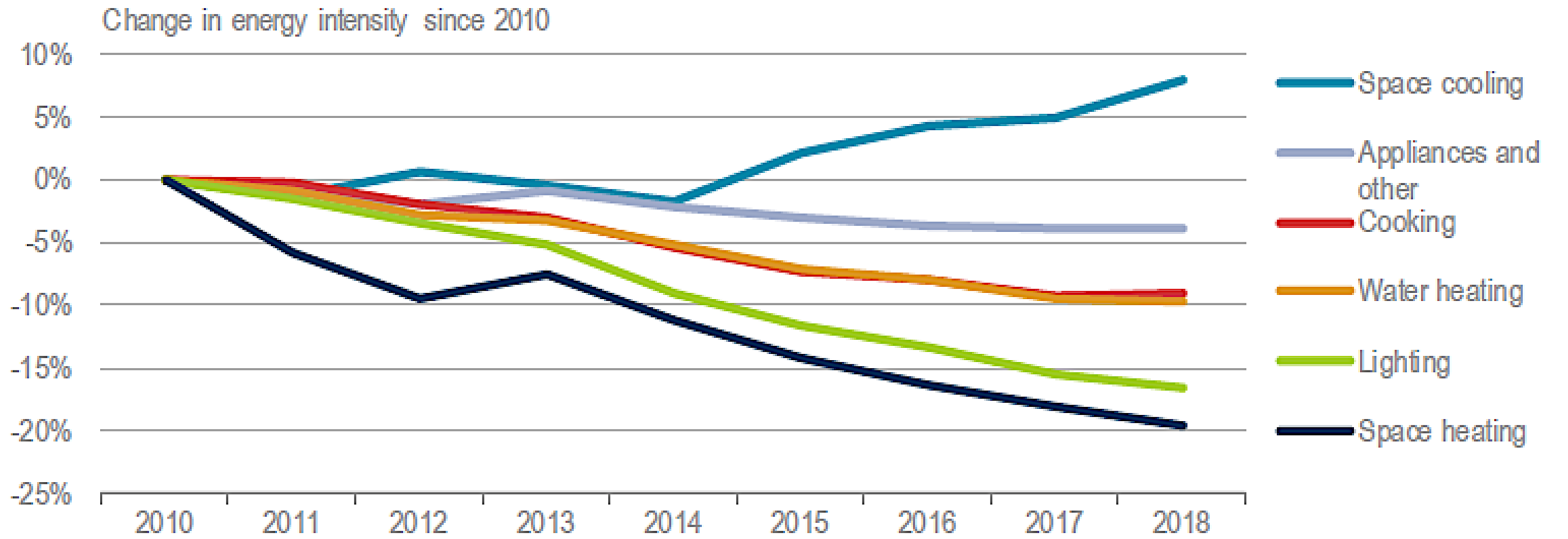


Notes: *Construction industry* is the portion (estimated) of overall industry devoted to manufacturing building construction materials such as steel, cement and glass. Indirect emissions are emissions from power generation for electricity and commercial heat.

Sources: Adapted from IEA (2019a), *World Energy Statistics and Balances* (database), www.iea.org/statistics and IEA (2019b), *Energy Technology Perspectives*, buildings model, www.iea.org/buildings.

Source: 2019 Global Status Report for Buildings and Construction, International Energy Agency (IEA)

Figure 5 • Global buildings sector final energy intensity changes by end use, 2010-18



Notes: *Energy intensity* is final energy used per unit of floor area. *Appliances and other* includes household appliances (e.g. refrigerators, washers and televisions), smaller plug loads (e.g. laptops, phones and other electronic devices) and other service equipment.

Sources: Adapted from IEA (2019a), *World Energy Statistics and Balances* (database), www.iea.org/statistics and IEA (2019b), *Energy Technology Perspectives*, buildings model, www.iea.org/buildings.

Key message • Owing to technological improvements, overall reductions have been made in energy intensity for space heating, lighting, appliances, cooking and water heating. However, space cooling energy intensity has increased as a result of greater cooling demand in hot regions.

Source: 2019 Global Status Report for Buildings and Construction, International Energy Agency (IEA)

CO_2 emissions by fuel type

CO2 emissions by fuel type for electrical generation	
Fuel	**Emissions, kgCO2 / kWh**
Lignite Coal	0.41 - 0.37
Anthracite Coal	0.34
Fuel Oil	0.28
Diesel	0.27
Crude Oil	0.26
Natural Gas	0.20

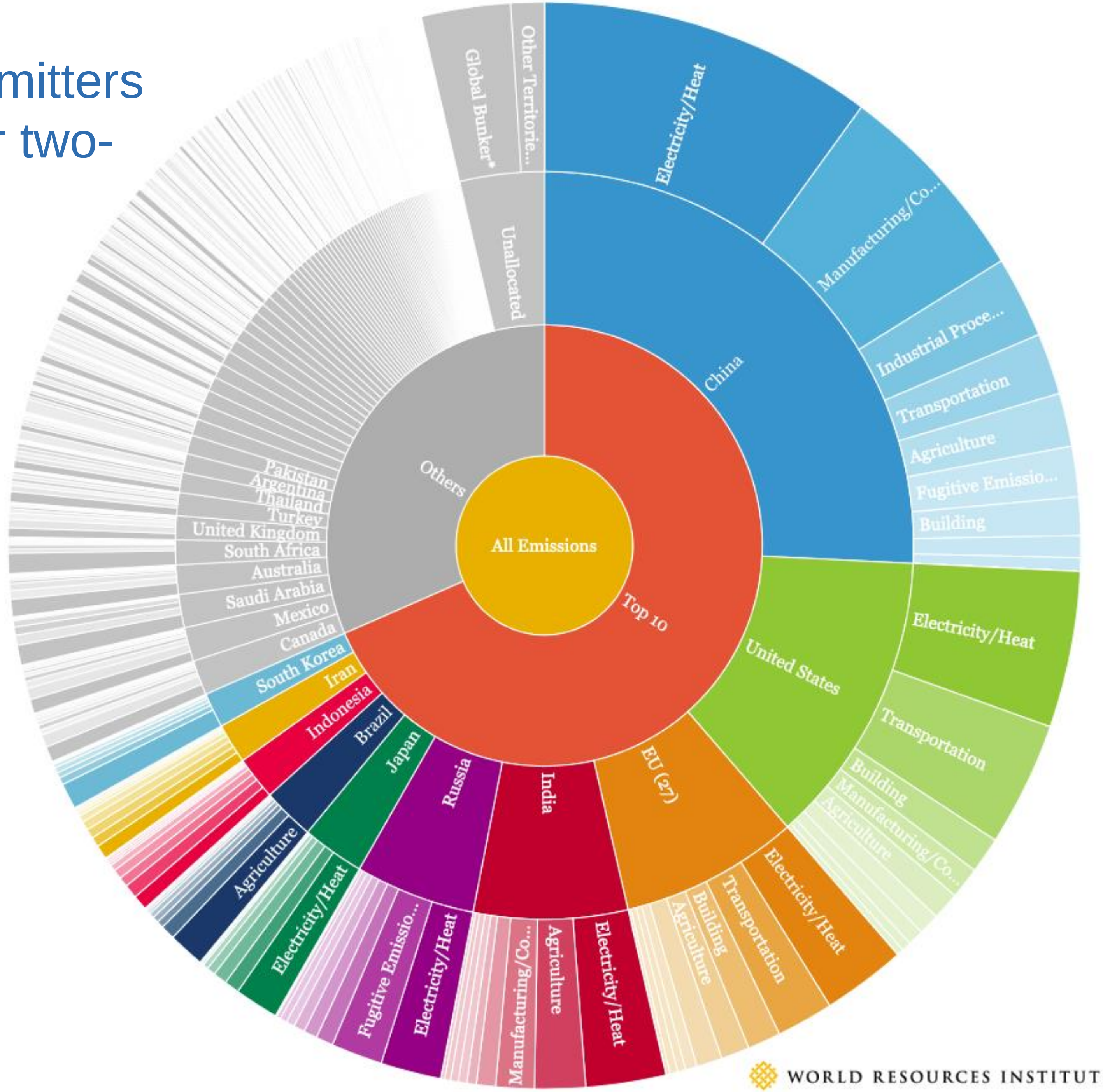
Note the high rate of emissions for grid electricity generated from coal, because of inefficient combustion.

In view of this, electric space heating, air conditioning or electric cars are not good solutions in Poland, Germany or other regions reliant on coal.

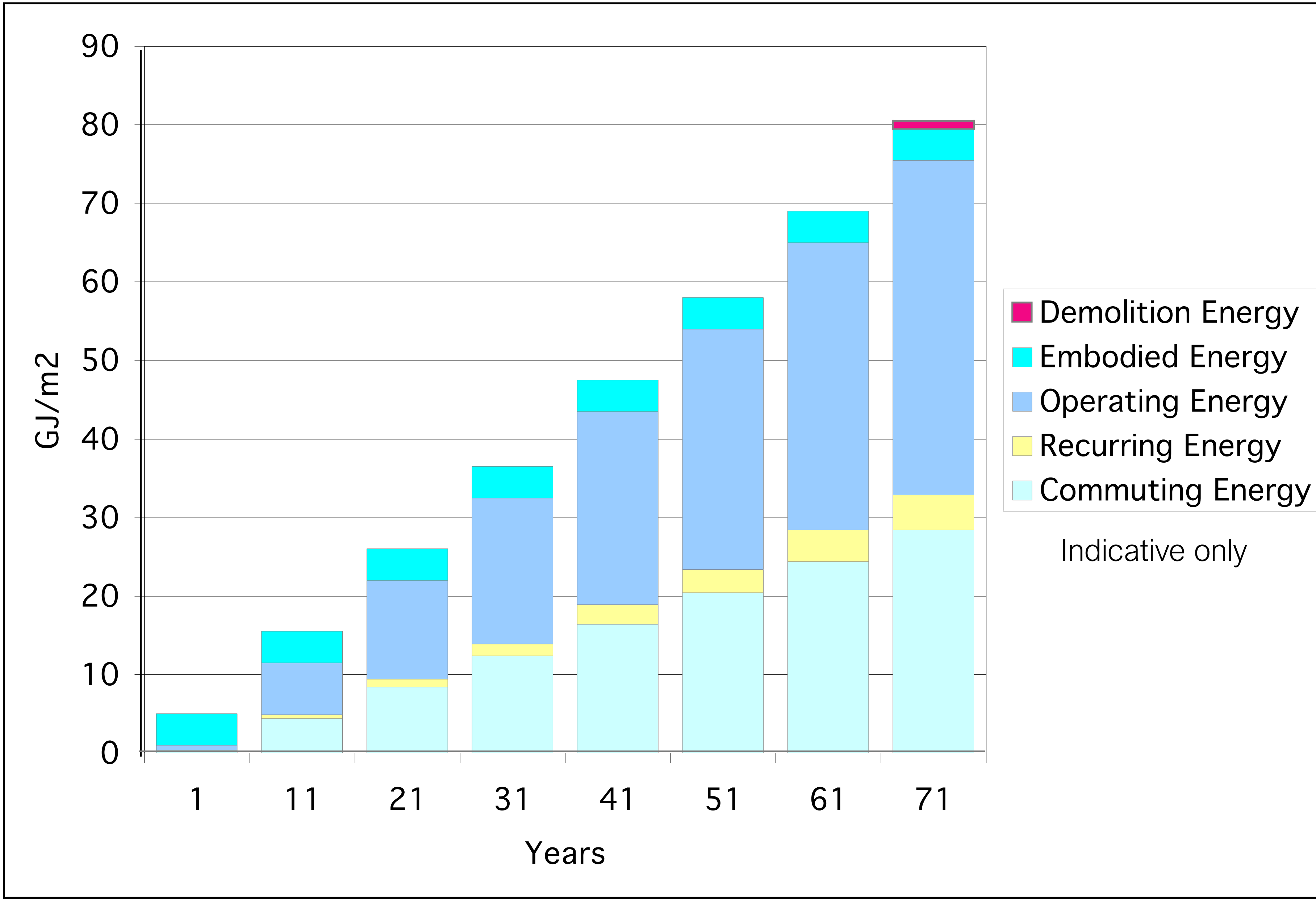
www.volker-quaschning.de

Current GHG emissions

Top 10 GHG emitters contribute over two-thirds of global emissions

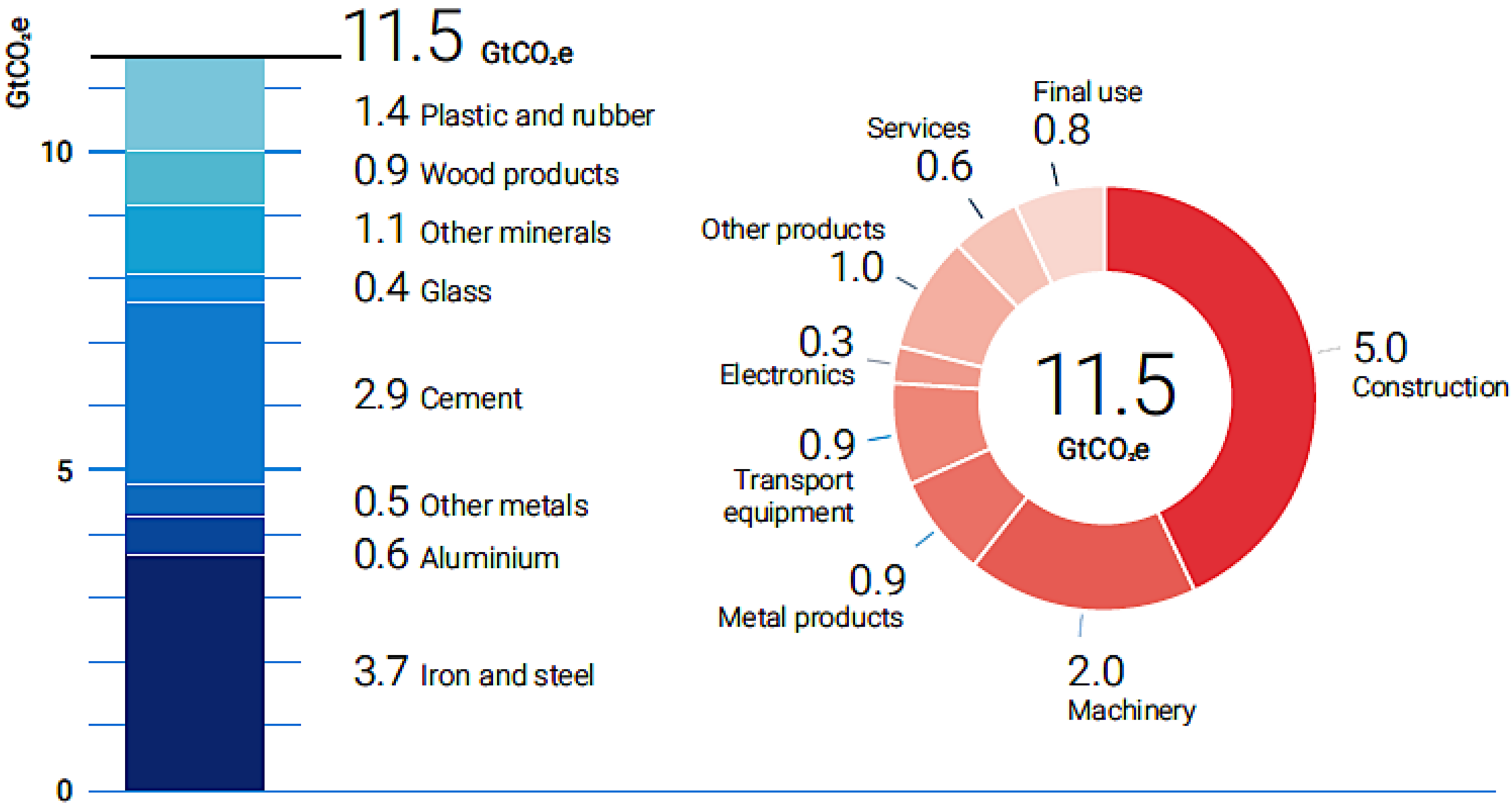


World Resources Institute 2020



Life-cycle energy and emissions

GHG embodied emissions related to building materials production and construction



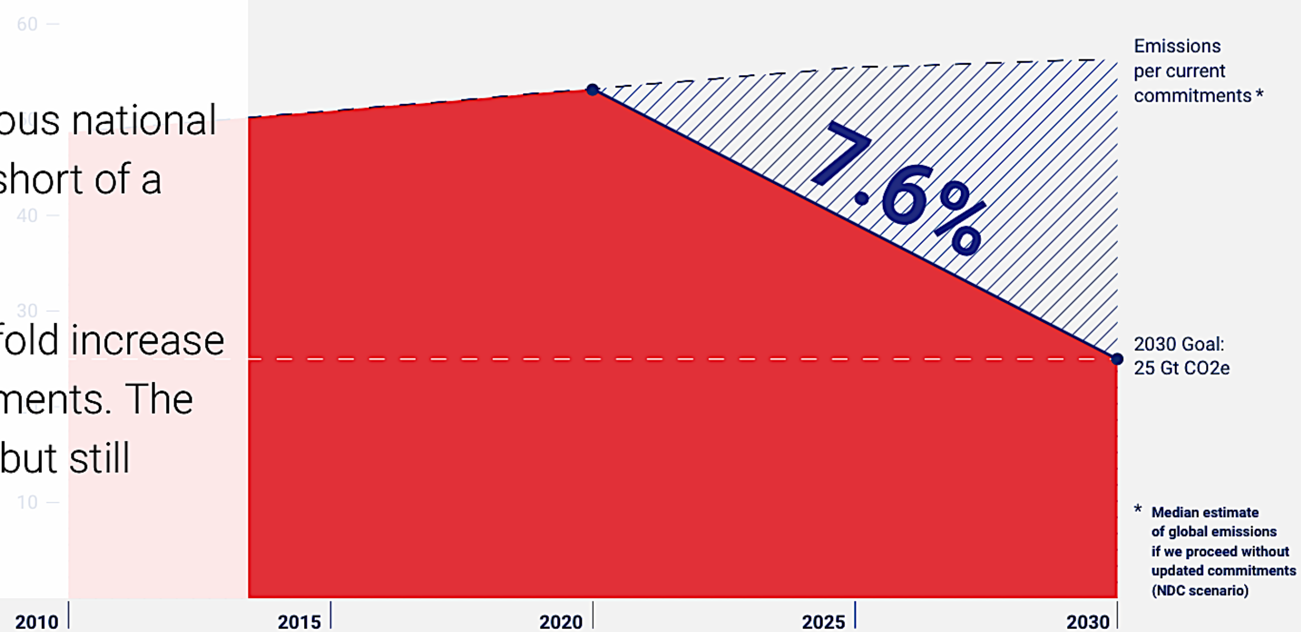
Emissions Gap Report 2019, UN Environment

Annual emission reductions needed **today** for a 1.5ºC maximum rise

Today, we need to reduce emissions by 7.6% every year.

Today, even the most ambitious national climate action plans are far short of a 7.6% reduction.

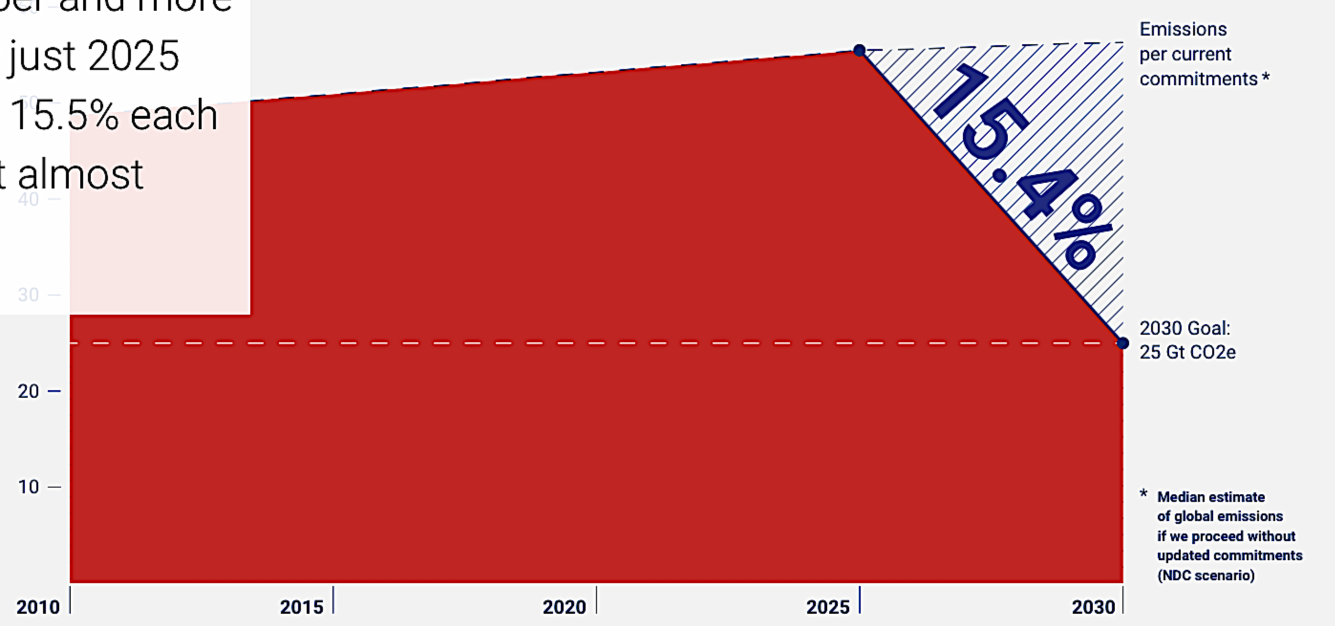
The world now needs a five-fold increase in collective current commitments. The cuts required are ambitious, but still possible.



Emissions Gap Report 2019, UN Environment

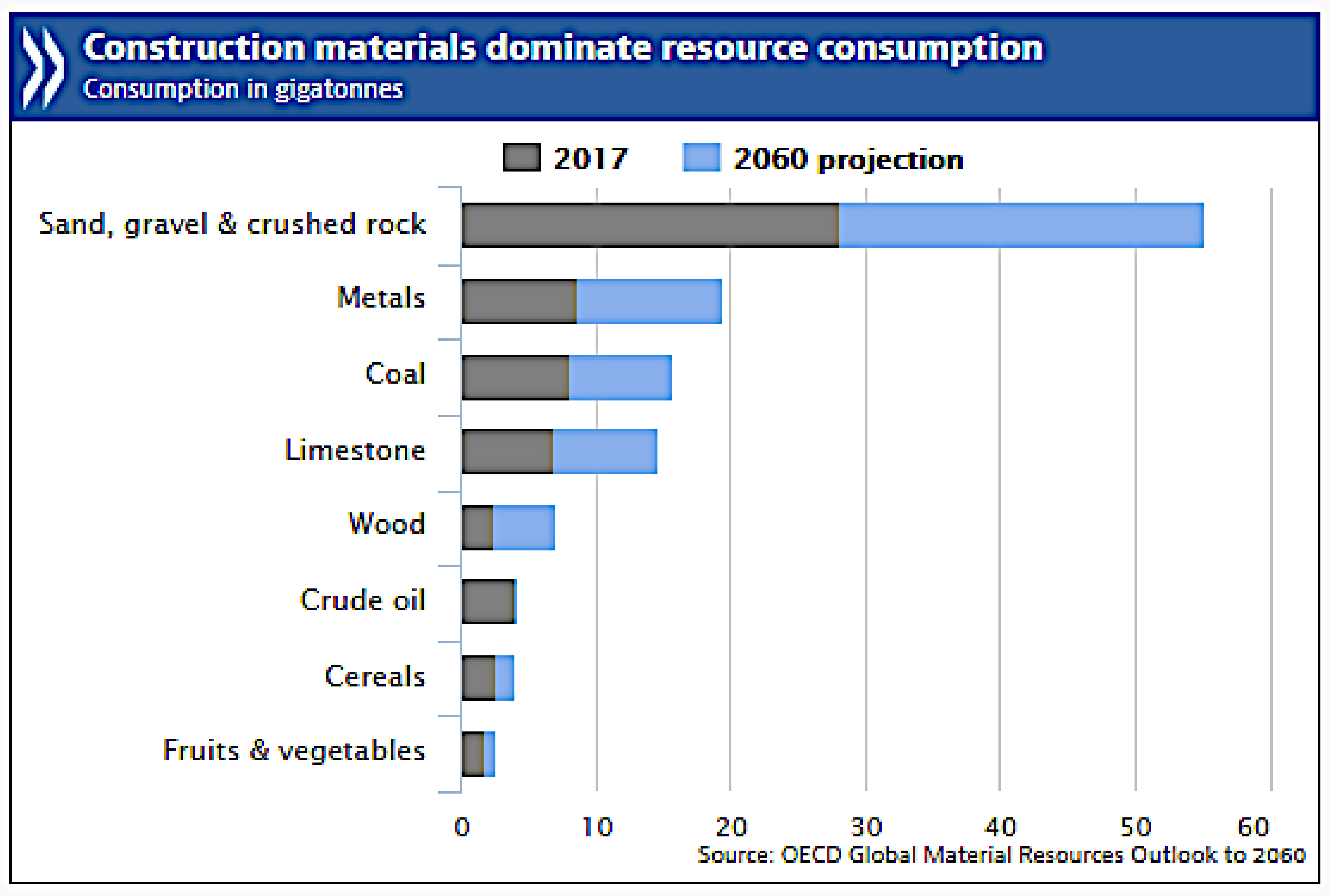
Annual emission reductions needed by **2025** for a 1.5ºC maximum rise

Every day we delay, the steeper and more difficult the cuts become. By just 2025 the cut needed would will be 15.5% each year, making the 1.5°C target almost impossible.



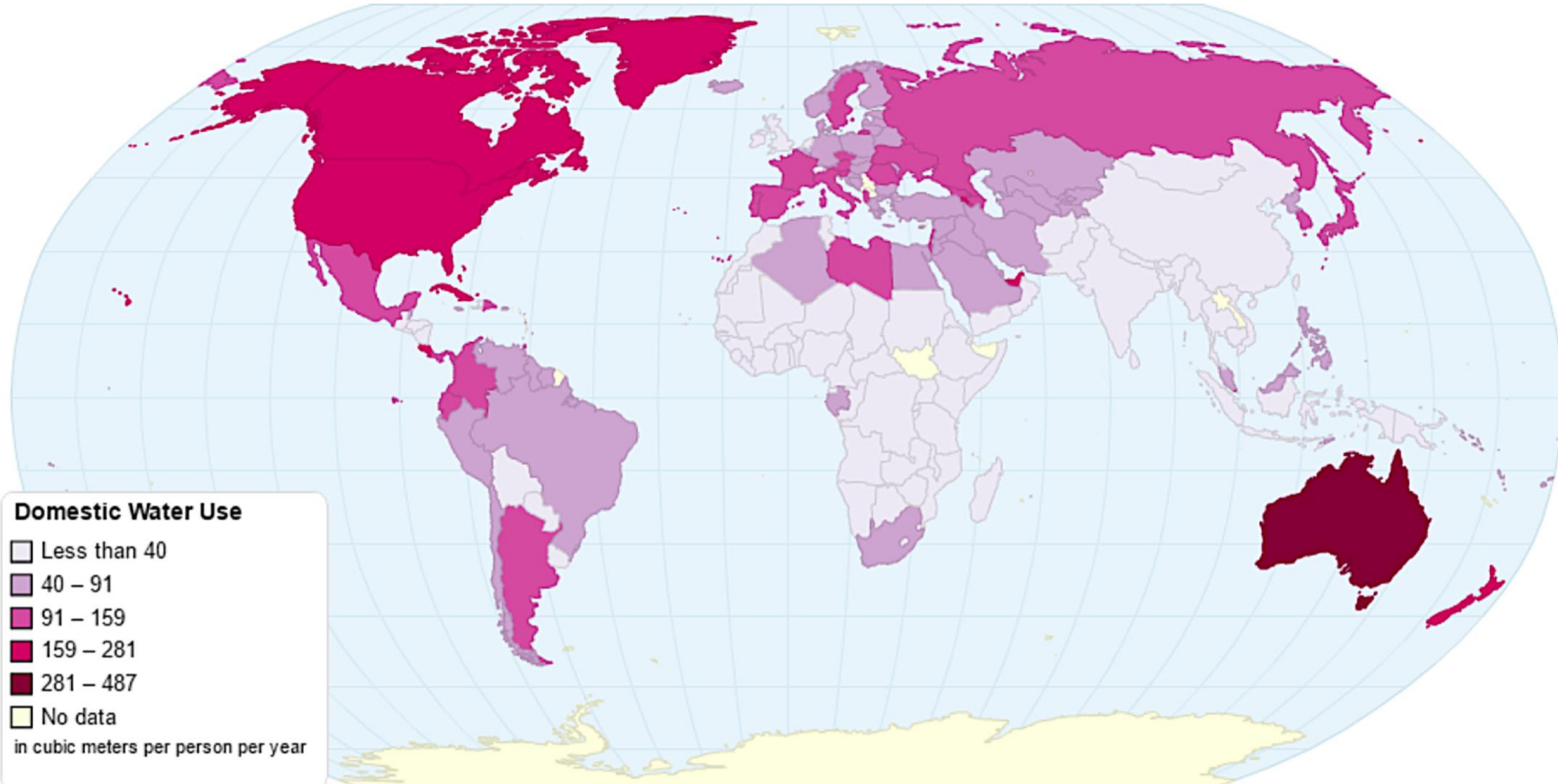
Emissions Gap Report 2019, UN Environment

Buildings and Resource Consumption



Source: Global Material Resources Outlook to 2060; Economic Drivers and Environmental Consequences, OECD Paris, 2019

Domestic water use by country, m^3 per person per year

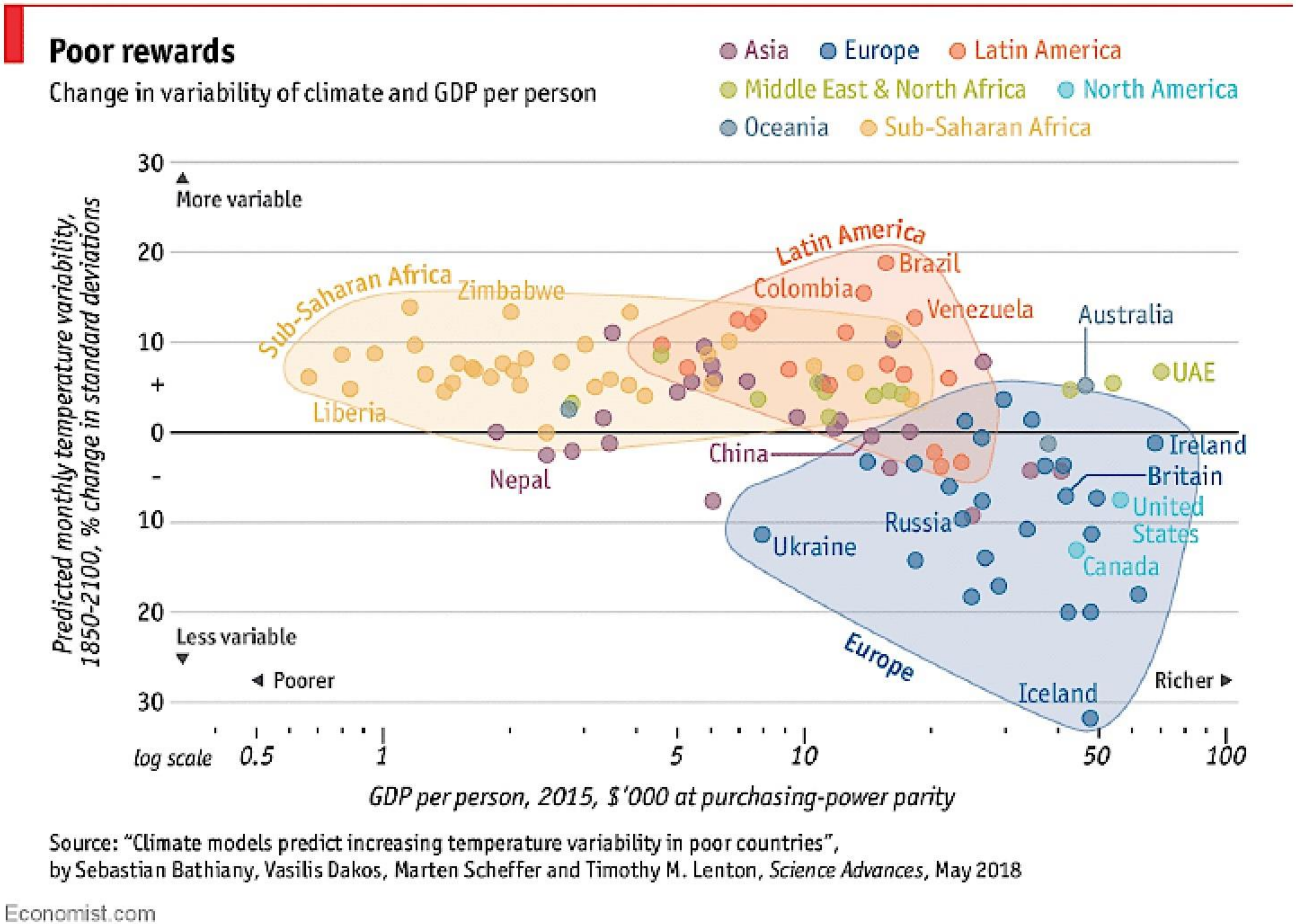


Domestic water use is water used for indoor and outdoor household purposes— all the things you do at home: drinking, preparing food, bathing, washing clothes and dishes, brushing your teeth, watering the yard and garden...

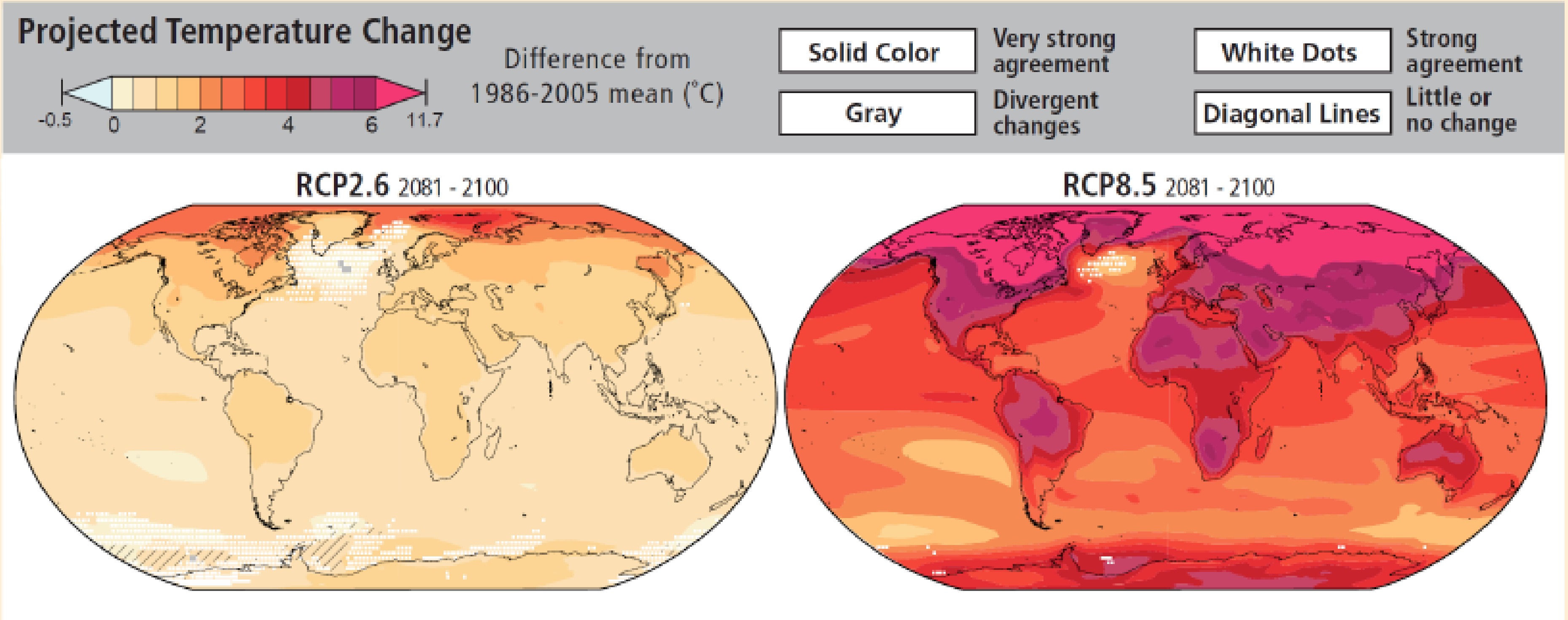
Domestic Water Use by Country, ChartsBin.com, <http://chartsbin.com/view/44463>

Climate change impacts on the built environment

Climate in developing countries will become far more variable



IPCC WG II, AR5: Summary for Policymakers



RCP = Representative Concentration Pathway.

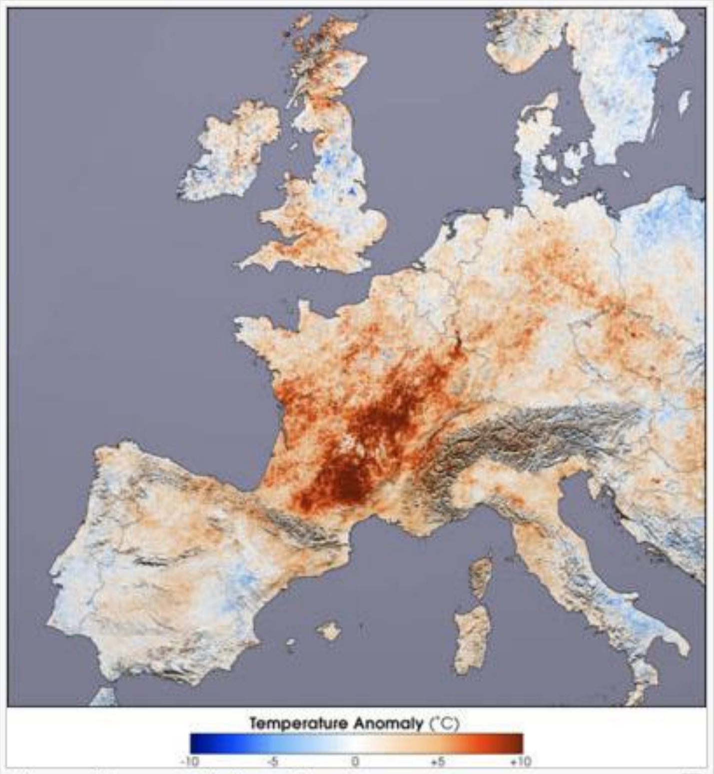
RCP 2.6 assumes a GHG peak of 490 ppm before 2100, then declining;

RCP 8.5 assumes 1370 ppm GHG emissions by 2100, and rising

see http://www.iiasa.ac.at

Specific impacts of high temperatures

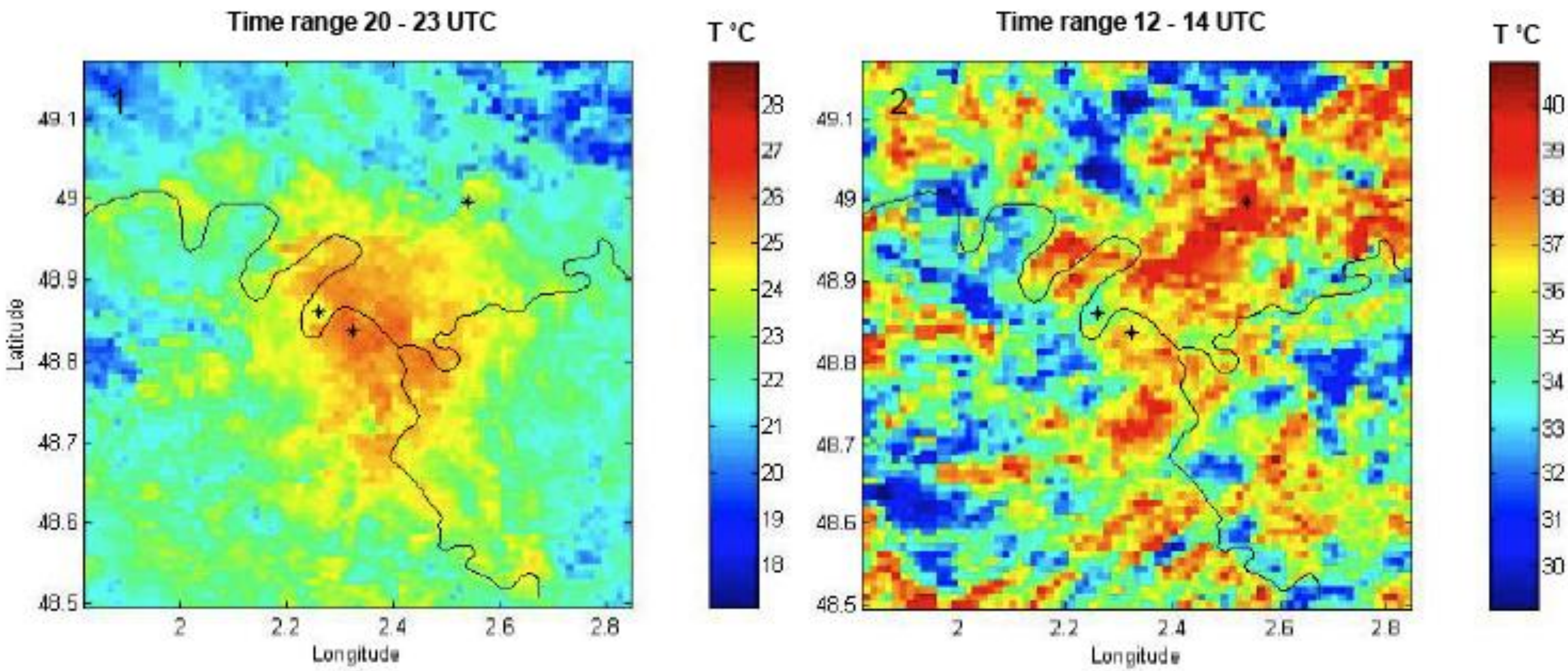
- Higher temperature increases evaporation rates, which aggravates water shortages;
- Higher temperatures leads to more use of mechanical cooling which creates more demand for electricity, which creates more GHG emissions.
- Heat waves can cause higher death rates, especially in the older population.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



Change of temperature in Europe from the average.

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

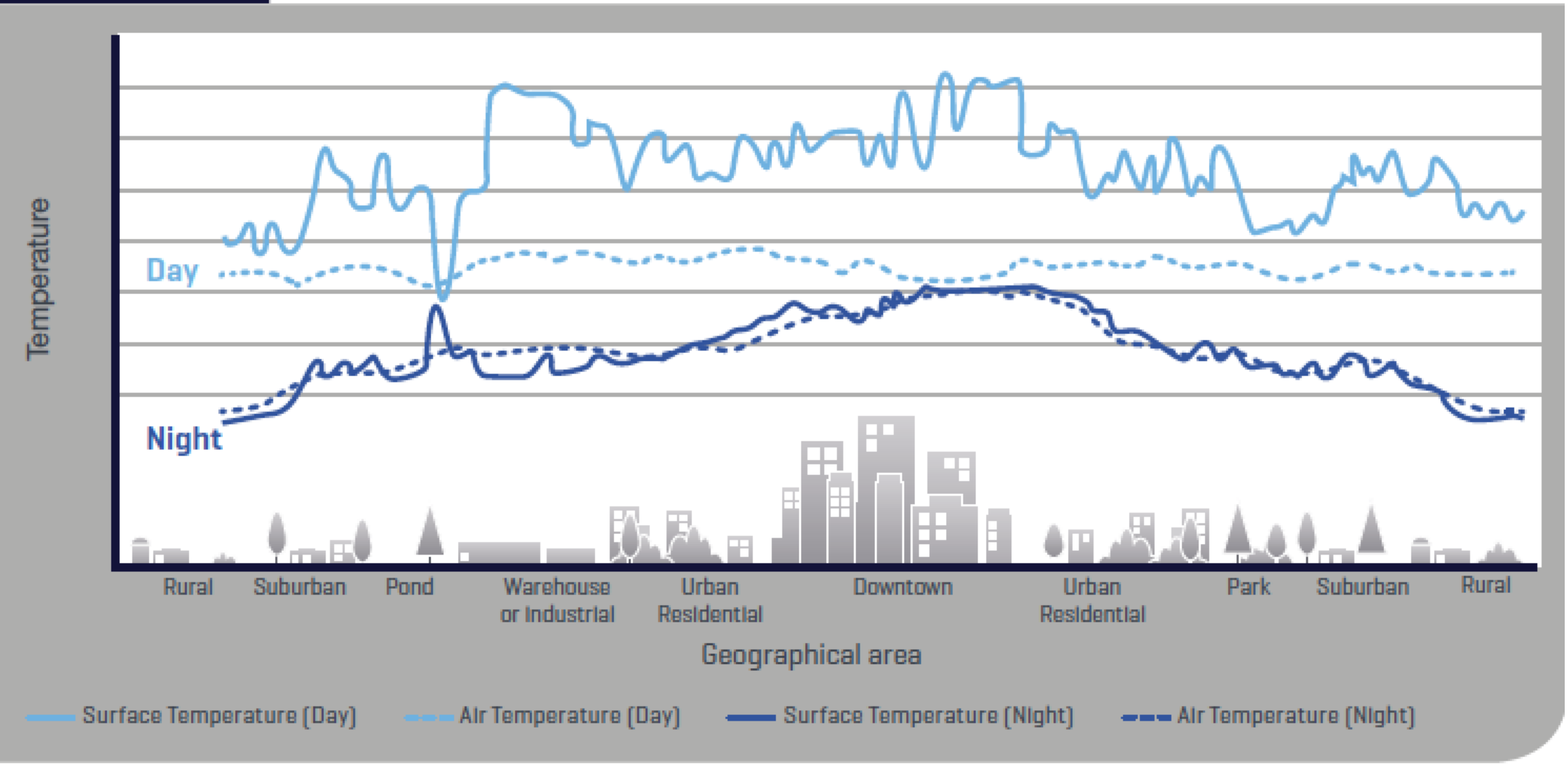
Urban heat islands: Paris, August 4-13, 2003



1) A large urban heat island centered in downtown Paris at night
2) Numerous heat islands scattered in the Paris suburbs in daytime.

B. Dousset, ESA user consultation meeting, Athens, June 2007

Figure 28 Urban Heat IslandTemperature fluctuation over different land use areas



Source: Climatic Risk Toolkit, RICS Research 2015

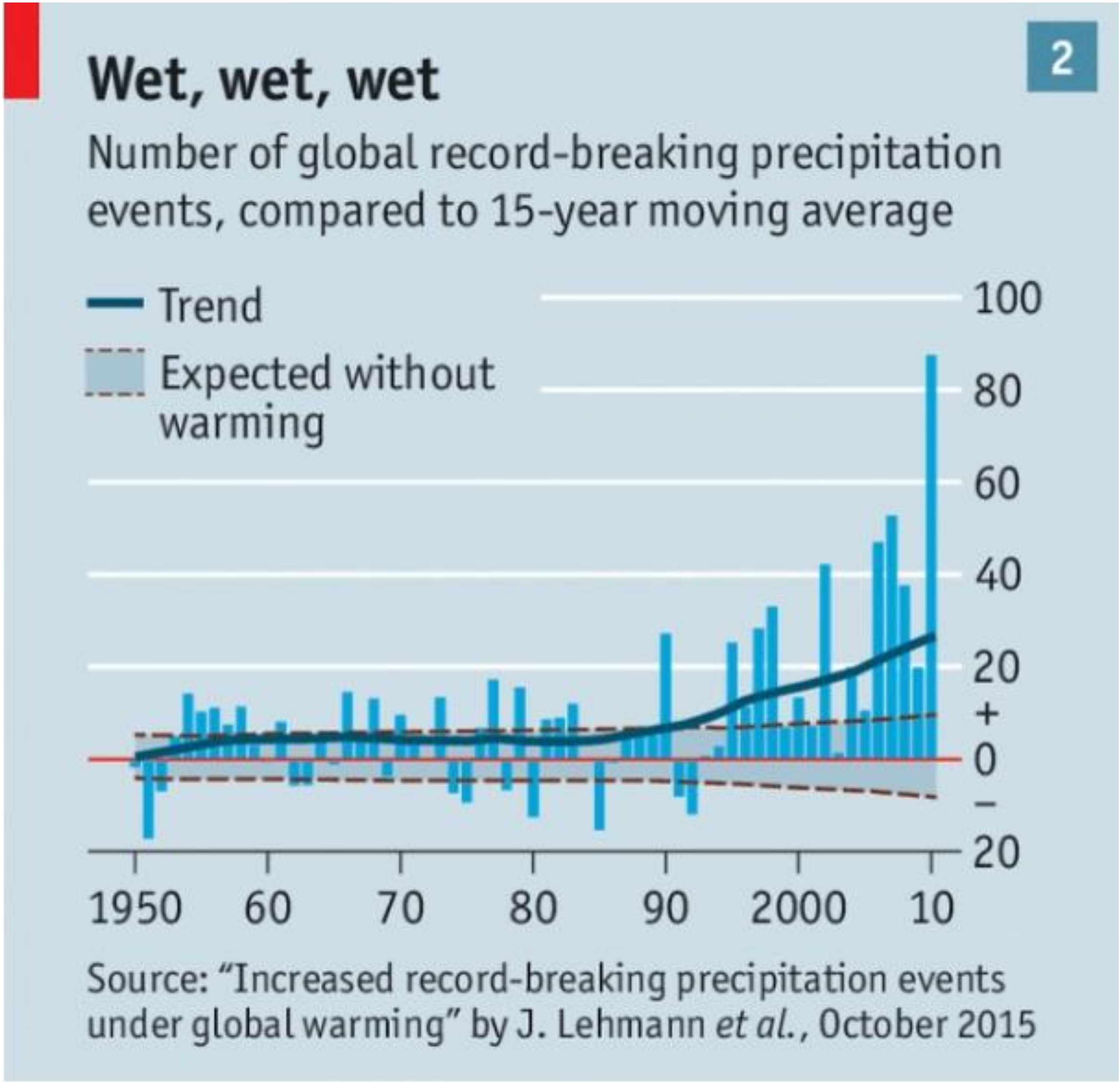
Projected energy cost of climate change in Europe

Table 1 Cost of Climate Change: Extra annual cost and cumulative cost in 40 years – Comparison with GDP and per capita

Country	TOTAL NIA[1] (office, hospital, retail, education)	Extra cost of climate change[2]	Cumulative cost in 40 years[2]	GDP[3]	% GDP annual[4,5]	Extra cost per capita[4,5]
	m²	million GBP per year	million GBP	million GBP per year		GBP per year
Sweden	111,100,000	18.98	15,600	312,000	5.0%	2.06
Norway	74,070,000	6.24	5,100	297,000	1.7%	1.22
Germany	1,110,700,000	271.77	222,800	2,040,000	10.9%	3.31
Ireland	32,770,000	3.86	3,200	125,000	2.5%	0.86
France	718,000,000	109.14	89,500	1,554,000	5.8%	1.70
Spain	236,100,000	89.87	73,700	802,000	9.2%	1.96
Greece	100,160,000	27.38	22,500	148,000	15.2%	2.45
UK	310,000,000	29.48	24,200	1,448,000	1.7%	0.48
Total	**2,692,900,000**	**556.70**	**456,500**	**6,726,000**	**6.8%**	**1.96**

Source: [1]BPIE (2014) [2]Sturgis Carbon Profiling LLP [3]World Bank (2012) [4]European Union (2014) [5]Statistics Norway (2014)

Source: Climatic Risk Toolkit, RICS Research 2015



Source: The Economist 05 Sep17

Vancouver airport will have a major problem with a 2ºC rise in temperature

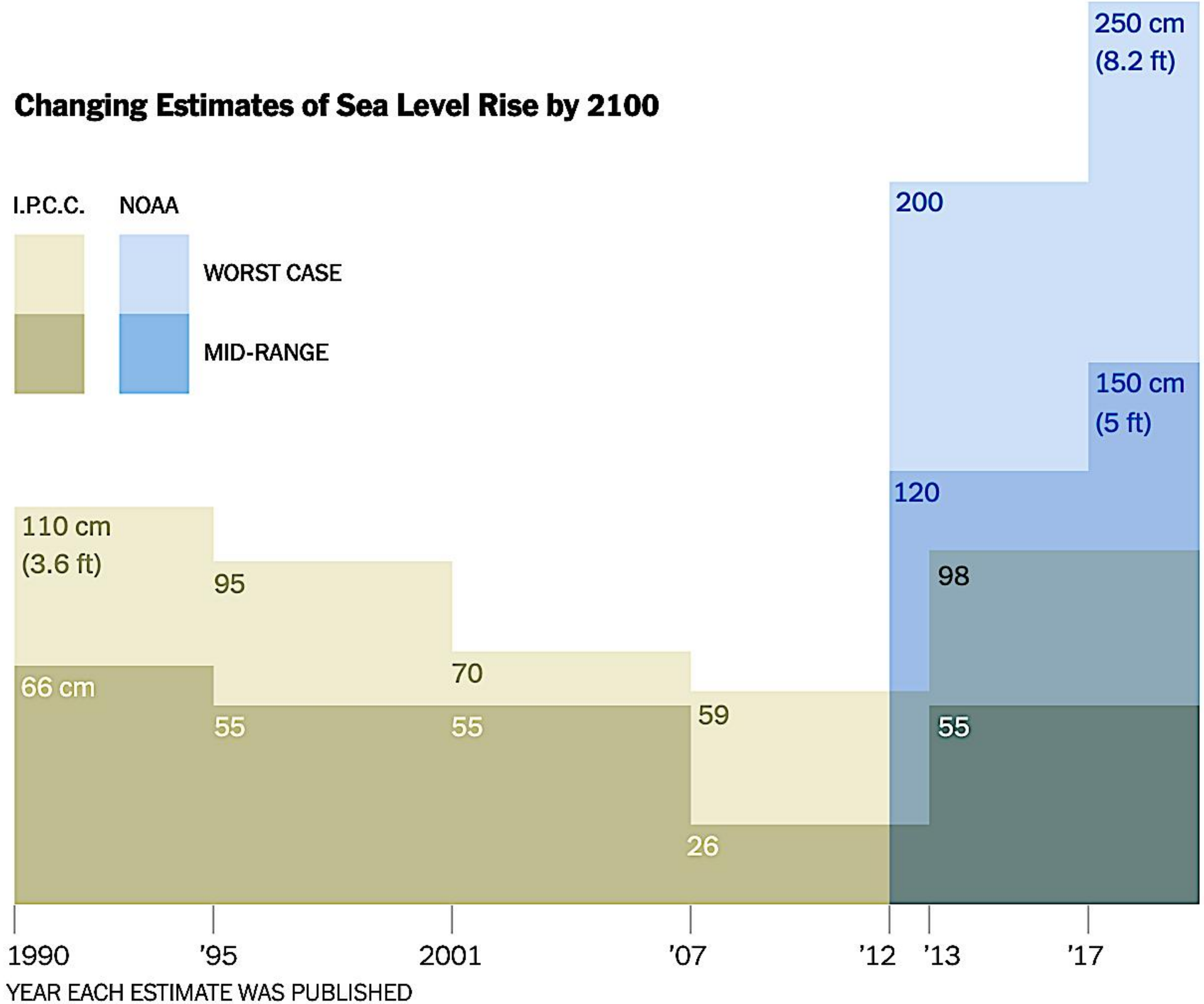
Climate Central

..and then there is Kansai airport

Getty Images

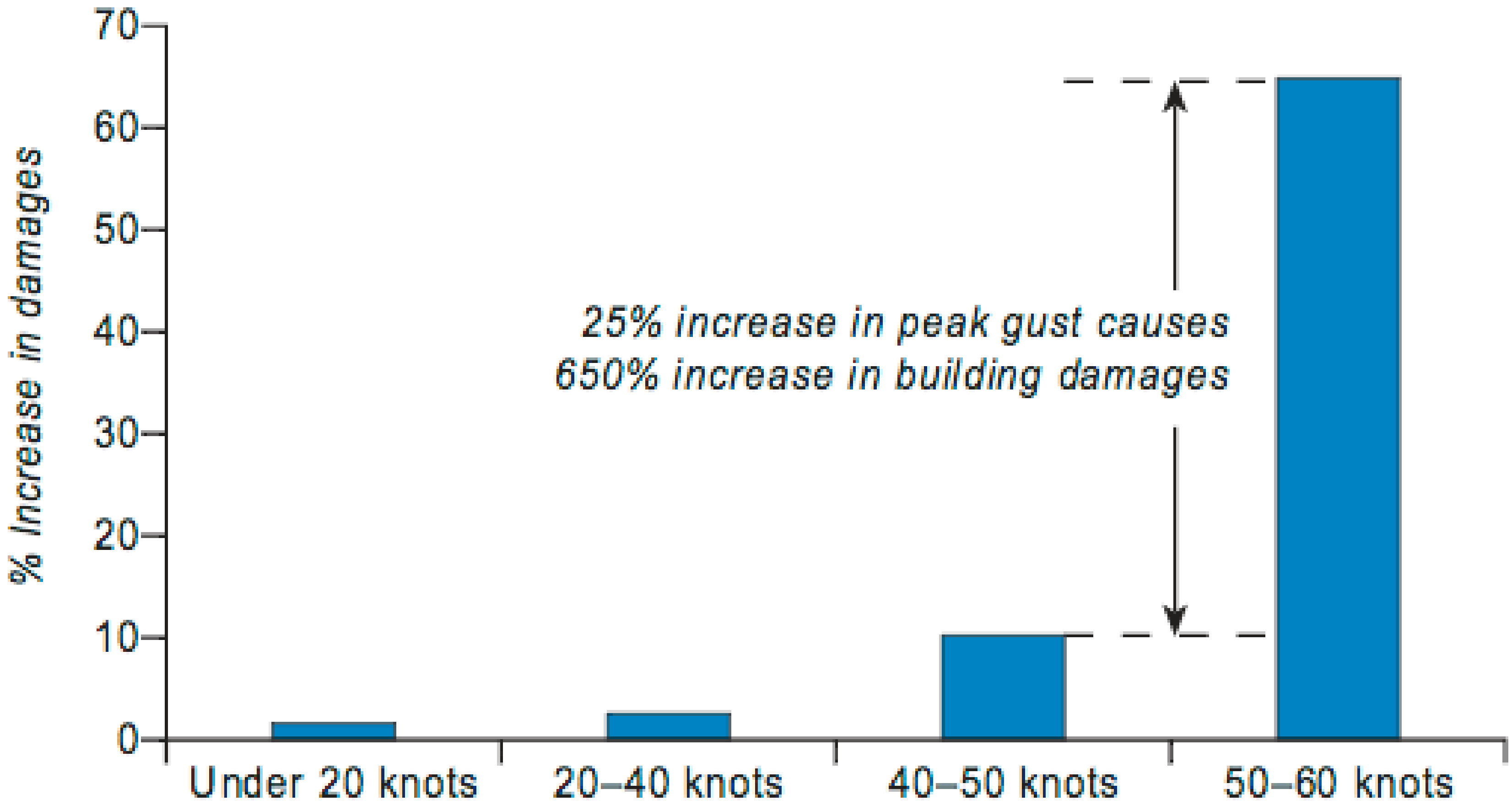
Estimates of the pace of sea level rise have recently changed

(NYT)



Note: The I.P.C.C.'s 2007 estimate of future sea level rise did not include satellite data on the contribution of melt water from Greenland and Antarctica because of disagreements among scientists.

Increased wind speeds will cause high levels of damage to structures



Source:
Climate Change Risks to Australia's Coast: A First-Pass National Assessment, Department of Climate Change, Government of Australia, 2009

Aerial photograph of the aftermath of Irma on the Dutch half of St Martin, Sint Maarten CREDIT: AFP

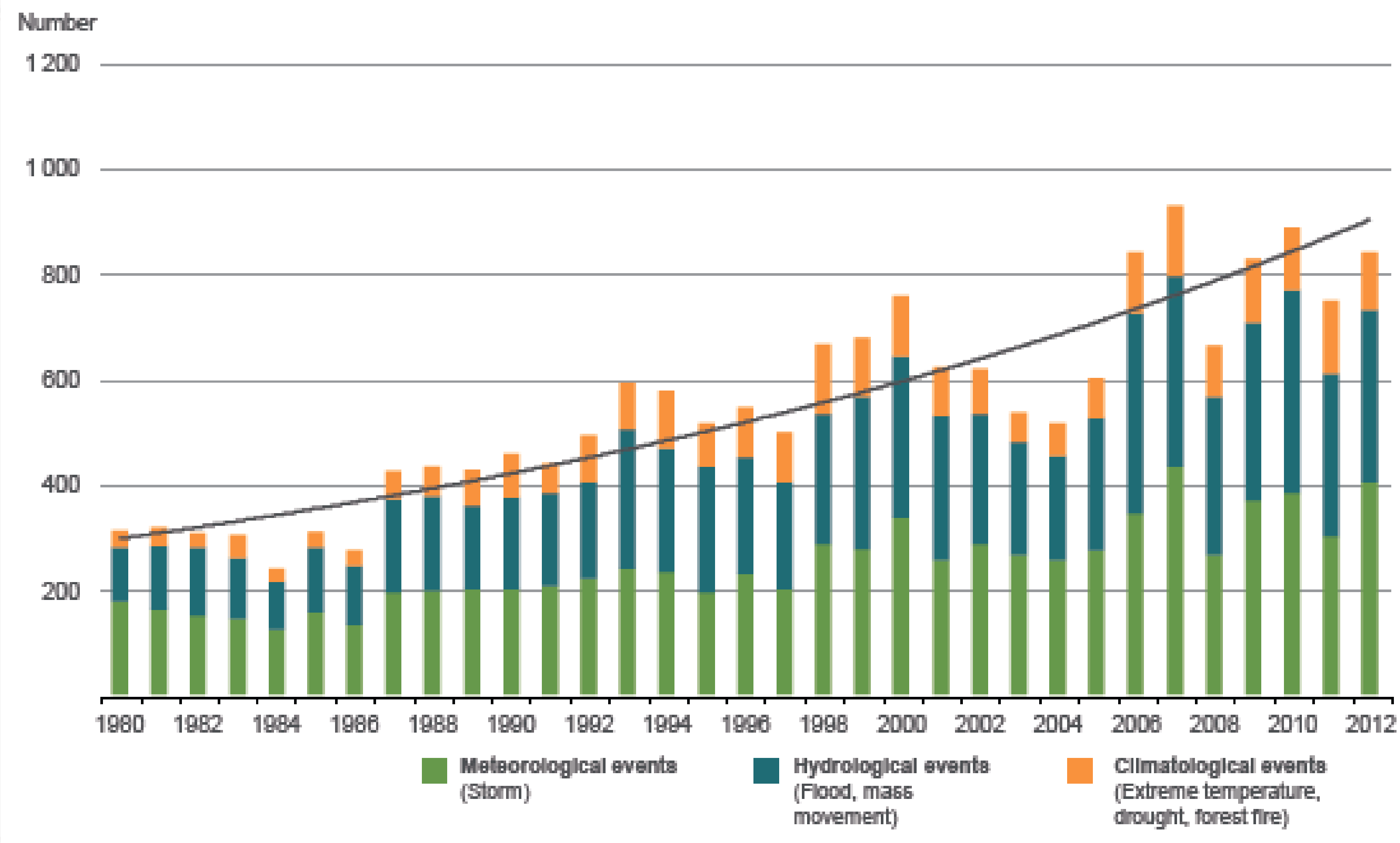
Source: The Economist 25 Sep17

NatCatSERVICE

Weather catastrophes worldwide 1980 – 2012

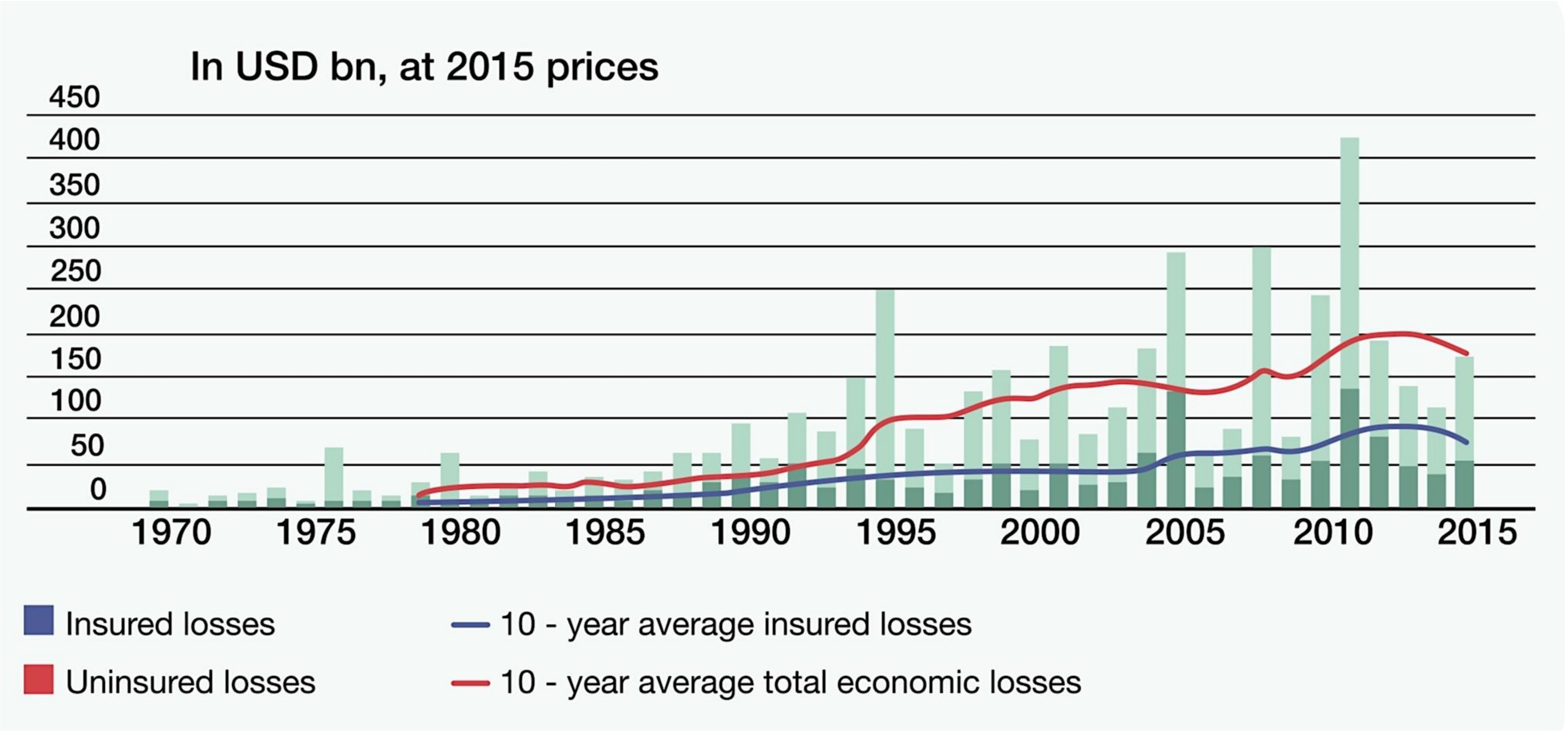
Number of events with trend

Munich RE



It is harder to find insurance for vulnerable properties

Economic v. insured catastrophe losses 1970-2015



Source: Swiss Re Economic Research & Consulting, 2015, in *Investing for Resilience*, ClimateWise, University of Cambridge, December 2016

Predicted climate change impacts on the built environment

from IPCC AR4 (2007), AR5 (2014) and other sources

Global trends	Likelihood of future trends	Examples of major projected impacts
Warmer and fewer cold days and nights over most land areas	Virtually certain (99% probability)	Reduced energy demand for heating; increased demand for cooling, declining air quality in cities
Warmer and more frequent hot days and nights over most land areas	Virtually certain (99% probability)	
Warm spells / heat wave frequency increases over most areas.	Very likely (90% probability)	Reduction in quality of life for those people in warm areas without appropriate housing; impacts on the elderly, very young and poor.
Area affected by droughts increases	Likely	Water shortages…reduced hydro generation, potential for population migration.
Heavy precipitation events. Frequency (or proportion of rainfall from heavy falls), increases over most areas.	Very likely (90% probability)	Disruption of settlements, transport and societies due to flooding; pressures on urban and rural infrastructure; loss of property.
Intense tropical cyclone activity increases	Likely	Disruption by flood and high winds, loss of insurance, population migration, loss of property.
Increased incidence of extreme high sea level (excludes tsunamis).	Likely (long term)	Costs of coastal protection v. relocation, loss of insurance, population migration, loss of property.

N. Larsson, iiSBE, 2009 & 2016

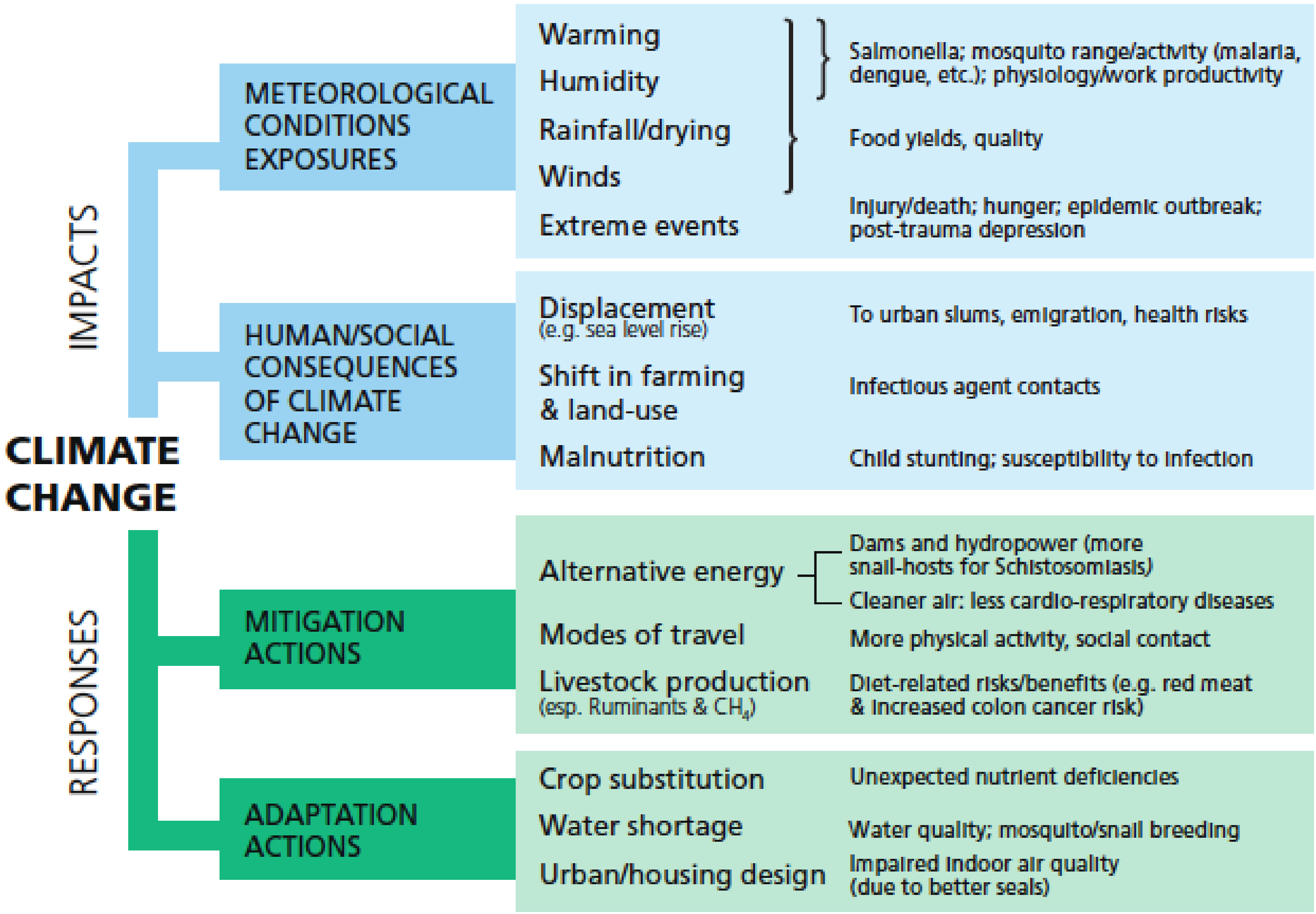
Some specific links between climate change and the building sector

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

Building issues in new temperature regimes

From IPCC 2007		Personal and other sources	
Global effects	**Examples of major projected impacts**	**Possible direct effects on urban areas and buildings**	**Secondary effects**
Warmer and fewer cold days and nights over most land areas	Reduced energy demand for heating; increased demand for cooling, declining air quality in cities	Growth of harmful insect populations, such as termites.	Repair of wooden structures.
		Melting permafrost in extreme North causes soil instability and release of Methane.	Repair, rebuilding, population relocation.
		Reduced space heating requirements.	Reduced energy consumption and emissions
Warmer and more frequent hot days and nights over most land areas		Increased urban heat island effect leading to higher ambient temperatures	Increased peak power demand from fossil-based power generation plants, with high GHG emissions. This also leads to smog formation with negative health effects.
		Reduced feasibility of night cooling	
		Increased building space cooling requirements.	
Warm spells / heat wave frequency increases over most areas.	Reduction in quality of life for those people in warm areas without appropriate housing; impacts on the elderly, very young and poor.	Reduced hydro or nuclear generation because of reduced flow rates and increased water temperatures.	Intermittent or reduced and more expensive power supply.
		Population mortality in housing and buildings with poor thermal performance and no space cooling, leads to greater demand for retrofit and space cooling.	Emergency building retrofits to improve hot weather performance.
			More space cooling installations leads to more pressure on power supply, greater GHG emissions and smog formation.

Examples of human health impacts

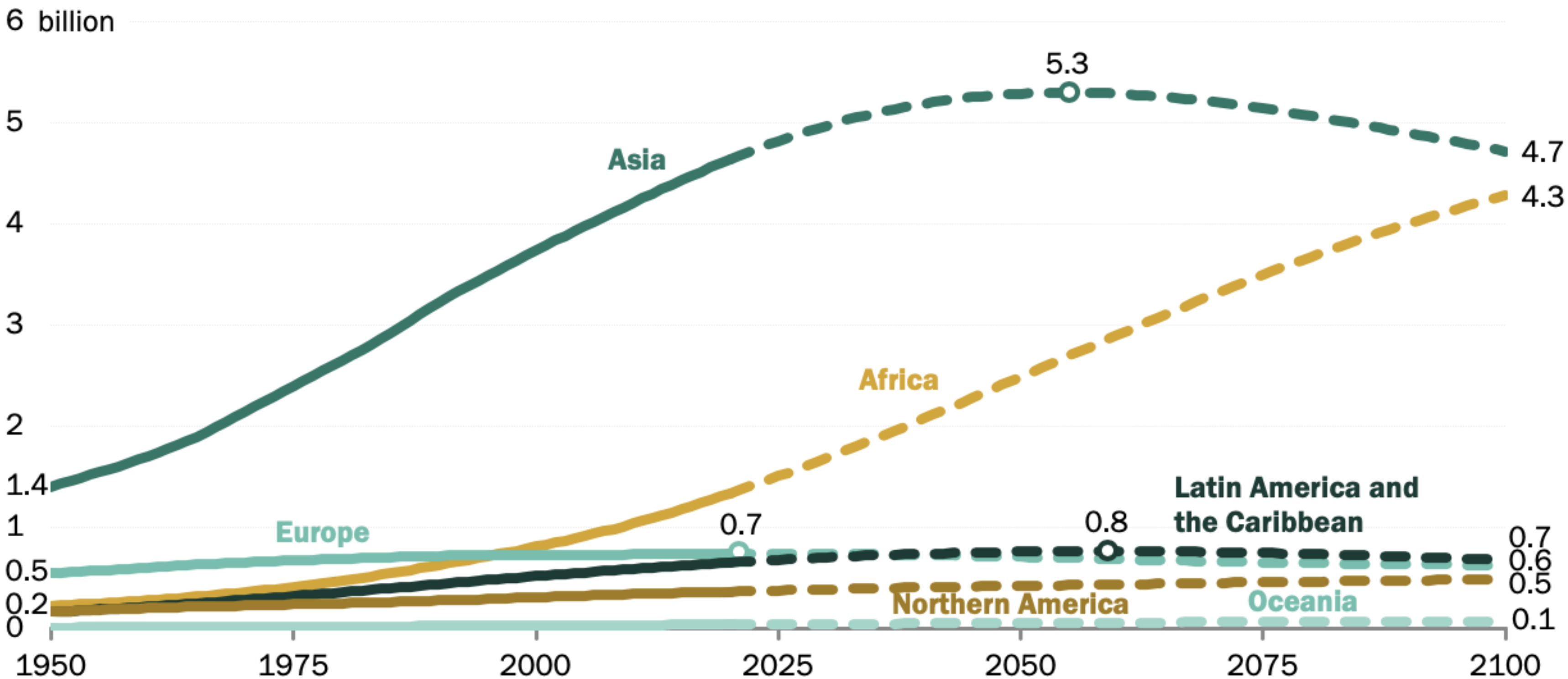


Source: University of Copenhagen Synthesis Report, March 2009, pg. 13

Drivers:
population growth and consumption levels

Population growth in Africa is projected to remain strong throughout this century

Population by region, in billions



Note: Data labels show projected peak population for each region: Europe (2021), Asia (2055) and Latin America and the Caribbean (2058). Regions follow United Nations definitions and may differ from other Pew Research Center reports.

Source: United Nations Department of Economic and Social Affairs, Population Division, "World Population Prospects 2019."

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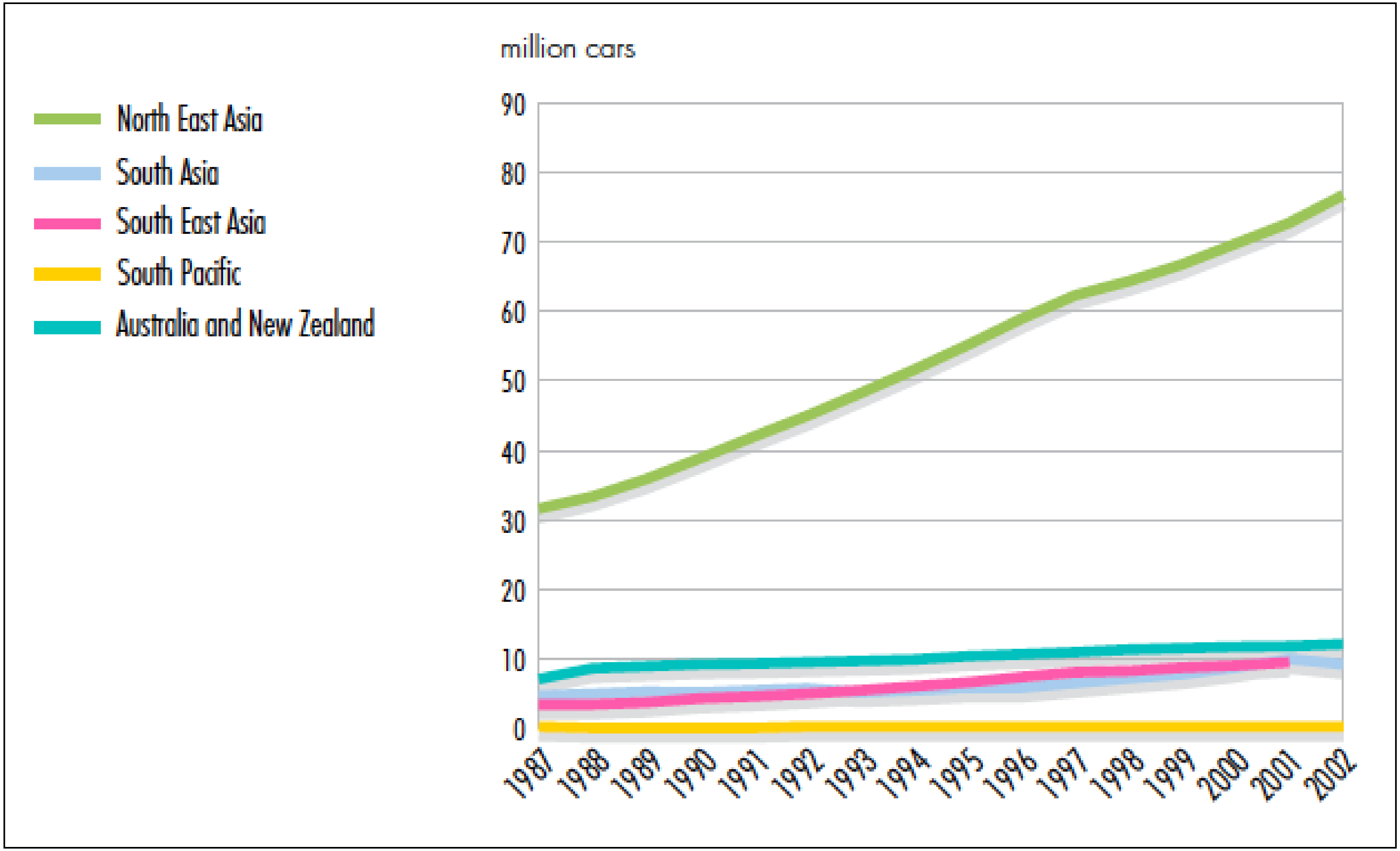
Global trends in passenger car ownership

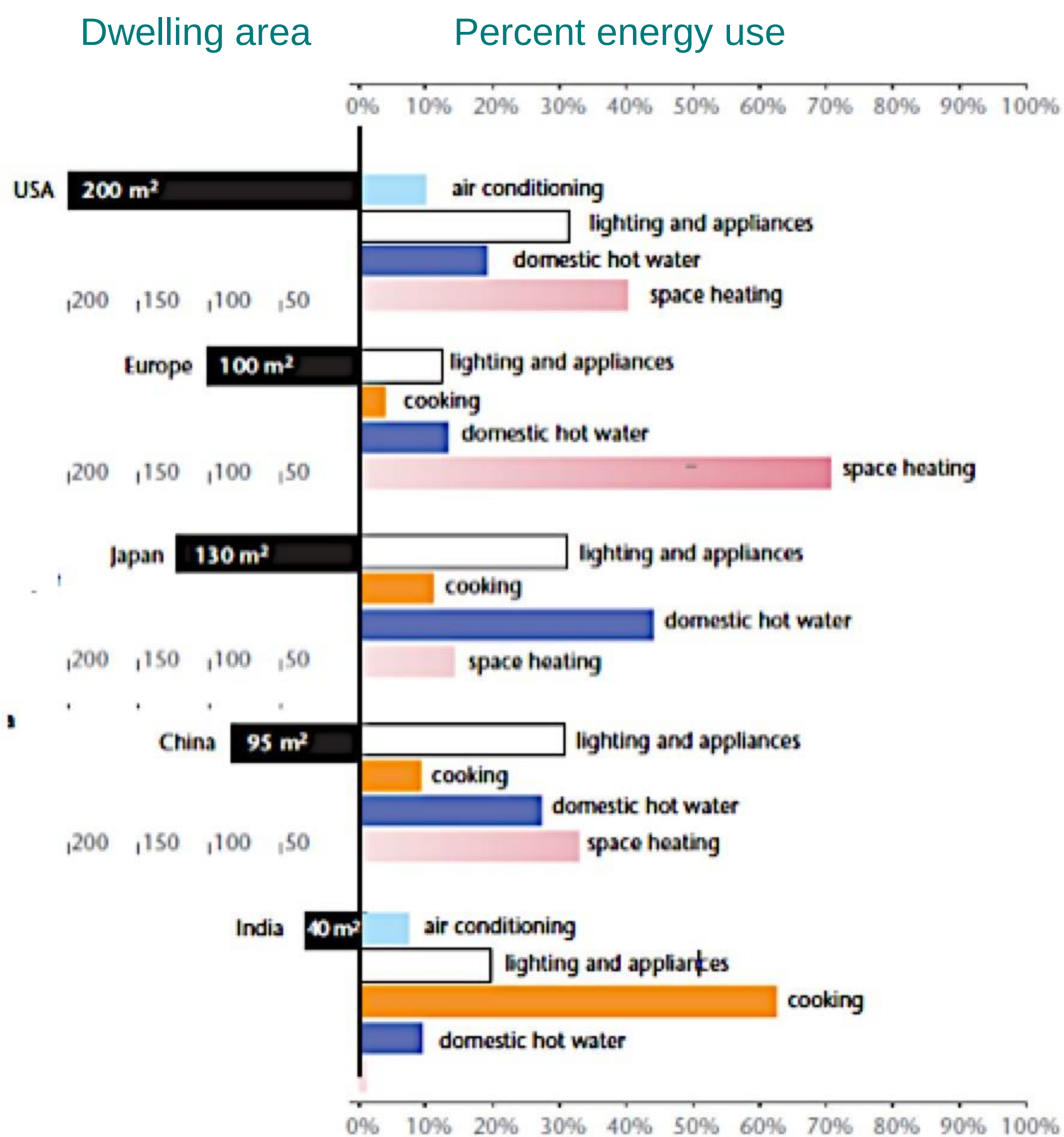


Source: UNEP, Global Environmental Outlook, GEO4 Summary for Decision Makers, 2007, pg. 15

The relationship between efficiency and consumption

- Great strides are being made in improving the ecological performance of materials;
- Building equipment is rapidly increasing in energy efficiency;
- And the emphasis on better design practice will undoubtedly help overall environmental performance of buildings;
- But we will not reduce overall greenhouse gas emissions nor depletion of key materials if more and larger buildings with a greater diversity of equipment are being built.

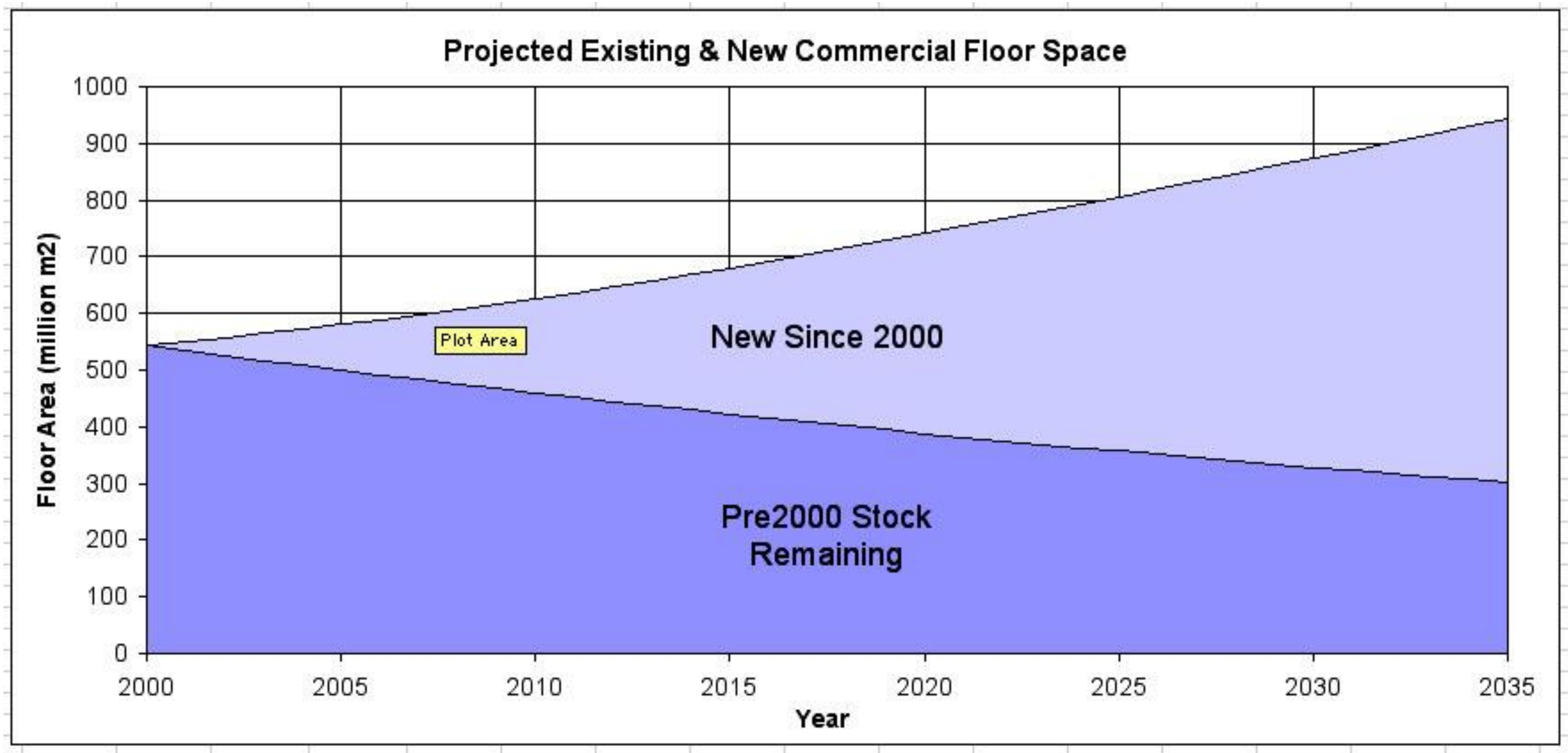
Dwelling size and energy use in selected countries



Source: World Business Council for Sustainable Development

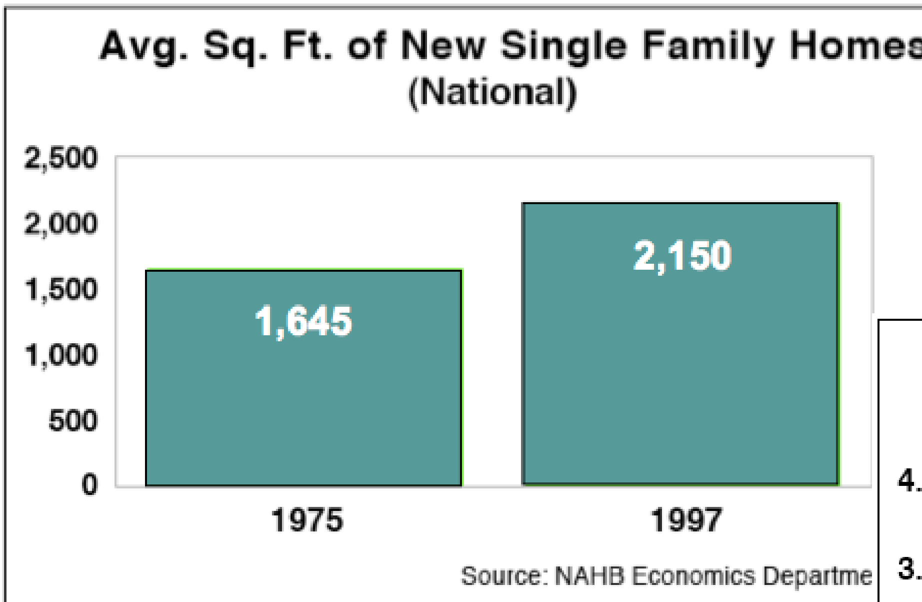
Current living standards will increase

Source: Society for Community Organization, Hong Kong

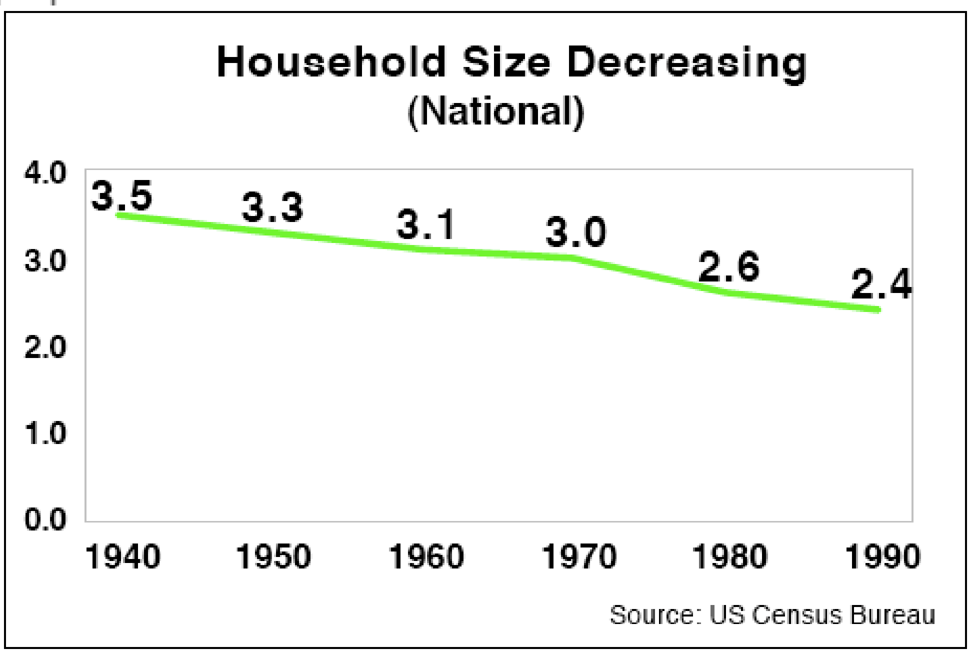


New construction has influence over the mid-term (Canadian rates of demolition and construction).

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 chart below shows a similar pattern in the USA.



Meanwhile, the average household size is decreasing...



Not shown is the considerable growth in household appliances and equipment

Proposed
Generic Actions

The problem

- Climate change has definitely arrived;
- It is driven by excessive consumption, lack of conservation of scarce resources and widespread inefficiencies;
- Key industry and government leaders have hesitated too long to implement adequate long-term mitigation measures;
- Measures that have been implemented are not sufficient to make the changes that are needed;
- But if serious measures have been delayed and must soon be introduced quickly under extreme conditions, with the probability of serious economic disruption and social unrest;
- We believe that regionally-sensitive plans for more rapid action are ***urgently*** needed, and we present a number of proposals along these lines.

Overview of Proposed Generic Actions

1. Identify regional vulnerabilities to climate change impacts;
2. Protect critical facilities, infrastructure and services
3. Prepare to house relocated populations
4. Introduce policies to reduce carbon emissions at a societal level through carbon taxes;
5. Support a shift from private to public transport
6. Support clean energy and renewables
7. Limit peak electrical demand
8. Mitigate urban heat island effect
9. Encourage urban agriculture;

Overview of Proposed Generic Actions

10. Develop strategies and performance targets for neighbourhoods;
11. Promote inter-building system synergies;
12. Freeze new construction in high-risk areas and limit development in other areas
13. Establish public building performance databases
14. Ensure very high performance of new buildings
15. Minimize embodied energy and emissions
16. Undertake intensive and deep green renovation
17. Strengthen equipment and appliance efficiencies
18. Adapt to local conditions and convince local elites to act

Proposed Generic Actions

1. Identify main regional vulnerabilities to climate change impacts

It is important for local key actors to be identify the local climate change impacts and the vulnerability of local ecological systems, infrastructure and buildings to these impacts.

The SNTool framework developed by iiSBE outlines key issues and provides a process to identify specific impacts and vulnerabilities.

Key issues covered include:

- Predicted Climate Change impacts in region
- Vulnerability to flooding events
- Vulnerability to windstorm events
- Vulnerability to major fire events
- Vulnerability to drought
- Vulnerability to earthquakes

Proposed Generic Actions

2. Protect critical facilities and infrastructure

   Ensure that facilities and services of critical importance can remain functional at a basic level of performance under extreme conditions.

   - Facilities and services of critical importance include hospitals, fire and police stations, harbours, airports, public transportation systems, food supplies, electrical distribution networks, telecommunications, water, sewage treatment and pumping systems.
   - Extreme conditions include power interruptions exceeding 24 hours, extreme winds, riverine or coastal flooding and extreme drought conditions.

Proposed Generic Actions

2. Protect critical facilities and infrastructure

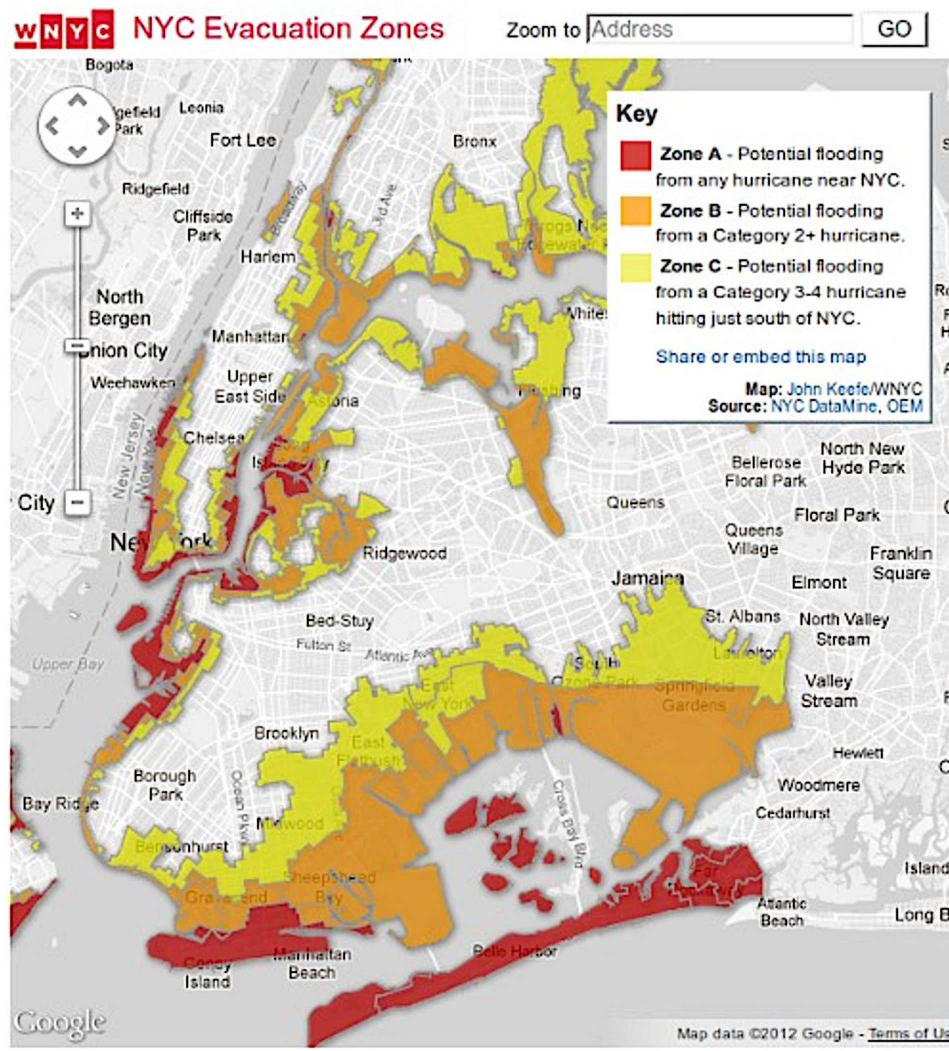
Proposed Generic Actions

3. Prepare to house relocated populations from within and outside the region

Estimate the number of weather refugees who may need to be relocated under various conditions.

Identify facilities that may be useful for short-term stay by relocated populations and hotels, office buildings, schools and other public-use buildings that may be suitable for rapid conversion to residential uses.

After being struck by Hurricane Sandy in 2015, New York City has developed plans to deal with future events.



Proposed Generic Actions

4. Introduce policies to reduce carbon emissions at a societal level through carbon taxes

Introduce policy measures to radically and rapidly cap and reduce carbon emissions linked to the built environment. Such measures have the added benefit of reducing air pollution.

Possible measures include carbon taxes, cap and trade or personal allowances. Examples of successful approaches can be found in Tokyo and British Columbia

The Tokyo Cap-and-Trade Program (TCTP), implemented in 2010, is an important measure…to achieve Tokyo's greenhouse gas target…. Data indicate that TCTP has been effective in reducing energy consumption… to meet … emission reduction goals, to introduce new technologies, and to raise awareness and drive behavioural changes for energy demand reduction.

.

Proposed Generic Actions

4. Reduce carbon emissions at a societal level…

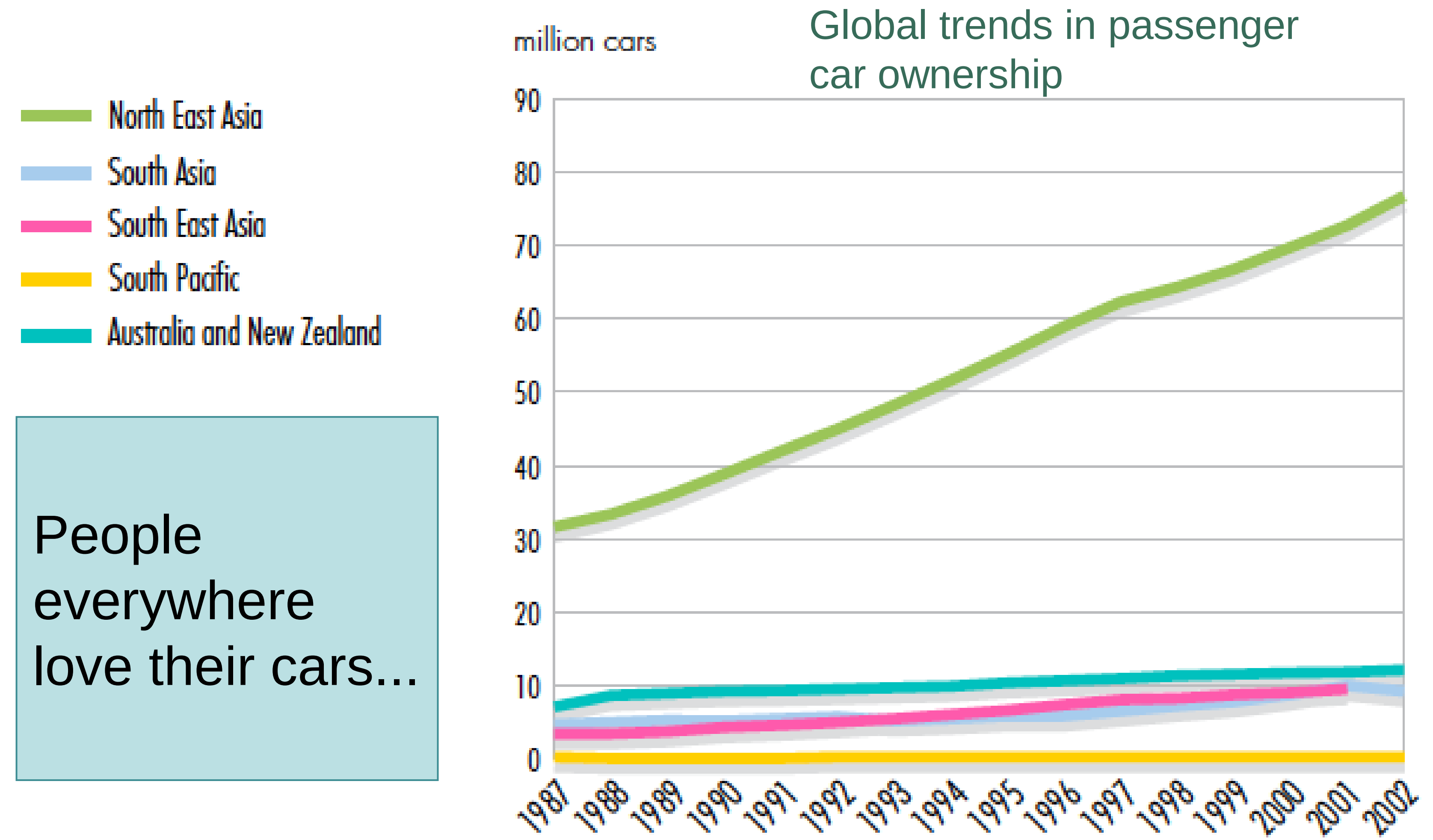
   .

   In 2008, British Columbia implemented the first comprehensive and substantial carbon tax in North America. By 2012, the revenue-neutral tax had reached a level of C$30/t CO_2, and covered approximately three-quarters of all greenhouse gas emissions in the province…

Empirical and simulation models suggest that the tax has reduced emissions in the province by 5–15%. At the same time, models show that the tax has had negligible effects on aggregate economic performance, though certain emissions-intensive sectors have faced challenges.

Proposed Generic Actions

5. Support a shift from private to public transport to reduce emissions, road and parking facilities



Source: UNEP, Global Environmental Outlook, GEO4 Summary for Decision Makers, 2007, pg. 15

5. Support a shift from private to public transport…

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Amount of space required to transport the same number of passengers by car, bus or bicycle

Source: poster in City of Muenster planning office, 2001

Proposed Generic Actions

6. Support clean energy and renewables

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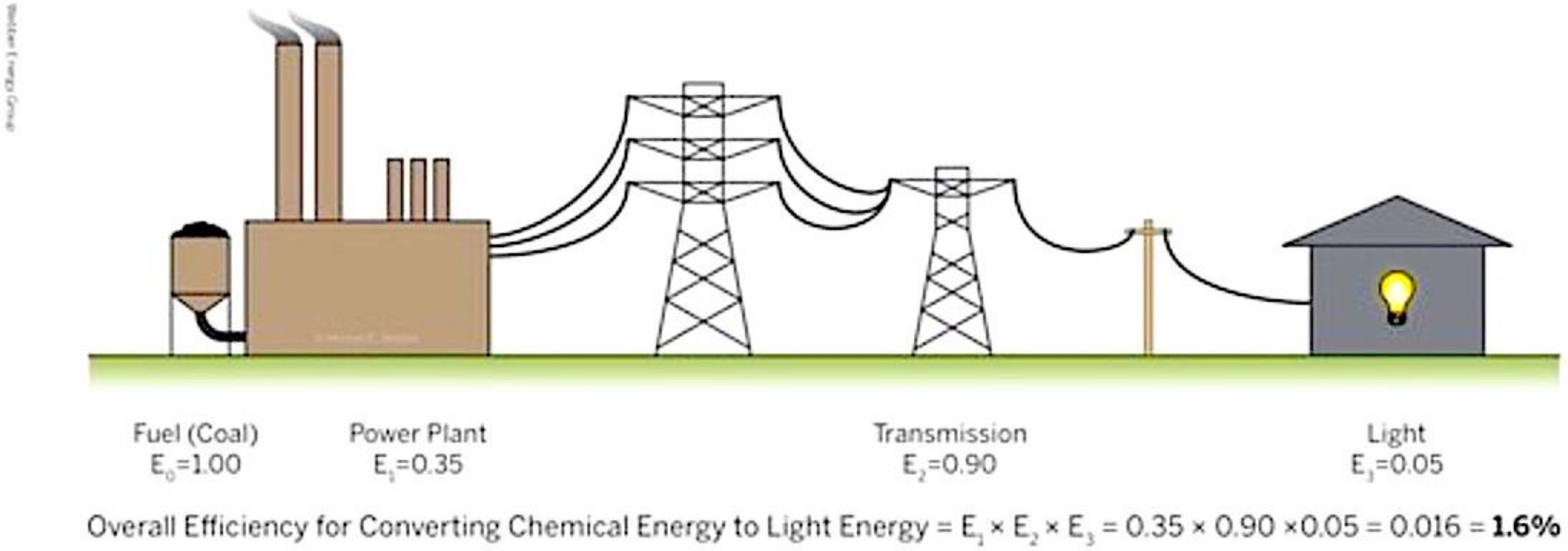
Minimize reliance on fossil fuels for electricity generation, upgrade power grids to accommodate renewable input sources and accelerate the introduction of decentralized renewable power sources.



Some arguments against wind turbines are silly

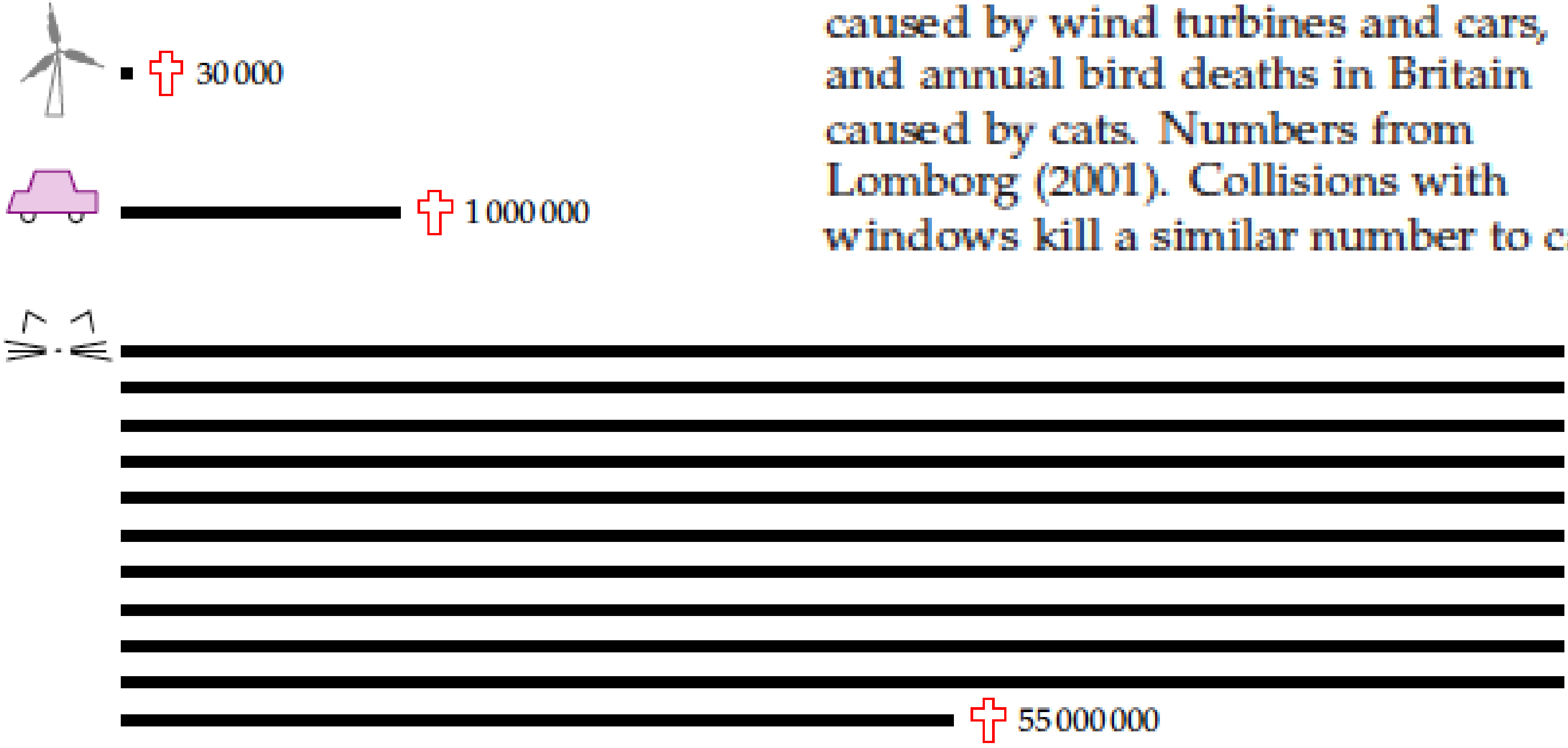


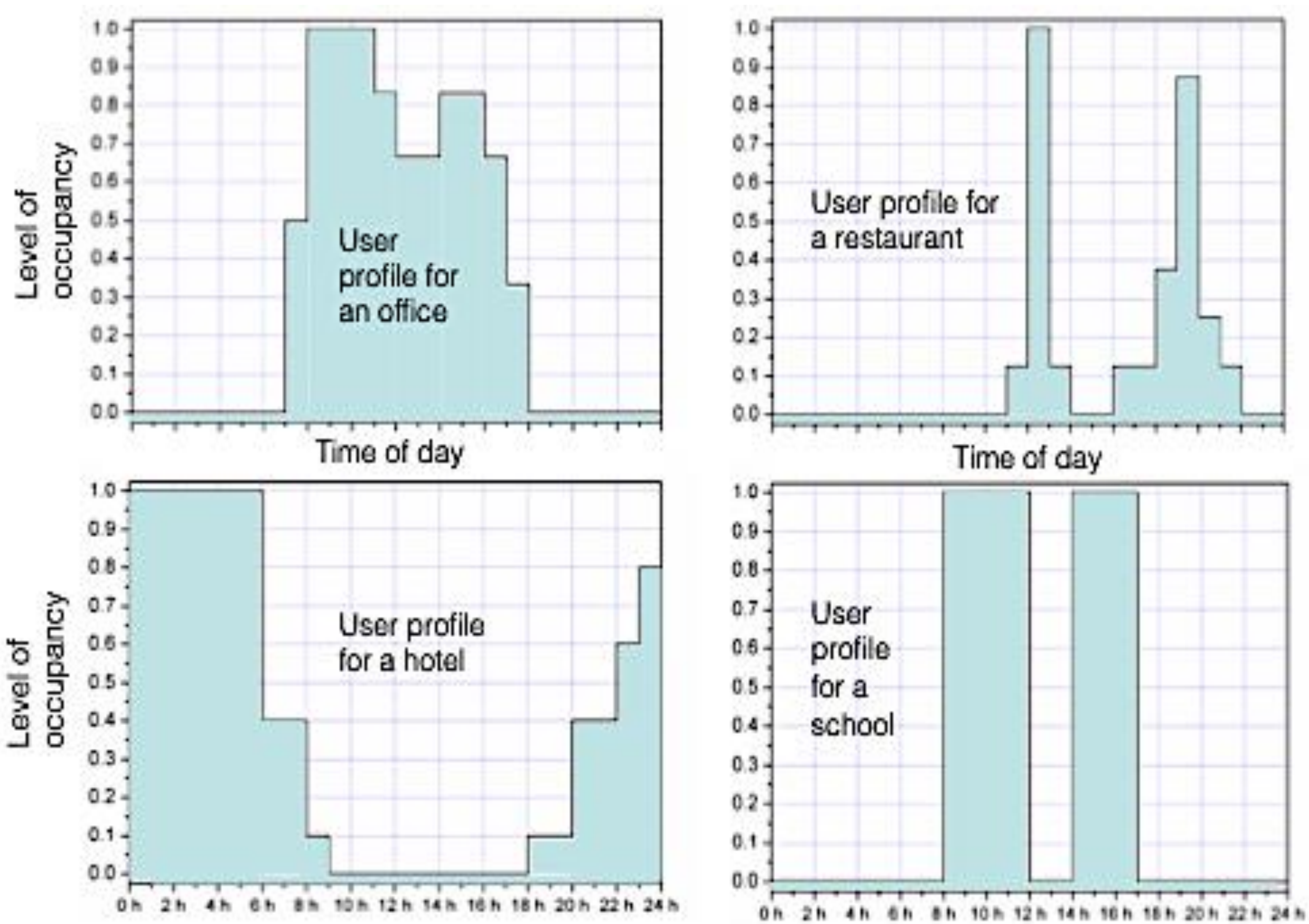
Figure 10.6. Birds lost in action. Annual bird deaths in Denmark caused by wind turbines and cars, and annual bird deaths in Britain caused by cats. Numbers from Lomborg (2001). Collisions with windows kill a similar number to cats.

Source: D. Mackay, withouthotair.com

Proposed Generic Actions

7. Limit peak electrical demand

Rapidly reduce peak loads in electrical networks through rate structures to meet demand and to ensure that existing generating facilities are efficiently used.



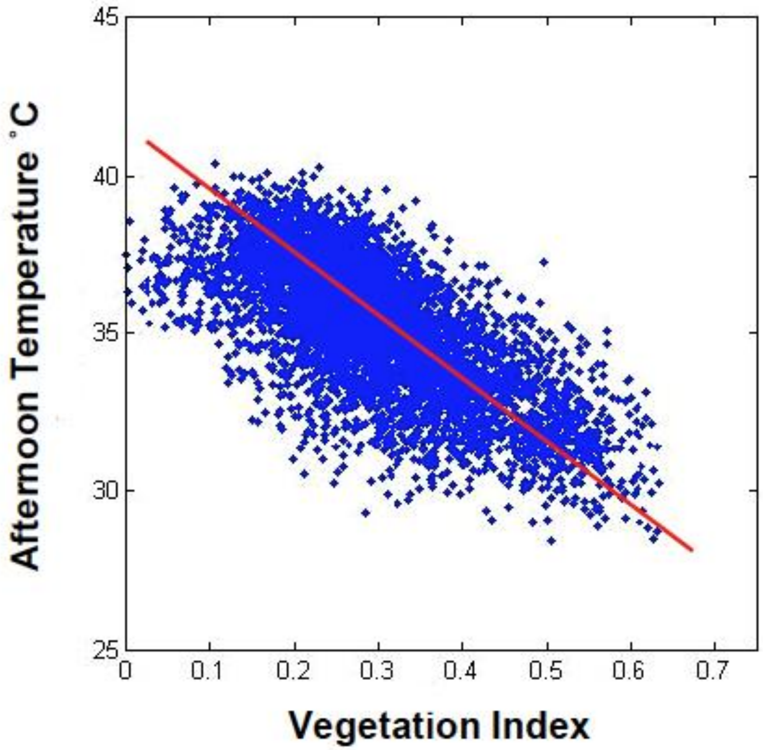
Diverse occupancy profiles provide opportunities

Source: Meli Stylianou, CANMET, NRCan,and BS EN 15232:2012: Energy Performance of buildings - Impact of building automation, controls and building management.

Proposed Generic Actions

8. Mitigate urban heat island effect by encouraging high-albedo surfaces and landscaping policies

Implement steps to reduce ambient temperature increases due to urban heat island effect. Measures can include increasing areas devoted to trees and park areas, higher albedo of building roofs, streets and parking areas; installation of green roofs and vegetated walls, and promotion of effective urban ventilation.



Proposed Generic Actions

9. Encourage urban agriculture

The availability of small and localized plots of land for urban agriculture will become of increasing importance as the use of transport and private vehicles is discouraged in urban areas, areas available in surrounding regions for agriculture are reduced, and traditional supply chains are interrupted.

Proposed Generic Actions

10. Develop improvement strategies and key performance targets for neighbourhoods

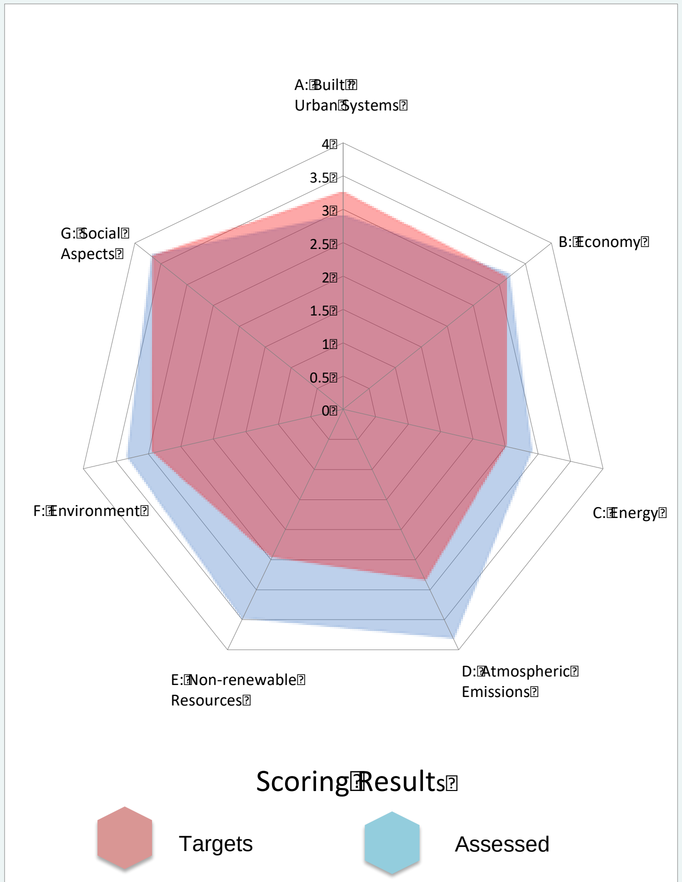
Neighbourhoods are a suitable level of analysis and action, since they allow a wide range of factors to be considered, but are less complex than cities. We therefore suggest that assessment of current performance and establishment of targets should take place at the level of neighbourhoods, in the following main areas:

- Vulnerability to climate change impacts
- Built environment and transport infrastructure
- Local economy
- Energy use
- Atmospheric emissions
- Water, wastes and use of non-renewable resources
- Environment
- Social aspects

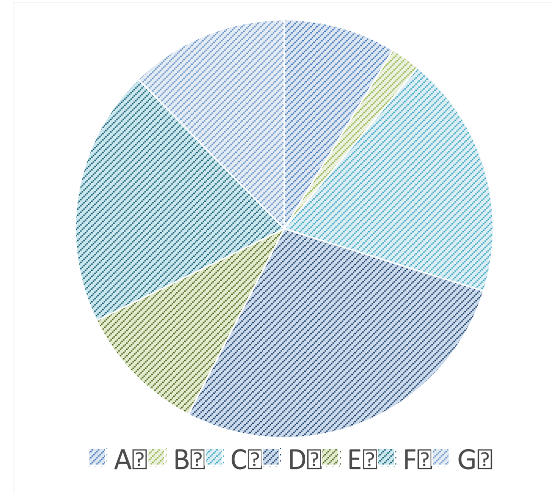
iiSBE SNTool:

The Results worksheet shows the aggregated scores of all active criteria, with both Target and Assessed (calculated) scores shown, as well as the ratio of Assessed Scores to Targets.

iiSBE	Performance results for an urban area performance assessment in Comporta, a neighbourhood of Lisboa	
iiSBE SNTool B Scoring File	Max	04May19



0 = Acceptable Practice; 3 = Good Practice; 5 = Best Practice



The number available criteria is:		156	The number active criteria is:		138
The number of active mandatory criteria with a score of less than 3 is:			Active low-level mandatory parameters:		8

	Issue	Active Weights	Weighted Target scores	Weighted Assessed scores	Scores v. Targets
A	Built Urban Systems	8.7%	3.23	2.87	0.89
B	Economy	2.3%	3.13	3.19	1.02
C	Energy	18.8%	2.51	2.91	1.16
D	Atmospheric emissions	27.8%	2.87	3.84	1.34
E	Non-Renewable Resources	10.2%	2.49	3.50	1.41
F	Environment	19.9%	2.94	3.32	1.13
G	Social Aspects	12.3%	3.64	3.66	1.01
	Weighted total score	100%	2.97	3.33	1.12

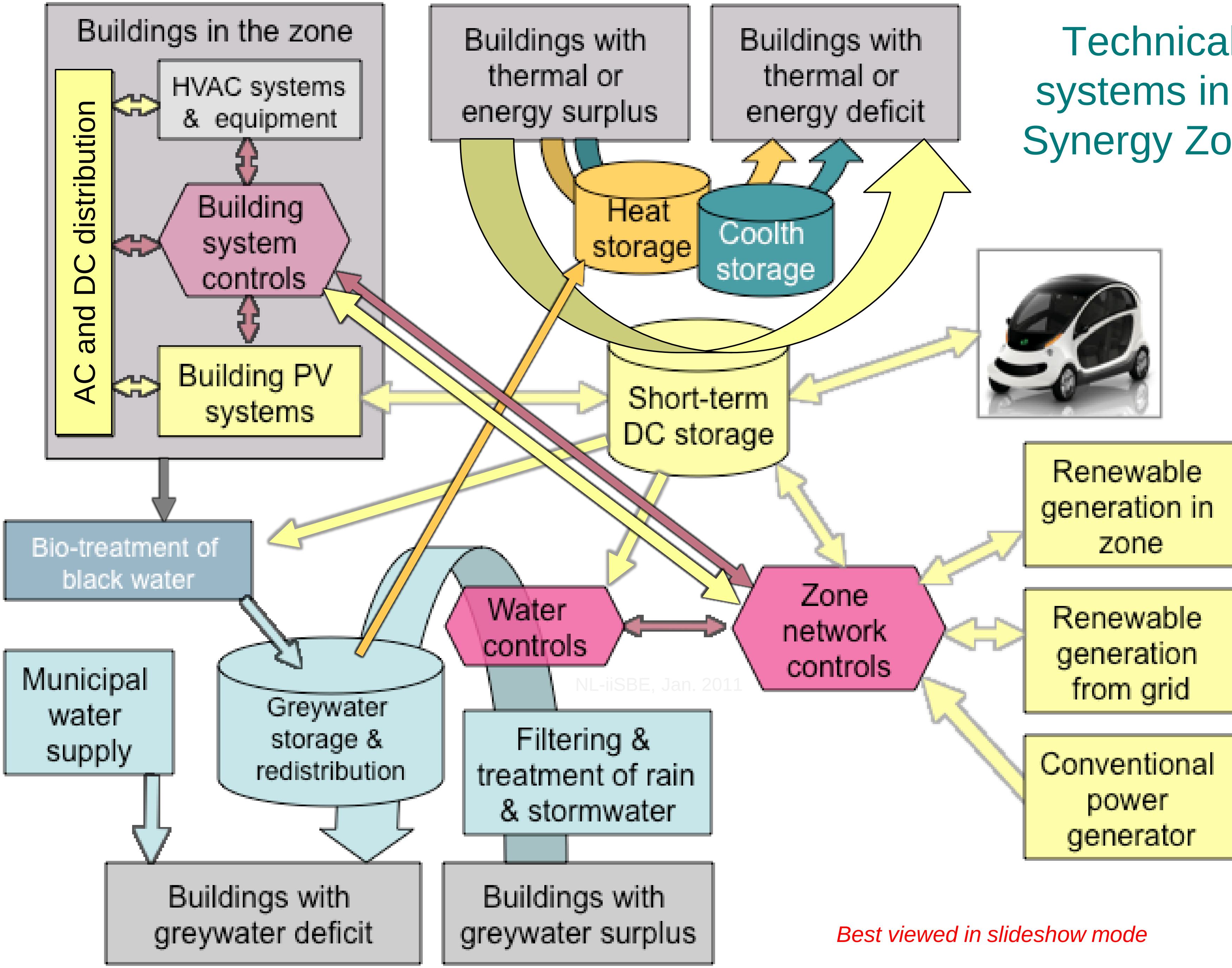
Proposed Generic Actions

11. Support development of inter-building system synergies.

A Synergy Zone is a cluster of buildings of various configurations and occupancies located in close proximity that offers energy and emission benefits due to differences in demand, supply or phasing of these;

- Thermal surpluses or deficits can be exchanged between buildings;
- Greywater surpluses and deficits can also be exchanged;
- But the most important advantage is the potential for the direct use of DC power that is collected in PV assemblies on the site or integrated in buildings;
- Using DC directly avoids conversion losses to AC of 8-10% in each direction;
- There is a potential major long-term market for DC-only equipment.

Technical systems in a Synergy Zone



Best viewed in slideshow mode

Proposed Generic Actions

12. Freeze new construction in high-risk areas and limit development in other areas

New construction results in embodied energy and emissions resulting from the use of land for building, the use of construction materials and the manufacture of building products. The long-term impacts include the use of non-renewable fuels for heating, cooling and ventilation, consumption of potable water for occupants, emissions of greenhouse gases and long-term environmental impacts;

In a time of approaching climate change, new construction activity should be viewed with scepticism, despite short-term economic advantages;

A major problem is that rapid population growth in developing countries will create added pressure for new construction.

Proposed Generic Actions

12. Freeze new construction in high-risk areas and limit development in other areas

Proposed generic actions include the following:

- Prohibit new construction in areas with a high risk of flooding or fire or with unstable soil conditions.
- In developed countries, except for cases of replacement or planned density increases within existing development zones, limit development of new construction and supporting infrastructure in un-serviced or low-density areas.
- For new development that is permitted, ensure that housing unit sizes are limited by means of taxation policies or regulation.

Proposed Generic Actions

13. Establish public building performance databases, track key indicators and maintain data

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Establish public performance databases that gather and maintain data on key performance indicators for buildings and adjacent local areas.

The data above should be provided for predicted performance, as simulated at the design stage, and also during each year of operation, starting 2 years after construction is complete. Individual records in the database will be comparable to other similar buildings, with confidentiality maintained.

1. Average annual occupancy, in maph;
2. Annual primary and delivered energy consumption
3. Average annual potable water consumption;
4. The difference between predicted and actual performance.

Proposed Generic Actions

13. Establish public building performance databases

2018 regulations in Ontario Canada for large buildings:

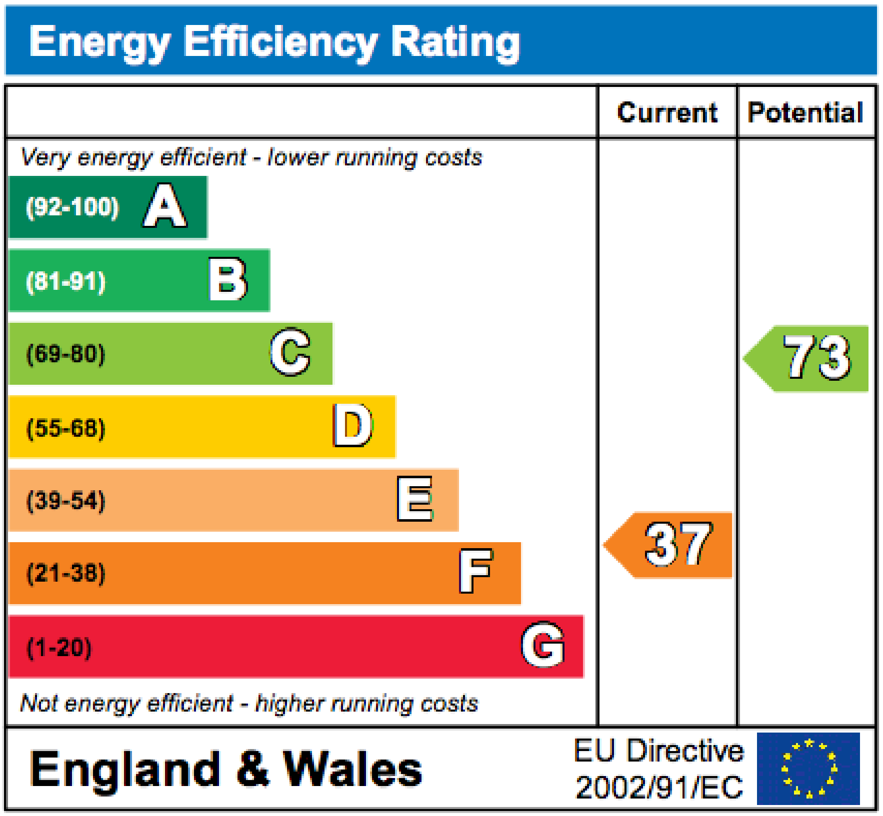
Large buildings, such as offices, condominiums and retail stores, play an important role to fight climate change and cut greenhouse gas pollution. In 2013, these types of buildings accounted for 19 per cent of Ontario's total greenhouse gas emissions.

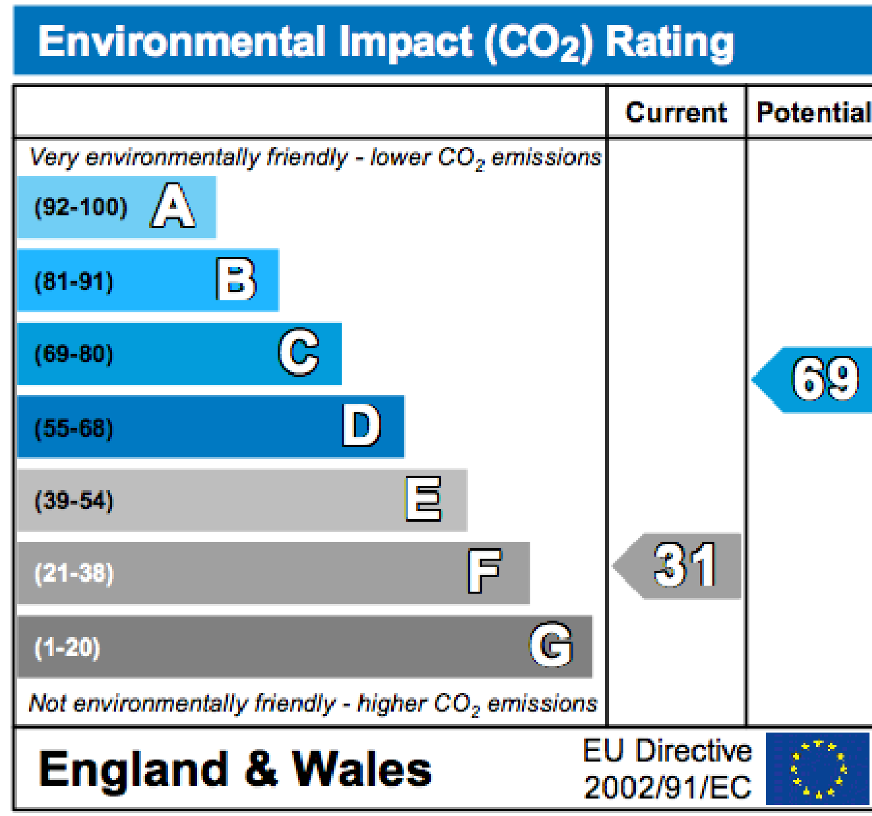
The goal of the regulation is to:

- benchmark how much energy and water buildings currently use
- identify ways to reduce energy and water use and costs
- compare specific buildings with similar buildings
- measure improvements over time

13. Establish public building performance databases

More focused criteria: Energy Performance Certificates





An *Energy Performance Certificate* (EPC), shows the predicted energy efficiency of a particular building, based on the performance potential of the building itself (the fabric) and its services (such as heating, ventilation and lighting), compared to a benchmark.

Source: Carbon Trust and *www.communities.gov.uk*

Proposed Generic Actions

14. Ensure very high operating performance of new buildings

Performance targets should be established for key performance indicators, using the public performance database as a guide in establishing benchmarks. KPIs should include:

- embodied emissions,
- operating GHG emissions,
- peak electrical loads,
- potable water consumption,
- environmental loadings,
- indoor environmental quality
- service quality,

Traditional performance goals must now be supplemented with measures to improve building resilience against new conditions of extreme wind, precipitation and flooding events, as well as better hot-weather performance.

Proposed Generic Actions

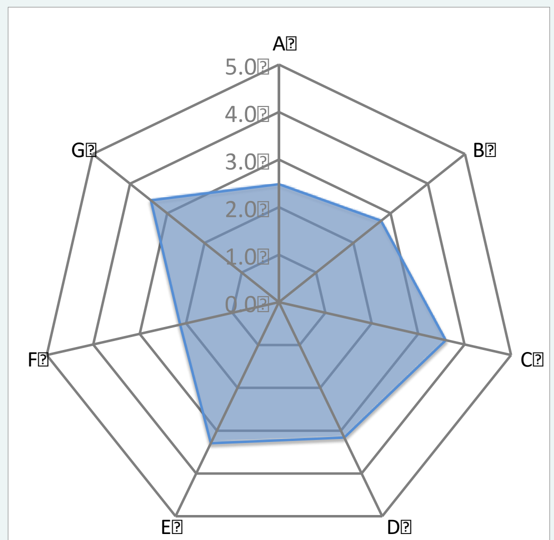
14. Ensure very high performance of new buildings

The SBTool, developed by iiSBE, permits multi-criteria performance assessment in a system that can be used at various scales, using local benchmarks and context values, all in a local language.

The trade-off is that considerable work must first be done to develop appropriate benchmarks and weights for the specific region and building type.

iiSBE / SBTool 2015	Self-assessment scores for ProjectX, AnyCity, AnyCountry	
Maximum version	Design Phase	Self-assessment scores

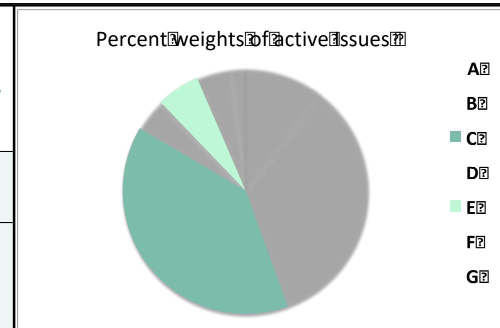
Whole building basis, All Criteria Focus



0 = Acceptable Practice; 3 = Good Practice; 5 = Best Practice

Relative Performance Results **B**

Performance target level is Good Practice or better



Project Information

Assumed life span is 75 years, and monetary units are in EUR		Amortization rate for embodied energy of existing materials is set at 0 %	
With current context and building data, the number of active low-level parameters is:	82	Max. potential low level parameters:	116
The number of active mandatory criteria with a score of less than 3 is:	3	Active low-level mandatory parameters:	9

	To see a full list of Issues, Categories and Criteria, go to the ParametersB worksheet.	Active Weights	Weighted scores
A	Site Regeneration and Development, Urban Design and Infrastructure	10.5%	2.5
B	Energy and Resource Consumption	33.9%	2.7
C	Environmental Loadings	39.0%	3.6
D	Indoor Environmental Quality	4.3%	3.2
E	Service Quality	5.7%	3.3
F	Social, Cultural and Perceptual Aspects	4.5%	2.1
G	Cost and Economic Aspects	2.0%	3.4
	Weighted project score		**3.08**

Proposed Generic Actions

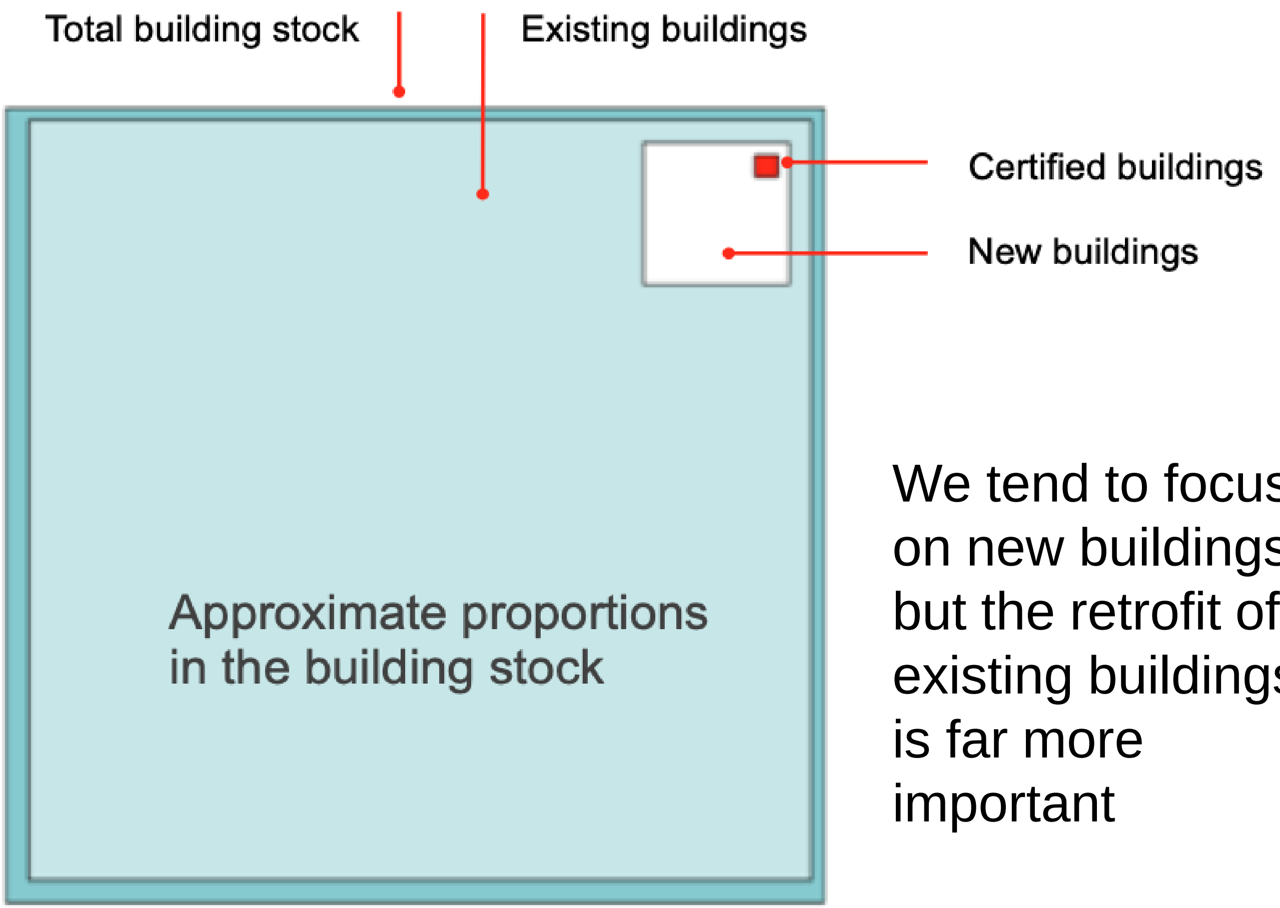
15. Minimize embodied energy and emissions

- Operating performance can be improved by added insulation or thermal mass, or by the use of systems such as high-performance windows or external shading devices;
- This strategy requires an investment of added embodied energy and emissions compared to conventional systems and reinforces the importance of considering energy and emissions over the total life-cycle;
- It should be recalled that most GHG embodied emissions are related to the use of a small number of heavy materials, such as gravel, sand, cement, steel and glass, and detailed calculations of secondary components and equipment may therefore produce little additional information of value.

Proposed Generic Actions

16. Undertake intensive and deep green renovation

Existing buildings are 95% to 98% of the building stock, and we need major programs for intensive and deep green renovation;



We tend to focus on new buildings, but the retrofit of existing buildings is far more important

Proposed Generic Actions

16. Undertake intensive and deep green renovation

- Where substantial performance gains are possible in a large number of residential and non-residential buildings, establish major programs for deep green renovation;
- Targets include nearly-zero operating emissions, better hot weather performance, reduced peak electrical loads and water consumption.
- Because of the variety of existing building types, training for contractors will have to be intensive and extensive.
- Minimum renovation rates of 5% per year of floor space in OECD regions and 3% per year in other regions have been suggested Obviously global goals will need adjustment for … variations in the suitability of existing building archetypes, the availability of appropriate equipment and of skilled workers.

See http://climateactiontracker.org

Proposed Generic Actions

16. Undertake intensive and deep green renovation

There are increasing cases of projects that include a mix of new, renovation and heritage conservation.

Proposed Generic Actions

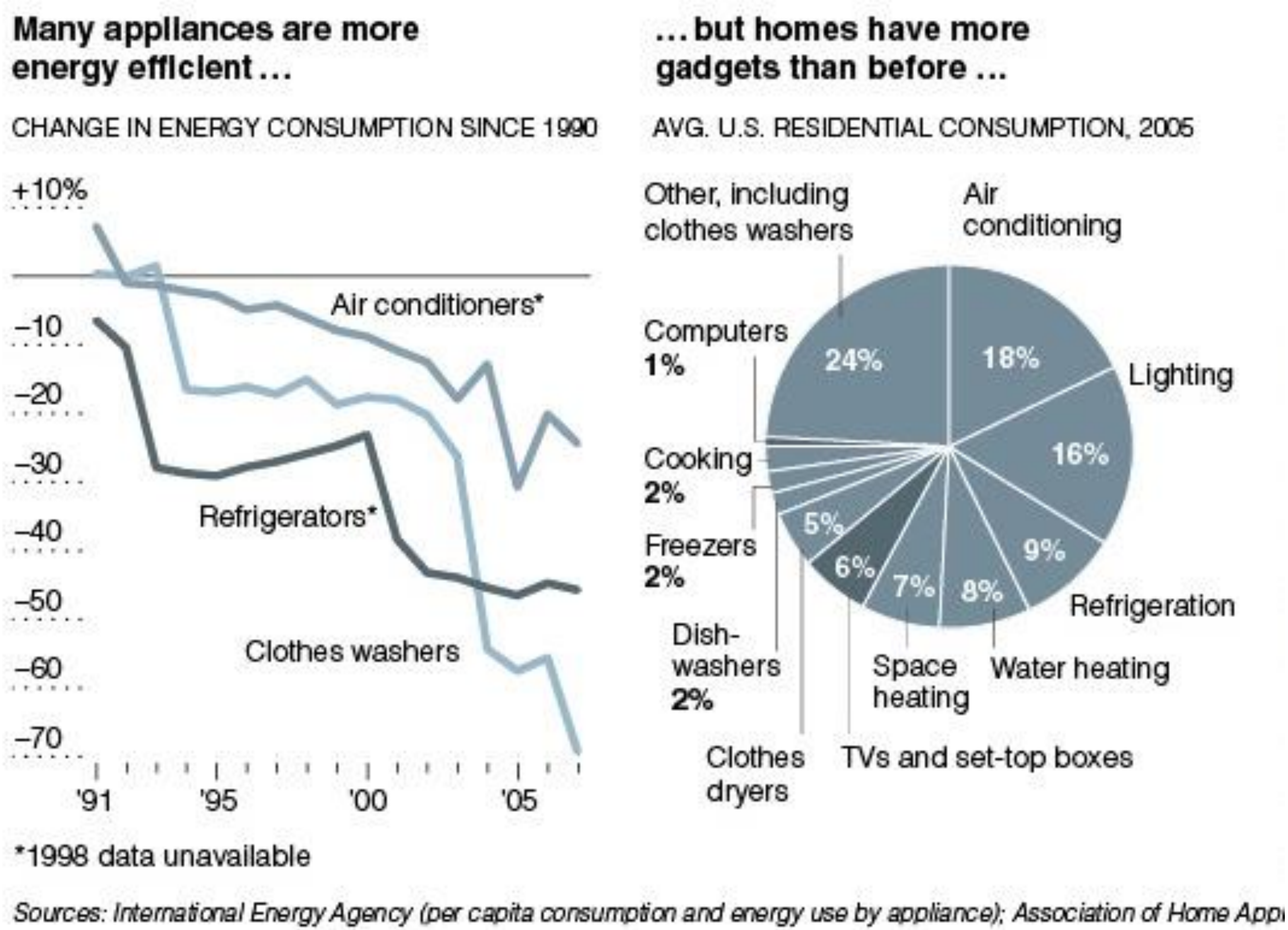
17. Strengthen equipment and appliance efficiencies

Prohibit the sale of appliances and equipment that do not meet high operating efficiency criteria (e.g. "A+++" label in Europe), and ensure the efficient recycling of components.

But it is also a question of not having more appliances than needed…

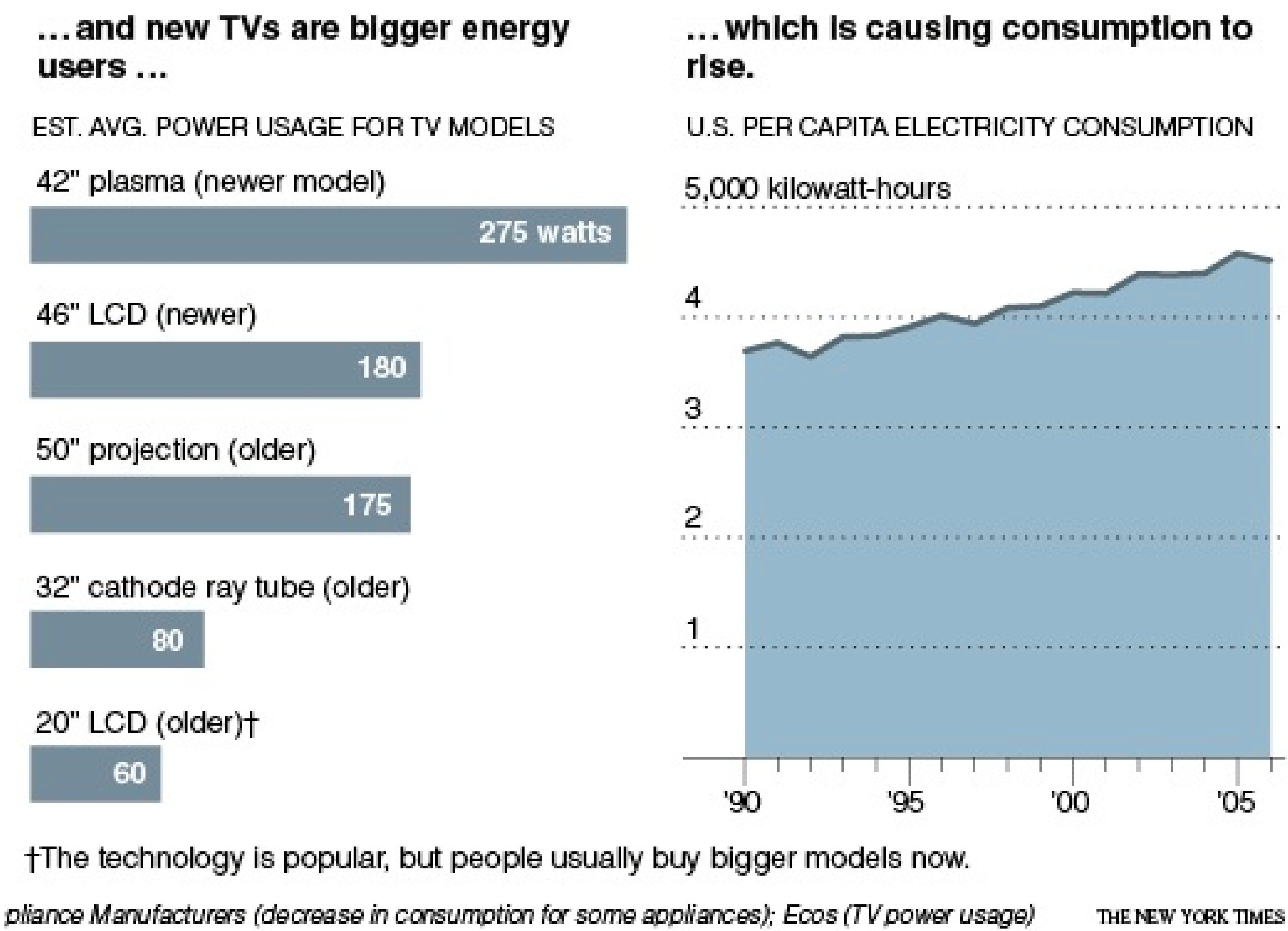
Proposed Generic Actions

17. Strengthen equipment and appliance efficiencies



Proposed Generic Actions

17. Strengthen equipment and appliance efficiencies



Proposed Generic Actions

18. Adapt to local conditions and convince local elites to act

Implementation of the proposed actions will depend largely on political action, and that needs to be supported (or led) by popular opinion.

The first step is to adapt the generic proposals to national or regional conditions and priorities, taking into account local impacts and measures that are likely to be effective.

A final step is to have the ideas accepted by local elites. This will involve discussing the adapted plan with local public- and private-sector decision-makers, property owners and community groups.

Other views on generic actions

Summary comments by the EGR report authors

Global

…this leaves no doubt that the current NDCs are blatantly inadequate to achieve the climate goals of the Paris Agreement.

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China

- Ban all new coal-fired power plants
- Continue governmental support for renewables, taking into account cost reductions and accelerate development towards a 100 per cent carbon-free electricity system
- Further support the shift towards public modes of transport
- Support the uptake of electric mobility, aiming at 100 per cent CO2-free new vehicles
- Promote near-zero emission building development and integrate it into government planning

Emissions Gap Report 2019, UN Environment

Project Drawdown

Project Drawdown is a climate change mitigation project initiated by Paul Hawken and climate activist Amanda Joy Ravenhill. Central to the project is the compilation of a list of the "100 most substantive solutions to global warming.” The list, encompassing only technologically viable, existing solutions, was compiled by a team of over 200 scholars, scientists, policymakers, business leaders and activists; The team measured and modeled each solution's carbon impact through the year 2050, its total and net cost to society, and its total lifetime savings.

Source: Wikipedia

Project Drawdown
Top 10 list for all sectors

Rank	Solution	Sector	TOTAL ATMOSPHERIC CO2-EQ REDUCTION (GT)	NET COST (BILLIONS US $)	SAVINGS (BILLIONS US $)
1	**Refrigerant Management**	Materials	89.74	N/A	$-902.77
2	**Wind Turbines (Onshore)**	Electricity Generation	84.60	$1,225.37	$7,425.00
3	**Reduced Food Waste**	Food	70.53	N/A	N/A
4	**Plant-Rich Diet**	Food	66.11	N/A	N/A
5	**Tropical Forests**	Land Use	61.23	N/A	N/A
6	**Educating Girls**	Women and Girls	51.48	N/A	N/A
7	**Family Planning**	Women and Girls	51.48	N/A	N/A
8	**Solar Farms**	Electricity Generation	36.90	$-80.60	$5,023.84
9	**Silvopasture**	Food	31.19	$41.59	$699.37
10	**Rooftop Solar**	Electricity Generation	24.60	$453.14	$3,457.63

Project Drawdown for Buildings and Cities

Rank	Solution	Sector	TOTAL ATMOSPHERIC CO2-EQ REDUCTION (GT)	NET COST (BILLIONS US $)	SAVINGS (BILLIONS US $)
27	**District Heating**	Buildings and Cities	9.38	$457.10	$3,543.50
31	**Insulation**	Buildings and Cities	8.27	$3,655.92	$2,513.33
33	**LED Lighting (Household)**	Buildings and Cities	7.81	$323.52	$1,729.54
42	**Heat Pumps**	Buildings and Cities	5.20	$118.71	$1,546.66
44	**LED Lighting (Commercial)**	Buildings and Cities	5.04	$-205.05	$1,089.63
45	**Building Automation**	Buildings and Cities	4.62	$68.12	$880.55
54	**Walkable Cities**	Buildings and Cities	2.92	N/A	$3,278.24
57	**Smart Thermostats**	Buildings and Cities	2.62	$74.16	$640.10
58	**Landfill Methane**	Buildings and Cities	2.50	$-1.82	$67.57
59	**Bike Infrastructure**	Buildings and Cities	2.31	$-2,026.97	$400.47
61	**Smart Glass**	Buildings and Cities	2.19	$932.30	$325.10
71	**Water Distribution**	Buildings and Cities	0.87	$137.37	$903.11
73	**Green Roofs**	Buildings and Cities	0.77	$1,393.29	$988.46
79	**Net Zero Buildings**	Buildings and Cities	N/A	N/A	N/A
80	**Retrofitting**	Buildings and Cities	N/A	N/A	N/A

Climate Action Tracker

10 STEPS

THE TEN MOST IMPORTANT SHORT-TERM STEPS TO LIMIT WARMING TO 1.5°C

1 ELECTRICITY: SUSTAIN THE GROWTH RATE OF RENEWABLES AND OTHER ZERO AND LOW CARBON POWER UNTIL 2025 TO REACH 100% BY 2050

All 1.5°C p
entirely of
showing th

2 COAL POWER: NO NEW COAL PLANTS, REDUCE EMISSIONS FROM COAL POWER BY AT LEAST 30% BY 2025

To close the gap between current ambition and what is needed for 1.5°C, while simultaneously limiting stranded assets, no new coal-fired power plant can be built. There must be consistent efforts to reduce emissions from current coal-fired power plants—by at least 30% by 2025—through, for example early plant

5 NEW BUILDINGS: ALL NEW BUILDINGS FOSSIL-FREE AND NEAR ZERO ENERGY BY 2020

A 1.5°C pathway demands rapid and near complete phase-out of direct emissions from buildings by 2050. It is easier and cheaper to build efficient buildings than to retrofit later. There is significant potential, especially for rapidly growing economies, to construct future-proof building stock now, but action is too slow. Policies can catalyse change through setting minimum building standards, extending obligations from public buildings to the whole economy, and through providing low-interest loans.

6 BUILDING RENOVATION: INCREASE RATES FROM <1% IN 2015 TO 5% BY 2020

A 1.5°C pathway demands rapid and near complete phase-out of emissions from buildings. Long lifetimes mean that only standards for new buildings—as described in the previous point—are not sufficient: existing stock also needs to be retrofitted. To transform the entire current standing building stock before 2050, we need to more than triple our current retrofit rates within five years. Governments can help through offering cheap loans and setting retrofit obligations.

From Climate Action Tracker November 2016
New Climate Institute, Ecofys and Climate Analytics

IEA and GABC Global Status Report 2019

Urban Planning

- Enact urban planning policies that account for the long-term goal of decarbonising the buildings and construction sector.
- Enable a systemic approach that can integrate energy demand and supply at the district level to deliver more efficient low-carbon solutions.

New Buildings

- Transition from voluntary to mandatory codes that set a minimum efficiency for new buildings.
- Establish a building code improvement cycle to strengthen performance requirements every three to five years, with the aim of achieving zero emissions and net-zero-energy codes.
- Integrate renewable energy into new building designs to achieve net-zero emissions or net zero energy.

IEA and GABC Global Status Report 2019

Existing Buildings

- Increase renovation rates in industrialised countries to an average of 2% of existing stock per year by 2025, and to 3% by 2040. Renovation rates in developing countries should reach 1.5% by 2025 and 2% by 2040.
- Enable deep energy renovations that reduce energy consumption of existing building by 30-50% or more.
- Make renovation financing available. Raise renovation rates by increasing access to/use of financing to enable private investment in renovations.
- Lead by example. Develop policies ensuring that existing government facilities are renovated to become efficient low-emissions buildings

IEA and GABC Global Status Report 2019

Building Operations

Key actions to improve the energy management of buildings include:

- Install energy management systems. Offer training in energy management systems and use energy management processes in all buildings, particularly non-residential ones.
- Strengthen human resources. Hire sustainability and energy managers and support capacity-building among them.
- Use smart controls. Deploy temperature, lighting and ventilation system controls and sensors as well as energy metering.
- Make information accessible. Provide data and information that will help building operators and occupants make better decisions

IEA and GABC Global Status Report 2019

Materials

Key actions to increase the sustainability of building materials and products include:

- Encourage people to purchase low-energy and low-emissions products and materials by implementing policies that promote better purchasing decisions based on embodied carbon and energy.
- Reduce demolition by implementing policies to help people make better decisions based on the impact of building demolition versus reuse.
- Recycle construction materials. Support the development of material recycling processes for products and materials that can reduce lifecycle embodied energy and emissions.

IEA and GABC Global Status Report 2019

Materials

- Phase out high-global-warming-potential (GWP) refrigerants through policies and technology evolution, enabling a phase-out of refrigerants that give off global warming emissions.
- Introduce information and awareness campaigns to disseminate information on low-carbon materials and technologies (e.g. wood and earth constructions, innovative concrete) among professionals involved in building design and construction.
- Lead by example by developing policies that ensure all government buildings invest in low emissions and efficient materials based on lifecycle analyses.
- Develop a circular economy by embracing a cradle-to-grave or cradle-to-cradle lifecycle approach in the buildings sector to promote systemic, material-neutral, performance-based methods and business models.

Conclusions

Conclusions

- Climate change is presenting an existential crisis to all human societies and settlements;
- Its impacts are slow but inexorable;
- Excess consumption and inefficiencies are major factors, but specific impacts and remedies vary by region;
- We need to make our buildings and urban areas more efficient in their use of energy and resources;
- The major emphasis has to be to reduce long-term life-cycle emissions but we also have to increase our resilience to withstand climate change impacts;
- But we must recognize that urban areas and buildings are only part of the issue – all aspects of life will be affected.

Local Conditions

Global strategies must be adjusted to take local conditions into account. Some examples:

- Latitude influences minimum and maximum seasonal temperatures, annual solar hours, precipitation patterns, local wind regimes;
- Local climate also supports or constrains the use of natural ventilation or mechanical cooling;
- Per-capita private automobile usage has a major impact on land use and embodied energy and emissions;
- Proportion of total building stock suitable for deep energy retrofits;
- Local regulations that affect building design or use;
- Cultural factors affecting dwelling size and use;

Can we do it?

Rationed Goods in the USA During the Second World War

A wide variety of commodities were rationed during World War II in the United States. Rationing ended when supplies were sufficient to meet demand.

Rationed Items	Rationing Duration
Tires	January 1942 to December 1945
Cars	February 1942 to October 1945
Bicycles	July 1942 to September 1945
Gasoline	May 1942 to August 1945
Fuel Oil & Kerosene	October 1942 to August 1945
Solid Fuels	September 1943 to August 1945
Stoves	December 1942 to August 1945
Rubber Footwear	October 1942 to September 1945
Shoes	February 1943 to October 1945
Sugar	May 1942 to 1947
Coffee	November 1942 to July 1943
Processed Foods	March 1943 to August 1945
Meats, canned fish	March 1943 to November 1945
Cheese, canned milk, fats	March 1943 to November 1945
Typewriters	March 1942 to April 1944

In the face of shock conditions, even U.S. consumers accepted cuts in production of consumer goods

Contacts & Info

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