AUTUMN 2009 ISSUE 12 **FLOWS** 10 EURO

DAYLIGHT & ARCHITECTURE

MAGAZINE BY VELUX

VELUX EDITORIAL
FLOWS

In December 2009, the entire world will be looking towards Copenhagen. 10,000 politicians, representatives of civil society and the media are expected to attend the COP 15 summit in the Danish capital. The aim is to get a new agreement off the ground to succeed the Kyoto Protocol, which expires in 2012. Goals for 2050 will be agreed and great expectations are held for the conference, some observers calling it "the last real opportunity to keep climate change within limits".

The VELUX Group believes that it is of immeasurable importance that an ambitious climate agreement with broad-reaching support is reached at the summit. We propose that buildings be put on the agenda as they account for up to 40 % of all energy consumption. We take responsibility as a company, and we strive to optimise our products and devise solutions for sustainable, CO_2-neutral buildings. Implementing solutions in practice requires legislative frameworks and political incentives.

We welcome incentives for energy renovation of housing that will improve the overall energy performance through renewable energy solutions like active and passive solar gain – with the objective of healthy buildings with good indoor climate, generous daylight levels and high air exchange rates with natural ventilation.

Words on CO_2 reduction must be transformed into realistic frameworks for action at COP 15 – also for the building stock. There is a huge potential in changing our energy consumption in housing and other buildings if we want to reduce CO2 emissions significantly. The path VELUX proposes is Sustainable Living. Basically, this is the concept of continually improving the quality of our homes and maintaining high living standards at the same time as reducing energy consumption and CO_2 emissions; to achieve this goal, the three key parameters are energy efficiency, healthy indoor climate and renewable energy.

The VELUX Group can contribute with solutions and know-how to reduce CO_2 emissions in buildings through products that will contribute to a sustainable future.

This issue of Daylight & Architecture puts the focus on flows in cities. Cities, being a constellation of buildings, are huge crossroads of a constant flow of resources; materials, energy, people, daylight, money and much more keep on flowing into and out of them day after day. 75 % of the world´s energy is used in cities, which represent a potential 75 % of the solution to the major questions of how to minimise and optimise our use of resources.

We have asked eleven experts to depict a specific urban 'flow' and an action point in terms of urban sustainability. The authors have developed scenarios of how urban flows could develop by the year 2050 and how we can make that development as sustainable as possible. After the scenarios, we then shift the focus to the decision makers, the key stakeholders for influencing developments towards 2050. How, today, can we define and implement strategies and tools that will bring us to our desired goals more than 40 years hence? C40 is a group of the world's major cities that have assumed leadership on how to reduce carbon emissions. We have interviewed the C40 secretariat on its approach to climate change. We also asked the local governments of London (founder of C40), Warsaw, Paris, Berlin and Copenhagen how they tackle the huge challenges.

Furthermore, the Danish Minister of the Environment, Connie Hedegaard, explains what is at stake at the COP 15 summit and how the business community can act against climate change. "The price to be paid for delaying action on climate change will just go on rising the longer we sit on our hands and do nothing", she argues.

Finally, we bring an interview with the CEO of the VELUX Group, Jørgen Tang-Jensen – holding up a mirror to ourselves and asking: how does the VELUX Group address and approach climate change problems and how do we actually reduce CO_2 emissions, by what means and timeframe?

In this issue, we have taken a different approach from all the previous issues of Daylight & Architecture, breaking with the usual categories and sequence. This is essential when discussing how we are to ensure a sustainable 2050, with resources and wealth for future generations.

Enjoy your read!

AUTUMN 2009
ISSUE 12

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INTERNET
VELUX.COM
ACTIVEHOUSING.NET

Daylight & Architecture presents eleven stories, posted on the Internet, about the 'flows' of our everyday lives and a building concept that could set a precedent – because it bridges the gap between resource efficiency, quality of life and the use of renewable energy sources. Find out more at da.velux.com and at www.activehousing.net.

Cities and buildings are gigantic crossroads of flows of people and materials, energy, water and information. How we organise these flows in the future will be a decisive factor in just how sustainable the further development of planet earth will be.

Daylight & Architecture 12 studies the flows that shape our cities and on which human life depends today. Mostly they are hidden, beginning and ending in uncertainty. This issue of Daylight & Architecture is therefore an attempt to make the invisible visible. Evocative black-and-white photos by Torben Eskerod show how flows are manifested in the environment of our daily lives. On the other hand, the colourful graphs by the graphic designers at Lamosca show the often hidden contexts and make the magnitude of things visible – both locally and globally.

The structure of Daylight & Architecture 12 also differs from all previous issues. Eleven articles, written by eleven international experts, form the first and largest part of this issue. They cover one topic each (one 'flow') in detail – beginning with mankind and ranging from the resources it requires to the changes in thinking that are necessary for adapting to climate change. And the authors do not just describe the status quo. They develop scenarios on what a better – or worse – world could look like in 2050, and they show options for taking action to achieve a sustainable future.

A colour code makes it easier for readers to find their way around this issue. The order of the articles has been intuitively selected. It begins with people, whose quality of life should be the goal of any sustainable development, continues with its immediate environment and ends with the big topics of our age, like water supply, renewable energy and the battle against climate change.

The second part of Daylight & Architecture examines what cities and companies are already doing to fight climate change today. How are they tackling what is probably the greatest challenge mankind faces today? What do they expect from politicians and how do they influence their citizens and employees?

Since 120 pages are not nearly enough to cover the subject of this issue exhaustively, VELUX has made further resources available on the Internet. Eleven short stories by up-and-coming Danish authors on the eleven 'flows' offer a layman's response to the experts' articles. We also refer the reader to the website www.activehousing.net, which shows how buildings can react to the requirements of the future – by producing their own energy, by making practical use of water as a resource and by promoting the well-being of the occupants with daylight and fresh air.

E

VELUX EDITORIAL

At the United Nations Climate Change Conference COP 15 in Copenhagen, an ambitious climate agreement with broad-reaching support will have to be reached. The VELUX Group believes that it is of immeasurable importance that buildings are put on the climate agenda with a higher priority than they have now, as they account for up to 40% of all energy consumption. The path VELUX proposes is Sustainable Living – our ability to continue improving the quality of our homes and maintaining high living standards while reducing energy consumption and CO_2 emissions. The three key parameters to achieve this goal are energy efficiency, healthy indoor climate and renewable energy.

D

DISCOURSE
BY TOR NØRRETRANDERS

Anyone who wants sustainability must reorganise the flows of our lives – from a one-way to a cradle-to-cradle system. Tor Nørretranders describes a way of thinking that has the sun as its starting point. It supplies many times the energy that human beings currently consume (and will ever consume), and it alone is necessary to keep all the earth's life cycles going.

Correction for Daylight & Architecture 11:
In the article entitled "This building makes me an optimist" in Daylight & Architecture 11, we reported that Wessel de Jonge Architects were planning the renovation of the Van Nelle Ontwerpfabriek in Rotterdam, together with Hubert-Jan Henket. This was incorrect - cooperation between the two architects' offices referred to renovation of the Zonnestraal sanatorium in Hilversum. Additionally, the Van Nelle factory is not on UNESCO's World Heritage List, though application for the same is under preparation.

SHORT STORIES

People, information and money, transportation, water and the climate are not issues that occupy scientists alone – they are also important topics in literature. Eleven of the most important up-and-coming Danish authors have written short stories on the 'flows' of our everyday lives exclusively for Daylight & Architecture. Their views are often surprising and sometimes provocative, but they all enrich the discussion on sustainability, climate protection and the 'good' life. They can be found on the Internet at da. velux.com

ACTIVE HOUSE

Active House is a visionary response to the challenges described in this magazine – buildings that produce their own energy, use resources in a sustainable manner, and improve people's health and comfort. They bridge the gap between mankind and its environment, between future technologies and common sense.
Buildings consume 40 percent of all energy in Europe. We spend 90 percent of our time indoors but only 30 percent of all buildings have a healthy interior climate. The concept of Active House uses takes facts as its starting point. An Active House is designed and constructed to achieve a balance between three parameters: energy, indoor climate and the environment. It uses the sun as an energy source to achieve a neutral CO_2 balance for the building, and as a light source to increase the well-being of its occupants. A well-insulated, air-tight building envelope forms the basis for its energy efficiency – but the concept goes far beyond this. Active Houses are adaptive houses; they adapt to the local climate conditions in terms of the use of daylight and shade, ventilation, and heating or cooling. By ensuring a view to the outside world, and by their interplay with their surroundings, they also merge with the local context..
More information on the concept of Active House, on the first examples and news on events in the field of 'active' architecture' are available at www.activehousing.net. Set up by VELUX, it sees itself as an open-source platform to which anyone can contribute.

COP15 – LIVE EVENT

A concrete example of an 'active house' is taking shape:
For the Copenhagen Climate Summit COP 15, VELUX developed a house that is carbon neutral and will provide its inhabitants with the highest standard of indoor comfort. Erected in front of Bella Center, the venue of the Climate Conference, it will provide the visitors of COP 15 an impression of how architecture can play a role in the worldwide efforts to overcome climate change. Find out more about the house at da.velux.com

THE FLOWS
PAGES 10–97

In 2050 over 9,000 million people will live on the earth – over two-thirds of them in cities. How can the flows of energy, materials and people be lastingly structured in them? Experts provide information on the individual topics – beginning with mankind and ranging from the resources it requires to the changes in thinking that are necessary for adapting to climate change.

01

PEOPLE
THE CITY OF THE FUTURE

Don Hinrichsen describes how the cities in an increasingly urbanising world can be made more suitable for human beings. Different strategies must be developed for rich and poor cities, though they must all be the same in one respect: they must bring the demands of mankind into line with the ecosystem of the earth.

02

INFORMATION
THE URBANIZATION AND VIRTUALIZATION OF THE PLANET

Florian Rötzer examines how people communicate with each other and how they will use information in future. Much is possible here – from the totalitarian Big Brother state to an enlightened society in which information is primarily used to improve the quality of human life.

03

MONEY
STRONG ECONOMIES FOR SUSTAINABLE COMMUNITIES

Think global, act local – this principle applies primarily where money and markets are concerned. For locally organised economic forms in particular can offer cities and communities major advantages - both economically and ecologically. Mark Roseland explains how they can be set up and promoted.

04

MATERIALS
BEYOND WASTE

A circular-flow economy instead of a one-way system; avoidance instead of thoughtless disposal. The way we deal with resources and raw materials will have to change considerably by 2050. Rachel Cracknell describes how our economies can be restructured according to the 'cradle-to-cradle' principle.

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TRAFFIC
BACK TO THE FUTURE?

The car moulded our lives in the 20th century. Do we want to continue to be dependent on it in the 21st century? Jeffrey Kenworthy answers this question with 'no' – and describes possible ways to achieve an almost car-free future.

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LAND
LAND AS A RESOURCE

Most of the world's cities are still expanding rampantly into the surrounding area; controlled growth is a major exception here. How the trend could be reversed and denser, more compact yet greener cities could result by 2050 is described by Anna Milkowski and Karen Seto.

07

WATER
A WORLD RUNNING DRY

More people require more water, yet in many places water has already become a scarcity, signalling a potential new conflict for the future. Fred Pearce describes two scenarios for future water use – one predicts anarchy and environmental destruction, the other hopes for increased efficiency and intelligent water management.

08

RENEWABLE ENERGIES
OUR SOLAR FUTURE

Mankind could meet all its energy needs with the power of the sun, but it is currently far from doing so. Richard Perez examines which technologies, supply networks and market conditions, as well as what kind of buildings, would be required to turn a solar future into a reality by 2050.

09

DAYLIGHT
WHICH DAYLIGHTING IN 2050

Daylight is free, available in abundance and even promotes good health. Nevertheless, it often fails to play the role it should in the lighting of buildings. In his article, Marc Fontoynont paints scenarios on how the use of daylight in architecture will develop up to 2050.

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MICROCLIMATES
CAN ARCHITECTS CHANGE THE WEATHER?

The larger and more densely a city is built, the less its internal climate is linked to local weather. The further climate change advances, the harder the 'urban heat island effect' hits city inhabitants. Peter Andreas Sattrup explains how architects and urban planners can have a positive effect on the urban microclimate.

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ADAPTATION
ADAPTING TO A CHANGED WORLD

A lot has already been said on the topic of 'sustainability' – but how can individual strategies be combined to form a big, all-encompassing strategy? A selection of quotes from great thinkers of the past and present - on possible concepts and necessary changes in thinking that can pave the way to a better future.

TIME OUT
PAGES 98–120

In December 2009, the COP15 UN summit in Copenhagen will hopefully point the way to future climate protection. More than 10,000 politicians and representatives of society, the business world and the media will meet in the Danish capital to discuss measures against further global warming. The expectations for the summit are enormous. But it is not just an issue for international politics – the climate problem concerns all of us and it is a challenge for both companies and individual citizens. Daylight & Architecture asked what the world's metropolises are doing to combat climate change and what strategies the VELUX Group is pursuing regarding this problem.

THE COP 15 CLIMATE CHANGE CONFERENCE
COP 15 MUST REACH AN AMBITIOUS CLIMATE AGREEMENT

What can – and must – politicians do at the COP 15 Summit in Copenhagen? And what can – and must – the business world do to combat climate change and limit global warming? In her article for Daylight & Architecture, Danish Minister of the Environment Connie Hedegaard answers both questions. She argues that reaching an ambitious global agreement on climate protection "is a matter of great urgency". The business community, she writes, "has a central role to play in finding concrete solutions." Moreover, whoever wants to stay competitive in the future will simply have to develop new green products and production forms.

CITIES AND CLIMATE CHANGE
"THE BATTLE AGAINST CLIMATE CHANGE WILL BE WON OR LOST IN OUR CITIES"

Unified for a major goal. Since 2005, the world's most important major cities have taken part in the initiative C40 to combat climate change. What strategies are they pursuing here, how do they motivate their citizens and how important is the mutual exchange of experience to them? Mayors and climate experts give their views in six interviews.

THE VELUX CLIMATE STRATEGY
BUILDING MUST BE GIVEN TOP PRIORITY IN THE CLIMATE DEBATE

In an Interview with Daylight & Architecture, VELUX CEO Jørgen Tang-Jensen provides an insight into the environmental concept of the company – and into the steps VELUX is taking to overcome the climate problem. In January 2009, VELUX launched a climate strategy, committing itself to reduce the Group's global CO_2 impact by 50% by the year 2020. Measures include energy efficiency measures in the VELUX factories, but also products that help clients to save energy.

VELUX is also acting to put sustainable buildings on the agenda. Under the concept of Sustainable Living, the company links energy efficiency, a healthy indoor climate and the use of renewable energies. Examples of this approach can be seen in the Model Home 2020 initiative. VELUX is collaborating with architects, clients, engineers and other building components manufacturers on this project to construct six CO_2-neutral houses. These real-life experiments, which will put possible technological solutions to the test, will be erected in five different European countries over the next two years.

FACTS & LINKS

More knowledge on the world's flows: remarks and further suggestions for reading on the articles on pages 12–99 are provided by eleven international experts.

DISCOURSE
BY
TOR NØRRETRANDERS

The Flow of the Future

Flow will be the core concept of the future. The present version of civilisation is based on the use of depots of energy, materials and knowledge. In the civilisation to come, the essential characteristic will be flows.

The climate crisis tells us why.

We are moving ahead from a world dependent on oil, coal, gas and uranium – finite depots of energy that we dig up from the surface layers of our planet and then burn. We use up the limited depots and convert them into depots of waste and pollution – a solution limited in time. The result is a crisis of climate and environmental degradation. Therefore, we are now moving into a world relying on renewable energy sources - wind, solar power, wave energy, biomass. They all stem from the constant flow of energy that hits the surface of the planet from the star we are orbiting, the Sun. The constant flow of sunlight is so rich in energy that there is more than 5,000 times more energy available than the total present energy consumption of all mankind.

We live in an environment with an incredibly rich flow of energy that industrialised societies have not been able to grasp. We have lacked the technology to reach out and pick the light passing by. But now, we are quickly trying to develop technology to catch the solar flow. We need to come on-line with the sunshine again.

But this is not only about power. Moving ahead from depot-dependence to the freedom of being part of a flow is not only about renewable energy. Flow is also the central concept when it comes to matter that we want to recycle, and ideas and links that we want to share.

For most of the industrial epoch we have used metals, carbohydrates and minerals of limited availability. Depots have been emptied and new, ever increasing waste deposits have been the result. This way of handling material stuff in not feasible in the long run. Instead, we have to be part of the flow of the living system of Earth.

All living creatures take in matter as food and give out matter as waste. But the very simple law of life is that the waste of one species has to be the food of another. Plants produce oxygen as a by-product, waste. Animals cannot survive without inhaling this waste product, oxygen. Animals, on the other side, produce carbon dioxide as waste – thus providing food for plants. What is waste to one is food to another. We must all share our shit to keep the rest alive.

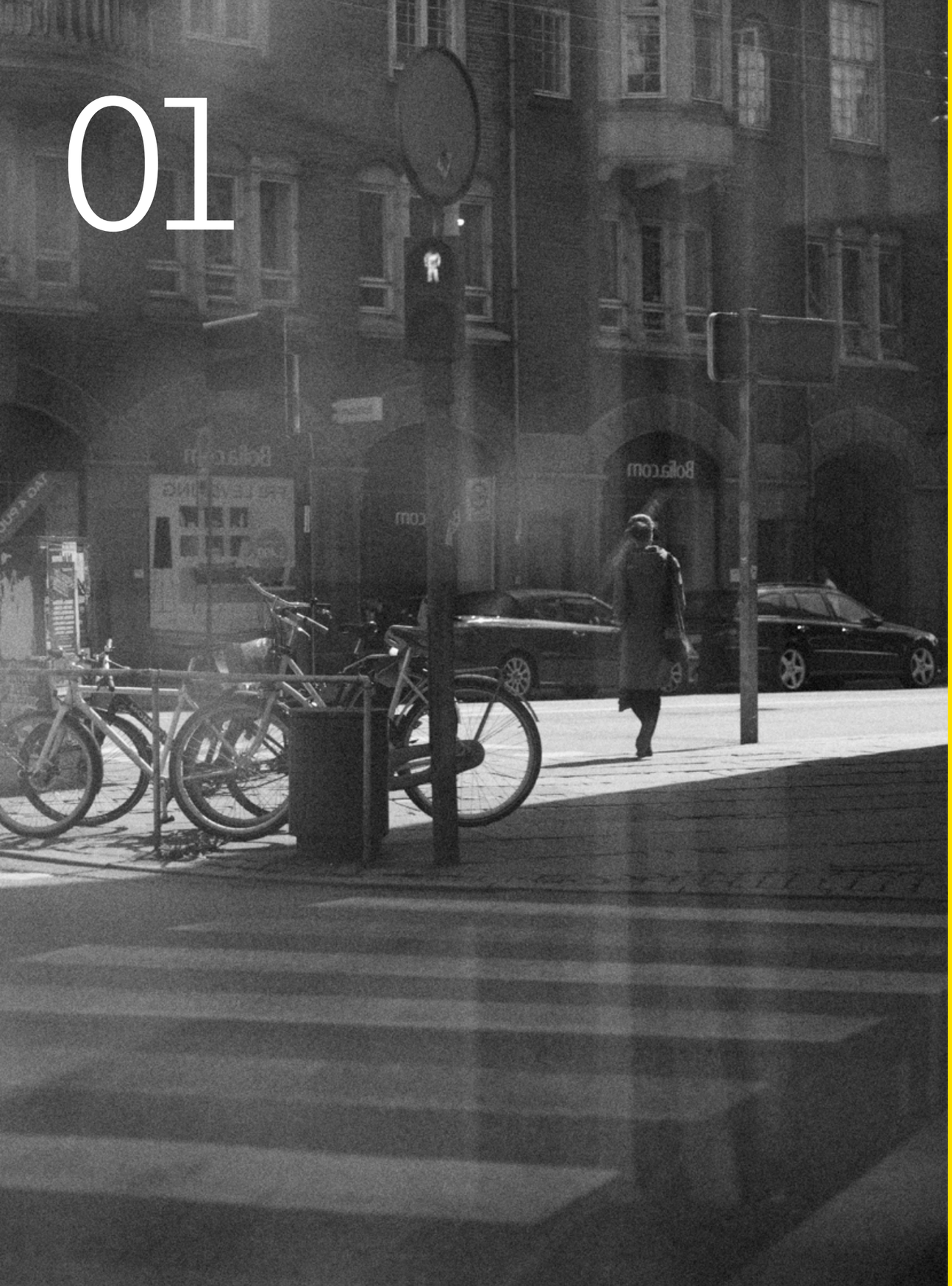
This matter flow – converting food into waste into food into waste – goes on and on. It results in no waste build-up at all and no resource shortage either. That is the nature of flows – everything is in constant motion. Change is the elusive yet constant feature of that reality.

All we need is the light from the Sun. The matter flow on Earth can run and run, on and on forever, as long as it gets the energy from daylight.

The flow of daylight is a ubiquitous and soft gift, all that we on this planet need from the cosmos outside to stay active and happily alive.

The task ahead is to build a civilisation based on that simple fact. Forget depots of oil, gas, coal and uranium. Forget depots of metals, carbohydrates and minerals. Reuse. Recycle. Go with the flow. Be soft and gentle. Just add daylight.

Tor Nørretranders is an independent author, thinker and commentator based in Copenhagen, Denmark. Originally graduating as a M.Sc. in environmental planning and the sociology of science, Tor Nørretranders is now adjunct professor in the philosophy of science at Copenhagen Business School. He received the non-fiction prize of the Danish Writers' Union in 1985 and the publicist prize of the Danish Publicist Club in 1988.



01

PEOPLE
THE CITY OF THE FUTURE: TWO VISIONS

In 2050, more than nine billion people will inhabit the Earth, of which more than two thirds will live in urban areas. What will this mean for housing, social structures, education and the ecological footprint of future cities? The answer to these questions will largely depend on decisions to be taken in the immediate future.

By Don Hinrichsen

WHY?

By the middle of the century there will be over nine billion people living on the earth – more than two thirds of them will be in cities. The cities of Africa and Asia alone will have almost four billion inhabitants by 2050. Humanity demands that they are able to survive in dignity, with adequate living space and basic medical and social care. And our own will to survive demands that population growth should be handled as efficiently as possible in terms of resources.

WHAT?

The prospects for the world's affluent and poor cities differ fundamentally. Here we have the vision of the 'eco-city', managing itself neutrally in terms of resources by 2050, with all its inhabitants having enough living space, healthy living conditions and economic sufficiency. And then we have 'Slumdog City', a southern megalopolis, with 15 million people living in slums in that city alone. They have no adequate income and no clean drinking water or basic health care either.

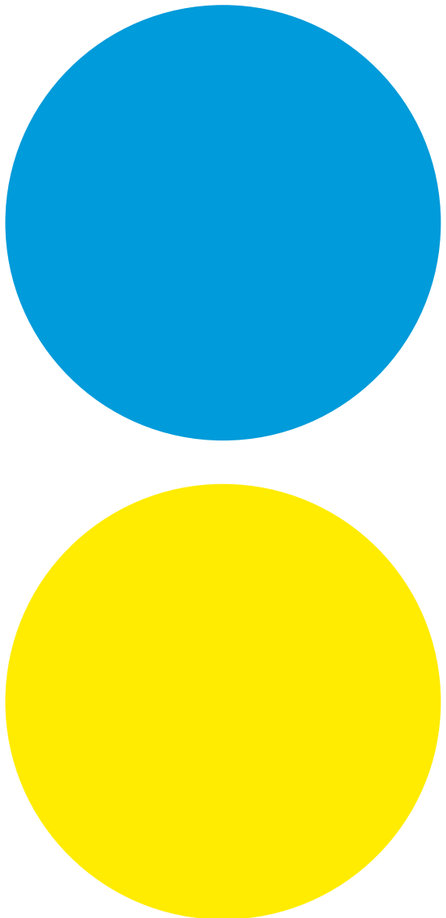
HOW?

Two scenarios – two strategies for bringing about the first and preventing the second. In affluent cites, living and working in the same quarter enhance the quality of life and reduce energy requirements. In the poorer cities, basic provision is central: drinking water and electricity for all, a vested right for land use, communal gardens for food supplies.
Health is paramount to quality of living in all cities – both wealthy and poor. In both strategies, therefore, healthier buildings that make use of daylight and fresh air will be an absolute necessity.

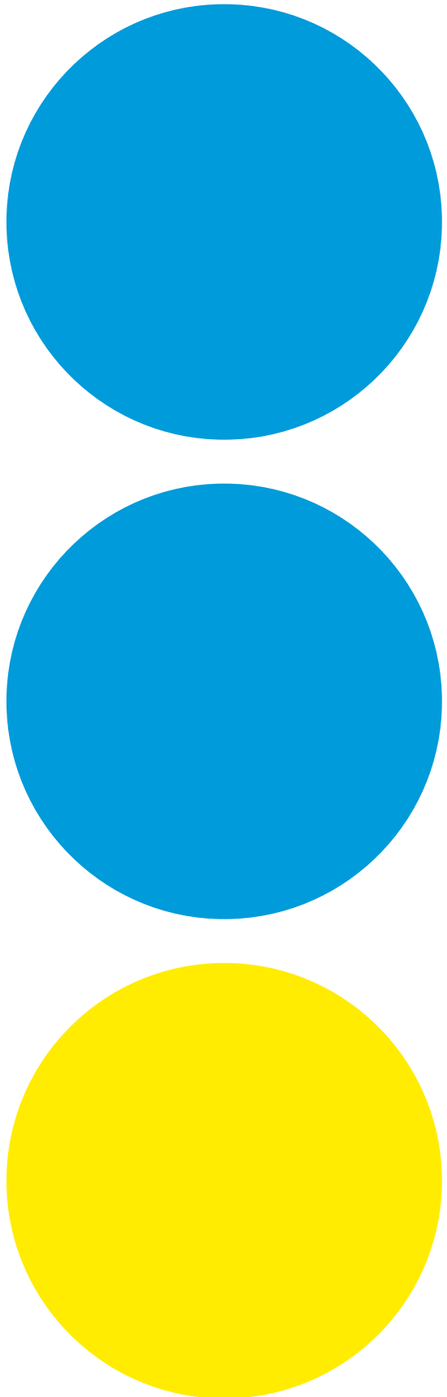
World population 2010 vs 2050: In 2050 the global population will level off to just over 9.1 billion. By then, the world's urban population will reach 6.4 billion, equivalent to the world's entire population in 2005!

Urban population
Rural population

2010



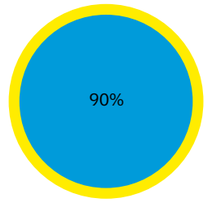
2050



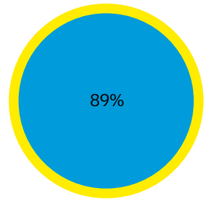
Urban population 2050

Urban population
Rural population

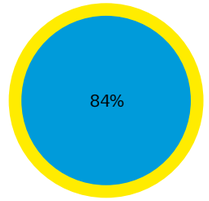
NORTH AMERICA



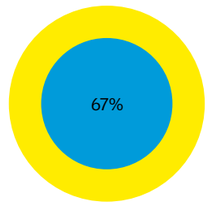
LATIN AMERICA



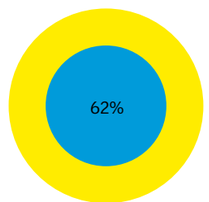
EUROPE



ASIA



AFRICA



The future size of the human population on this besieged planet, and hence the state and quality of its burgeoning urban areas, will be determined largely by decisions made or postponed, opportunities sized or squandered, over the course of the coming two decades. We are already confronted with unprecedented urban growth as people exodus rural areas in increasing numbers and as immigrants and refugees flock to cities and towns in search of opportunities and better livelihoods.

By July 2009, the global population reached 6.8 billion, with some 78 million added every year. In 2008, for the first time in human history, half the world's population resided in urban areas – a percentage that will accelerate to the middle of this century. We are, and will be in the future, a predominately urban species.

By the middle of this tumultuous century, the global population will level off to just over 9.1 billion (assuming the UN's medium-term projections are borne out). By then, the world's urban population will reach 6.4 billion, equivalent to the world's entire population in 2005! Of this vast number, the overwhelming majority – some 5.33 billion – will be scratching out a living in the sprawling cities of the developing world. Only a little over one billion people will reside in developed country cities.

Within four decades, Africa's urban population will be over 1.2 billion, while Asia's teeming cities will hold close to 3.5 billion. By contrast, Europe's cities will have 557 million residents and North America's just over 400 million.

The proportion of people residing in urban areas in 2050 will be staggering: 62 per cent of Africa's population will be urban, 67 per cent of Asia's, 84 per cent of Europe's, 89 per cent of Latin America's and 90 per cent of North America's.

The number of mega-cities with over 10 million inhabitants will grow from 19 in 2007 to 30 by 2030 and over 50 by 2050. Half of these cities will be located in Asia, and Asian cities are projected to contain more than 50 per cent of the world's entire population by 2050. By the middle of this century, Tokyo remains the world's largest urban agglomeration with close to 40 million people (the Tokyo-Yokohama region is completely urbanised).

As urban populations soar, larger cities sprawl across the peri-urban landscape, devouring park and agricultural land in the process. The results by 2050 are sobering: Beijing and Tianjin are now one continuous urban zone and so too is the gigantic urban area of Rio de Janeiro and São Paulo, Brazil. In the United States, the East Coast Urban Corridor now extends from Boston to New York and Philadelphia, with built-up areas running south to Baltimore and Washington D.C, containing around 70 million people.

What will the world's urban areas look like in 2050? Two scenarios are presented here: a future perfect, with cities, at least in the developed world, planned for people. These cities of the future will conserve energy and use renewable sources to generate heat and electricity. They will utilise resources efficiently and provide space for urban gardening and larger connected parks and green areas. They will minimise each person's ecological and carbon footprints and offer affordable housing and inexpensive public transportation.

The other scenario is business as usual. Here we look at the future of urban areas from the developing world perspective, with sprawling slums comprised of millions of dispossessed and disempowered urban dwellers living on the edge of survival, and city governments virtually unable to cope with the infrastructure and resource needs of runaway populations. It is an apocalyptic vision of a world gone horribly wrong, where life is mean, brutish and short.

ECOCITY 2050: PEOPLE CENTRED URBAN LIVING

This scenario conjures up one possible urban future – one predicated on governments making important, strategic decisions between now and 2020. This is our window of opportunity to select an urban development path based on the following trends:

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urban populations will continue to expand in the developed world, but will stabilize and even drop (in some countries) by mid-century

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the needs of urban populations will necessitate the need for municipal governments to develop a people-centred approach to urban development, involving planned growth that incorporates the use of renewable energy sources, non-polluting vehicles, green space and connectors, low-cost city centre housing, better public transport systems and other essential services that enhance the quality of life while decreasing human footprints on the planet's finite resource base

_
societies in Europe will be multi-ethnic and multi-cultural, as immigrants from Asia, Middle East and the former Soviet Union provide necessary skills, offsetting to some extent declining population bases in most of Europe

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cities will be polycentric, not monocentric, as a result of the revival of inner cities as vibrant communities and places to work.

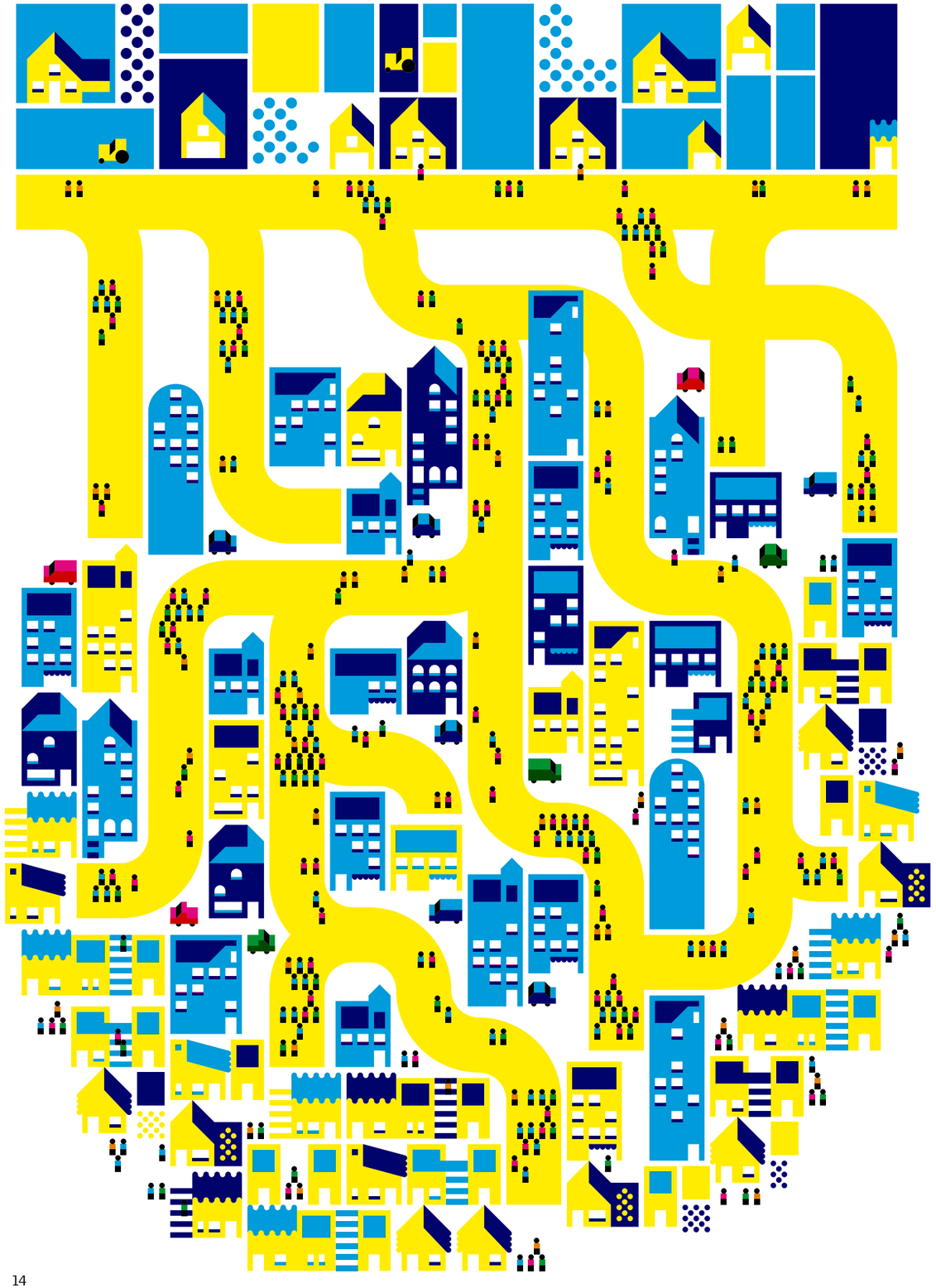
The year is 2050. The place: somewhere in Western Europe. EcoCity 2050 could, in fact, turn out to be any number of urban areas – Malmö, Sweden; Copenhagen, Denmark; Amsterdam, the Netherlands; Berlin, Germany; Barcelona, Spain; or Athens, Greece, to name a few. All these cities have already invested in precedent-setting alternatives: more efficient public transport (including hydrogen or electric-powered buses), faster underground rail systems, affordable public housing, more green areas and urban gardens, rooftop solar water heaters and a host of other people-centred innovations.

Climate change has made Europe's weather warmer in the summer, but unsettled. Severe weather events are more common and rising sea levels have prompted some coastal cities to erect barriers to hold back storm and tidal surges.

EcoCity 2050 has stabilised its population at between 4 and 5 million. Over the past 40 years, urban areas in Europe have stabilised or even lost population, as fertility levels dropped to below replacement level (less than 2.1 children per woman on average).

Family planning and reproductive health services, now universally available in Europe, have contributed to this trend. Fewer unintended pregnancies, especially among young people, have had a beneficial knock-on effect – reducing municipal budgets for education, health and other essential services.

A shrinking population base has proved to be both a problem and an opportunity: a problem in that the number of pensioners has now reached upwards of 20 per cent of the population; an opportunity because municipal governments have been given breathing space, time to



Rural exodus versus urban exodus. Especially in poorer countries, millions of people move from the country to the slums at the outskirts of major cities every year. On the other hand, in industrialised countries the wealthy urban population has been moving 'out to the countryside' for decades. A reversal of this trends is often invoked, however is yet to be proven empirically.

invest in efficient public transportation, revived city centres with more green space, and renewable energy sources, among other things.

Falling populations in most of Europe have been offset by increased immigration from non-EU countries in the former Soviet Union, the Middle East and Asia. A point system, somewhat like Canada's, has allowed the EU to take in the best and the brightest – immigrants with knowledge, skills and, in some cases, investment capital. The larger cities are all multi-ethnic and multi-cultural.

Many of these immigrants settle in secondary cities, as well as in the larger cities (also known as primate cities). Most European countries no longer have formal population distribution policies in place, as fewer births have relieved pressure on urban areas. By 2007 the trend was clear: only 39 per cent of developed countries had policies to influence population distribution, compared to 75 per cent of developing countries.

Most of the people who live in EcoCity 2050 live in flats, rather than individual houses. But every apartment building and house is connected to an efficient co-generation plant that provides both district heating and electricity. These plants using advanced fluidised bed technology, burn a variety of fuels, including domestic wastes, bio-fuels, and clean coal. Additional peak electricity is provided by solar cells and wind farms, situated in peri-urban areas.

All urban vehicles are either electric or hydrogen powered. Hybrids have been developed that run on both. Air pollution from vehicle exhausts and factories have been brought down to negligible levels, while more green space and parks have enriched air quality and provided the city with natural air conditioning during the hotter summers. Bicycle paths are commonplace on all streets, while walking paths allow residents to traverse the city following green corridors that connect one neighbourhood to another (a concept borrowed from Singapore).

The advent of price stabilised, affordable public housing, has meant that most people can live closer to where they work. Following the worldwide economic crises of 2008–2011, government-backed low interest loans made it possible for many individuals and families to buy their apartments or condos at reasonable prices. New high speed Internet connections with Skype allow more people to work from home one or more days a week, reducing commuter congestion.

EcoCity's new high rise apartment blocks, with rooftop gardens, dotted with solar panels, contain central atriums sporting plants and small trees. They are both eco-friendly and people-centred living communities. These complexes have replaced dilapidated, sub-standard housing blocks, reviving urban communities and making it possible for people to live in vibrant, active neighbourhoods. The city has become polycentric rather than mono-centric.

Neighbourhood committees have been set up, allowing citizens to comment on and debate new zoning measures and urban development plans. This has allowed future development to be people-friendly, planned from the bottom-up not the top-down.

HOW TO MAKE THIS HAPPEN:

If the city of the future in Europe is to be people-centred and eco-friendly with planned, sustainable growth, both spatial and economic, then the decisions to bring about this vision have to be made between now and 2020. The coming decade is the Decade of Decisions.

Cities like Singapore, Kobe, Japan, Copenhagen, Denmark and others already have an advanced planning process in place that does the following:

_
curbs urban sprawl by concentrating on making city centres more functional and people-friendly

_
makes it possible for people to live closer to where they work, cutting down on commuting congestion

_
builds efficient public transportation networks, combining commuter trains, buses and underground

allows for more green space, including parks, green connectors joining together different neighbourhoods, and urban gardens

_
introduces incentives for residents to own and operate vehicles powered by electric motors or alternative fuels such as biogas and hydrogen

_
offers tax incentives or outright subsidies for new office and housing developments that incorporate principles of low energy use, green areas and noise buffers, and combine offices and residences in the same complex, among other innovations

_
establishes ways and means for residents to react to and comment on future development plans and projects

We have the expertise and tools to make this future a reality, but it takes willpower, commitment and the recognition that planning must go hand-in-hand with people's needs.

SLUMDOG CITY 2050: APOCALYPSE TOMORROW

This scenario is predicated on a number of current trends that, unless reversed or offset, will bring about this nightmare vision of an urban future. The trends contained in this scenario can be summarised as follows:

_
most future population growth will take place in developing world cities

_
the growth rates are too fast, in many cases, for overwhelmed municipal governments to cope with the accelerating needs of floods of new residents

_
lack of rational planning mechanisms results in unbridled development, urban sprawl, rising levels of pollution (both air and water), the proliferation of slums and squatter settlements, and the erosion of social services

_
overcrowding and lack of job opportunities creates a large underclass of uneducated, poor people with few skills and fewer opportunities to earn a living; this gives rise to soaring crime rates, religious extremism and feeds global terrorism

_
saddled with more people and a shrinking tax base, the inner cities become virtually unmanageable, with growing social and economic divides

_
social inequalities and lack of opportunities for women result in more early marriages – very young girls aged 10–15 – married off to older men, contributing to higher growth rates, as well as sex trafficking and bride napping.

Slumdog City 2050 is in Asia, the continent holding the dubious record for the largest populations, the largest concentration of urban dwellers and the largest number of mega-cities (with over 10 million inhabitants).

Slumdog City is a coastal megacity, with close to 30 million people. It has been growing by nearly 3 per cent per year since 2010, enough to double its population roughly every generation. The indigenous city population has been overwhelmed with migrants from the countryside, seeking a better life, as rural, agricultural economies have collapsed; the result of globalisation and lack of rural investment.

This unprecedented growth has paralysed the municipal government. Services cannot keep up with the social, health and infrastructure needs generated by the arrival of 1,000 newcomers every day.

One half to two thirds of Slumdog city's resident live in slums and squatter settlements, amounting to upwards of 15–20 million people. The slums consist mostly of low-rise, dilapidated apartment dwellings covered with grim and mildew, with communal taps and toilets. One entire family of six lives in each room; commonly flats are shared by three families. Each water tap serves 200 people and the toilets are nothing more than latrines – concrete slabs with holes in the middle. The water is from untreated surface waters and needs to be boiled for 30 minutes before it can be used for cooking; potable drinking water is purchased from vendors who charge one-fourth of the average slum dweller's weekly income for it. The toilets are so unsanitary that many people prefer to defecate in parks and along the river, contributing to pollution levels and disease burdens.

The squatter settlements are even worse. Perched precipitously on cliffs, on unstable land, in swamps or on flood plains, these self-fashioned homes made from waste wood, canvas and tin house one family each in a room with a dirt floor and no access to potable water or sanitation facilities. Cooking is done outside using

whatever combustible material is available. Pollution from cooking fires, nearby industries and vehicles causes serious air pollution, with high levels of heavy metals, particulates, and sulphur and nitrogen dioxides.

Due to air and water pollution, respiratory infections are common, along with gastro-intestinal diseases and parasites. Pollution-induced illnesses reduce the time slum and squatter residents can devote to productive work. Most of them earn money in the brown or black economy, selling whatever they can procure from informal networks: anything from vegetables and fruits, to pencils, cooking oil, moped parts, and bicycle chains.

Unable to afford to pay school fees, most poor families educate only one or at most two of their children, usually the boys. The girls are sold off as early as possible to much older men for added income, as virtual household slaves, while others end up in the sex industry. This contributes to more births as uneducated girls, married off at the tender ages of 10–15, tend to give birth early.

With medical care out of reach for most residents and education unaffordable for most of their children, a restive, unemployable underclass is being born. Fed on a constant diet of domestic and street violence, these children of the underclass become reckless, violent adults. Crime rates are high and violent crime is common. Kidnapping the children of the rich and upper middle classes and holding them for ransom is now a growth industry.

The violence of the inner city has driven many of the well off into distant suburbs – gated, self-contained communities patrolled by armed private security guards. This has eaten up more agricultural land. With built-up areas extending further outside the city centre, the sprawl has contributed to greater 'heat island' effects in the hot, dry season, with temperatures up to 10 degrees hotter than the countryside, which continues to recede as the city gobbles up more and more of the surrounding land.

Assaulted by climate change, with choking air pollution and all surface waters unfit even for industrial use, Slumdog City becomes a permanent environmental and health disaster for most residents. It has become a breeding ground for crime and religious extremism, a haven for terrorists and basically a living hell for over half of the city's residents. Yet still they come!

HOW TO AVOID THIS:

This apocalyptic future can be avoided, if national, state and city governments do the following to head it off:

_
introduce policies that encourage more even population distribution among secondary cities; taking pressure off large primate cities

_
put in place policies and practices to allow squatter settlements to own or at least control the land they squat on; empowering local communities to improve their plots, negotiate for piped water and build better, sanitary latrines, attract investments and provide for needed social services

_
improve slum conditions by empowering neighbourhoods to develop better affordable housing, attract investments, and allocate funds for better services including health care and education

_
introduce national health insurance schemes for the poor

_
plan for and allocate land for urban gardening, which can provide the poor with a source of nutrition and income

_
improve public transport, especially by switching to electric buses and trains

_
extend the electricity grid to unserviced sections of the city

_
eliminate the need to burn biomass, wastes, wood and other materials for cooking by providing poor neighbourhoods with propane burners, and solar or electric cookers, or other less polluting alternatives

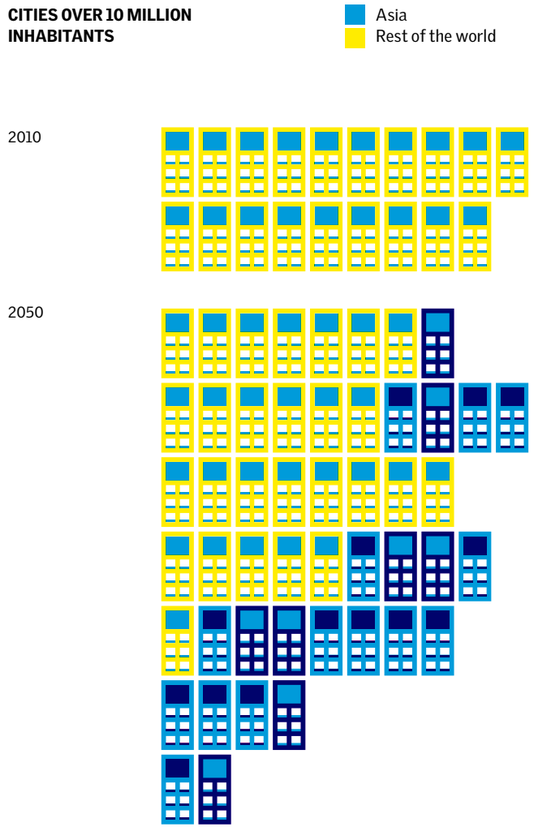
_
encourage families to educate their daughters, as well as their boys

_
allow NGOs, where possible, to absorb some of the fun ctions normally provided by municipal governments

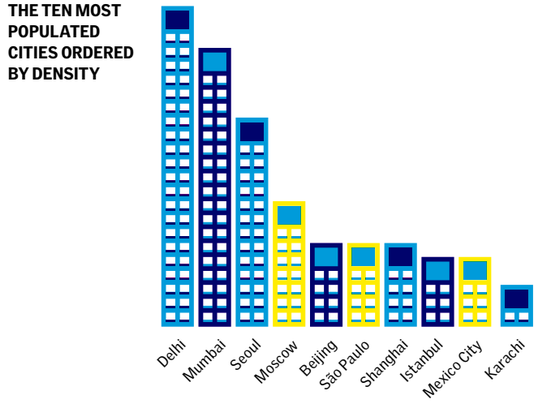
_
local, neighbourhood health care, especially maternal and child health, environmental management, waste collection, and provision of other services (e.g. social and legal)

_
set up Grameen Bank type financial institutions with the express purpose of making micro-loans to poor families, especially women.

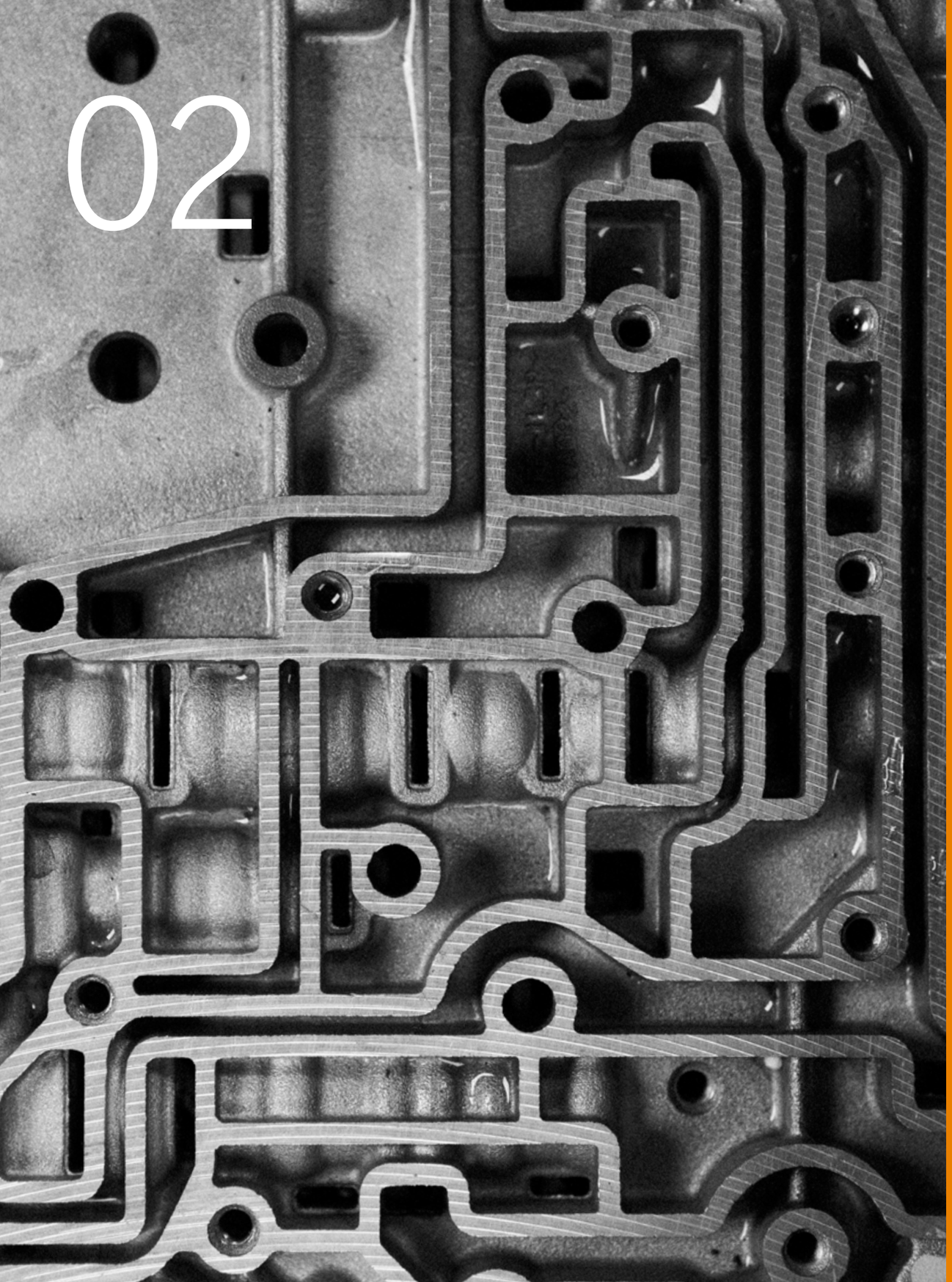
CITIES OVER 10 MILLION INHABITANTS



THE TEN MOST POPULATED CITIES ORDERED BY DENSITY



Don Hinrichsen is an award winning writer and UN consultant, and has worked in over 100 countries, including 60 in the developing world. He has written five books, mostly on environment and development issues. He is currently the Senior Development Manager for the Institute for War and Peace Reporting, based in London, UK.



02

INFORMATION
THE URBANIZATION AND VIRTUALIZATION OF THE PLANET

Real and virtual space in our cities have both been inseparably intertwined for a long time now. In future, data streams and data collectors will increasingly be with us at every stage. Is mankind becoming a globally networked 'super-organism' offering world-embracing knowledge for all – and opening up the way for surveillance mechanisms?

By Florian Rötzer

WHY?

Even in 2050, people will still communicate with each other face to face. Nevertheless we are experiencing an unprecedented penetration of all spheres of life by 'intelligent' data processing systems. At the same time, the poorer cities in particular are growing ever more rapidly. Social pressure and thus the need for data security as well are increasing. But security always has another aspect: it means surveillance and control – to the point of incapacitation.

WHAT?

Reasonably priced chips and new radio networks, and the increasing miniaturisation of electronic components in the form of 'Smart Dust', mean that data is being collected, everywhere and all the time. It is increasingly used as a basis for social action – whether in the liberal 'knowledge society' or in a totalitarian surveillance state. It is possible to imagine a future in which each individual can be located constantly and everything he or she does can be revealed at any time. Only the very poor will be able to avoid this scenario – they live in the 'Black Holes' of the digital world – and the very rich.

HOW?

One basic requirement for preventing a world like Orwell's 1984 is social balance. This alone can reduce social tensions and thus the need for security and control. Added to this should be improved education for all strata of the population. Only 'responsible adult citizens' can defend themselves against control, censorship and being patronised. On the other hand, if used in the right way information can help to make people's living environment more pleasant, healthy and environment-friendly. In active houses, daylighting, ventilation, energy supply and other factors of the interior environment are co-ordinated by 'intelligent' control systems to improve comfort and lower energy use.

Urbanisation has already come to an end in most industrialised countries. A saturation point was reached because 70–80 per cent of people already live in cities. Cities are scarcely growing any more, and some have already started to shrink because the population is decreasing as a result of limited immigration, the increase in single households and lower fertility rates; and people are no longer migrating from the country to the city, but from declining cities to those that are thrusting forwards economically. This is quite different in the Third World. Here cities and megacities will continue to grow at immense speed in the next few decades, and will reach vast dimensions. The explosive urbanisation of the global population has long been out of control, regardless of political will and lack of opportunities.

But this could change very soon, as space, objects and people are rapidly being networked at every turn, and this process will be boosted again by the large-scale introduction of RFID and GPS chips, wide-ranging radio networks and the version 6 internet protocol (IPv6), because then absolutely everything can be interlinked as 340 sextillion possible internet addresses will be available. At the same time, items from sensors and actuators right down to robots will have shrunk to nano-sizes; they will form mobile Smart Dust networks and also move into people's bodies and brains. Digital networking will enfold urban space in particular, but the planet as a whole (with significant and highly ambivalent consequences forming a data space that interacts with the planet but at a planetary level) making it into a kind of super-organism. It is possible to call this extended reality, or conversely a virtuality released to flow into reality. We have still to face the real information revolution.

VIRTUAL SPACE IS GROWING OUT OF URBAN SPACE AND ENVELOPING IT

One aspect is increasing interlinking, which is creating a virtual space, or more accurately: the new virtual world metropolis, which is urbanising the entire planet and making every user of the internet and mobile phone networks (which are starting to merge) one of their citizens, regardless of whether they are in one place or moving around in the country or in town, in a public space, in vehicles, buildings or private spaces. The virtual metropolis is growing at an alarming rate. In 2002, one billion people had mobile phones – by 2009 it was already 2.6 billion, far exceeding the number of internet users. In the year 2000, there were 300 million internet users; the billion threshold was reached in 2005, and now over 1.5 billion people spend larger or smaller amounts of time in the virtual world, professionally and privately, at home or while moving around. All users of mobile phones with internet access and other portable devices are citizens of the virtual metropolis as well, and at the same time they can be followed step by step, while at the same time geolocation means that they are not just guided through space 'on the run', but can receive and distribute all kinds of information from their surroundings, on a large number of channels. This means that they actually occupy two worlds that have to be coordinated in many ways, and by no means not just technically. These worlds often conflict with each other and influence and change each other.

Over half the world's population already lives in cities. This means that cities have become our dominant environment – or fate –, with all their extensions into the transport, information and communication links that extend the urban network all over the globe. The planet and humanity are being urbanised, which means that the Utopia that has persisted since cities were 'invented' 10,000 years ago has passed its peak. Certainly the structure of the city has changed considerably since the start of industrialisation, which acted as a space-condensing machine. Today the structures that are perceived as cities in the traditional sense are nothing more than larger or smaller cores in an urban landscape that can sometimes extend for hundreds of kilometres. These often contain several tightly linked, spatially condensed zones of development, infrastructure such as roads, motorways, stations, airports, harbours, power stations and industrial estates with parks and leisure areas, smaller housing estates, neglected zones and areas used for agriculture – and in the megacities of the Third World extensive slums that will grow more in the next few decades.

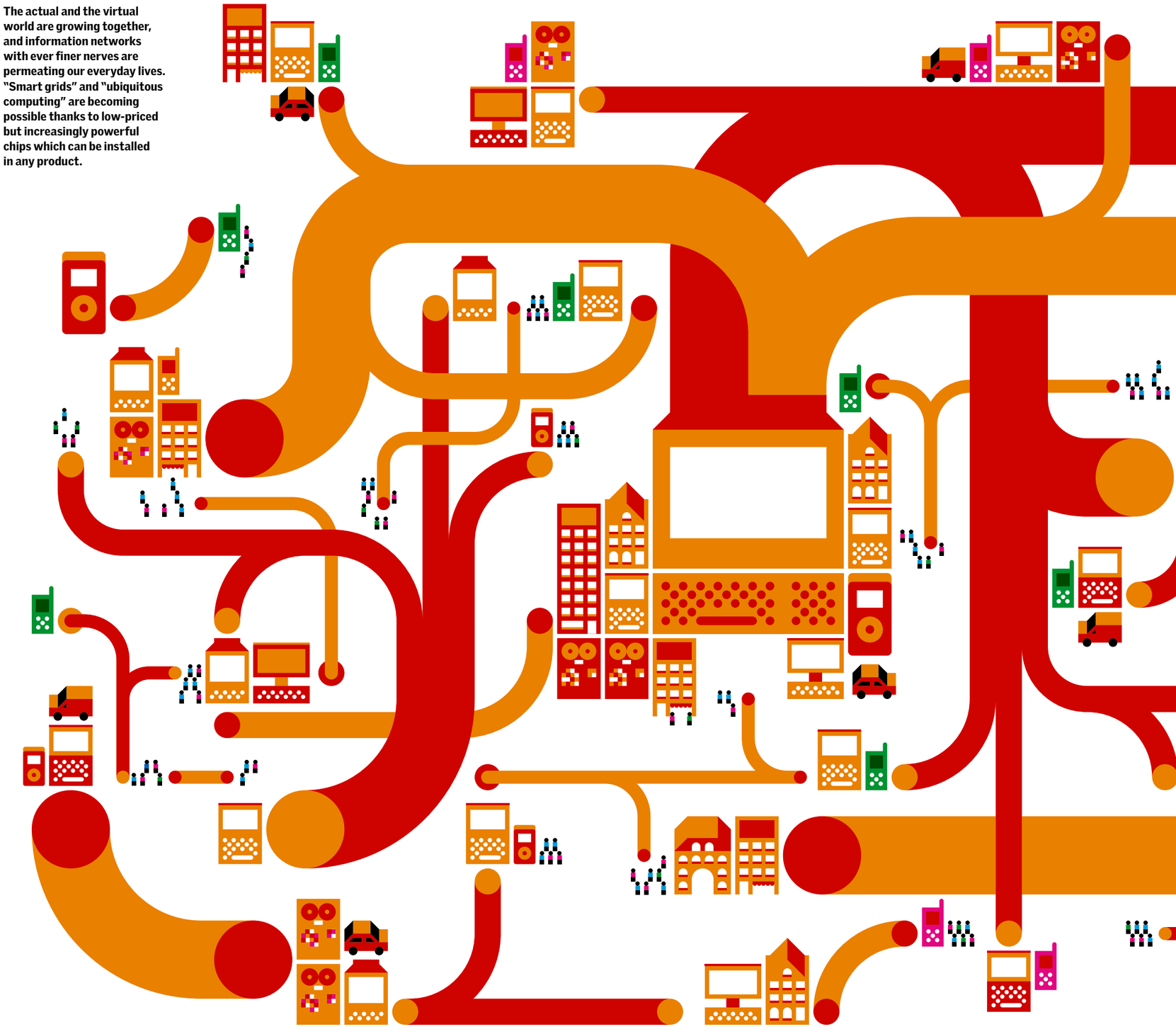
GIGANTIC DATA VOLUMES AS A BASIS FOR SOCIAL ACTION

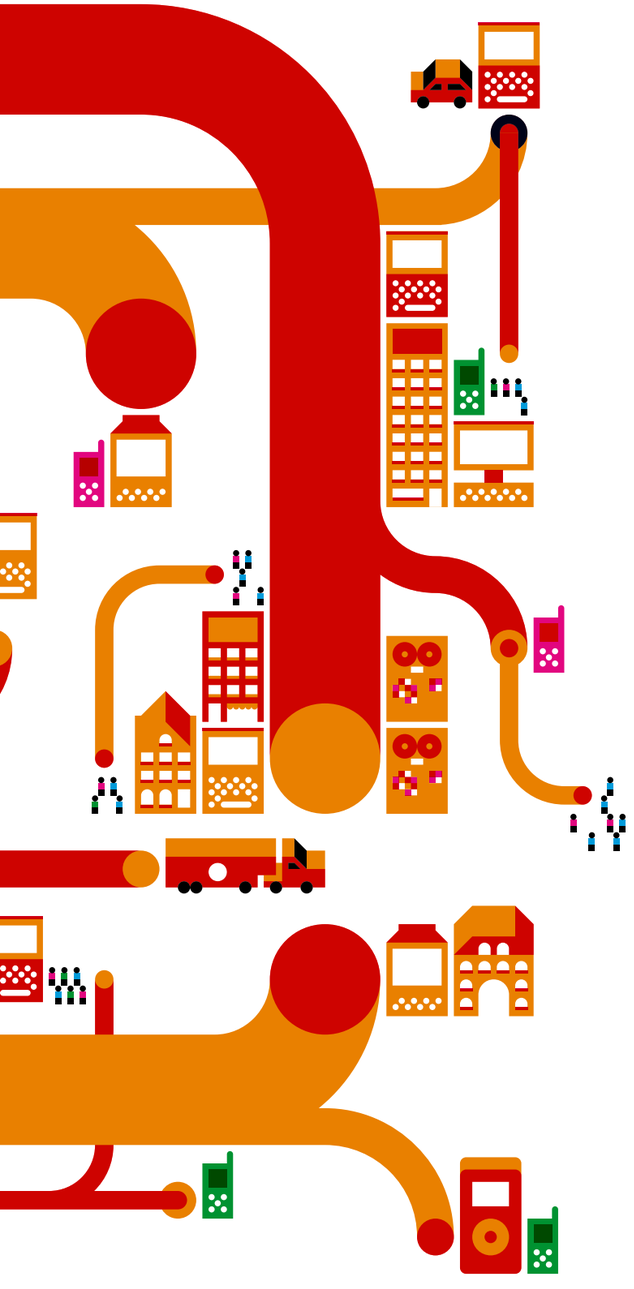
If the urban population continues to increase at the present annual rate of 1.8 per cent, it will have doubled within 35 years. And here the focus of urban concentration will shift to the Third World, which has hitherto had a predominantly rural population. In the year 2000, just under two billion people lived in cities there, but by 2030 the figure is predicted to have reached four billion. 5 million people migrate into cities in the developing world every month. And it is currently estimated that a third of the urban population of the Third World lives in slums. It is quite possible that half the global urban population will soon be living either in gigantic slums or in irregular urban residential zones located in richer urban areas or city centres like satellites or plug-ins, even though they represent Black Holes politically, economically and in terms of security strategy. Even in 15 years, the population of Kinshasa, say, will have risen from its current 8 million to 17 million, or that of Lagos from its present 10 to 16 million.

Migrations of this kind, which are happening much more quickly than they did in Europe and North America during the ultra-rapid urbanisation brought about by the industrial revolution, are perhaps most clearly observed in China. By 2025 alone, it is assumed that 350 to 400 million additional people – more than the current population of the USA – will be living in cities, which means the urban population could have doubled to a billion by 2030 – in 22 years. Everything about this trend is gigantic – the migrations from the countryside to the towns, the resultant restructuring of town and country, the building measures, the suburbanisation and sealing of land that could be used for agricultural purposes, energy and water supply problems, pollution, the increased risk caused by natural disasters, the development of transport infrastructure with roads, dozens of new airports or a large number of new means of mass transport. Despite the current economic crisis, China is likely to remain the world's largest building site – most recently the urban regions were growing by two billion square metres annually.

Scarcely controllable growth is further exacerbated by security

The actual and the virtual world are growing together, and information networks with ever finer nerves are permeating our everyday lives. "Smart grids" and "ubiquitous computing" are becoming possible thanks to low-priced but increasingly powerful chips which can be installed in any product.





problems. Conflict has increasingly been thrust into cities for a long time now, where asymmetrical wars are waged. The 'failed states' that are sinking into chaos are being joined by more and more weak or wild states, which are falling completely or, at best, partly out of state control. This turns cities into primarily military operating spaces devoted to security strategy that have to be subjected to surveillance and cleansing, where law and order have to be restored through conflict and stabilisation measures, as has clearly been happening recently in Iraq and Afghanistan.

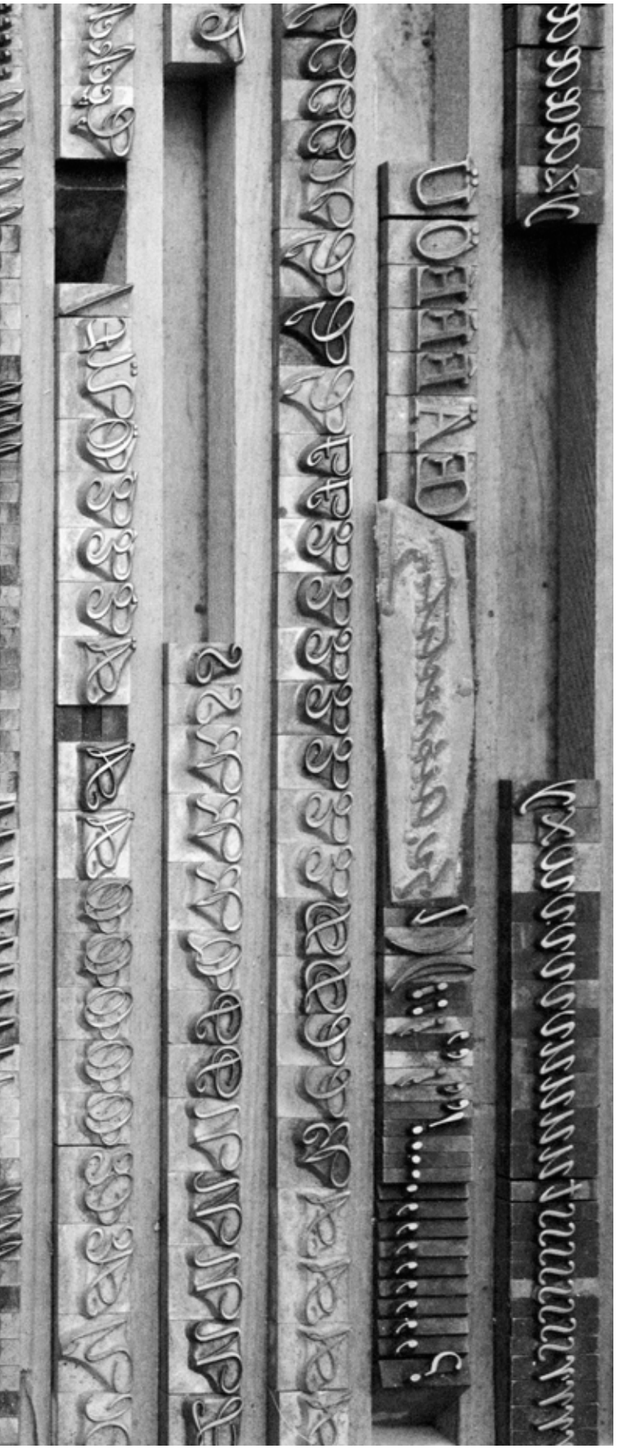
But – under the heading of cyber-terrorism, cyber-criminality and protection of the networked infrastructure – virtual space that is anchored in urban reality, forming the global or planetary metropolis, has increasingly to be protected. Here cyberspace has an important part to play. Not only does it enable comprehensive control of urban space in real time, italso has a bridging function, as the trend towards 'gated communities' is becoming stronger in the developing countries and the industrialised world, as a result of the poor and (super-)rich drifting apart and the middle class crumbling. The secure national urban 'islands', linked world-wide and separated by walls, fences, electronic surveillance devices and biometric recognition technologies, security staff and soon by robots are also interlinked by information and communications technology, as well as by connections to motorways, stations and harbours. These, in turn, should repel attacks and intruders with firewalls and other security devices, and thus also represent 'gated communities'.

Greater Shenzhen has over 12 million inhabitants. Here a kind of urban panopticon is to be set up, offering a wide variety of surveillance technologies. At the heart of the system are tens of thousands of surveillance cameras, some already capable of face and behaviour recognition and the possibility of operating over 360 degrees. In addition, there is a broadband network powerful enough to carry the massive quantities of data generated. It is hoped that this will not only make it possible to recognise people in public places but also to identify suspicious behaviour, for example, for preventive purposes. This will make Shenzhen the best monitored city in the world by 2010, with 2 million cameras. But the aim of the national 'safe cities' programme is to build up a national database, making it possible to coordinate and compare images from the surveillance cameras and data from other sources such as the monitored internet and mobile phone system, and also from the use of credit and other chip cards.

COLLECTING, COORDINATING, EVALUATING AND CONTROLLING

Similar projects for collecting data from the largest possible number of sources and accessing them by 'data mining' are being pursued all over the world, and of course also provide a basis for military strategy (C4ISR – Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance). IBM has just developed software for its 'A Smart Planet' project, intended to collect these enormous masses of data and analyse them in real time. This is all about surveillance and recognition in the broader sense, in other words about streams of traffic and people who can be followed by means of GPS and mobile phone localisation systems, about weather data, financial transactions, energy loads, images from all kinds of sensors, technology installed to make it possible to see through internal and external walls, or about medical and physiological data from a wide variety of sources, distributed regionally and globally. But this also makes it possible to monitor swarms of creatures, particles, micro-organisms or indications of biological, chemical or nuclear weapons in air and water.

New data will be generated all the time in every case, collected, coordinated and evaluated on the basis of certain criteria in order to recognise trends and risks or to optimise processes on local, regional, national or global levels, facilitating an immediate response. The dimensions of a data-space that is created, explored and analysed so dynamically will be gigantic. Even now, American scientists are collecting and evaluating mobile phone location data and so collecting and evaluating the movements of over 100,000 people over six months, producing a mobile 'fingerprint' for each individual in a way that is not entirely acceptable in legal terms. The world is becoming transparent, a panopticon. In principle,



this would make it possible to control the development of cities, minimise energy consumption, quickly track down possible environmental pollution or identify risky places, buildings and people, or explore interesting global marketing opportunities. Individuals could also optimise their activities by interacting with the data streams, which could include their physiological data, such as blood pressure, pulse, EEG, urine analysis and body temperature. At the same time, techniques are already being developed for automatically recognising people's behaviour and intentions from their gait, gestures or facial expressions, but also from physiological data that can be read remotely, which could serve to prevent crime and also help neuromarketing.

But even if state or private optimisations for monitoring and controlling in real time could be coordinated with the behaviour of people, such optimisation and regulation would undermine the tightly welded bases of freedom, anonymity and privacy. Geoscientists Jerome E. Dobson and Peter Fisher talk of the beginning of a form of 'geo-slavery', simply on the basis of location technology or Human Tracking.

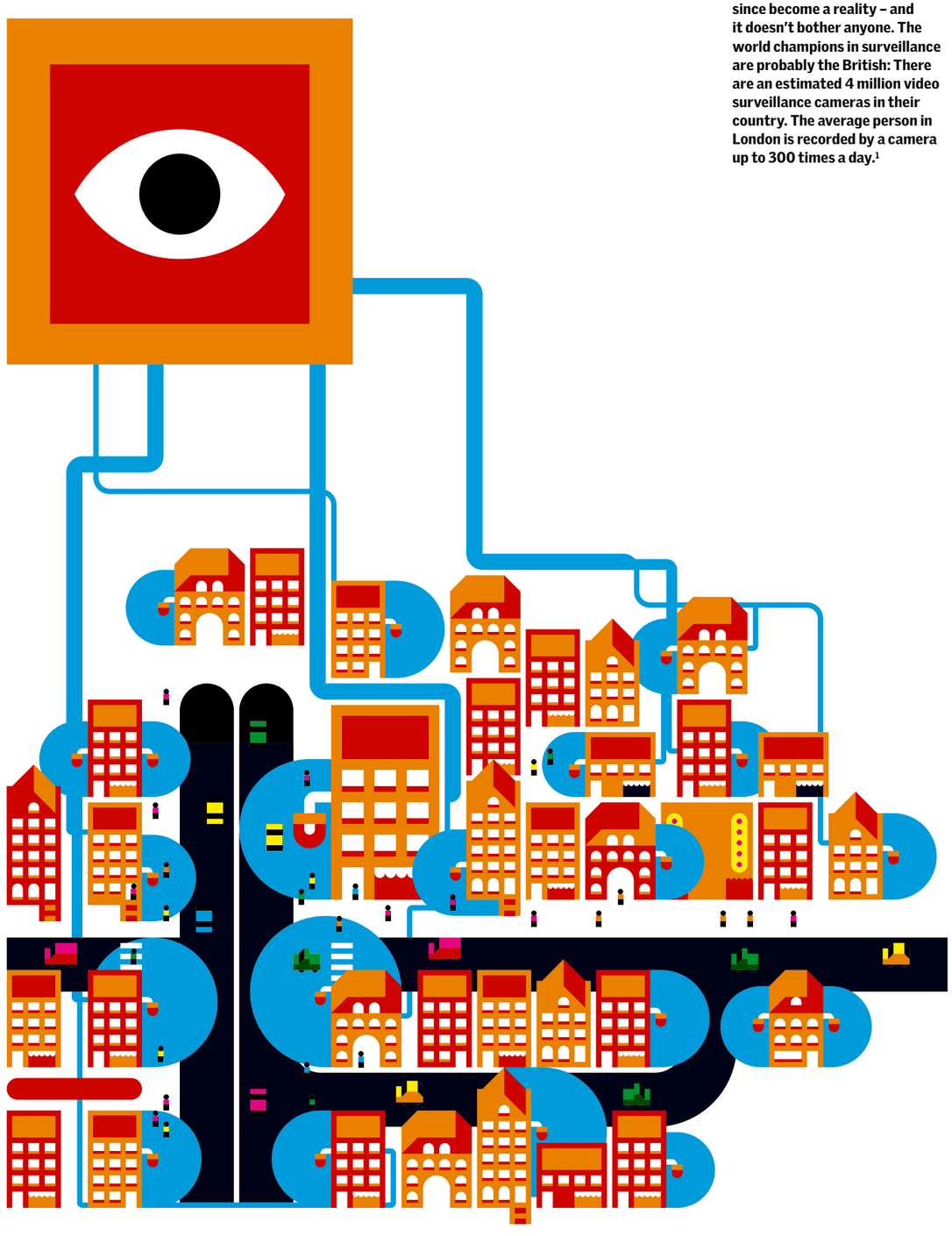
THE DIGITAL DIVIDE

But the global super-organism so fervently longed for by many people will not just have a large number of 'black holes', particularly in places dominated by poverty. Rich information societies will increasingly be concerned to seal off data-spaces (that overlap with real geographical and architectural spaces) from political or commercial competitors and to clarify who has access to what which data and who is to be spared the digital panopticon, under what conditions and how this will be realised technically. This will have become reality when all vehicles, equipment, goods and individuals can be tracked and located on a permanent basis via GPS transmitters, RFID chips, IP numbers etc, but also via 'intelligent' streets, buildings and infrastructures.

In the year 2050, the digital aristocracy will be distinguished by their ability to determine for themselves when, where and under what circumstances they are on- or off-line in the middle of the archipelago of rich, protected islands of affluence. But they will also have to reckon with digital criminals and rebels or state and private security forces, who will want to penetrate the 'gated spaces' and manipulate them with as few obstacles as possible in the way.

The trends described here originate mainly in the slumming down of Third World cities, increasing poverty and the fact that rich and poor are drifting apart, even in rich countries. Presumably such trends will be further reinforced by the financial crisis and the debt mountains that are piling up to cope with it. Global warming will also contribute to sealing rich countries and rich elites off even more if it results in waves of migration or natural disasters, unless something is done in advance to prevent this. The only effective defence strategy would be state and economic reforms, above all redistributing education and knowledge in order to bridge the gulf between rich and poor. Rather than seeking to tame the democratising power of the internet with surveillance, internet bans and undue regulation, societies could invest in removing the 'digital gulf' that still exists between different population groups. This would be a way of creating the transparency and public quality that are so sorely needed in terms of (global) politics, as well as providing open access to knowledge.

Florian Rötzer, born in 1953, studied philosophy then worked as a free-lance author and journalist specialising in media theory and media aesthetics. In 1996 he was a co-founder of the online magazine Telepolis (www.telepolis.de) and has been its editor-in-chief ever since. He has published books including *Digitale Weltentwürfe* (Munich 1998); *Megamaschine Wissen* (Frankfurt am Main/New York 1999), *Renaissance der Utopie* (Ed, with R. Maresch; Frankfurt am Main 2004) and *Vom Wildwerden der Städte* (Basel 2006).



Big Brother is watching you – George Orwell's surveillance scenario from '1984' has long since become a reality – and it doesn't bother anyone. The world champions in surveillance are probably the British: There are an estimated 4 million video surveillance cameras in their country. The average person in London is recorded by a camera up to 300 times a day.[1]

03

MONEY
STRONG ECONOMIES FOR SUSTAINABLE COMMUNITIES

The recent financial crisis in almost all parts of the world has clearly shown the shortcomings of the globalised economic system. To make cities economically more resilient and to fight poverty more effectively, our economy will have to be based on strong local communities rather than on the interest of global corporations. The result would be a new, smaller – and, for most people, better – world.

By Mark Roseland

WHY?

The current economic crisis has shown the limitations of the globalised world economy. An economic system that concentrates money, power and knowledge in the hand of the few does not create prosperity, does not combat poverty and restricts cities' freedom of activity. And cities in particular are faced with great challenges in the future; adapting to climate change, restructuring transport and energy systems and achieving social balance are the most important.

WHAT?

Weak local economies cost people a great deal financially, ecologically and socially. But a strong regional economy helps cities to resist the pressure of globalisation. It is the basic prerequisite for functioning social systems, health care provision, affordable living space and an efficient urban infrastructure. And local operators treat the available ecological resources much more responsibly than global operators; people are more easily made accountable for extravagant and polluting behaviour if they are to be found on the spot.

HOW?

Sustainable development can succeed only if social dependence on economic growth is reduced. Development should be the focus, not growth: growth means getting bigger – development means getting better. Thus the aspect of value versus cost should be regarded from a perspective of sustainability. In times of CO2 emissions trading, energy will be used like a currency. However it will not be sufficient merely to save this currency; we will also have to change our supplies – from fossil fuels to renewable sources.

The summer of 2008 dramatically illustrated a choice of economic futures. In summer 2008, oil was surging toward $150 a barrel and US gas [ed: petrol] prices were hitting $4 a gallon. When the price of oil went up, recession followed. The recession brought those prices crashing down, and today it may seem like high oil prices are one of the few economic problems that we don't have to worry about. However, triple-digit oil prices will return and stay high because demand will consistently outstrip supply, which arguably has peaked anyway, in the coming years.[1] If we don't want to continue down the path of globalisation, how can we begin to think about an alternative economic future?

Strong local economies are the foundation of strong communities that can grow and withstand the pressures created by an increasingly urbanised world. And strong communities require a holistic approach that not only provides the traditional deliverables of economic development – jobs, income, wealth, security – but also protects the environment, improves community infrastructure, increases and develops local skills and capacity, strengthens the social fabric, and respects heritage and cultural identity. In this way, strong local economies also provide a foundation for strong national economies. Cities and towns provide enormous untapped opportunities to strengthen local economies by pioneering new approaches to sustainable development and community management.[2]

Whether human settlements are villages, towns, suburbs, or megacities, local economic development has a critical impact on the sustainability of urban areas. Whenever agricultural or forest land is cleared for other purposes, whenever roads are built or expanded, whenever a new shopping centre or subdivision is created, whenever an urban area is 'redeveloped' – in short, whenever the natural or built environment is changed through human action – the health of communities and the planet is affected.

The economic development that generates these changes in the natural and built environment should benefit urban residents by improving their economic lives. Weak local economies are expensive for residents who suffer from poverty and its associated consequences, such as malnutrition and disease. Yet despite the enormous potential of cities to reduce poverty, recent evidence shows that the wealth they generate does not automatically lead to poverty reduction. On the contrary, inequalities within cities are on the rise, particularly in Africa and Latin America. Poverty is a severe, pervasive, and largely unacknowledged feature of urban life.

Even 'successful' national economies can be expensive in terms of local human, social, health, and ecological costs. China's recent gains in economic growth and productivity provide a vivid illustration, as China is now home to 16 of the 20 most polluted cities on the planet. Economic gains there have in many cases exacerbated environmental problems in the cities.[3]

Cities around the world can be thought of as lying on a continuum of economic development – from wealthy cities such as New York, Los Angeles, Vancouver, London, and Stockholm to poorer cities such as Lima, Caracas, and Mumbai. Yet within each wealthy city there is also a poor city (as evidenced, for example, by the 2005 riots in the outskirts of Paris), while seasoned travellers can attest that in most poor cities there are also wealthy enclaves. Sustainable development looks very different in each of these contexts. It means the difference between economic development that, on the one hand, encompasses multiple bottom-line objectives to enable continued prosperity without compromising the planet's natural support systems and, on the other hand, alleviates poverty and creates sustainable livelihoods so that people can live secure, healthy, and dignified lives.

FROM GLOBAL TO LOCAL ECONOMIES

Urban economic challenges are often ignored in part because of our flawed understanding of the economic system itself. Most conventional economic development efforts are rooted in the belief that economic benefits trickle down–from the rich to the poor, from the state to the city, from the market to the consumer. But such trickle-down strategies may actually exacerbate the very problems they are designed to ameliorate. Rather than only trickling – or even pouring – economic development down, weaknesses in the trickle-down effect illustrate that there is a strong case for economic development to also be 'from the bottom up.'

Yet the past several decades have witnessed unprecedented economic expansion and the emergence of the 'global economy'. International development efforts of the last 20 years have focused on facilitating the integration of developing countries into this global economy through mechanisms such as the structural adjustment programmes and policies of the International Monetary Fund and the World Bank, which were designed, among other objectives, to alleviate poverty through macroeconomic restructuring.

Recognising the failures and shortcomings of past approaches to economic development, the United Nations Millennium Declaration adopted in September 2000, committed nations to a new global partnership to reduce poverty. Eight Millennium Development Goals were set for 2015, with the aim of not only addressing issues of extreme hunger and poverty but also promoting gender equity and the basic human right to health, education, shelter, and security.[4]

There is a consensus that there have been more failures than successes. In light of this, in 2005 the UN Millennium Project presented its final recommendations, Investing in Development: A Practical Plan to Achieve the Millennium Development Goals, calling for both an increase in aid from western countries and a reallocation of funding priorities in developing countries. More interesting, however, is that the report also called for more aid to be given at the local level. With an emphasis on local assistance, the Earth Institute at Columbia University in New York has also started the Millennium Villages Project, a "bottom-up approach to enabling villages in developing countries to lift themselves out of the poverty trap." The 12 underlying principles of this project include community empowerment through participation and leadership, local-level capacity building, and strengthening local institutions.[5]

Many international development efforts seek not only to integrate developing countries into the global economy but also to globalise the economy itself. Capital mobility, increasing trade, and the decline of national state regulation have made individuals and the communities they live in more vulnerable than before. Conventional approaches to economic development at best only address the conditions under which local economies connect more or less favourably to external economic circuits. For example, 'cluster strategies' that emphasise the competitive advantage of a local commodity are concerned with how to plug local economies into the high value-added parts of global commodity chains. While these strategies are important, they do not guarantee sustainable, equitable, local outcomes.

In North America and Europe, the global economic expansion of recent decades has been felt in local communities in a variety of ways. Perhaps the most noticeable and currently debated result has been the commercial retail 'big box' boom – that is, the proliferation and increasing dominance of multinational superstores.

As an example, consider WalMart, the world's largest retailer. If WalMart were a country, it would be the twentieth largest in the world; if it were a city, it would be the fifth largest city in the United States. WalMart's critics have long complained that WalMart is a bad employer, neighbour and corporate citizen. But the company might be changing. In 2004, WalMart launched a long-term sustainability initiative focusing on areas such as packaging, real estate, energy, raw materials, and electronic waste . The company partnered with environmental consultants, non-profit organisations, and other groups in order to examine business practices through the lens of restoration and sustainability.[6]

In October 2005, WalMart's CEO announced three new goals for the company: to rely 100 percent on renewable energy, create zero waste, and sell products that sustain resources and the environment. In April 2006, WalMart was one of a handful of major retailers and energy companies urging the U.S. Congress to impose mandatory carbon caps on their businesses. It has also become the world's largest supplier of organic food, not only reducing its ecological footprint but making organics more accessible for everyone. If global forces such as WalMart are signing on to save the planet by supplying organic produce and lobbying for carbon caps, why bother trying to strengthen local economies?[7]

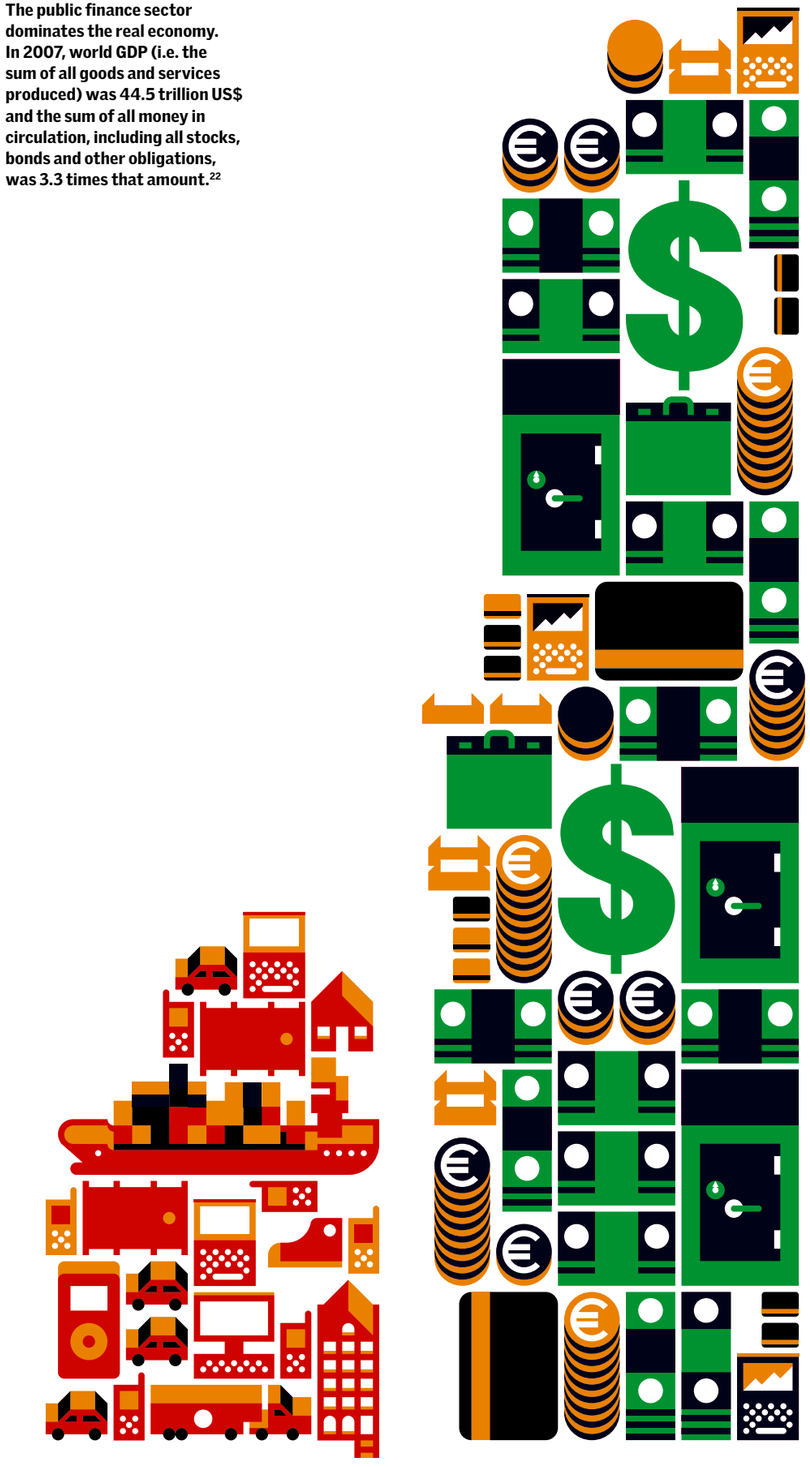
There are several critical reasons to pursue such a strategy. First, economic development rooted in local ownership and import substitution has clear benefits in terms of stopping economic leakage. Economic leakage refers to community income that is spent outside the local economy. For example, each time residents shop in a different town or larger centre, the amount spent represents dollars and income lost to the home community. There are two basic forms of leakage: immediate and secondary. Immediate leakage occurs when members of a community travel to another centre and use their locally generated incomes to make non-local purchases. Secondary leakages occur when a resident makes a purchase in the community but the product was purchased or manufactured outside the community. Money spent outside the community represents a loss to the local economy.[8]

Second, locally owned businesses are more likely to be a stable generator of wealth for many years, often for generations, and they are more likely to adapt to rather than flee from the introduction of reasonable labour and environmental standards. During business downturns, they are less likely to relocate production to lower-cost regions, and in boom times they are less likely to move for a slight increase in the rate of return on investment.[9]

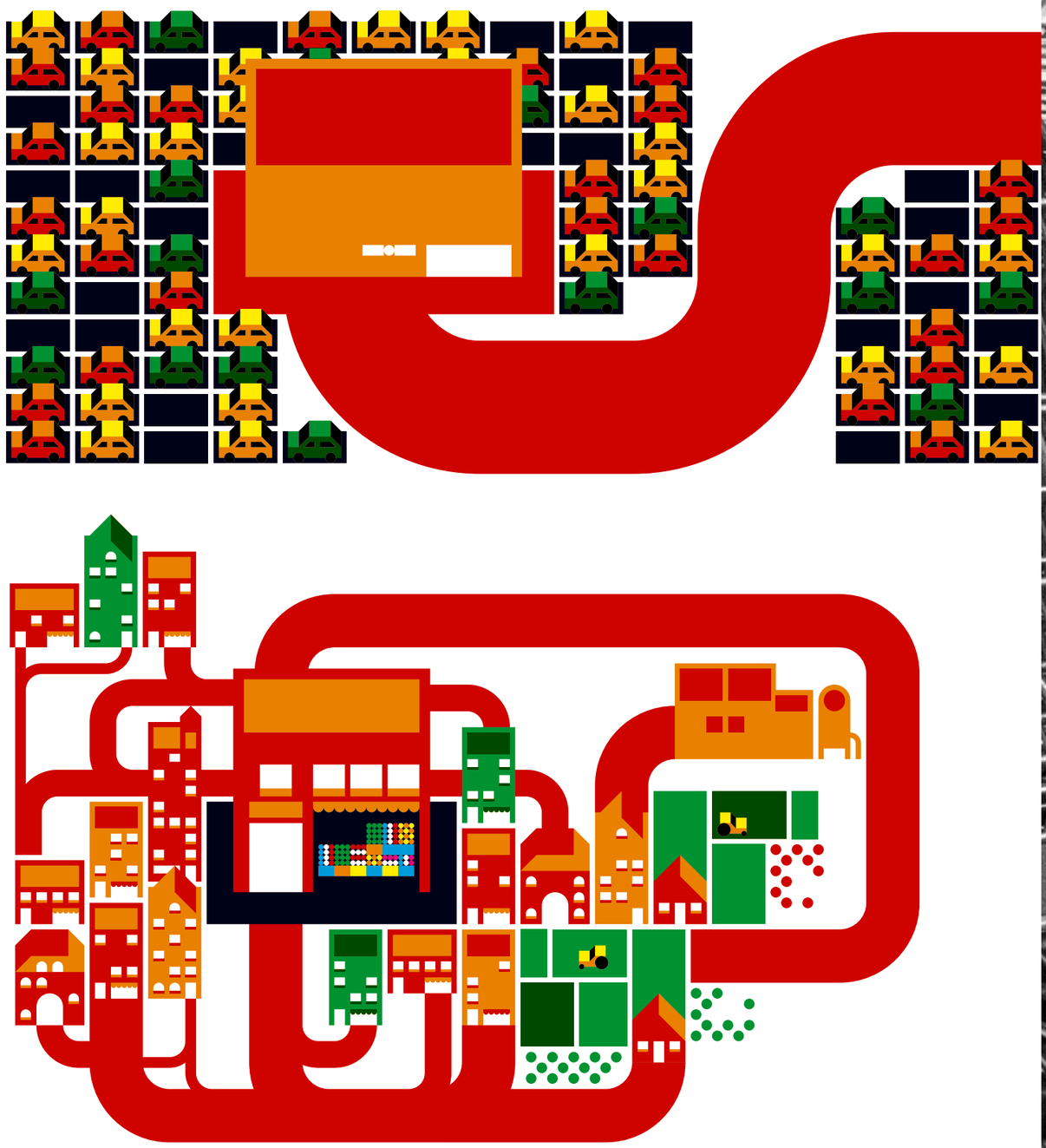
Third, while big-box stores such as WalMart expand commercial choice and offer good consumer value, some studies have found that these stores do little to contribute to local economies. Compared with locally owned stores, multinational chain stores siphon revenues out of communities through economic leakage. By displacing local businesses, they also contribute to increasing unemployment and decreasing overall incomes.[10]

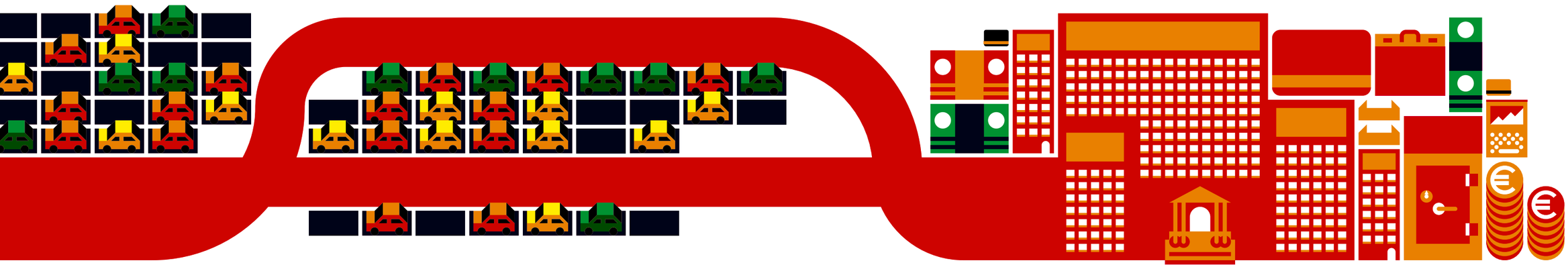
Finally, in North America a prevailing myth is that in order to foster economic development a community must accept growth. The truth is that growth must be distinguished from development: growth means to get bigger, development means to get better – an increase in quality and diversity. Local governments will often subsidise superstore development through infrastructure expansion in the name of economic development, only to facilitate more sprawl and municipal debt. Two alternatives for development without growth are supporting existing businesses and increasing the number of times a dollar is spent in the community. Local purchasing is the primary means both of supporting existing businesses and of increasing the economic multiplier, resulting in a more efficient, self-reliant, economically resilient community.[11]

The public finance sector dominates the real economy. In 2007, world GDP (i.e. the sum of all goods and services produced) was 44.5 trillion US$ and the sum of all money in circulation, including all stocks, bonds and other obligations, was 3.3 times that amount.[22]



The globalised economy (above) with its 'big box' shopping centres takes little account of the needs of local segments of the population. It siphons off their income and routes it to far-away banks and investors (p. 35). Small, locally organised money flows in which every Euro is spent multiple times at the respective location are more sustainable (below).





COMMUNITY CAPITAL: USING ALL OUR RESOURCES

Alternative economic theories and ideas are not new: E. F. Schumacher proposed the idea of "new economics" in his influential book Small is Beautiful: Economics As If People Mattered, promoting small-scale development based on meeting people's local needs. Since then, alternative local economic approaches have been put forward in both industrial and developing countries – approaches that are rooted in community and designed to meet local needs and objectives. Community Economic Development (CED) and sustainable livelihoods are two examples of these alternative strategies. [12]

Community Economic Development provides a conceptual means of addressing sustainable economic development at the community level. Its core principles include a community-based approach to development; direct and meaningful community participation; integrating economic, ecological, and social aspects of local development; asset-based development founded on community strengths and resources rather than on deficiencies; and building community self-reliance. Its distinguishing features are captured in this definition: CED "is a process by which communities can initiate and generate their own solutions to their common economic problems and thereby build long-term community capacity and foster the integration of economic, social, and environmental objectives." [13]

Just as sustainability has prompted a shift in transportation and energy planning away from traditional concerns with supply to a new focus on managing demand, the focus of economic development needs to shift from traditional concerns with increasing growth to one of reducing social dependence on economic growth – or what could be called EDM, Economic Demand Management. This has distinct implications for sustainable community development, particularly regarding employment and community economic development. [14]

Examples of sustainable CED initiatives include:

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car cooperatives to reduce the cost and necessity of car ownership (Vancouver)

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sustainable employment plans to create jobs, spur private spending, and reduce pollution through public investment in energy conservation and audits (San Jose, California)

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new product development to encourage manufacturers to develop environmentally friendly products through municipal research and development assistance (Gothenburg, Sweden)

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increases in affordable housing supply through zoning codes that promote a variety of housing types, including smaller and multifamily homes (Portland, Oregon);

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experiments with local self-reliance through establishment of closed-loop, self-sustaining economic networks (St. Paul, Minnesota)

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community-supported agriculture projects to preserve farmland and help farmers while making fresh fruits and vegetables available in city neighbourhoods (Vancouver; London, Ontario; New York City)

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creation of local currencies such as LETS, Local Employment and Trading Systems, which seek to recirculate local resources and strengthen social ties (Toronto; Ithaca, New York; United Kingdom)

_
a local ownership development project with a revolving loan fund to encourage employee-owned businesses, which are considered more stable over the long term and more likely to hire, train, and promote local residents (Burlington, Vermont)

_
a community beverage container recycling depot that employs street people–'dumpster divers'–and provides them with skills, training, and self-esteem (Vancouver). [15]

Closely related to CED is the sustainable livelihoods approach to poverty alleviation, which aims to address the immediate as well as the long-term needs of individuals and households and which takes into consideration the social and environmental as well as the economic sustainability of livelihood activities and strategies. The idea of sustainable livelihoods provides a framework to understand the practical realities and priorities of those struggling in poverty – that is, what they actually do to make a living, the assets that they are able to draw on, and the everyday problems they face. [16]

Beyond income generation, successful strategies under a sustainable livelihoods approach should serve to improve access to and control over local assets and help to make individuals less vulnerable to shocks and stresses (such as illness, natural disasters, or job loss) that could otherwise exacerbate situations of debt and poverty. [17]

Historically, the sustainable livelihoods framework has been used primarily in the context of rural poverty alleviation. But the same framework can easily be applied to situations of urban poverty and livelihood generation. In fact, a sustainable livelihoods approach is necessary in order to tackle issues of urban poverty over the long term. According to the ILO, 184 million people in the world do not have jobs, although this figure reaches at least 1 billion if underemployment is also taken into account. [18]

The concepts of community economic development and sustainable livelihoods together provide a useful framework for an alternative approach to economic development that emphasises the development of strong local economies.

A NEW MINDSET FOR THE FUTURE

How will the overall approach to economic development need to change in order to facilitate the development of strong local economies?

Cities, communities, and local economies are multidimensional, with a complex interaction of social, economic, ecological, and cultural factors. Some analysts think of local economies in terms of assets or capital. The term community capital, conventionally used to refer just to economic or financial capital, has more recently been used to include natural, physical, economic, human, social, and cultural forms of capital. Strengthening local economies means focusing attention on these six forms of capital:

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Minimising the consumption of essential natural capital means living within ecological limits, conserving and enhancing natural resources, using resources sustainably (soil, air, water, energy and so on), using cleaner production methods, and minimizing waste (solid, liquid, air pollution and so on)

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Improving physical capital includes focusing on community assets such as public facilities (such as hospitals and schools), water and sanitation provision, efficient transport, safe and high-quality housing, adequate infrastructure, and telecommunications

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Strengthening economic capital means focusing on maximising the use of existing resources (using waste as a resource, for example), circulating dollars within a community, making things locally to replace imports, creating a new product, trading fairly with others, and developing community financial institutions

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Increasing human capital requires a focus on areas such as health, education, nutrition, literacy, and family and community cohesion, as well as on increased training and improved workplace dynamics to generate more productive and innovative workers; basic determinants of health such as peace and safety, food, shelter, education, income, and employment are necessary prerequisites

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Multiplying social capital requires attention to effective and representative local governance, strong organisations, capacity-building, participatory planning, and access to information as well as collaboration and partnerships

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Enhancing cultural capital implies attention to traditions and values, heritage and place, the arts, diversity, and social history. [19]

This approach is increasingly referred to as sustainable community development and includes both community economic development and sustainable livelihoods strategies.

While individual actions and lifestyle choices, such as buying organic produce, are important personal contributions, strengthening local economies requires a collective shift in individual actions and political choices. Community mobilisation has been effective in some contexts and some regions. The cooperative economy of Emilia Romagna in northern Italy, the Grameen Bank in Bangladesh, Vancity Credit Union in Vancouver, the Women's International Sewing Cooperative of Nueva Vida, and the campaigns for local trade across North America are all examples of the potential of community mobilisation to help strengthen local economies.

TOWARDS A NEW, BETTER, SMALLER WORLD

Strong local economies are a fundamental part of sustainable communities. They give communities the capacity and resources to address specific and immediate problems such as the provision of health care, adequate housing, clean water and sanitation, and disaster prevention and response. Human settlements – large and small, rich and poor – need strong local economies to withstand the pressures created by an increasingly urbanised world.

Globalisation was not the result of wise economic theories brilliantly applied, but rather of cheap oil. Sustainable communities with strong local economies will not come easily – they require significant change in our structures, attitudes, and values. Sustainable development implies a shift in the capacity of individuals, companies, and nations to use resources that they have the right to use – and are encouraged to use – under present legal and economic arrangements. Although even the most conventional analyses recognise the need for changing these arrangements, few openly acknowledge that moving toward a sustainable society requires more than minor adjustments to existing practices. Those who benefit from current arrangements will resist efforts to decentralise the economy and strengthen local communities. Municipalities around the world have worked together successfully to influence global change on environmental matters; they must now incorporate a strong local economy focus into their sustainability agendas. [20]

While developed economies have bounced back from past oil shocks, and new technologies hold out the possibility of reducing dependence on oil, high oil prices are a virtual certainty – but a certainty to which we can adapt. Without cheap oil, developed countries are likely to import less from low-wage countries like China and make more things at home, from steel to furniture to food. [21] In many respects, the new smaller world awaiting us will be a better and more sustainable world than the one crashing around us now.

This article is based upon M. Roseland with L. Soots, "Strengthening Local Economies," in Worldwatch Institute, State of the World 2007: Our Urban Future (New York: WW. Norton & Co., 2007).

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MATERIALS
BEYOND WASTE: MANAGING MATERIAL FLOWS IN THE 21ST CENTURY

Fossil energies are not the only resources that are being over-used at present. Many materials are being extracted from the ground or the biosphere at a non-sustainable rate. Any sustainability strategy for 2050 will therefore have to address the problem of waste and material flows. The good news is that there are numerous economic, political, social and technical concepts available already that will help us achieve this goal.

By Rachel Cracknell

WHY?

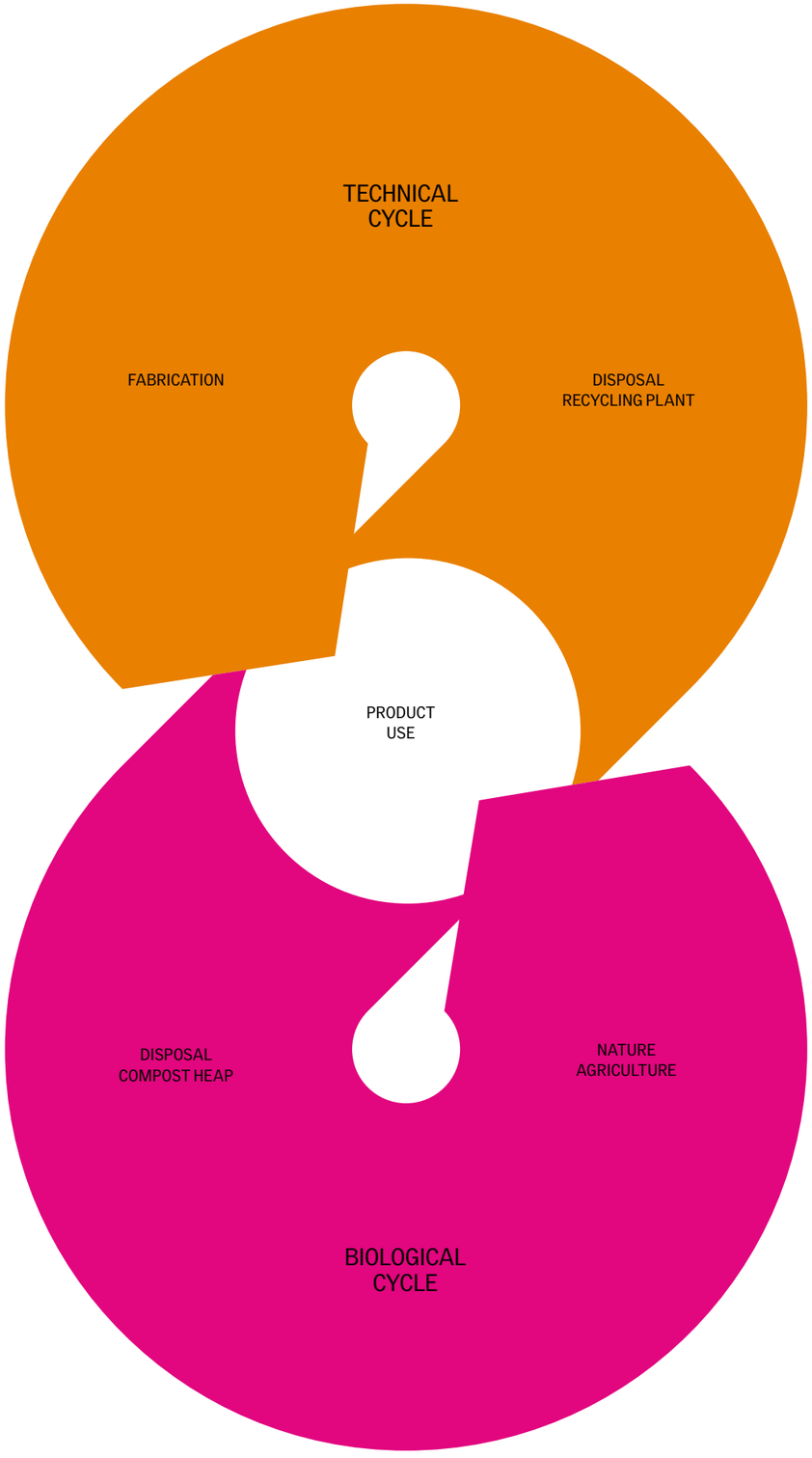
The higher the standard of living, the more resources and materials are used. This applies almost anywhere in the world: experts have calculated that the industrial nations would have to reduce their output by 90 per cent in order to stop over-exploitation of the environment. But there is no sign of any different thinking; the world's states subsidise raw material prices, and thus the exploitation of resources, to the tune of a billion US dollars per year. At the same time, our lifestyle promotes consumption and the growth of rubbish mountains; we spend money that we do not have to buy things that we do not need.

WHAT?

More efficient and more profitable use of resources can maintain the living standard of the affluent at the same time as enabling economic growth for poorer people. The ultimate aim could be an economic approach working on the 'cradle to cradle' principle – a cyclical system in which refuse is food and no resources are lost. But clear preferences have to be established if this aim is to be achieved. Thus avoidance comes before re-use, and recycling is better than incinerating rubbish or disposing of it at landfill sites.

HOW?

Strategies for reducing the use of resources are already being tried out in parts of the world today. Negotiation is needed in four fields: politics, economics, social fields and new technologies. Subsidies, taxes and charging for rubbish could point things in the right direction. Architects, engineers and designers have specific obligations; they have great influence when products that are more efficient in their use of materials are to be manufactured.



"Our enormously productive economy ... demands that we make consumption a way of life ... We need things consumed, burned up, worn out, replaced and discarded at an ever-increasing rate."

Victor Lebow[1]

Opposite page **The 'cradle to cradle' system is based on two mutually complementary material circulation systems, i.e. one technical in which all materials are repeatedly recycled and one biological in which waste rots and becomes nutrients. The term 'waste' no longer plays any role in a system of this kind.**

Every year more than half a trillion tonnes of materials are dug up, processed and thrown away. Less than 1% of the materials embodied in the products we consume are still in our possession six months after purchase[2]. All the rest have become waste, be it from construction, commerce, manufacturing or households. Much evidence suggests that today's growing society is using more resources and generating more wastes than the planet can sustain, and that our consumption habits have led us to an environmental crisis point, with depleting resources, the spread of dangerous pollutants, the undermining of ecosystems, and the threat of unhinging the planet's climatic balance.

Radical change is needed to move humanity from the prevailing economic system of manufactured goods and over-consumption to one where people significantly reduce their use of resources. However, the deep divides that exist within humanity make this a hugely complicated task. An ever-growing body of evidence suggests that the current global consumer class of 1.7 billion people needs to significantly reduce its consumption, but an equally large number of people in an emerging global middle class are striving to emulate the perceived "good life" - in stark contrast to the 3 billion people who live on less than USD 2 a day[3].

Clearly, the solution should not be one that allows the entire global population to consume at the rate current in Western society, nor can it involve moving to a place where Western consumption is accepted whilst the poor are denied a decent standard of living. Instead, the rich need to curb their over-consumptive lifestyles and industry needs to reduce the resources embedded in products.

Calculations suggest that to achieve the twin objectives of environmental protection and social equity, those living in the developed world may need to cut their use of materials by about 90%[4]. Yet at present it appears that we are moving in the wrong direction. Modern economies produce, at ever-decreasing prices, commodities that consumers regard as little more than goods to be discarded relatively quickly rather than items embodying valuable energy and materials that should be repaired, maintained, and designed to last over a long lifespan.

The good news is that meeting human needs while becoming more resource-efficient can be more profitable and can deliver a higher standard of living than maintaining current practices. A new model of prosperity for an environmentally degraded and poverty-stricken planet may be found in efforts to lower consumption, in practices that increase resource efficiency, and systems that circulate materials through recovery and reuse.

WASTE MANAGEMENT OPTIONS

Until recently, waste management focused on "end-of-pipe" solutions with landfill as the predominant means of disposal. But in today's society, sustainable waste management relies on managing resources so that wastes can begin to be avoided altogether. The root of this transition requires moving from a mindset of "waste" as unwanted material requiring disposal to one where it is regarded as a raw material to be fed back into the production process as part of a closed loop system. Energy and carbon are also becoming key issues, with a drive towards systems that maintain the embodied energy or carbon held within the materials.

To effectively manage wastes, therefore, we need to address the issues of sustainable production and consumption using a lifecycle-oriented approach. To effect such a transition, viable opportunities for waste reduction at source need to be identified through:

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designing products that are less wasteful and easily recyclable

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promoting the effective reuse and remanufacturing of products during their lifecycle

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moving towards selling services rather than products where possible, and

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ensuring that the correct infrastructure and public willingness allow reduced consumption and recycling of viable materials at the end of their useful life.

THE WASTE HIERARCHY

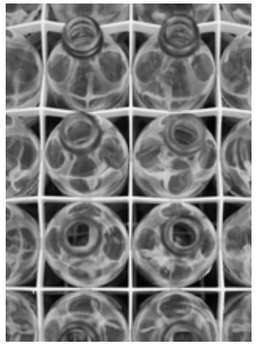
The waste hierarchy[5] is a useful framework that has, rightly or not, become the cornerstone of modern-day waste management. It sets out the order in which options for waste management should be considered, based on their environmental impact. Although this hierarchy has taken many forms, the basic aim remains the same: to extract the maximum benefits from consumer items and generate the minimum amount of waste.

The hierarchy has been criticised both for being unscientific and not applicable to all countries. It should therefore only be used as a guide. It does not mean that under all circumstances, at all times, a higher option will be better than a lower one. In most cases a combination of options for managing the different waste streams will be needed. Nevertheless the hierarchy provides a simple rule-of-thumb guide to the relative environmental benefits of different options.

Globally the waste hierarchy has been applied almost exclusively to managing wastes once they have entered the waste stream, but it actually conveys a much broader concept – that end-of-pipe solutions need to be coupled with strategies that look at the essence of the problem, such as how product design and consumption patterns can prevent or reduce waste production.

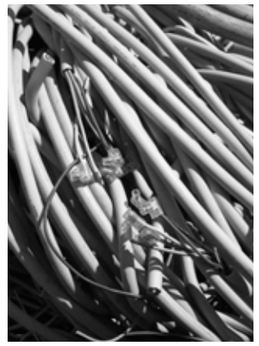
WASTE AS A RESOURCE: CAN WE MOVE BEYOND WASTE?

Waste management experts are beginning to think that the present system may have fundamental flaws, and that a thoroughly effective system may need an entirely new way of looking at waste. As a result,








talk about "resource management" rather than "waste management" is becoming increasingly common, together with a "zero waste" philosophy.

The aim of zero waste is to stop thinking of waste as a "waste" and instead to see it as a valuable resource for society. In this sense waste will cease to exist. Put simply, "zero waste" extends current concepts of recycling into a circular system whereby as much material as possible is reused[6]. In this it replicates natural ecosystems that have evolved over millennia so that the waste products of one organism naturally become the resources or feedstock for another, and the major nutrients of carbon, nitrogen, hydrogen, and oxygen are cycled and recycled between animals and plants the planet over. Thus life has evolved and flourished on Earth for most of its history.

To move towards such a system will involve breaking away from the current "linear" economy whereby resources are extracted, converted into products, consumed and discarded, and instead embrace a "circular" economy that imitates nature's highly efficient "cradle-to-cradle" system that allows nothing to be wasted.

HOW CAN WE ACHIEVE THIS?

The encouraging truth is that there is no problem without a solution. To move towards a resource-efficient cradle-to-cradle system whereby all the planet's inhabitants live sustainable lives will require the correct balance of economic, social, political, and technological measures. The following list is by no means exhaustive, but sets out some of the ways more sustainable resource management practices can be achieved.

ECONOMIC MEASURES

Subsidies and eco-taxation: A key means to achieving more sustainable resource and waste management practices is to send effective pricing signals that encourage more sustainable practices. Numerous subsidies currently make products such as fuels, timbers, and minerals far cheaper than they would otherwise be, encouraging their increased consumption. Although it is difficult to derive an exact value, it is estimated that global subsidies amount to over USD 1,000 billion per year, with OECD members accounting for three-quarters of the total7. Phasing out destructive subsidies and shifting a proportion of the funds to resource efficiency initiatives would help address unsustainable resource consumption practices.

Ecological tax reform is the process whereby market prices are adjusted to reflect the full environmental costs of economic activities. Examples include levies on the use of virgin materials, landfill fees, and other waste and pollution charges that incentivise manufacturers to reduce their generation of wastes and emissions. In California, a recycling target of 50% diversion from landfill by 2000 was set in 1990. All municipalities were threatened with a USD 10,000 fine per day for non-compliance. Although it took longer than anticipated to reach this goal, by 2005 California reached a recycling rate of 52% with some communities diverting over 60% of their waste[8].

Costing externalities: by incorporating the cost of a wasteful process into the price of a commodity, the total amount of waste generated can be limited. For example, plastic bags are provided free in almost all countries, but Ireland has levied a 15c (10p) charge on plastic bags since 2002, a policy that reduced usage by 95%[9]. Similar success was experienced in South Africa, where bags were made more durable and expensive to discourage disposal, generating a 90% reduction in usage[9].

Another example of incorporating the cost of environmental impact into commodity prices lies in beverage containers. Sweden has achieved an 86% recovery rate for these, driven primarily through an industry-imposed bottle deposit of 10c[10]. Similar success has also been achieved in Michigan, USA, where a 10c bottle deposit has generated a 95% recovery rate[11].

Pay as you throw (PAYT): Charging households for the amount of non–recyclable waste they generate has been a successful way both to increase recycling and reduce the absolute volume of waste generated by a population. The first community to implement PAYT was Richmond, California, in 1916, and since then, over 6,000 communities in the US alone have implemented PAYT schemes[12]. PAYT charges residents for collection of waste based on the amount they produce, providing a direct economic incentive to generate less waste and increase composting and recycling. Such schemes have demonstrated huge success in decreasing collection costs, reducing waste volumes, and increasing recycling.

Green procurement: Through the products and services they buy, governmental institutions have great influence. Public purchasing in industrialised countries accounts for up to 25% of GDP. In the EU, government procurement totalled more than USD1 trillion in 2001, while in North America it reached USD2 trillion[3]. Institutions can therefore have a powerful influence on their suppliers. Through the placement of environmental demands, institutions can shift markets and influence design, efficiency, and durability. This is "green procurement".

In 1998, the US government set a standard demanding the recycled content of all federal paper to be 30%. This generated a shift in recycled content of paper from 10% in 1994 to 30% in 2000 and also increased federal consumption of recycled paper from 12% to 90%3. The increased government demand also boosted the overall market standard for recycled content in the country. Buying recycled products is the important final stage in the process as it effectively "closes the loop". Many countries are taking this on board: Denmark is a world leader in green procurement with a law in place since 1994 requiring all national and local authorities to use recycled or recyclable products.

SOCIAL MEASURES

Influencing consumption: the global consumer class is a key player in reshaping patterns of resource consumption, simply because it consumes the bulk of the world's resources. However, influencing consumers is a major challenge. As already noted, a well-designed eco-tax can play a useful role, but the capitalist system leaves decision-making in product purchase almost entirely up to the consumer. More controls on purchasing would be undesirable, but some aspects of individual household consumption can be influenced. For example, current consumption patterns lead to the production and purchase of many goods that are used infrequently by the consumer. It is estimated that the average DIY tool is used for just 10 minutes, the rest of life it sits gathering dust[13]. This leads to far greater material consumption than is actually necessary.

Governments and communities can take action to help redress the balance between private and public forms of consumption. Car sharing is rapidly becoming popular in many European cities, and governments can facilitate such initiatives through tax incentives and grant schemes. Similarly, local communities can set up tool and appliance sharing arrangements so that not everyone has to own a separate item.

The "work-spend" lifestyle into which so many are locked drives growth in disposable income, which naturally translates into greater consumer purchases. As the saying goes, "we spend money we don't have, to buy things we don't need, to impress people we don't like". It is clear that consumption goes way beyond satisfying an individual's physiological and physical needs. Material consumption is used by many people to create and maintain a sense of identity and to show allegiance with certain social groups. Communication and education will therefore have to play a major role in achieving sustainable consumption. People will change their behaviour if they understand the reasons for doing so and if it is made easy for them. They need to be informed of the environmental and resource-related consequences of their purchasing and lifestyle decisions. Education is also needed to encourage the use of products made from recycled or recovered materials as well as to inform individuals about the importance of source separation of their household waste.

Developing a recycling culture: most countries achieving a high level of recycling post-consumer waste have done so by creating a culture of doing so. In Germany, schoolchildren are taught about the importance of properly separating their waste, and separate bins are provided and weighed. The less mixed waste you have, the less you pay. In Vienna airport, all public bins have four different-sized compartments: paper, glass, metal and "other". In the town of Kamikatsu, Japan, a goal of zero waste to landfill or incineration by 2020 has been adopted, due to the closing of both local incinerators. Although there was initial resistance from the local community, the town now achieves recycling rates of 80% for household waste in the absence of either legislative measures or financial instruments. Local residents take their waste to the local waste centre and separate it into 34 categories.

Product service systems: a whole new way of thinking about products, the way an economy functions, and what it is supposed to accomplish has recently emerged. Instead of just selling goods, manufacturers are moving towards provision of services – essentially a transformation of consumer habits whereby they do not specifically demand products but rather seek the utility that these products and services provide. By using a service that meets their need rather than a physical object, more needs can be met with lower material and energy requirements.

Several companies have already begun to expand on this concept. Xerox already leases over 75% of its equipment, and Dow Chemical and Safety-Kleen have begun to lease organic solvents to their industrial and commercial customers. They advise on the proper use of the chemicals, which they recover themselves instead of making their customers responsible for disposal.

Corporate social responsibility (CSR): many companies are beginning to address environmental issues due to the positive association such moves will have with their brand. Wal-Mart has been pioneering in its approach to addressing sustainability through several initiatives, including one that concerns packaging. In 2006, Wal-Mart set a target to reduce all supply chain packaging by 5% by 2013. Additionally, it has set a target for all transport packaging to be reused and or recycled by 2011 through improved pallets and reusable plastic containers. The sustainable packaging programme is committed to using materials of the highest recycled content without compromising quality. This includes using components chosen based on recyclability post-use.

POLITICAL MEASURES

Governments will play a critical role in moving towards implementing new sustainable waste and resource management processes. Specifically, regulation will allow industry to gain confidence in investing in new technology development, as investing in facilities that are not required to meet regulatory standards under legislation is risky.

Product regulation and labelling: governments have the potential to influence product development through regulatory mechanisms. National minimum standards for product performance can be set. Minimum standards are complemented by eco-labelling programmes to give purchasers information and encourage manufacturers to design and market more eco-friendly products.

Integrated product policy: at EU level, there is support for an integrated product policy (IPP)14. This aims to influence the environmental impact of products by looking at all phases of their lifecycles – not just the consequences of disposal but also the impacts of production and factors such as energy use in consumption – and taking action where it is most effective. With so many dif-

ferent products, no one simple policy measure can be applied to all. Instead, a whole variety of tools – both voluntary and mandatory – can be used to achieve the IPP objective, including economic instruments, substance bans, voluntary agreements, environmental labelling and product design guidelines.

Extended producer responsibility (EPR): waste can be avoided if manufacturers factor in environmental considerations at the product design phase. EPR laws encourage this by imposing accountability with manufacturers over the entire product/packaging lifecycle and requiring companies to take back products at the end of their useful life. EPR typically bans the landfilling and incineration of most products, establishes minimum reuse and recycling requirements and specifies whether producers are to be individually or collectively responsible for returned products. This mechanism shifts the responsibility for waste from government to private industry and encourages the internalisation of waste management costs into product prices.

In Europe, this concept has been embraced and legislation exists to control waste from electronic and electrical equipment, cars, tires, batteries, office equipment, furniture, construction materials, and packaging. Germany has been the EPR pioneer in tackling packaging, and passed a law in 1991 requiring producers to take packaging back for reuse or recycling. Over three years, recycling waste paper rose to 54% from 45% where it had stagnated for 20 years[3]. Austria instituted a similar system in 1993 and has achieved 73% recovery and 64% recycling[14].

Tradable permits: governments can use permits to regulate and reduce resource consumption, waste generation, and environmental pollution over time. The concept behind tradable permits is that all polluters are sold a defined amount of permits allowing them to discharge waste or pollution. If an organisation can reduce its discharge, it can sell its remaining permits. For example, landfill allowance trading schemes (LATS) allocate tradable landfill allowances to each waste disposal authority in England, allowing the disposal of a certain amount of biodegradable waste per year. These authorities can then use their allocations in the most effective way, such as trading with other disposal authorities or saving them for future years.

TECHNOLOGICAL MEASURES

None of today's industrialised economies is truly sustainable and all could be leaner without suffering significant setbacks. Annual material throughputs in America and Europe are estimated as 80 and 51 tonnes/person respectively, but for an average Japanese it is just 21 tonnes. Given the broadly similar living standards of Americans, Europeans and Japanese, there is clearly considerable room for improvement in both the US and Europe.

Hidden material flows: much of the material flow in industrialised economies never passes through consumer hands, but these flows account for around 60% of the total in Europe and around 70% in the US. Dealing with these "hidden flows" requires some of the most destructive practices, i.e. logging, mining, and smelting in particular, be downsized. This can be accomplished though numerous technical solutions that improve energy and material efficiency, boost recycling and reuse, and lengthen the lifetime of products, so that the need to extract virgin raw materials is much reduced.

Rethinking production: 80–90% of products' lifecycle economic and ecological costs are already inevitable once they have been designed, and before manufacture. We must therefore address how we make things, from their design to how they are put together and how they are used. Products should be designed to last, so that they become "waste" less quickly, and to be easily remanufactured, deconstructed or recycled when they do become waste. Complementing this, manufacturers should move wherever possible towards using recycled materials.

Individuals may deliberately choose items made from recycled materials, such as a carpet from recycled bottles. However, such materials have been "down-cycled" to make new products. When a car is recycled, the high quality steel is mixed up and contaminated with copper cables, plastics and paints that decrease the quality of the steel and limit further options for its use. Recycled steel sometimes requires high quality virgin steel to be added to make it usable again and it will still not be of a grade sufficient to produce a new car. Indeed, recycling inevitably uses energy and generates new forms of waste and these efforts probably only postpone the ultimate fate of the resources by a few lifecycles. They will still end up in landfill. A major problem to be addressed, therefore, is that almost no product on the market is actually designed with recycling in mind.

Product design coupled with new technological advancements can help to address this issue. "Active disassembly" makes use of smart materials, such as shape memory polymers, that will change their shape at a "trigger temperature"[15]. This allows for product components to be easily disassembled and separated so that the different materials can be collected and reused, remanufactured, or recycled.

Dematerialisation: this process is aimed at reducing the amount of raw materials needed to create a product. Advocates have pushed for a "factor 10" reduction – policies that aim at providing a given volume of goods and services with 1/10th of the material input4. Indeed, there was some success in this area with resource productivity in the EU improving by 30% between 1980 and 1997. However, this improved efficiency has not translated into an overall reduction in resource consumption, which has instead remained essentially constant as consumer wants and needs continue to increase. Although dematerialisation is an important step towards achieving more sustainable economic activity, alone it may be insufficient to contend with humanity's increased desire for consumption and must thus be coupled with strategies addressing consumption.

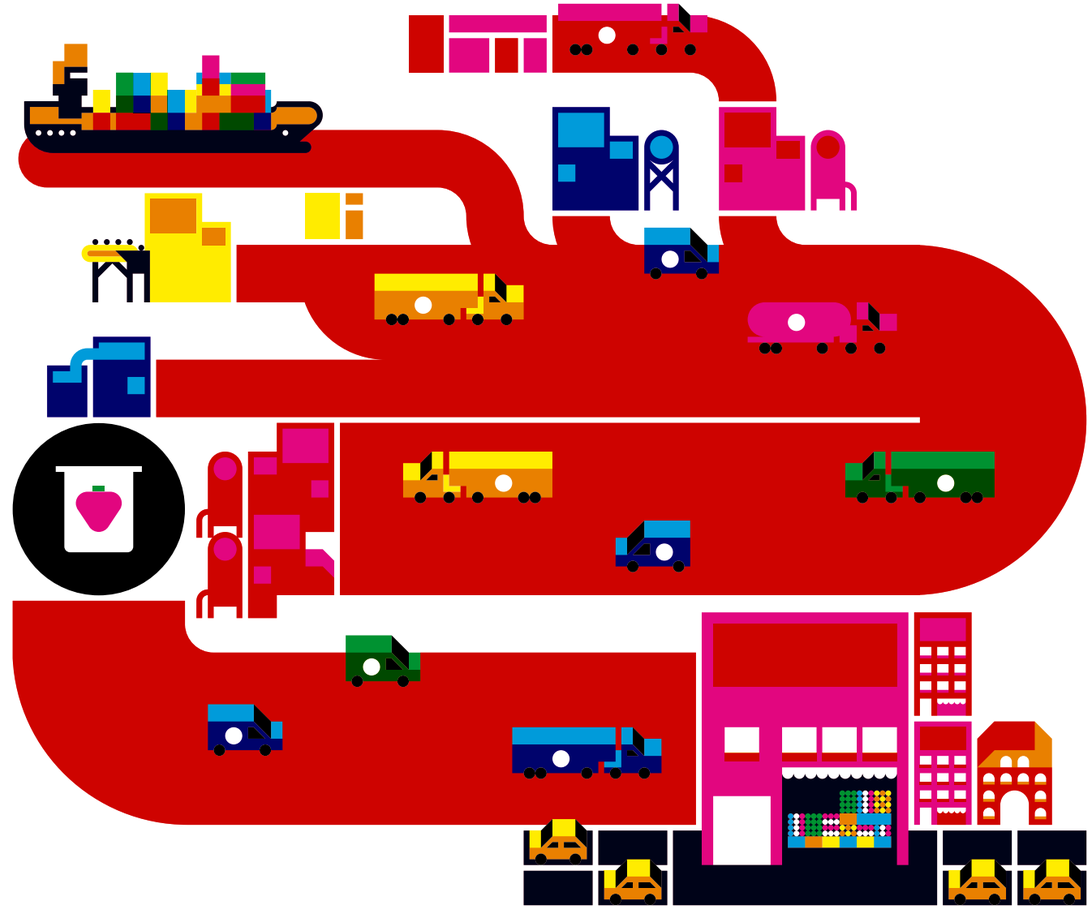
Clean production: toxic materials are another matter for concern, yet there are plenty of opportunities to reduce and even eliminate reliance on them in manufacturing to prevent air and water pollution and avoid hazardous waste generation. An innovative example of achieving cleaner production was in a pulp and paper mill in Maine, USA. In the early 1990s, it was a major polluter but a shift in management led to active co-operation with local stakeholders. Initial focus on end-of-pipe pollution control was replaced by the implementation of pollution-preventing measures. There was a rapid reduction in the release of organic pollutants and mercury, dioxin and chloroform emissions were eliminated, and particulate emissions reduced by 50%. Hazardous waste generation decreased by 95% by 1998 and solid waste to landfill by 91%[3].

Industrial ecology: this is the "cradle-to-cradle" system of integrated, closed-loop material flows whereby the by-products of one organisation become the feedstock of another. The community of Kalundborg in Denmark is widely regarded as the best example of industrial ecology. Here, an increasingly dense web of symbiotic relationships among local companies has slowly evolved over the past three decades, yielding both economic and environmental benefits. For example, natural gas from the refinery becomes feedstock in a plasterboard factory, fly ash from the coal-fired power station is used by a cement manufacturer, and sludge containing nitrogen goes to nearby farms for fertiliser. Interestingly, rather than planning for sustainable manufacturing, the business relationships in Kalundborg evolved spontaneously due to their economic benefits.

Cradle-to-cradle design: the current destructive qualities of our cradle-to-gate system can be seen as a fundamental design flaw rather than the inevitable output of modern-day economies. Good design, based on natural systems and a cradle-to-cradle philosophy, can transform the making and consumption of things into a positive system. Indeed, the traditional approach to sustainability focuses on improving the efficiency of material use and energy consumption and while this is a useful strategy it tends to reduce harmful impacts rather than prevent the harmful activity in the first instance. As Cradle-to-cradle design: Michael Braungart, one of the cofounders[6] of the cradle-to-cradle concept, put it: "By destroying a little less, we are not protecting anything. So it is not about being less bad, but about doing the right thing"[17].

Modular products: most consumer products are made in ways that render them near impossible to repair and have damaged or broken parts replaced. Even when something can be repaired the cost is often so great that it encourages people to throw the old model out and buy a new one.

Durability, repairability, and upgradability are essential to lessen the environmental impact of consumption. A modular approach permits access to individual parts and components so that they can be easily replaced. Companies like Xerox have adopted this philosophy and extended the useful life of their products, leading to increased opportunities for maintenance, repair, upgrading, recycling, reuse, and remanufacturing, and thus greater business and employment potential throughout product life. Xerox, a pioneer of remanufacturing, kick-started its Asset Recycle Management initiative in 1990, which led the company to design products from the outset with remanufacturing in mind and every part reusable or recyclable. As a result, 70–90% of equipment returned to Xerox at the end of its life can be rebuilt[3].



CONCLUSION: BEYOND WASTE

Waste is a crisis of human doing and it is becoming increasingly difficult simply to ignore. It is a result of the ever-increasing population combined with our growing consumerist culture.

As Einstein is reputed to have said: "The world will not evolve past its current state of crisis by using the same thinking that created the situation."

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Arup's Drivers of Change programme explores those global areas of influence that have been identified as most likely to have a major impact upon society and upon business. The programme was started by Chris Luebkeman and the Foresight, Innovation & Incubation (FII) team, a group tasked with exploring emerging trends and how they impact upon business.

The individual components of a common strawberry yoghurt travel over 9,000 kilometres until it ends up on the supermarket shelf. Stefanie Böge of the Wuppertal Institute already calculated this back in 1992. She also found out that a lorry has to be moved approximately 14 metres for each cup of yoghurt.

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05

TRAFFIC
BACK TO THE FUTURE? URBAN TRANSPORT 2050

By 2050, urban transport will have been shaped by oil shortages, climate change and the destructive effects of the automobile on urban environments. Major fields of action will be the reorganisation of cities, their density, the kinds of centres they have and the mixture of activities in close proximity. Moreover, the quality of the public realm is key to future transport, as it will enable people to travel by superior public transport, and comfortably and conveniently to walk and cycle.

By Jeff Kenworthy

WHY?

There are at least three good reasons for weaning our cities away from the car: oil extraction will soon have passed its peak, climate change is marching on and cars take up space – a lot of space that could be used for other purposes. In American cities, up to 70 per cent of all surfaces are reserved for transport by car and the services associated with it. The motorised society's hunger for land is gradually eating up square metres of land that could be fertile and cultivated in and around our cities.

WHAT?

The cars of the future will be electric and thus more efficient and quieter. But there is a great deal to be said for restricting their use overall and promoting public transport, cycling and walking. The fact is that all these transport systems are more land-efficient than the car – and many cities are now up against their limits in terms of transport management. The key nodes in the polycentric cities of the future will mostly be connected by rail, which will also take on an important role in local goods transport.

HOW?

First of all, the need for transport should be avoided – by rebuilding our cities in more compact form with a better mix of uses. Producing food near the city also helps to cut down transport distances. Street space will change: other means of transport will join the car on an equal footing. Many squares, above all in inner cities, will have their traffic tamed and thus regain their attractiveness in terms of spending time there. But planning changes are also due: long-term predictions will become increasingly impossible; they will have to be replaced by a more markedly participative and flexible approach.

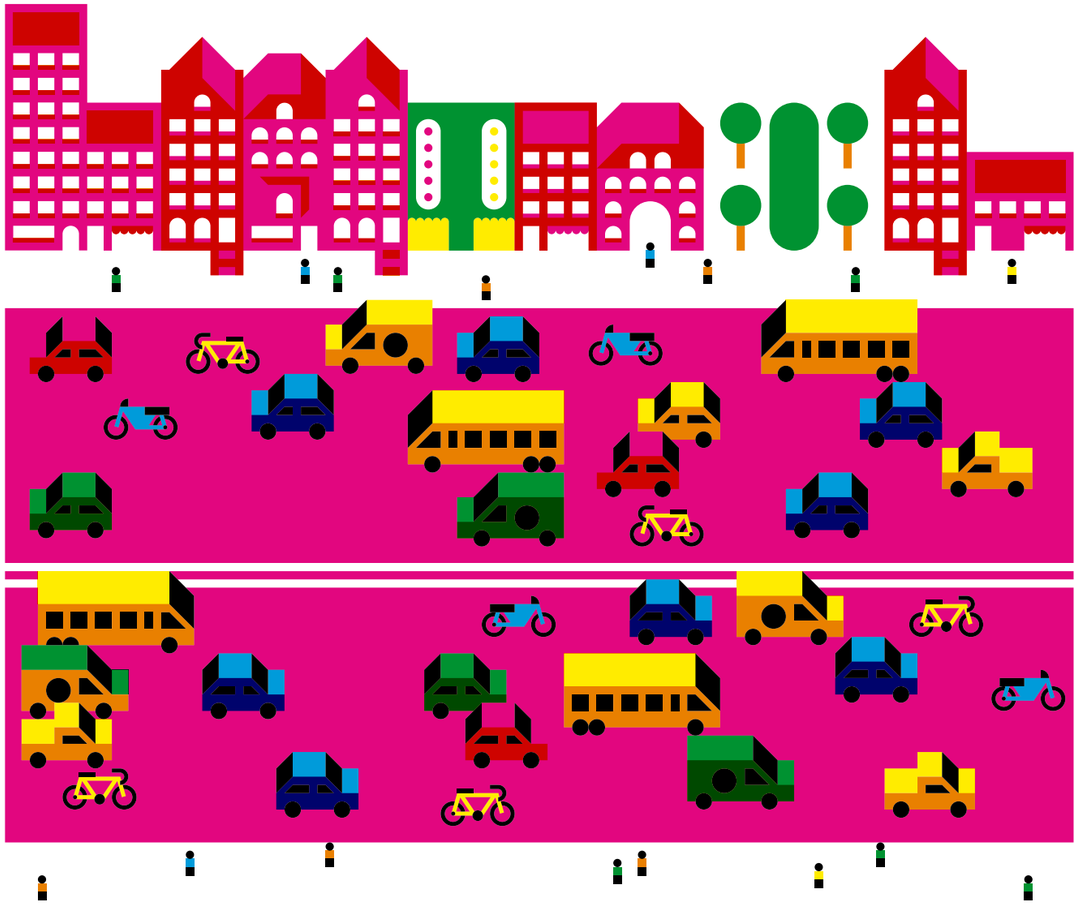
Road traffic in 2009 (left) and road traffic in 2050 (right): While, despite lip service, cities are currently still dominated by car traffic, in the ideal green city of the future many traffic systems will exist side by side as equals. Bicycles and pedestrians in particular will play a much greater role.

Crystal ball gazing is by nature a hazardous exercise and one that allows for all manner of debate. There can be no right or wrong answers until the years have been fulfilled. The only transport 'prediction' I can recall being more or less fulfilled was the 'doomsday' outlook in the late 1800s concerning what the 'horseless carriage', courtesy of Karl Benz, would do to society and cities in particular - not least because the early cars ran on alcohol, just like many of their drivers. Even though cars were, indeed, bad news for the horse and carriage, they were good news for people's freedom, choice and independence in travelling, and the car remains one of the most transformative pieces of technology ever adopted.

There is no doubt that the car is a very good servant, but it is also a very bad master when it dominates transport systems. To the bitter chagrin of police and road safety campaigners the world over, many car drivers still continue to run on alcohol. And the automobile's many negative impacts on society have extended way beyond just transport death and injury to include a host of environmental, social and economic costs.

Any look at urban transport in 2050 is of necessity, therefore, concerned with the future role of the car and the many factors that then spin off that, such as the role and type of public transport, the magnitude of walking and cycling in cities and the kind of land use arrangements that will go with the future transport picture.

This article looks at the possibilities for urban transport 40 years from now. It first looks briefly at a transport history of cities to help understand the future vision for 2050. It then examines some of the critical issues shaping urban transport today. It argues that, due to the plethora of problems facing transport (in particular the continuing rampant motorisation of cities with cars, motor cycles and trucks and the decline of the public realm), the kind of cities we will have in the future, and the balance of transport modes prevalent in them, will be very different from the automobile-dependent and automobile-saturated environments characteristic of so many cities today. But they will not be unrecognisable from the land use arrangements that have dominated cities in the 9,000 years or so of urban history that preceded the mass production of the car.



It is only by first considering this brief history of transport in cities that we can get a sense of what might unfold by 2050

A TRANSPORT HISTORY OF CITIES

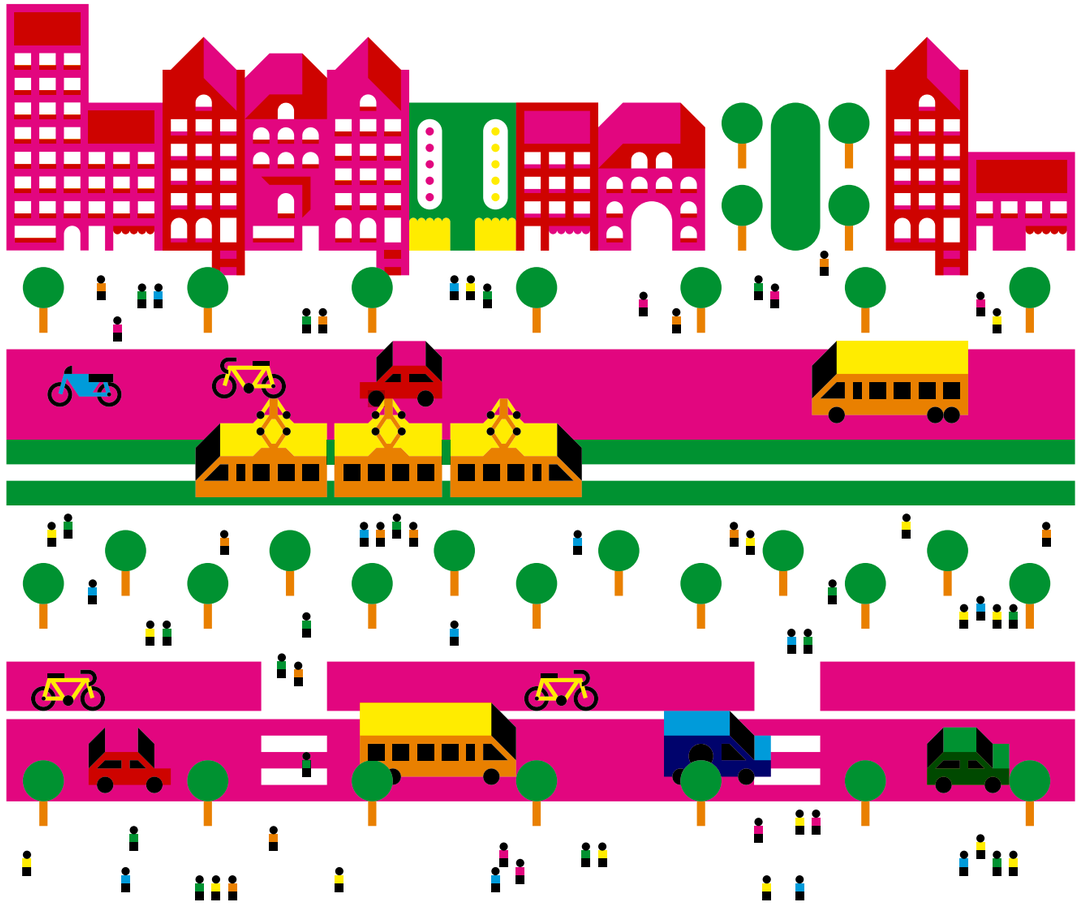
Automobile cities are the invention of the post-World War 2 period. For the vast sweep of urban history, cities were very compact, dense places and were 'slow cities', based on walking. Cities in the now developed world enjoyed a brief period of about 100 years between 1850 and 1950 when public transport became a dominant mode. Cities in developing parts of the world remained largely walking cities and did not develop very sophisticated public transport systems. The public transport city era saw the invention of horse drawn trams, then steam trams and steam trains, followed by electric trams and trains and at each step in this evolution, urban development clustered closely around the rail systems, either in linear forms along the tram lines or in nodal forms around train stations. It was only at the end of this period, when diesel buses started to gain ascendency, that we saw the ability of land use to disassociate itself from the public transport system and begin to fill in the interstitial spaces between the rail lines. The urban bus was the harbinger of sprawling land use patterns that would later burgeon in settlements based almost exclusively around the automobile.

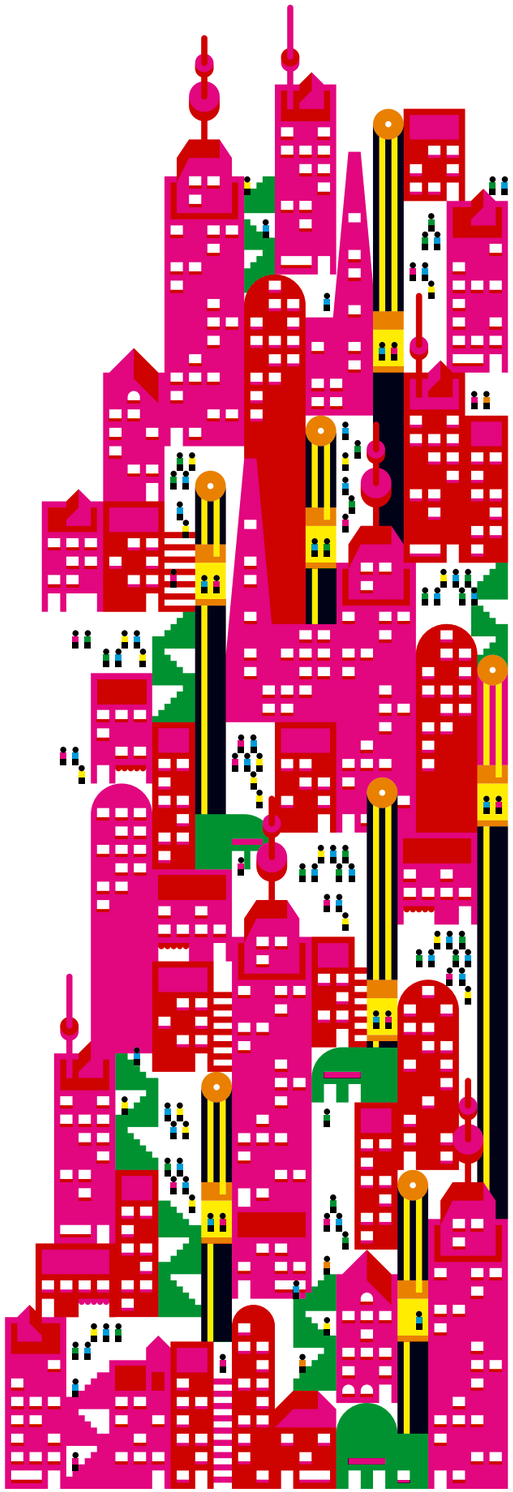
Unlike this evolution, poorer cities today are leaping, with a single bound, from walking and cycling based environments to automobile and motorcycle dominated cities, and they cannot cope.

PROBLEMS OF PRESENT TRANSPORT SYSTEMS

The two starkest realities to which urban transport must respond today are, firstly, the declining physical availability of oil and ultimately very much higher prices, notwithstanding the current global recession and depressed price of oil; and secondly, the major problem of climate change or global warming, which could see thousands of coastal cities inundated and millions of environmental refugees unless global CO_2 production can be significantly curbed, and rapidly so. The imperative to reduce the burning of fossils fuels globally is not really a choice anymore, unless we collectively decide to commit mass suicide, which, it could be argued, is unfortunately not entirely off the agenda. There are simply no hiding places left from global warming and every city must contribute to solving the problem.

The first issue is better known as 'the peak oil problem', which occurs when 50% of known conventional oil reserves are used and the world's demand for oil far outstrips its supply possibilities. The remaining 50% of oil is so hard to get and requires such





costly and energy intensive extraction techniques that it is impossible to avoid this growing gap between supply and demand. Even though it is tempting for some to believe that new oil discoveries will provide salvation, they will mean nothing more than a short delay in the inevitable post-petroleum age; daily world oil production will simply go into unstoppable decline. Every oil well and every oil province goes through this cycle and some senior oil industry analysts argue that, globally, oil production has already peaked - as early as 2006 but. if not, certainly by 2015.

Transport today assumes an unbroken and cheap supply of oil for its survival. Any deviation from this causes major dislocations which manifest themselves as chaos at the petrol pump, even violence, trucking blockades, stockpiling of fuel and criminality associated with fuel theft. The world had a taste of this in 1973/4 and again in 1979 in the USA when people attacked each other in the gas queues. But these OPEC and Iranian-led events were mild compared to what we are potentially heading for in this century.

It is also clear that it is actually physically impossible to substitute the current level of oil demand for urban transport with alternative energy sources. There has to be a reduction in energy demand as well as a diversification of supply in terms of renewable energies. But even if it were possible that some 'silver bullet' for energy were to come along, such as being able eventually to run all car fleets on electricity generated from renewable sources in a Vehicle to Grid system (V2G) (which is on the horizon), there are so many other good reasons to wean cities off profligate use of cars. For a start, no one has invented the fold-up, portable car yet, so cities continue to explode in physical size with destructive effects.

The space consumption alone of automobiles for roads, parking and ancillary services consumes over 40% of land in auto-dependent cities and up to 70% in critical areas like some central cities in the US. For every car in US cities, there is an average of eight separate car parks, at work, at shops, other businesses, sports areas and so on and at 35 square metres per bay that is 280 square metres per car, just for parking. In higher density environments common in many European cities and redevelopment areas in North American cities, one dwelling, including all the ancillary urban land uses like local parks, shops and so on, occupies only about half that amount of land[1]. In public transport, walking and cycling environments (where typically over 70% of daily trips are by these modes), roads, car parks and the like occupy closer to 15% of land.

This appetite for land based on automobile lifestyles is rapidly eating up every piece of fertile arable land in and around cities, threatening food production and supporting an unsustainable global food system based on the '3000-mile Caesar Salad' instead of the '100-Mile Restaurant', which is just becoming popular in America. China has already realised that its current trajectory of urban development, accompanied by demolition of the agricultural and food production base of the nation, which in turn is driven by a thriving domestic car industry and the policy of 'private car entering family', is simply impossible to continue. Unless, that is, it is decided that eating is no longer necessary or that 1.2 billion people can be fed on imported food!

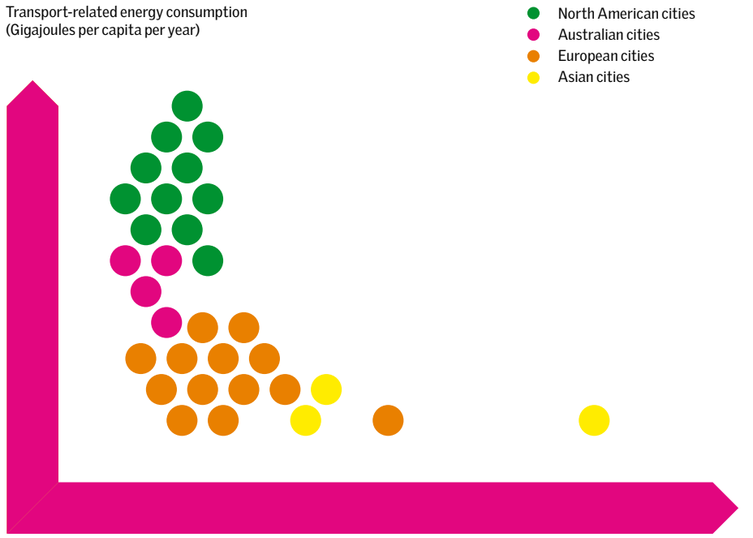
The other big issue here is the freshwater needed for drinking and growing food, which is in critically short supply in the world. Automobile cities drastically diminish water infiltration into groundwater aquifers and sprawling urbanisation actually reduces rainfall compared to cities that maintain extensive green natural areas.

URBAN TRANSPORT 2050

So what will urban transport look like in cities in 2050?

It is the contention here that, yes unquestionably, there will be many technological innovations in transport, but the most fundamental change in urban transport will be in the shape of cities and the capacity of people to conveniently use walking, cycling and public transport. Transport is a derived demand and the form and size of that demand is shaped by land use arrangements. An extreme example is in Singapore and Hong Kong, where much transport movement is vertical, up and down elevators to reach the rich diversity of amenities that lie right at the base of buildings and within a few hundred metres of dwellings.

As already stated, new cars will certainly be produced, probably running on electricity from renewables,



Left: **Traffic not only occurs on a horizontal plane. Especially in very dense cities like Hong Kong, lifts and escalators play just as important a role as roads and paths.**

Right: **The more densely cities are built, the less energy they consume for traffic. This relationship can be empirically proven world-wide. However, in an international comparison it becomes apparent just how similar the cities of one continent are both structurally and with regard to traffic systems.**

and these vehicle fleets will form an important storage mechanism for renewable electricity. Will we be driving those new cars to the same extent as we drive the internal combustion engine car today? An unequivocal no is the answer. The world cannot sustain that, but the push will be there because many perceive the cost of fuel as the only limiting factor to car use.

The automobile will certainly be with us in a new cleaner, efficient, safer and most likely electrically powered form, and it will be used for those trips not possible or convenient by public transport, walking or cycling. But because its level of usage will be dramatically reduced, streets will have a beautiful balance of modes. They will be avenues of trees and gardens, graced with wide footpaths and cycleways, frequent, quiet, electric public transport modes offering 5 to 10 minute services or less, and lanes for electric cars.

So car use will be better managed, as it desperately needs to be even now, through both urban planning and transport policies to limit demand and curb supply of new private transport infrastructure, as well as a variety of possible charging mechanisms for the right to road space, according to the individual city's need. Gone will be the days when one does not have to even think about the decision to jump in the car and add to peak period congestion. Car use will finally join the rest of the world in terms of pricing according to demand level. We see the tentative beginnings of this in London's central city charge, Singapore's area licensing scheme and its onerous prices for the right to buy and use a car, and Hong Kong's road pricing scheme.

Urban systems are straining at the seams right now to contain and manage current and growing car usage. Destruction of agricultural land and natural habitat is rife, environmental impacts are huge, the infrastructure costs of new sprawling development unaffordable and the social negatives of declining community and connectedness are tearing some cities apart from the inside. And in many cities obesity is growing at an alarming rate due to auto-lifestyles.

Like the car, new versions of existing public transport technologies will continue to appear, just like the revolution we have seen over the last 25 years in the technology of trams in the form of new Light Rail Transit (LRT) systems. They will look better and will run increasingly on renewable energy, predominantly electricity. They will become ever more attractive to people as pieces of hardware through their increasing comfort, onboard amenities, attractive designs, service levels and reliable, real-time timetable information. As Japanese rail researchers have said, rail systems will shift radically in the future from offering timetabled services based on a 'fast food menu' to providing a 'gourmet menu' of services based more on individual needs.

There will, however, be no magic technology bullets. Public transport, regardless of technology, will not be able to pick up enough people, unless there are also changes in urban form to create the concentrations of people and business needed by public transport systems. The same goes for walking and cycling. Bikes continue to improve technologically. For example, increasingly in Europe we see electrically assisted, battery pushbikes and the next step in this is solar recharging stations around cities where bikes may refresh their batteries. Of course, the ability to conveniently transport bikes on public transport vehicles, especially buses, is something that will almost certainly become more prominent around the world; a simple innovation which greatly extends the scope of bike travel and adds to public transport use too.

But the more fundamental issues for both walking and cycling are short travel distances, (which means more compact, mixed land use), improved safety, better quality of urban spaces and good facilities such as lockers, showers and, of course. direct, safe cycle paths on all streets, as in most Dutch and Danish cities.

With respect to city form, we can expect that by 2050 many urban regions will have evolved into very strong polycentric forms. Even cities such as Sydney and Los Angeles today are heading in that direction and Vancouver, British Columbia is a fine example of this, especially in the quality of the public environments in its centres. Vast numbers of cities will have built new public transport systems, mainly in the form of new rail lines. These rail lines, both radial and circumferential, will link together a series of centres at both a regional and local or neighbourhood scale. Feeding into these centres from the areas around will be fleets of electrically propelled buses and smaller LRT lines. Biodiesel, which is touted as a new transport fuel, especially for buses, is quite an environmentally unsustainable fuel for widespread application, especially in terms of its demand for biomass and impacts on food production.

In terms of freight we may well see tram freight systems to help distribute goods, particularly at night, when regular passenger tram services do not operate. Or short spur lines might be built purely for freight trams. And we may well see sophisticated networks of solid pipeline technologies appearing under some cities as a way of delivering goods from their origin to destination without trucks. It is possible that people may be able to order their shopping from within the home and have it delivered by such systems directly into the dwelling. But, as with all technologies one has to weigh up the downsides, which might include encouraging even greater levels of physical inactivity with its attendant health costs, or further diminishing community.

2050 – THE VISION AND THE MODEL

So what is the vision for cities and transport systems by 2050? This ten-point list assumes technological innovations, including some of those described above, but the critical elements determining the character of transport in 2050 are the land use, urban design and social framework in which such new technologies are deployed.. Technological innovation is seen as a given in transport in 2050, but not the driving force. We can summarise this in a simple ten point conceptual plan.

1.
The city is compact, with a mixed-use urban form that uses land efficiently, shortens travel distances, makes walking, cycling and public transport the dominant modes and protects the natural environment, biodiversity and food producing areas.

2.
The natural environment permeates the city's spaces and embraces the city, while the city and its hinterland provide a major proportion of its food needs. Urban agriculture is practiced in every available space and buildings have been 'greened'. Green cities are hot spots for walking and cycling.

3.
Freeway and road infrastructure are de-emphasised in favour of transit, walking and cycling infrastructure, with special emphasis on rail. Car and motorcycle use are minimised. Significant numbers of existing freeways in thousands of cities around the world have been torn down, as in Seoul in 2006 where 6 km of elevated freeway were demolished and replaced by a river and green boulevarde. The realisation that traffic is a gas, expanding and contracting to fill the space available, and not a liquid flowing over everything if its space is removed, is a central pillar of transport policy. Traffic is made to compress to fill the space available and not the reverse, which dominated transport planning for 150 years.

4.
There is extensive use of environmental technologies for water, energy and waste management – the city's life support systems become closed loop systems. This is important for the way compact, mixed uses are designed for increased density because there has to be space for these local "life support" systems and the complexes must be designed around solar orientation.

5.
The central city and sub-centres within the city are human centres that emphasise non-auto access and circulation and absorb a high proportion of employment and residential growth.

6.
The city has a high quality public realm throughout that expresses a public culture, community, equity and good governance. The public realm includes the entire transit system and all the environments associated with it. This greatly assists the attraction of non-auto transportation by creating livable environments and effectively bans the provision of excessive auto infrastructure because of its space demands and devastating effects on the public realm.

7.
The physical structure and urban design of the city, especially its public environments are highly legible, permeable, robust, varied, rich, visually appropriate and personalised for human needs, again promoting more walking and cycling.

8.
The economic performance of the city and employment creation are maximised through innovation, creativity and the uniqueness of the local environment, culture and history, as well as the high environmental and social quality of the city's public environments. This helps change the nature of the transportation function away from long distance trips for commuting and other purposes to more local, sustainable trips.

9.
Planning for the future of the city is a visionary 'debate and decide' process, not a 'predict and provide', computer-driven process. The old paradigm of predicting how much traffic is going to be generated 40 years in the future and how many roads will be needed to accommodate it, was changed by 2015 to a community driven process of envisioning the future sustainable transportation system and working step by step to reach a vision of green transportation by 2050.

10.
All decision-making is sustainability-based, integrating social, economic, environmental and cultural considerations, as well as compact, transit-oriented urban form principles. Such decision-making processes are democratic, inclusive, empowering and engendering of hope. They have created a society in 2050 that is far more participatory and decentralised in its critical decision making, while fitting in with an overarching framework of sustainability.

When we look at the planning visions for cities, we see that they are, in fact, the key elements of all such visions, with some variations and innovations to suit the particular circumstances. A good document to look at in this respect is the international competition for sustainable urban systems design from 2003. It documents in detail sustainable cities visions for Russia, the USA, China, Canada, Japan, India, Germany and Argentina 100 years into the future[2].

The figure on the opposite page summarises some of the ideas in this article in a 'future city' conceptual model. In the centre in white, we have the old walking city, which, in most cities, corresponds to the original central city and, depending on the age of the city, could have been surrounded by protective walls. In dark red we have the inner city tram systems of the 19th century and first half of the 20th century, based often on a grid street network. Then, leading out of these inner areas into new rail-based suburbs of the town planning era, we have the steam train and later diesel and electric train lines around which nodes of concentrated development occurred at stations. In so many cities we can see these historical realities still today. Then, in pink, we have the auto-based suburbs, mostly evolved after the Second World War when the automobile became a dominant mass consumer item.

The yellow lines represent new rail based transit systems of greatly improved and more attractive rail technologies (heavy rail and light rail systems). The lines include new radial lines, since central and inner areas in cities will continue to have evolved and become more important in 2050. But in addition to this, there will be circumferential rail lines allowing movement around the city with effective interchanges between modes and lines (rail to rail and rail to bus and reverse). These lines will have been made possible by the fact that all stations will have a centre of varying size and intensity, the green nodes in the diagram. This centre will have a radius of between 500 m and 1 to 2 km. In effect, it will be a modern day manifestation of the walking city. It will be green, compact, walkable and bike-friendly. It will have a diversity of amenities that not only serve the people who reside in the centre but will also be a focal point of life for suburban dwellers, enabling short car trips into the centre in small urban electric cars or equally convenient short bus rides on fleets of electric "urban village buses or on feeder tram/LRT lines.

The overall structure of the metropolitan region will be a modern reinvention of the public transport city. In many cities around the world today, it is possible to see this very evolution happening now. Vancouver is one of the best examples of a metro area rapidly developing this model, while Sydney and even Los Angeles are heading in this direction. Cities such as Singapore and Hong Kong and Tokyo are also interesting examples of the model, though there is no necessity for all cities to develop such a high-rise urban form or to be so intensely urban in every way.

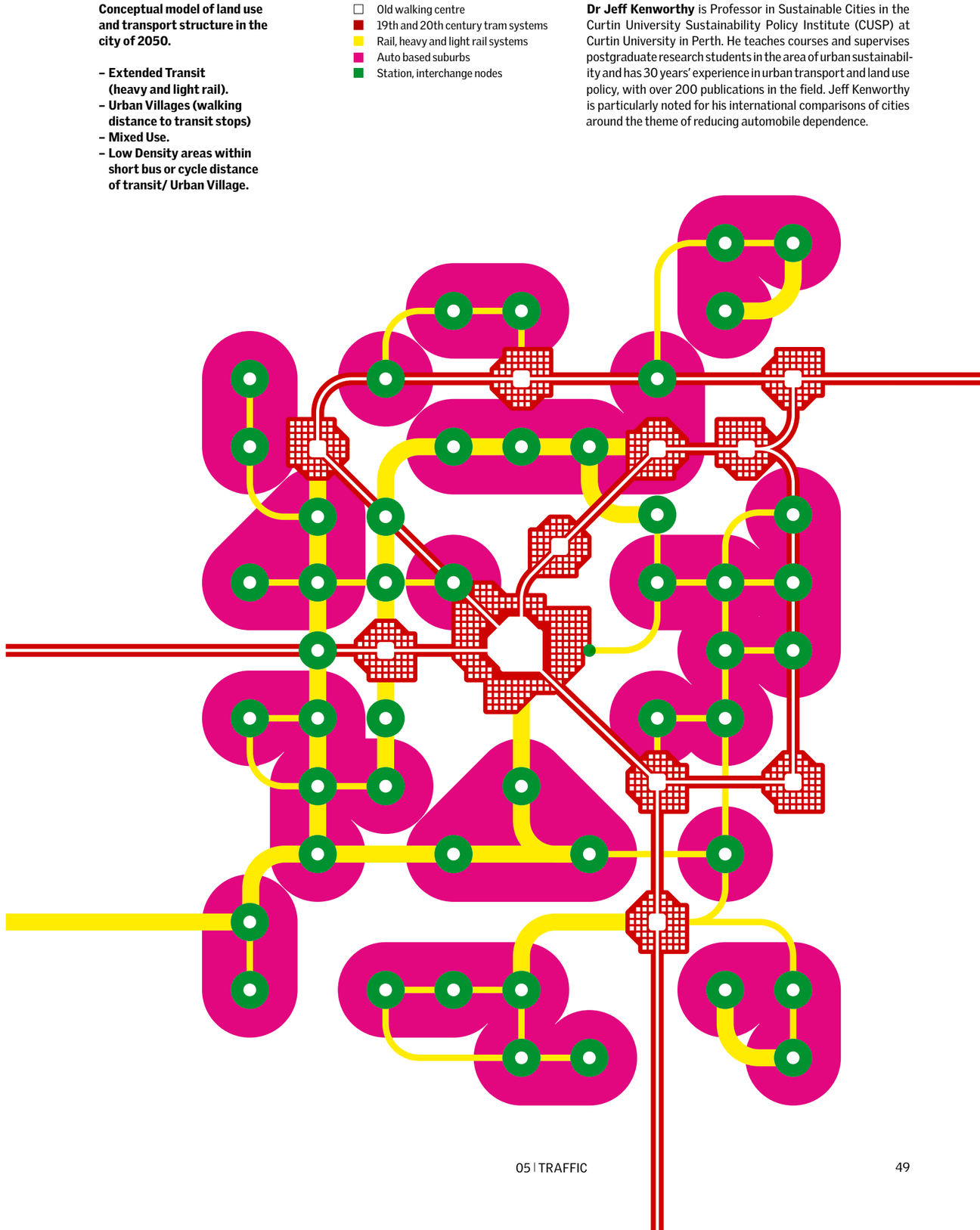
CONCLUSIONS

The kind of land use change necessary for the above model can be achieved with the beautiful four to five storey development characteristic of German cities such as Freiburg, in areas such as Rieselfeld, der Seepark or Vauban or in Munich's Messestadt Riem. Freiburg is perhaps the world's best model of all the ten points discussed here, with its superb conditions for pedestrians and cyclists, its beautiful green public realm, its growing deployment of environmental technologies, its excellent LRT system running on grass track beds and its planning philosophy to continue to strengthen its sustainability credentials.

The automobile and the cities it has created are a mere blink of an eye in the long history of cities. In many ways the basics of transport in 2050 will be a case of 'back to the future' in terms of city form and movement patterns, building on the long history of the walking and public transport city. Embedded within this basic framework, however, will be a plethora of new and upgraded transport technologies and more than likely some breakthrough innovations that reflect a far more intelligent, caring, equitable and benign approach to transport than the juggernaut that dominates too many cities in the world today.

Conceptual model of land use and transport structure in the city of 2050.

– Extended Transit (heavy and light rail).
– Urban Villages (walking distance to transit stops)
– Mixed Use.
– Low Density areas within short bus or cycle distance of transit/ Urban Village.



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06

LAND
LAND AS A RESOURCE

Urban economy, energy consumption, social welfare and microclimate are all determined by how cities use their land – and their hinterland. Cities will need to be a fundamental component of sustainability. In order for this to happen, they will have to do the seemingly impossible: they will have to be both dense and green, scaled to the individual and the globe, and make economic and social ends meet.

By Anna H. Milkowski and Karen C. Seto

WHY?

Land use means use of resources. Efficiency in cities' management of their land directly influences their ecological footprint. And this usually bears no relation to the land areas that are actually available; London's footprint alone is already greater than the whole of the UK. By 2050, the situation will be much more acute, particularly in the developing countries: this is where the greatest growth of populations and economies is to be found.

WHAT?

Dense, greened cities, planned for people are the model for the future. They come off well in all three sustainability categories – ecologically, economically and socially. Sustainable urban policy and planning affects the location and size of cities just as much as the nature and distribution of area use.

HOW?

Urban density must go hand in hand with a sensible mix of uses: urban monocultures generate additional private car traffic and thus higher emission levels. Urban transport systems have to favour pedestrians and cyclists. At the same time, buildings should respond to the visible and invisible characteristics of the site, its landscape and surrounding buildings. In dense cities especially, intelligent land-use will provide the basis for an extensive provision of daylight and fresh air to buildings and their inhabitants.

Over the past 20 years, the amount of cultivatable land that has been lost world-wide is equal to the total cultivated area in the US. Germany alone still 'consumes' over 100 hectares of land daily for new housing areas and infrastructure facilities.

THE IMPERATIVE

Land use drives resource use. How we use urban land will make or break global sustainability. Urban areas occupy a small portion of Earth's surface, but exert environmental and social impacts far beyond the urban boundary. With more than 60% of the world's population expected to live in cities by 2030, urbanisation is shaping the world, entwined with global trends of greenhouse gas emissions, economic development, and dietary shifts that promote chronic disease. At the same time, urbanisation offers enormous opportunities to achieve sustainability in terms of efficiency of resource use, delivery of sanitation, education, and other municipal services, building up rather than out, and multiple modes of transportation. In the coming decades, we expect the majority of urban growth to occur in developing countries. We already have 19 megacities with populations exceeding 10 million. Cities now grow not just by expanding but by merging. Many new cities have been rapidly usurping prime agricultural land, driving a concentration of food supply that hinges upon cheap transportation and increases vulnerability to climate events and food-borne illness.

Cities and accompanying urban lifestyles also impact land outside urban boundaries. The urban diet generally consists of increased consumption of meat and dairy products, degrading the environment by converting land for agricultural use, changing biochemical cycles, and depleting fresh water supplies. The demands of cities for construction materials and energy also drive global land conversion. These crucial mechanisms link urban land use to global sustainability.

2050 VISION

The urban vision for 2050 is one of humane dense-with-green compactness: scaled to the individual and the globe; maximising both physical space and economic, environmental, and social purpose. It will make cars obsolete, empowering pedestrians and cyclists with unintended consequences of promoting health and social capital; create an ethos of sharing that minimises consumption and environmental impact; and displace wealth of possessions with wealth of community, identity, and creativity. Furthermore, it will include accessible and safe green spaces consistent with high density, promoting fresh food, ecological knowledge, and environmental ethic. Urban sustainability must range across different scales from the local to the global. Cities that glow green because they exert impacts outside their accounting boundaries have to be exposed as unsustainable frauds.

Cities differ but share similarities that invite common strategies. In some locations we are building brand new cities, in others retrofitting old ones. In some places urban parks can serve as wildlife corridors; in other locations they merely support invasive species. Green roofs will look drastically different across climate, and might not even be green in some places. But common challenges exist. We can consider the opportunity to promote the components of sustainability through planning decisions related to: location of cities, size of cities, land use allocation and configuration.

Economic: urban land use can promote economic growth consistent with environmental and social goals. City location should consider anticipating the impacts of climate change, from environmental changes to rising costs of energy. The costs and benefits of land conversion related to urbanisation should account for disruption of ecosystem services provided by that land, such as water filtration that might need to be replaced by a human-constructed facility. In the 1990s, New York City determined that conserving land in the watershed that provides its drinking water was more cost-effective than building a filtration plant. Within cities, economy of scale and comparative advantage explain the role of urban areas as national economic engines. But even cities seemingly divorced from natural resources, such as the Silicon Valley of India, Bangalore, have developed based on natural characteristics contingent upon climate and environmental quality that impact where people want to live and work.

At the scale of city, land use that is compact-with-green can promote economic goals in addition to environmental and social ones. In the United States, the "green jobs" initiative associated with growth in the clean energy sector seeks to jointly promote both energy independence and urban renewal. Advocates such as Van Jones emphasize the opportunity for green jobs to benefit impoverished minority communities that have traditionally been excluded from the environmental movement. Green urban land uses associated with economic growth include concessions, ecosystem service markets, energy production (windmills, solar), and the increase in property values generated by proximity to parks and gardens.

Environmental: urban land use can further environmental goals. We must stop the conversion of prime agricultural land, rare biodiversity habitat, and vulnerable coastal areas into urban landscape. Maximising use of space to enable people-powered transportation is essential. Cities such as Vancouver and New York are exemplary. Efficient use of space hinges upon incorporation of urban features such as green roofs and scaffoldings and reduction of impervious surface associated with roads and parking lots. In older cities, it involves re-envisioning and repurposing of abandoned lands such as brownfields. Inclusion of green space can mitigate the urban heat island, provide a carbon sink, encourage urban biodiversity, and promote hydrosystems. Access to green space that enables experience of nature by children and others can also foster the environmental ethic. Equally important but less visible is the potential for compact space to promote compact consumption.

There is a growing understanding that urban diets have significant impacts on the global landscape. Urbanisation drives consumption of meat and dairy products, foods with high environmental costs in terms of inputs of land, water, fertilizer, and fossil fuels. Urban agriculture that replaces meat and dairy products with fresh fruits and vegetables could not just improve health, but significantly impact environmental outcomes. Local agriculture can promote the character of a community that defines its appeal as a place to live. Additionally, increasing local food security and diversifying the food supply are adaptive measures against projected climate change impacts such as increases in weather variability, rising transportation costs, and food shortages.

Social: compact green urban land use can also foster social objectives. It can promote public health and social capital if the physical arrangement of space promotes exercise, good nutrition, and community engagement. These have implications for economic growth and climate change resilience: the global rise in obesity and chronic disease threatens municipal and national economies; and social capital – a measure of the strength of community ties – influences health outcomes. For instance, lack of social capital is implicated in the very high death toll (13,000) of a 2003 heat wave in France, in which social isolation contributed to the deaths of many elderly people. Cities can be designed to minimise present and future risk to natural disasters. Rapid urbanisation in the low-elevation coastal zone vulnerable to sea level rise is an ominous and short-sighted trend. We will need compact use with diversity of purpose, with land advancing goals ranging from art to carbon sequestration to workforce retention. We need to scale to the person – bikeable, walkable, and with equitable access to fresh food, outdoor exercise, and clean air. Design that minimises heat island effect and climate change itself can promote health, as can less driving and more exposure to green space.

HOW CAN WE GET THERE?

Describing a four-dimensional integration across physical scale, temporal scale, academic discipline, and profession is simple compared to implementation. Stakeholders include

governments, developers, businesses, homeowners, industry, non-profits, architects, scientists, educators, and health professionals all seemingly clamouring for the same land to promote an array of objectives across an array of time scales. Solutions will be place-specific, and we must avoid assumptions about causal chains that seem logical but that may not be substantiated by evidence. For instance, density itself does not confer energy efficiency or enable human-powered transportation – if residential and business sectors are geographically far apart, for example. Some public transportation systems are highly inefficient. China is filled with examples of coexisting high density, energy inefficiency, and lack of human-powered transportation. Research and practice on urban land use tends to focus on production of compact urban space, overlooking the equally important subject of compact urban consumption.

Research: we need far more research on the links between urban land use and environmental and public health outcomes. Profound gaps in understanding and dialogue exist: conservation biologists and urban climatologists; hydrologists and environmental economists; and chronic and infectious disease epidemiologists. The urban setting represents a confluence of forces, the complexity and opportunity of which remain to be understood and realised. For evidence rather than assumptions to drive action, measurement of baselines and evaluation of impacts are necessary. Engineering coups such as farms in urban skyscrapers could be part of the solution.

Communication: integration across researchers, practitioners, and the general public and across levels of government can facilitate sharing of best practices and recognition of regional differences, while increasing the adaptive capacity of policy makers. Climate change should be viewed as a unifying theme across sectors of government, not a special sector or office. Success of policy hinges upon integration of stakeholders. In the U.S., the Chicago Climate Action Plan has been successful partly because the process to produce it incorporated residents and business leaders from the outset. Increasingly, public health professionals are becoming involved in discussions on land use planning.

Policies, programs, and services: policy can align the economic best path with one that maximises environmental and social outcomes, since these often converge over a longer time scale. We must engage in ecosystem service markets; internalise the cost of sprawl by incorporating true costs of infrastructure expansion; invest in urban agriculture and commuting; create energy efficient public transportation; subsidise best-practice consulting and auditing for private urban land use; and employ the urban landscape as a cost-effective tool for public health. Programmes such as communal bike rentals seen from Montreal to Barcelona, shared car programs such as ZipCar, tax credits for homeowner installation of solar panels or a windmill, car-free days, and large urban farmers markets are steps in the right direction.

Land use policy can shape physical space and sustainability outcomes. Zoning and design can set optimal defaults of walking and bicycling as the most convenient means of transportation. In this way, compact land use can dictate transportation preference and right size homes, rather than allow preferences for supersized homes and cars to dictate land policy. Equity failings such as disparities in economic well-being, health, and access to green space indicate the opportunity of disadvantaged communities to benefit most from sustainable land use. For instance, the organisation Sustainable South Bronx in New York City runs a green jobs training program in an impoverished section of the city and argues fiercely that economic growth, health, and urban renewal can all be promoted through improved land use featuring more parks, greenways, and gardens.

A principal challenge to redefining land use is its path-dependence – decisions made decades ago shape what is possible now. Focusing sustainable land use in low-income areas faces the additional challenge of the perception that other goals such as economic development and health take priority over land use, without recognising the opportunity for land use to cost-effectively further these objectives.

Education: cities present a concentrated educational opportunity. Sustainable urban land use can promote knowledge of best practices by professionals, students, and citizens who bring ideas to other places. Urban green space can promote knowledge of ecology and the environmental ethic through education of schoolchildren, adults, and practitioners. Often knowledge itself – of energy use or plants that promote urban biodiversity – is sufficient to change behaviour, on a scale ranging from the individual to a country. This phenomenon even has a nickname – 'the Prius effect' – that describes how the mere existence of a fuel-efficiency monitor on this hybrid car's dashboard spurs drivers to change their driving habits to improve fuel-efficiency. Concepts such as food-miles travelled, virtual water, and carbon footprint are increasingly incorporated into consumer labelling schemes. None is without flaw, but conceptually they advance accountability for invisible impacts and empower consumers to align purchasing with values. Governments can be slow to change; the private sector, driven by consumer demand, can act with comparative speed.

Social norms: sustainable urban land use hinges upon a transformation of social norms. Cities, our nexus of innovation and trends, are the best places to redefine wealth as independent of ownership and consumption. Art, education, identity, shared responsibility, and connection to place are assets too. We will need to re-frame sharing of space and transportation and hold each other accountable for environmental transgressions. We will need to increase consciousness of concepts such as vehicle-miles travelled and the lifecycle of a lawnmower, or better yet, a reel mower. This initiative will need to transcend traditional dividers such as political affiliation and education. It will take place in parks, churches, schools, and government halls and draw on an array of motivations for sustainable land use, from children's health to social equity. But change is happening. Who would have thought that programmes like shared cars, once dismissed as the earthy-crunchy ideal of the environmental fringe, would take root in mainstream society? That prestigious universities would plant vegetable gardens and compost food scraps? That churches would be leaders in fighting climate change?

WHERE TO BEGIN

Cultural shifts, a massive initiative of integrated global-scale urban science, and policy to align economic incentives with sustainable outcomes constitute a daunting prescription. But a consequence of this mission's size and scope means there is something here for everyone. Small actions do matter. We can start with offsets: for every Tata Nano, two fleets of children walking to school; for every new Chinese peasant discovering fried eggs and bacon, a rooftop urban garden; and for every razed forest, ten neglected urban lots repurposed to include public art, a solar panel, and a tree that welcomes a migrating bird.

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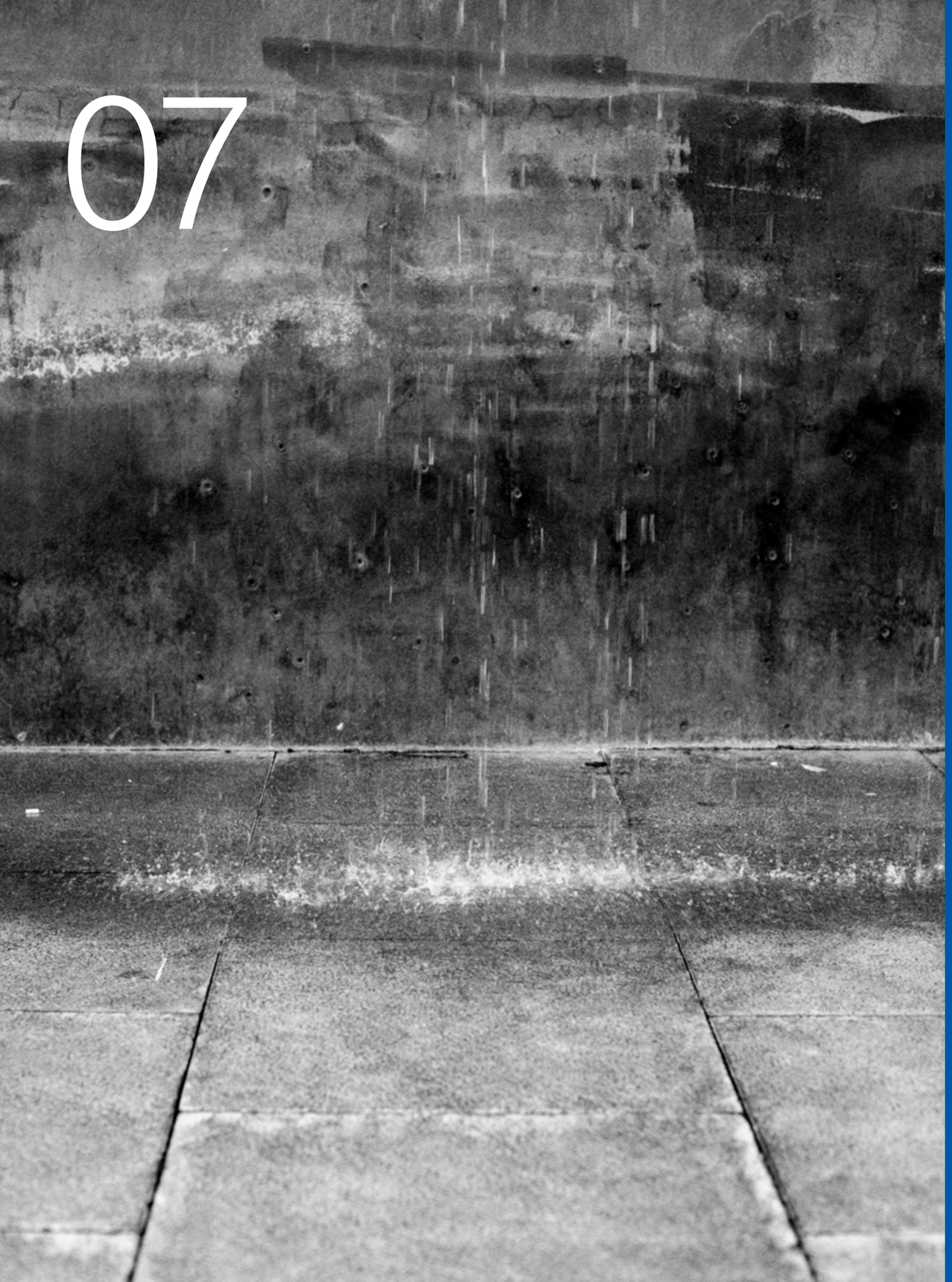


07

WATER
A WORLD RUNNING DRY: URBAN WATER USE IN 2050

Water is set to be one of the defining environmental issues of the 21st century. How will cities cope? Fred Pearce explores two scenarios: the continuation of business as usual and a world where we start taking this new limit to our activities seriously.

By Fred Pearce

WHY?

In some regions of the world, water is in abundant supply – in others, it has long been a scarcity. Agriculture and urban populations compete for water usage priority – with the result that groundwater levels are sinking rapidly in many places. Water is also being wasted to an increasingly alarming extent; up to 50 per cent of the water in urban systems is lost through leaks. Affluent individuals create golf courses and swimming pools in desert areas, while poor people have no drinking water.

WHAT?

There are two conceivable 'water scenarios' for the future: the first is one of scarcity, with rich nations helping themselves out with desalination plants and large-scale canal systems, while in the world's poorer regions a kind of mafia controls water supplies. The second shows legislation and pricing responding to scarcity: anyone who saves water is rewarded – and anyone who wastes it pays extra.

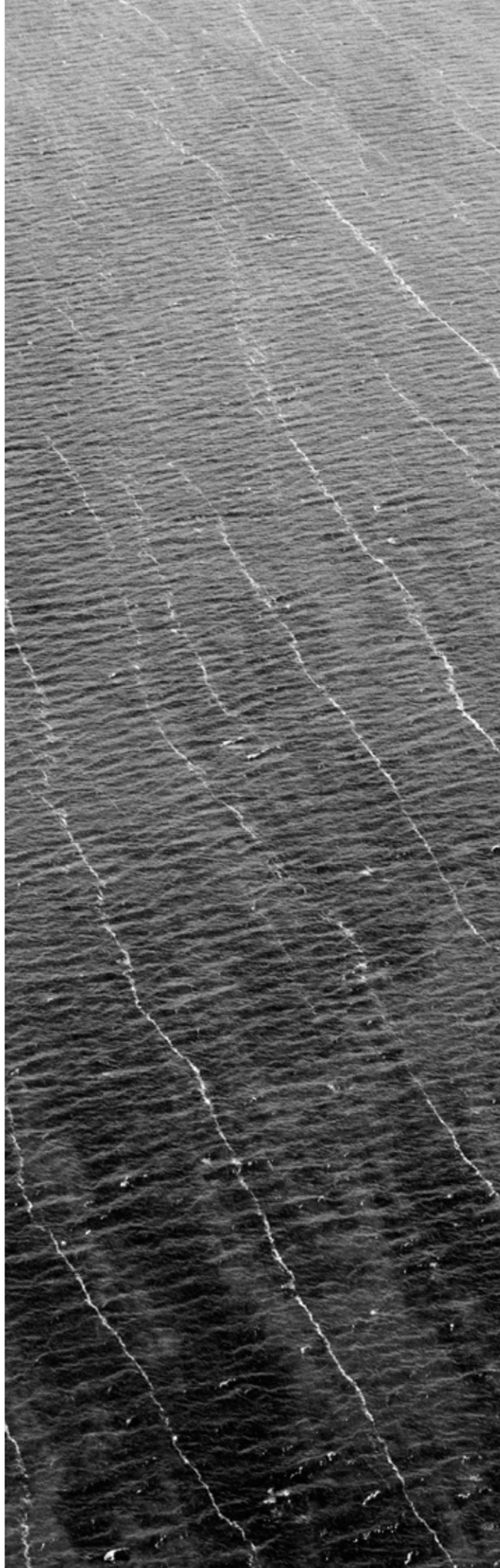
HOW?

National laws and international agreements – and technical progress – can improve many things. The key is efficiency and multiple water use. Economical fittings and grey water recycling are just as important as comprehensive refurbishment of urban water infrastructures. Thought must also be given to retained rainwater: water that is stored in the ground is available to the city. Since buildings can be considered 'water processors', they will play a crucial role in urban water use everywhere in the world.

"Most of the world's rivers now no longer reach the sea for much of the year, causing widespread ecological decay, and the loss of inland fisheries vital for millions of poor people."

Fred Pearce on the 'Apocalypse 2050' scenario

Less than 1% of the earth's total surface water is accessible to human beings as drinking water. 97.5% fills the world's oceans as salt water, while the rest is stored in glaciers and areas covered in ice and snow throughout the year.



The year is 2050. Climate change has extended drought zones round the world and left rivers that once provided water for billions of people running empty. Meanwhile the world population has increased by an extra two billion during the 21st century. Most of those people now live in cities. The world first became predominantly urban in 2009, but now two-thirds of the world lives in urban areas – six billion people. That is twice as many urbanites as half a century before.

And their water demands have been soaring. Back at the start of the century, politicians worried about a future of water wars between nations. Those did not happen. What did happen was wars within countries. Water wars between cities with their ever growing water demands and farmers, whose crops require water to grow, but who can no longer expect to take the lion's share of national water supplies as they once did.

APOCALYPSE 2050: URBAN ARCHIPELAGOS IN A SEA OF DROUGHT

With individual cities coalescing to create urban archipelagos, the demands on water supplies are vastly greater than at the start of the century. The Yangtze delta, centred on Shanghai, now has 100 million urban inhabitants; Tokyo and Osaka are now joined by a long urban corridor; Sao Paulo, Rio de Janeiro and Belo Horizonte in Brazil are now effectively one huge urban zone. These zones – dubbed megalopolis by geographers - suck up whole rivers and empty underground water reservoirs. They leave nothing for farmers. Globally, urban and rural areas divide water supplies 50:50, whereas at the start of the century, agriculture took two-thirds and urban areas one third.

The wars have been bitter. In China, the Yellow River has long since run dry and the region's two great megacities, Beijing and Tianjin, have commandeered the underground water reserves beneath the North China Plain. There have been trials and executions of farmers who defied orders and pumped water earmarked for urban use from beneath their land in order to grow crops. But, in response to the executions, gangs of rural 'water terrorists' have repeatedly blown up the pipelines that bring water to the two megacities.

Similar scenes have been played out in arid south and west India, in Pakistan and Mexico and in the Middle East. In India, farmers began capturing all the rain falling on their land, causing reservoirs on rivers downstream to dry up and cities to run dry. In Gujarat, marshal law was declared in an effort to stop the practice. Ministers declared that the rain was owned by the state.

The problem is that, for some years, the world's people have been using virtually all the water available to them, and more. Some 9000 cubic kilometres of water flow down accessible rivers annually (excluding those in remote rainforests and Arctic regions). It is virtually all taken for water supply or hydroelectricity generation (one of the key renewables technologies belatedly being used to curb climate change). Most of the world's rivers now no longer reach the sea for much of the year, causing widespread ecological decay, and the loss of inland fisheries vital for millions of poor people.

River water has been supplemented by pumping out underground reserves from porous rocks. Little of this water is replaced by the rains, so water tables have fallen. In many areas, the water reserves, often thousands of years old, have virtually given out.

Some of the world's cities have emptied of people because the available water ran out. Sanaa, capital of Yemen, pumped its underground aquifer dry in 2020. Amman in Jordan did the same and, of course, long since ceased to receive any water from the River Jordan, because Israel takes it all. Other cities in deep trouble now include those in the Andes that relied on rivers fed with meltwater from the mountain glaciers – cities like Lima, Quito and La Paz, capitals of Peru, Ecuador and Bolivia respectively. As global warming speeded the melting, the cities grew. But now the glaciers are almost gone, the rivers are drying up. Bolivia plans to move its capital.

DESALINATION PLANTS FOR SOME, WATER ANARCHY FOR THE MANY

Admittedly, there have been some technical advances. Australian cities, much of the US – even parts of Europe, now – get their tap water from desalination plants, turning salty sea water into something drinkable. Even London finally built the desalination plant on the Thames estuary proposed in the first decade of the century and initially rejected by government. But, though prices for desalination have fallen, the plants still require a lot of energy, and poorer countries cannot afford that. In any case, desalinated seawater is far too expensive for farmers or most industries.

Some countries have developed huge new national water grids to keep their cities afloat. China's South-North project, which opened for business in 2013, proved less effective than expected because of spreading drought in the south of the country, which partially dried up the Yangtze River where the water was to have come from. But Australia successfully brings water from its subtropical north to keep taps full in drought-hit southern cities like Brisbane, Sydney and Adelaide. The project was launched after Adelaide had to be partially evacuated in 2016 following a decade-long drought on the Murray River, the city's main water source.

Within cities, too, there have been battles for control of water supplies. Slum areas in many developing countries have long since relied on water vendors touring the lanes with tankers to supply water obtained (usually with bribes or outright theft) from municipal water reservoirs and pipelines. This was accepted practice while the city authorities were incapable of delivering piped water to their poorest and most vulnerable citizens. Many poor communities were paying a quarter of their income to buy water. By mid-century, these small-time water vendors have turned into major crime bosses, able to hold the city to ransom.

The armed gangs run by the water Mafiosi now control the reservoirs and water pipelines – and often the city authorities as well. They are effectively untouchable because they are the only source of water for hundreds of millions of people in cities like Karachi, Lagos and Rio de Janeiro. They now hold middle class neighbourhoods to ransom, too, charging extortionate prices and protection money for ensuring the water stays flowing.

There is a new water anarchy in many urban areas. The richest households sink deep wells beneath their land and live in constant fear of the water table falling or becoming contaminated. Everybody is pumping as much water as they can and storing as much as they can. Cellars and basements are lined and turned into emergency water warehouses.

But the tragedy is that, despite being precious enough to fight battles over, water is still used with fantastic inefficiency. The almost militaristic approach to securing supply means that few have got to grips with the idea of managing water demand, of using water sparingly. In fact, if you have water, it is such a status symbol that you flaunt it.

Through history, desert people with water would build giant fountains, irrigate lawns and golf courses and, in the late 20th century, build outsize swimming pools. American desert cities like Phoenix, Arizona, luxuriated in their access to water from the River Colorado, while the river itself dried up and Mexican farmers over the border were left with shrivelled fields. Now that madness has spread with the deserts. Across the Thar desert in India, the country's new industrialist potentates build lakes and water gardens in cities like Jaipur and Jodhpur that are as luxurious as those once owned by the princes they have replaced. They capture the rare desert rains but leave the millions of poor farmers in the surrounding countryside without.

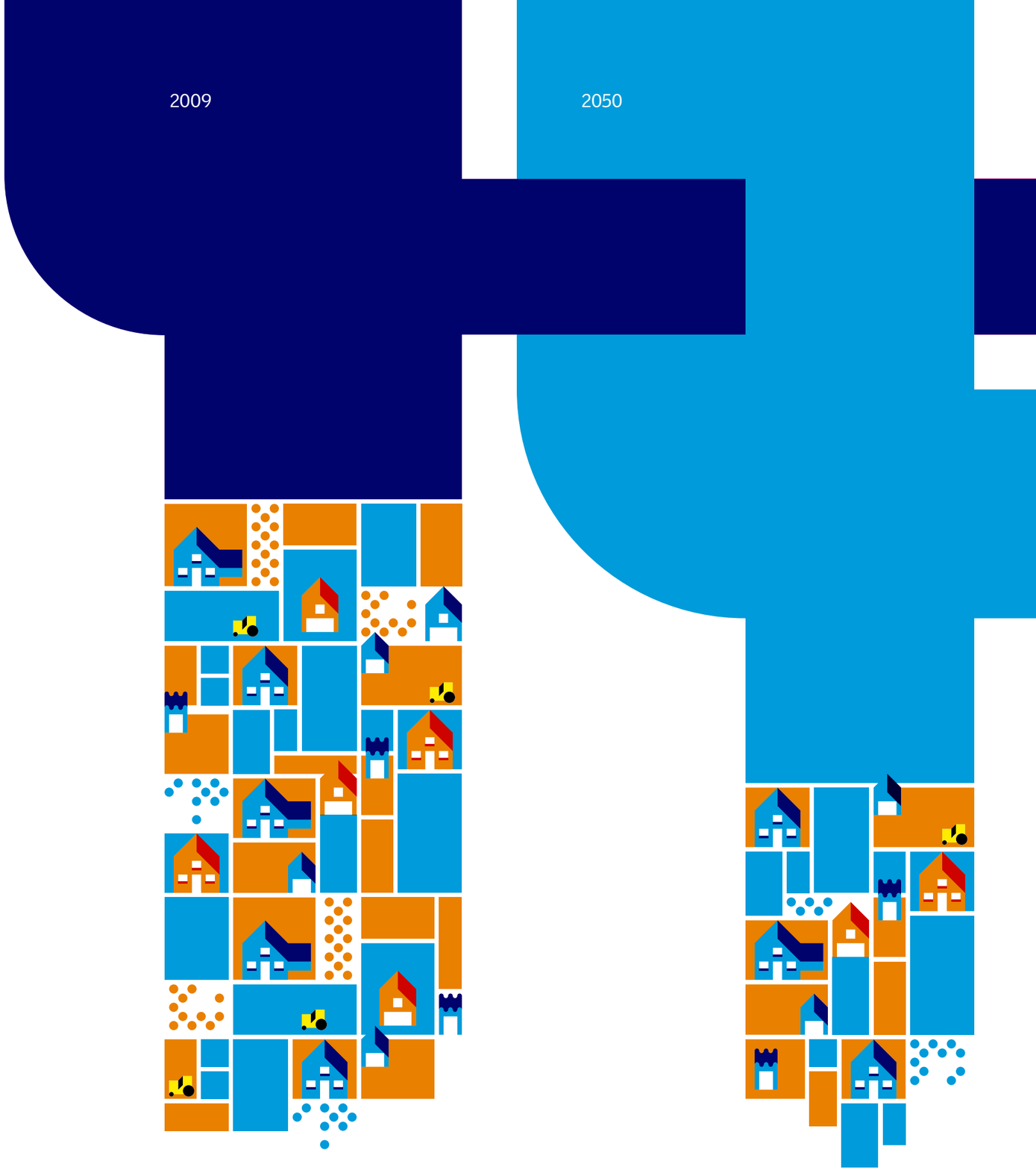
As the cities grab all the water, more and more farming is concentrated round city margins where there is a growing market in buying the filthy water in city sewers. Filthy as it is, the sewage is an essential source of irrigation water (and free fertilizer) to grow crops. In Mexico, there have been epidemics of diarrhoeal diseases now that the citizens of Mexico City are mostly fed on crops watered with their own sewage.

With water increasingly being taken from farmers and given to cities, world food supplies are faltering. Many countries can no longer feed themselves for want of water to irrigate their crops. They used to rely on importing thirsty crops like what and rice. But there are few countries today with enough spare water to grow crops for foreigners. Thus local water shortages are precipitating a global food crisis. Many believe that, a century after the first warnings were given, the world will soon be unable to feed itself – and the appropriation of water by cities will be to blame.

A DIFFERENT APPROACH: REDUCE, REUSE – AND HARVEST THE RAIN

2050 turned out differently. The UN decreed access to water as a human right, and governments adopted policies to distribute it fairly. They ensured cheap access to basic supplies, but rising prices for profligate users. These basic changes in water governance were enough to trigger massive investment in more efficient water technologies. From washing machines to power stations, water frugality is now at a premium. Water is policed by meter and tariff rather than at the point of a gun.

Every building, including private homes, collects rainwater from the roof for use in the garden or to wash the car. Most countries require this 'rainwater harvesting' by law. Most landlords and residents do it any way. It is as natural and routine as recycling. And it cuts water bills. The late 20th-century fad for 'green' roofs where plants once grew has now become a mainstream activity, with roof water used to grow vegetables on what seem very like a rooftop version of 20th century urban allotments.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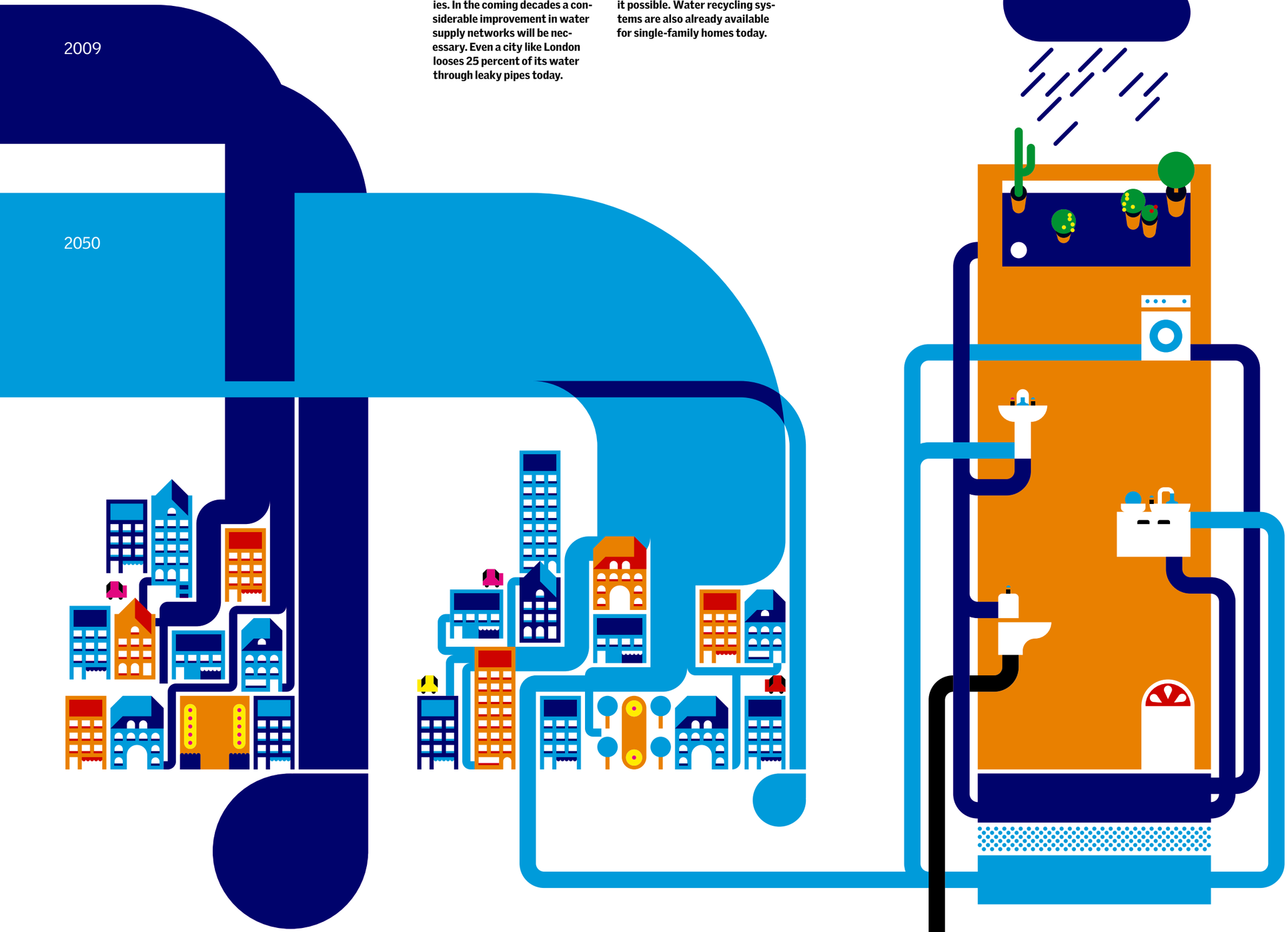


Currently, two-thirds of the water used by human beings flows into agriculture. In 2050 it will probably only be 50 percent, with the rest being used in cities. In the coming decades a considerable improvement in water supply networks will be necessary. Even a city like London looses 25 percent of its water through leaky pipes today.

Water will also be increasingly recycled in future. Separate pipes for fresh water (light blue), grey water (dark blue) and waste water (black) make it possible. Water recycling systems are also already available for single-family homes today.

An author and freelance journalist based in London, UK, **Fred Pearce** has reported on environment, science and development issues from 64 countries over the past 20 years. He is environment consultant for New Scientist magazine and writes the Greenwash column on the Guardian web site. He has published more than a dozen books including, most recently, When the Rivers Run Dry and The Last Generation (on climate change) as well as Confessions of an Eco Sinner.

The plumbing of most buildings is quite different from that at the start of the century. Rather than water coming in from the water main, being used once and expelled through the drains, it is now recycled within the building. Water from baths, showers and washbasins is routed to toilet cisterns through a secondary 'grey water' plumbing system. Combined with water-efficient domestic appliances, hyper-low-flush toilets and other devices, this has cut per capita domestic water use from 150 litres a day to 60 litres.

In many parts of the world, especially where big cities and irrigated agricultural areas are close to each other, treated liquids from sewage works is the main source of water for irrigating crops. Thus the majority of the water available is used twice over, first in the city and then for farming. The investment in treatment works and distribution pipes was expensive, but it has meant there are few 'water wars' between cities and rural communities.

City water distribution networks are much more sophisticated than they once were. Early in the century, it was not unusual for cities to lose half the water put into distribution through leaky water mains. The water was either lost, seeped underground and became too polluted for future use, or had to be expensively recaptured and pumped back into the system. But following the example of Singapore (which even early in the century had cut leaks to 5 per cent), most cities have plugged their leaks and introduce sophisticated telemetry systems to maintain stable pressure in the pipes and indentify leaks fast. The telemetry, coupled with full real-time metering in individual buildings, allows profligate water users to be identified and either penalised or hit by punitive water prices.

Other transformations have been equally dramatic. The idea of the 'porous city', first tentatively tried out early in the century in Germany, has become the norm in urban developments. Los Angeles is just one city that had spent billions of dollars bringing water from distant mountain reservoirs and then billions more on flood drains to get rid of water after the occasional intense rains. Finally they figured that combining the two activities might make sense, that water supply and drainage can combine rather than compete.

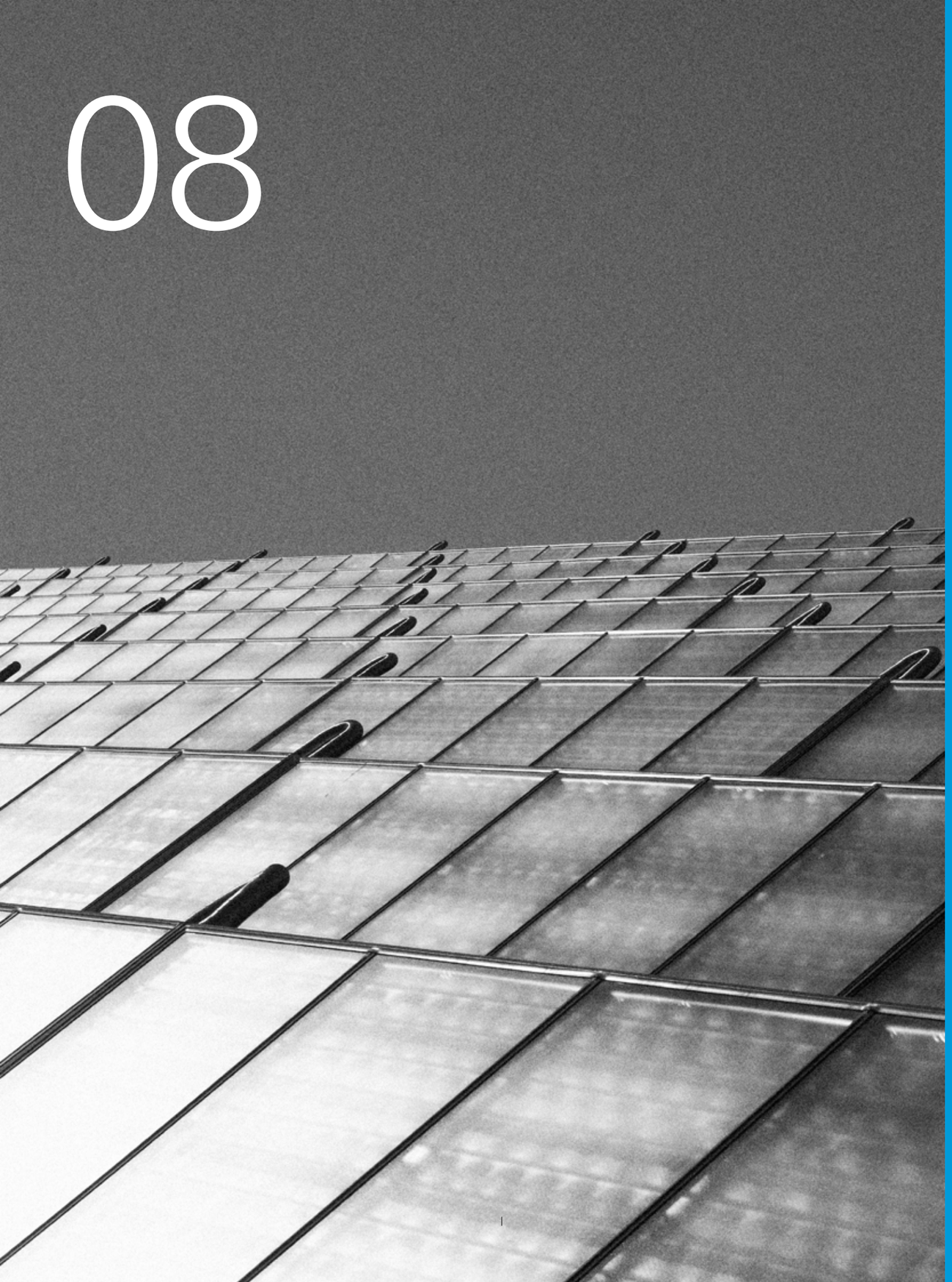
Today, Los Angeles has soakaways that use rainwater to recharge underground reserves. Street gutters and playgrounds, parking lots and every paved area in cities are made porous so that the rainwater no longer rushes away but is conserved for future use, either in the rocks beneath the city or in urban reservoirs.

Desalination technology has developed more slowly than it would have done without these water conservation measures, but it has developed. However, plants are generally built as stand-by facilities in case of extended drought, to protect rivers from over-abstraction, rather than as a routine water source.

Thanks to such innovations, there is still water in most rivers, and underground water reserves are protected from water 'mining' and remain largely intact. Underground water has proved an immensely valuable buffer against the vagaries of climate change. But it is never used so much that water tables fall. Underground water is regarded in international law as being as worthy of protection as rainforests.

Meanwhile, at least 30 per cent of river water flows have to be maintained as an 'ecological flow', protecting inland fisheries as part of a widespread global initiative towards ecological recovery of the planet.

08



RENEWABLE ENERGIES
OUR SOLAR FUTURE

Every day, the Earth receives 1,500 times as much energy from the sun as mankind consumes. A fully solar-powered future of the world's cities is, therefore, by no means inconceivable. Efficiency measures and 'secondary' renewables such as wind and biomass will assist in the energy transition to come, but ultimately, the greatest promise lies in a combination of large-scale solar power plants and small-scale, building-integrated, solar energy uses.

By Richard Perez

WHY?

World energy consumption will have grown by another two thirds by 2050. At the same time, all energy reserves – except renewable energies – are limited; so is nuclear energy, which relies on the conversion of uranium. But climate change is providing the most powerful stimulus for restructuring our energy supplies; CO_2 emissions can be halved by 2050 only if the use of renewables is promoted alongside greater efficiency.

WHAT?

What are the renewable energies sources with a future? Wind power alone could cover mankind's needs, but its use is already approaching the limits in many countries. Biomass should be restricted to uses for which burning processes are essential. This leaves the sun as the main provider of energy; it gives the industrialised states alone 1,500 times more energy than mankind consumes at the moment.

HOW?

The question to be asked about solar energy provision is not whether supply should be centralised or decentralised; the two concepts have to be taken together if requirements are to be met. Energy provision will have to come from renewable sources, in the future even more than now. This means that the buildings we build or refurbish today must be based on a carbon-neutral energy supply from sources such as solar panels, and be provided with adequate storage facilities for heat and electricity.

At present, the total primary energy consumption of the world is of the order of 480 exajoules[1] per year, amounting to a constant power demand of 16 Terawatts[2]. This consumption is not distributed equally, with rich industrialised countries such as the United States of America using almost 22% of the planet's energy with only 5% of its population. Growing economic powers China and India are rapidly increasing their demand for energy with a combined consumption now exceeding that of the United States, suggesting that the current worldwide figure is headed for a strong growth. The US Energy Information Agency anticipates that worldwide demand will reach 23 Terawatts by 2030 and trend to 28 by 2050. Over three quarters of the growth is expected to take place in non-OECD countries, occurring primarily in commercial and transportation sectors.

Unfortunately such 'official' predictions by national and international agencies also anticipate that the bulk of this growth will be met by coal, with renewable energies playing only a side role. However, a fundamental look at the energy resources of the planet suggests that this business-as-usual outlook may be both short-sighted and unrealistic.

MEETING ENERGY DEMAND

There are two ways to meet worldwide energy demand and its anticipated growth:
1. On the demand side, by acting to reduce, and eventually reverse, the growth rate, using conservation and increasing efficiencies: e.g. better engines, higher efficiency lighting, better insulation and avoiding unnecessary waste; in a few words: smarter, better and smaller. The McKinsey report on climate change[3] indicates that over 40% of the consumption of major consumers like the United States could be met economically by smart conservation and efficiency alone.
2. On the supply side, by tapping existing and new resources capable of meeting the demand remaining after conservation. Table 1 shows the current contribution of different resources to the planet's supply-side needs.

RENEWABLE OR FINITE RESOURCES?

The figure on the opposite page compares the one-year potential supply of renewable resources against the finite reserves of conventional energies.

Fossil fuels: apart from their environmental impacts, Figure 1 suggests that the recent 'boom-bust' volatilities in oil and gas markets are early symptoms of their finiteness when demand begins to outstrip supply. As for coal, while reserves are vast, they are not infinite and would last at most a few generations if this became the predominant fuel, notwithstanding the environmental impact that will result from such exploitation if now elusive 'clean coal' technologies do not fully materialise.

Nuclear energy is not the global warming 'silver bullet' claimed by some. Reserves of uranium are large, but they are far from limitless. Setting aside all the long term environmental and proliferation unknowns associated with this resource, there would simply not be enough nuclear fuel to take over the role of fossil fuels – the rise in the cost of uranium that paralleled, and even exceeded, that of oil from 1997 to 2008 is symptomatic of this reality. Of course this statement would have to be revisited if an acceptable breeder technology or nuclear fusion became deployable. Nevertheless, short of fusion itself, even with the most speculative uranium reserves scenario and assuming deployment of advanced fast reactors and fuel recycling[5], the total finite nuclear potential would remain well below the one-year solar energy potential.

The solar resource: it is plainly evident that the magnitude of the solar resource dwarfs any other finite and renewable resources. The yearly, indefinitely renewable supply of solar energy received by the emerged continents alone is more than 30 times larger than the total planetary reserves of coal and 1,500 times larger than the current planetary energy consumption.

The solar resource is well distributed and widely available throughout much of the planet. It is of course more abundant in the tropical belts than it is in the temperate zones[6], but consider that even such a modestly sized, northern, and sometimes cloudy country as Denmark receives a total of nearly 5 TW-year worth of solar energy every year, that is one third of the energy consumption of the entire planet.

It is widely believed that deploying solar energy on a massive scale would utilise too much space. Nothing could be further from reality: assuming a 30% solar-to-useable energy conversion rate (certainly achievable by 2050[7]), less than one half of one percent of the emerged continent's area would be sufficient to produce all the projected energy used by the planet. This is an area smaller than the earth's currently [sub]urbanised land – and much of the urbanised landscape can be used for solar harvesting with very little visual or operational impact. Consider the city of New York, for instance, arguably one the densest energy demand hubs on the planet: together with smart demand-side operational efficiencies, New York City could certainly be solar self-sufficient electrically by 2050 using only 20% of its surface, i.e. the size of its current roof space.

Another interesting point of reference is to contrast solar generation area requirements with hydroelectric artificial lakes. In the United States, for instance, artificial lakes occupy 100,000 square kilometres of flooded land to produce only 7% of the country's electricity. By contrast, with 30% PV efficiency, under two tenths of that flooded space would be sufficient to produce all the electricity in the US.

Other renewables: how about wind power, hydropower, biomass/biofuels, marine currents, waves, ocean thermal energy conversion (OTEC), geothermal, and tides? First it is worth noting that, with the exception of tides and geothermal, all the renewable resources are second and third-order by-products of incoming solar energy – just as fossil fuels are by-products of solar energy stored in the earth over millions of years. These renewables are, indeed, concentrated forms of solar energy, which makes them more economical to exploit in the short run, especially hydropower. As such they will have an important role to play initially. However, as by-products, their potential is considerably smaller than that of the primary solar resources.

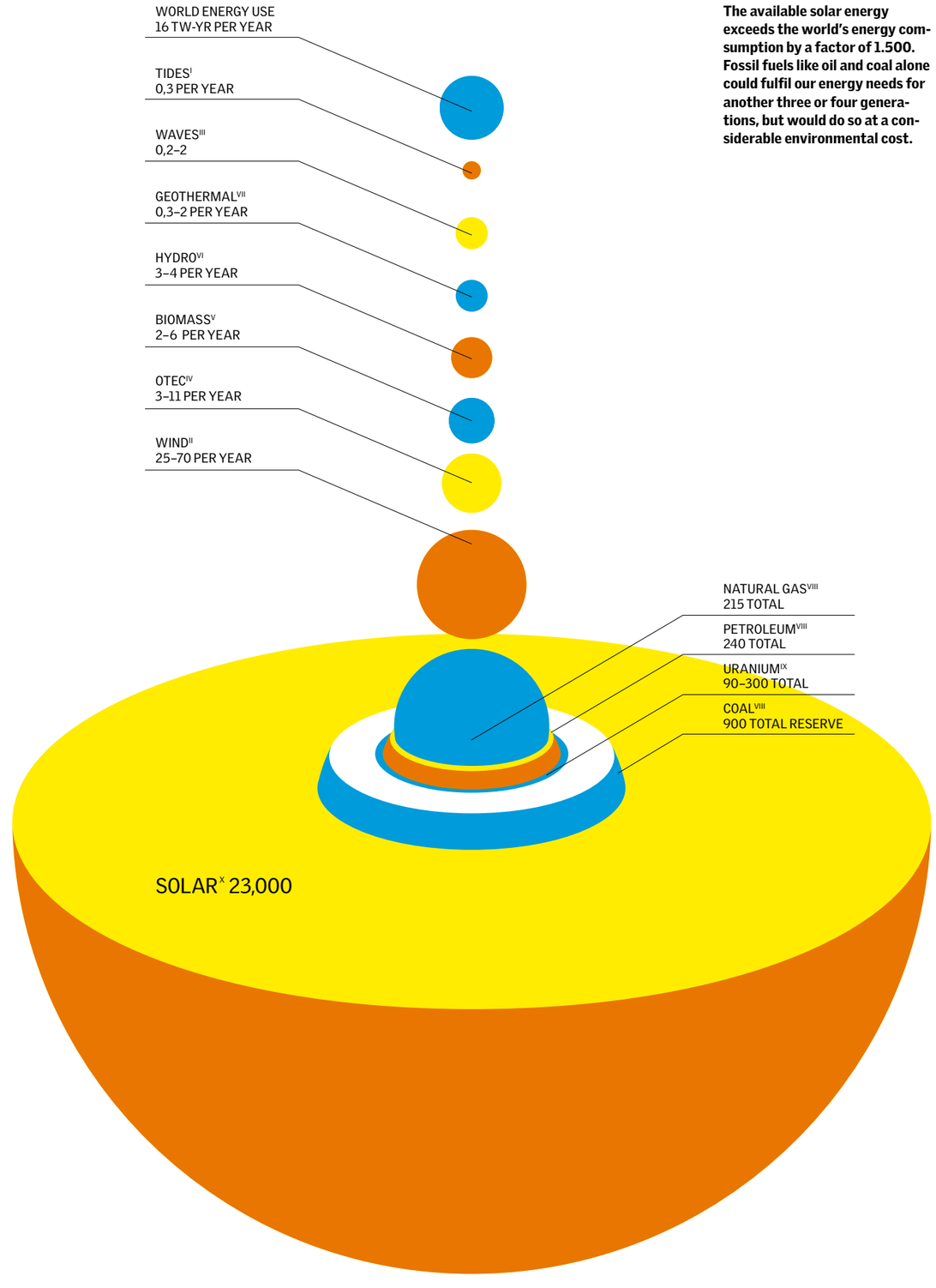
Wind energy could probably satisfy all of the planetary energy requirements with some room to grow if exploited to a substantial portion of its potential, but none of the other renewables, alone, could. The current explosive growth of the wind power industry – the largest installed incremental electricity generating capacity in 2008 in OECD countries – is certainly an expression of this potential and of the resource's current economic advantage over direct solar energy conversion. Hydropower is nearly maxed out in most OECD countries, with some good opportunities left in the rest of the world (e.g., the Mekong river in south-western China), but the environmental price of further developing this resource is not trivial. OTEC, marine currents, and tides also certainly offer promising localised economic opportunities. However, these resources are not scalable to levels that would satisfy planetary energy demand, while the environmental side effects of their massive exploitation could be far-reaching. Concerning biomass and biofuels, the rise in food cost that paralleled the 2008 rise in oil prices is symptomatic of the underlying reality that crops for energy, while certainly providing lucrative opportunities for some, cannot become a replacement to fossil fuels. Biofuels will certainly have a role to play, but will have to be reserved for those applications where high energy density liquid fuels will remain unavoidable for the foreseeable future such as air transportation.

A COMPREHENSIVE RENEWABLE ENERGY SOLUTION

While stressing that demand-side conservation and efficiency are an inherent part of any solution, a nearly 100% supply-side renewable future for the planet is not inconceivable. Given the size of the finite reserves and the size of the renewable solar supply, logic alone would say that such a future is inevitable.

Beyond conservation and efficiency, a comprehensive solar approach will first involve maximising the utilisation of the direct end-use solar applications which have the highest on-site solar-to-application efficiencies: hot water, daylight, passive heating and passive cooling where climate permits.

But the key will lie in electricity generation via any of the leading direct solar technologies – PV and concentrating solar power (CSP) – supplemented initially by indirect solar technologies (wind, smart bi-



The available solar energy exceeds the world's energy consumption by a factor of 1.500. Fossil fuels like oil and coal alone could fulfil our energy needs for another three or four generations, but would do so at a considerable environmental cost.

omass), and in the development of creative solutions and infrastructures to serve the energy, transform it, and store it as needed to meet all end-uses.

Infrastructure: two very distinct infrastructural models are envisageable:

1. Local, decentralised production of solar-derived electricity near points of utilisation – largely using PV, but also wind, taking advantage of available space – particularly space that can be used for solar harvesting in addition to a primary role like building envelopes, industrial exclusion zones, transportation right of ways, etc. The resource is large enough in almost every part of the world to fulfil most needs. However, a considerable technological challenge will have to be addressed because the largest renewable resources (solar and wind) are intermittent and vary seasonally. Smart, interactive electrical load management and energy storage technologies will have to undergo a fast development phase.

The main attraction of this decentralised deployment model is that it would result in indigenous, highly-secure, and robust energy pathways. Because of the decentralisation of production, demand management, and storage operation, the failure of any one decentralised unit, with built-in minimal stand-alone operation capability, would be insignificant.

The storage panoplies that will have to be developed will range from very short-term technologies (capacitors, flywheels, batteries, load-demand response) to mid-term (e.g. interactive electric/hybrid cars[8] load/backup management), to long-term (e.g. flow batteries, hydrogen, compressed air)

2. At the other extreme are continental, and possibly planetary, super power grids. The basic ideas behind this vision are that some places on the planet receive more solar energy than others (e.g. subtropical deserts) and that the average solar yield of the entire planet is nearly constant (i.e. it is always sunny somewhere on planet Earth). There are conceptual proposals on the drawing board in both Europe and in America[9] considering this type of solar energy deployment. The approach will necessitate the development of very high voltage, highly conductive super power lines and, more importantly, will necessitate a strong and tacit agreement between all involved parties and countries to maintain and protect such a network.

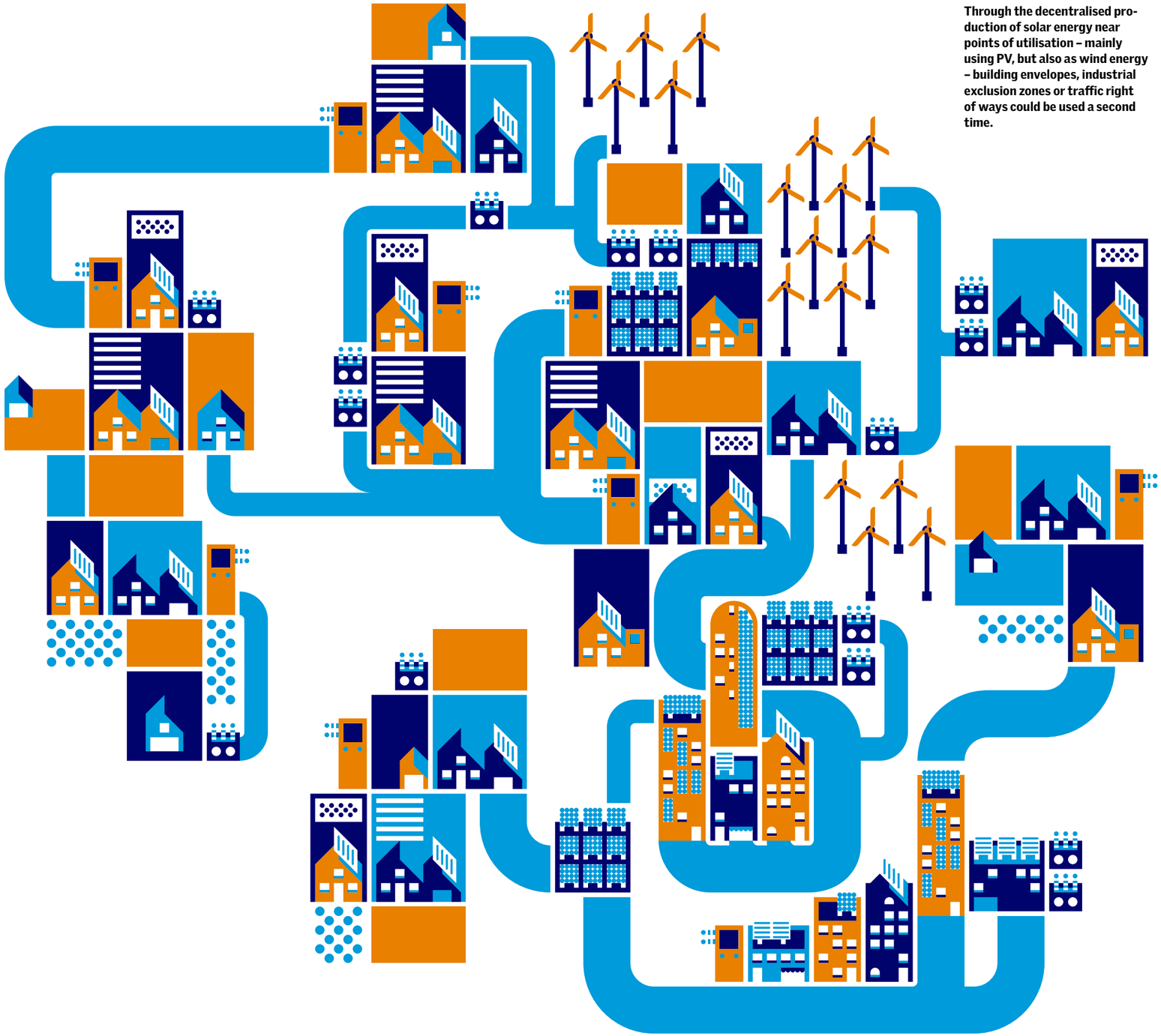
The future will likely be a combination of both fully decentralised systems and subcontinental-scale networks with centralised generators. The good thing is that the two approaches are not incompatible and could even be complementary. Large corporations and utilities will probably prefer centralised applications because of economy of scale and similarities with the current electric production/distribution system. In this scenario, wind energy – largely centralised, or semi-centralised by nature[10] – will play a major role initially. Ultimately, the decentralised systems should flourish and prevail as technology costs fall, and, more importantly, the value and resiliency of on-site generation can be fully captured. As discussed below, the costs of producing clean renewable energy and its value are still largely disconnected entities in the current business environment, although this question is already being addressed in some embryonic form via incentives such as feed-in tariff (FIT)[11] legislation proposals patterned after that of Germany, with highest value given to decentralised solar applications[12].

Serving all energy needs from renewables: because of the universal nature of electricity produced by direct and indirect solar technologies, the great majority of energy demand sectors will be adequately served, albeit with some adaptation/evolution. Transportation in particular currently relies on fossil liquid fuels. A shift to renewables will require particular attention but the task is not insurmountable: by 2050, ground transportation will have become largely electrical through increase of electric rail-based mass transportation, the advent of all-electric vehicles and plug-in hybrids – e.g. spearheaded by projects such as BetterPlaces[13] designed from the onset to exploit renewable energy – and new concepts such as Personal Transportation Networks[14]. It is also possible to produce fuel, or fuel equivalents, derived from solar/wind electricity – hydrolysis of hydrogen being the most familiar, if not the most promising, method. The so-called 'second generation' biomass should be reserved for the remaining applications that could not easily rely on electricity directly or indirectly, such as air transport and, to a lesser extent, water transport.

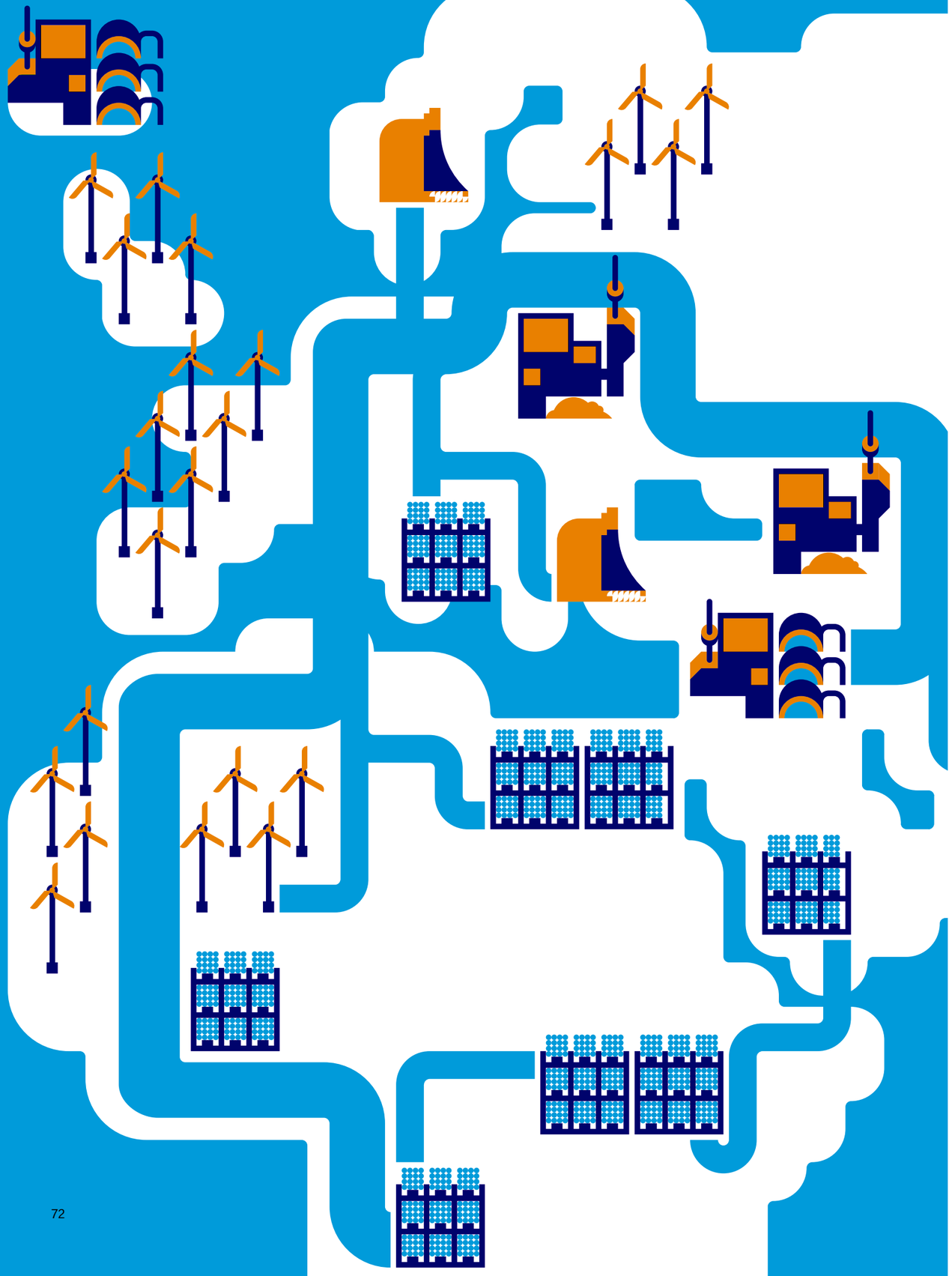
A reality-check check – the growth of the wind and solar industries: a quick look at the direct and indirect solar industries that are fast emerging throughout the world today indicates that the 'big-picture' renewable visions discussed in this article already have a strong head start. Considering the growth of PV, wind, and CSP alone over the last ten years[15] and projecting this growth rate in the future indicates that the majority of the new electric generating capacity installed in the world will come from renewable resources in less than 20 years. This growth rate may not be quite sufficient yet given the fossil energy depletion and environmental pressures, but it is already impressive; and suggests that when additional countries and decision-makers become aware of the need for a fast transition, a rapid renewable takeoff and switch-over is not pie in the sky but a likelihood – and rapid change of awareness is taking place here and now. For a long time confined to visionary leaders such as Germany, Denmark or Japan, the drive for renewables that caught up in the rest of Europe is now gathering momentum in the United States, driven by a new administration. At the same time, China, which became the world's largest PV producer in 2008, edging Germany out of first place, has just adopted a major upward revision of its renewable energy deployment plans, including 100 GW of land-based wind generation by 2020.

HOW MUCH WILL IT COST?

Of course, switching overnight to direct/indirect solar would incur a seemingly impossibly large financial burden[16], a point often raised by detractors of renewable energies. However, a fast-track growth and complete turnover within 50 years will be affordable, especially as both apparent and real costs of conventional energies escalate. In the end, what will matter is the value proposition offered by solar and renewables, not the cost. If value exceeds cost, then there is no question that renewables will be the way to go, and many indicators point in that direction. The price we pay in our energy bills today simply does not include all the costs incurred by society: two major costs that are not yet included, as they should be, are the costs associated with the degradation of the environment (chiefly global warm-



Through the decentralised production of solar energy near points of utilisation – mainly using PV, but also as wind energy – building envelopes, industrial exclusion zones or traffic right of ways could be used a second time.



ing) and the depletion of finite energy resources[17]. Other un-incurred costs, more site-specific in nature, include power grid reliability and security, as well as the lost value opportunities of job creation[18] and economic growth associated with the advent of renewables. It is important to note that as societies, we are already paying for these un-incurred energy costs and lost opportunities one way or the other, but not yet via direct energy bills – through taxes, insurance premiums, military budgets, and by borrowing heavily from our descendants. Once the value proposition is fully integrated – and common sense says it will by 2050 – it will become evident that it is much less expensive to generate electricity directly or indirectly from the sun, even after including the storage/management technologies needed for their high penetration, than by using finite and polluting resources. At that point, the incentives used today to level the playing field, such as FITS, will no longer be needed.

In essence, the long term economic soundness of a solar future can be simply expressed in this one fundamental reality: all direct and indirect solar technologies have an energy payback of 3–5 years today and are constantly improving, i.e. when operated under average conditions these technologies produce more energy in a few years than is used to construct and install them. With operational lifetimes far exceeding their energy pay-back period, these technologies are, in effect, energy breeders capable of powering themselves into growth. Energy payback is a fundamental physical measure of long-term economic viability to societies investing in it. For a monetary translation of this physical reality, let us look at a worst-case example: a totally unsubsidised PV installation (the most expensive solar technology today, likely to be 2–3 times cheaper in 20 years) in the north-eastern US (a region with a modest solar resource) valued against current wholesale electricity (a 'rock-bottom' number excluding all the grid support, fuel depletion, environment and business growth values mentioned above). The financial return of this conservative worst-case scenario is of the order of 2–3% per year, which still represents an attractive long-term societal investment, knowing that this is the most secure, stable, and risk-free investment there could be. The real return to society will, of course, be much higher.

HOW WILL CITIES LOOK IN 2050?

To the passing observer, cities will probably look very much as they do today. They will simply be much more electrified, both on the demand and supply sides. We will have shifted away from (fossil?) fuels, especially for transportation. Exhaust and noise levels will be considerably reduced, and so probably will congestion: a by-product of conservation associated with smarter (i.e. smaller) electric personal vehicles, the advent of exchange programmes like the Parisian vélib'; consider that even New York, home of the giant gas-guzzling yellow taxi cabs, will see its fleet turned over completely to hybrids by 2012.

Many buildings particularly in cities' suburbs will have become net energy producers from both higher operational efficiencies and use of available solar energy-harvesting surfaces, as well as energy management/storage hubs at the nodes of smart electrical grids. However, their appearance from the street need not change much from today's. Load management and storage facilities, required to manage the flow of renewables, will not be conspicuous, and could be embedded in the framework of residential, commercial and industrial districts. Just to give an idea of the sizes involved, picture a highly efficient, daylit, two-storey, two-apartment residential building with a footprint of 100 m^2 in northern Europe. Its roof space will produce more electrical energy than needed by the occupants for all uses, including commuting and transportation. The year-round energy storage needed to sustain a 100% combination of grid-interactive solar, wind and hydropower would be substantial but not inconceivable. Using a promising sustainable flow-battery technology, the physical size of the load management and storage facilities required for the above two-apartment building would be a two-metre cube that could be located just about anywhere on the smart power grid.

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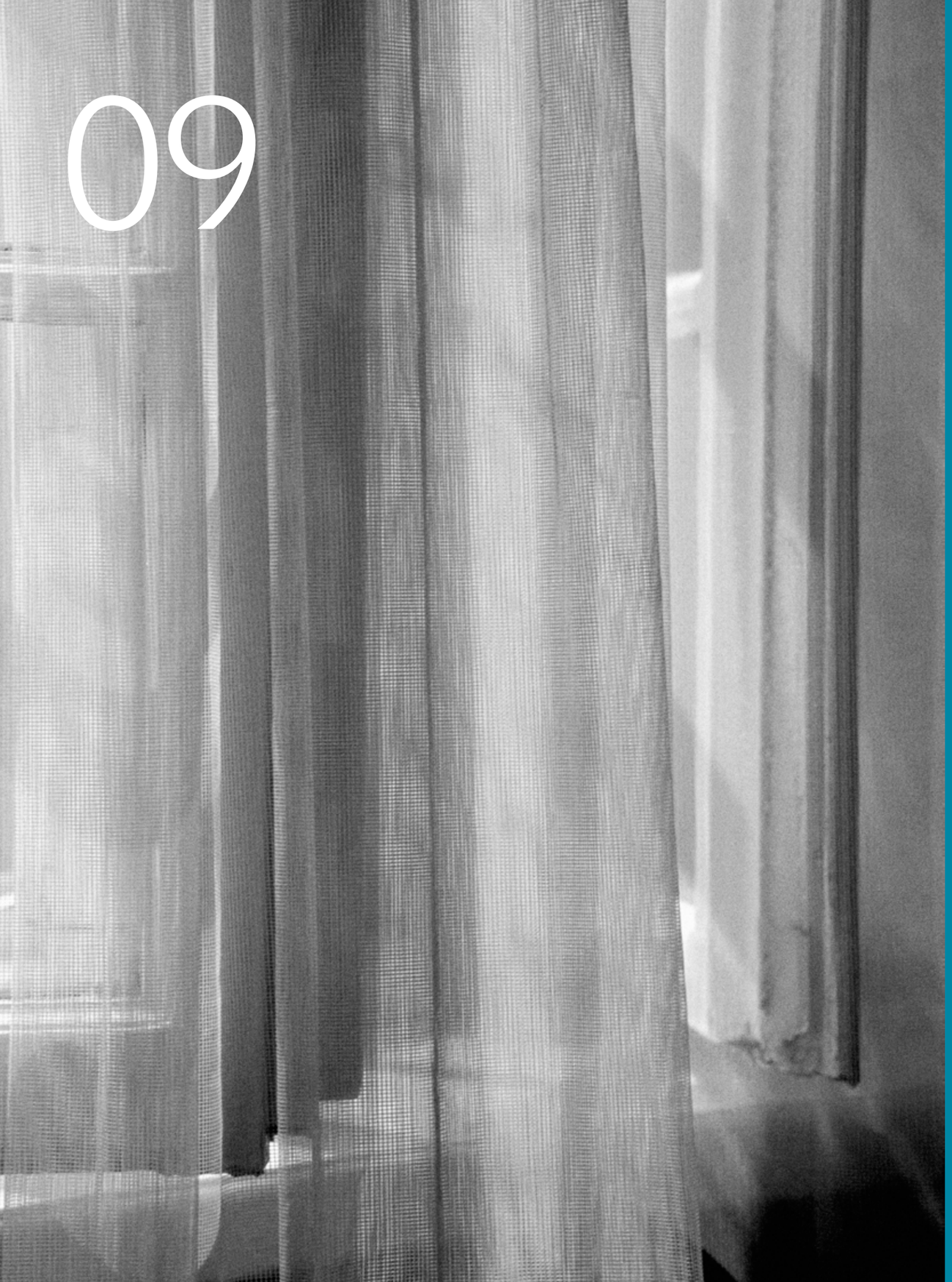
Opposite page: **International supply networks for renewable energy in which every form of energy is used where it occurs in concentration are a practical addition to decentralised energy production. One organisation that is pursuing this kind of objective is the Desertec Foundation, which will bring solar-derived electricity from the Sahara to Central Europe.**

TABLE 1: Primary energy consumption per source and 1995–2005 growth trends for OECD and non-OECD countries[4]

	Petroleum		Natural gas		Coal		Hydro		Nuclear		Other*		Total
	TW-yr	% total	TW-yr	% total	TW-yr	% total	TW-yr	% total	TW-yr	% total	TTW-yr	% total	TW-yr
OECD 1995	3.01	42.6%	1.49	21.1%	1.37	19.5%	0.44	6.3%	0.68	9.7%	0.06	0.9%	7.05
OECD 2005	3.32	41.4%	1.80	22.4%	1.59	19.8%	0.42	5.2%	0.78	9.7%	0.12	1.4%	8.02
growth 1995–2005	10%		21%		16%		-5%		14%		91%		14%
Non OECD 1995	1.76	34.6%	1.22	24.1%	1.59	31.3%	0.40	7.9%	0.10	1.9%	0.01	0.2%	5.08
Non OECD 2005	2.34	31.8%	1.80	24.4%	2.51	34.1%	0.55	7.4%	0.14	1.9%	0.03	0.4%	7.38
growth 1995–2005	33%		47%		58%		36%		47%		129%		45%
Total 1995	4.76	39.3%	2.71	22.3%	2.96	24.4%	0.85	7.0%	0.78	6.4%	0.07	0.6%	12.13
Total 2005	5.67	36.8%	3.60	23.4%	4.10	26.6%	0.97	6.3%	0.92	6.0%	0.14	0.9%	15.40
growth 1995–2005	19%		33%		39%		14%		18%		98%		27%

SOURCE: US ENERGY INFORMATION AGENCY (2005): INTERNATIONAL ENERGY ANNUAL REPORT

* INCLUDES GEOTHERMAL, BIOMASS, WIND AND SOLAR



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DAYLIGHT
WHICH DAYLIGHTING IN 2050?

How much daylight there will be in our future buildings and cities depends on a variety of factors: the density of cities, the amount of air pollution and the price and efficiency of electric lighting, to mention but some. Windows may even have to compete with other uses of solar energy for space of building envelopes. Yet some trends also point in a positive direction: New building codes will demand mimimum daylighting standards, and advanced simulation methods will allow for a better understanding of daylight and its potentials.

By Marc Fontoynont

WHY?

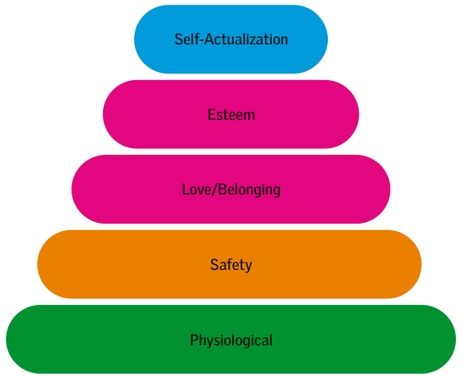
Basic human needs, such as physical well-being, visual comfort and safety, will not change substantially by 2050. But demands for efficient energy use in buildings will increase considerably and life-cycle costs, rather than just construction costs, will provide the basis for decisions. In other words, the lighting systems of the future will have to promote health and to be energy-efficient.

WHAT?

In nature, daylight is free and abundantly available. It will play a key role in the future lighting of buildings, in all seasons. The building envelope will increasingly become an energy provider: windows and other daylight systems will then be competing with other solar energy systems for a 'place in the sun'.

HOW?

A few basic considerations are often enough to ensure better daylight provision but new building regulations must set minimum daylight levels and define qualitative daylight requirements for all buildings. Furthermore, computer-aided simulation programmes will ease the efforts of architects to ensure daylight optimisation.



Pyramid of fundamental human needs according to Abraham Maslow, 1943

Self-Actualization morality, creativity, spontaneity, problem solving, lack of prejudice, acceptance of facts

Esteem self-esteem, confidence, achievement, respect of others, respect by others

Love/Belonging friendship, family, sexual intimacy

Safety security of body, of employment, of resources, of morality, of the family, of health, of property

Physiological breathing, food, water, sex, sleep, homeostasis, excretion

TOWARDS WHAT FUTURE?

Predicting major trends in building technology 40 years ahead may be judged arrogant. After all, this exercise would be comparable to the prediction in 1909 of the global evolution of architecture and cities to be realised in 1950. It would have been hard at the beginning of the 20th century to imagine the profound evolution of our life style associated with the development of cars, aircraft or electric lighting. This exercise is actually even more difficult today due to the acceleration of technological progress and its impact on our lifestyle.

To investigate what drives human progress, it appears logical to assess fundamental human motivations. In the Theory of Human Motivation (1943), Abraham Maslow proposed a hierarchy of needs in 5 levels, starting with fundamental physiological needs (1), followed by safety (2), love/belonging (3), esteem (4) and self-actualisation (5). It is clear that daylight exposure is a fundamental need for human beings, and for most living species, as is the quality of the air we breathe. Light is also fundamental for level 2: it is essential to human activity (such as employment, through the lighting of our industrial buildings and offices). Daylight is also a way to provide our lighting needs in daytime – it is abundant, free and safe.

HOW WILL WE LIVE IN 2050?

Taking into account Maslow's approach, it is clear that we will always work hard towards improving our well-being (for instance – medical progress, comfort in our buildings, hygiene) and try to secure our wealth (and our resources), although this may be harder in the near future (since they may become scarce). The evolution of our cities and buildings should respond to these concerns.

One difficulty is that their life span is far longer than that of most of the products that are on the market today but that will soon would disappear (cars, computers, telephones, TVs), replaced by others, sometimes with completely new technologies. We can, however, identify the general constraints of this evolution: energy-efficiency, lightness, extended services, cost reduction, life cycle cost, and adaptation to global world markets. In many of these respects, the equipments of our homes may be far more efficient in 2050 than now. Daylighting technologies will naturally evolve in the same direction: glazing with higher insulation, improved fenestration components, better solar protection.

But this first level approach is not sufficient, since it cannot address how strategic daylighting will be in 2050. A detailed analysis of probable scenarios for 2050 should help us identify how different our built environment will be from that of today. One major difficulty is to assess the balance between our expectations for a better built environment and our desire for increased mobility. How will the future generation compromise between the two, what will be the priority? Will the population be more and more concentrated in cities, or will rapid public transportation systems allow other alternatives? An increase in population density in cities may modify our expectations of contact with nature and the value we give to it.

We will discuss below various hypotheses that could impact the way we will light buildings and the role that daylighting techniques could play in 2050.

TWO HYPOTHESES CONCERNING DAYLIGHT AVAILABILITY

Hypothesis 1: the changes in the content of atmospheric components will not be large enough to modify daylight availability over our planet. Volcanic eruptions, for instance, can fill the atmosphere with dust. The eruption of Pinatubo in the Philippines in 1991 reduced direct solar radiation for 4 years, but it was not powerful enough to significantly reduce global irradiation. Major events that could reduce daylight availability would be the impact of meteorites or a major nuclear war. However, let us assume that none of this will happen! This means that daylight will still be abundant in Europe, supplying 4,000 hours of daylight per year, and could meet the large majority of our lighting needs in daytime. We presently have the know-how and the technology to design buildings with high daylighting performance, making them slightly less deep, possibly increasing their ceiling heights, as well as using clear indoor finishes and an efficient organisation of the building volumes. However, in our cities, exposure to daylight in everyday's life may still be low, as will our exposure to UV radiation due to the high absorption by the polluted atmosphere above cities.

Hypothesis 2: global warming will be noticeable in 2050. Annual average temperatures at ground level will increase by about 1.5 to 2°C in 2050 (up to 4°C projected in 2100 depending on the scenarios). This means that for most of countries in the world the issue of summer comfort in building will become more challenging. This will require increased used of external solar shading, night ventilation, geothermal cooling, and air conditioning (with heat pumps). This evolution could challenge daylighting strategies due to the possible increased risk of overheating.

TWO HYPOTHESES REGARDING ENERGY

Hypothesis 3: globally, the world will continue to increase its demand for fossil fuels, unless a major new economic crisis occurs. The use of fossil fuels will gradually shift from oil to gas and then to coal. But the 'peak use' of all these sources is near. A few years ago, before the world economic crisis of 2008–2009, the dates of peak production were expected to be 2015 for oil, 2030 for gas and 2050 for coal. In 2050, oil, gas and biofu-

els will be used mainly for chemical applications, or for applications that cannot easily use electricity, such as aviation and long distance ground transportation. Their price will be too high to use them as a simple burning fuel. To give an idea of the value of this fuel, an equivalent cost of 500 $/barrel of oil (151 litres) could be a hypothesis for 2050 but this is, of course, only speculation. Buildings will probably run mainly on electricity, generated either by nuclear power plants (EPR), new-generation coal power plants or renewable energy systems. Electricity costs will become a major issue for building operating costs. By 2050, the cost of a KWh generated by nuclear reactors and renewable energy should be rather stable, and partly disconnected from the cost of oil and gas. Electricity will be partly produced by centralised power plants (coal and nuclear, 1,000 to 6,000 MW) and partly through small power generation units connected to the grid (1 KW to 10 MW). Progress in energy storage will significantly impact the evolution of low-power electricity generation. A growing fraction of the energy will therefore be produced in a decentralised way in our industrial buildings, commercial centres, office building and homes. Windows and daylighting systems will therefore compete with photovoltaic generators for a place on the building envelope.

Hypothesis 4: fusion reactors will not be ready replace to EPR nuclear reactors in 2050. And the dream of a cheap and powerful source of energy, with no limitation of supply, will not be fulfilled at that time, if it ever will be. Results from the experimental stage of this development may, however, modify the global strategy for production of electricity and its possible effect on changes in building design.

CHANGES ON THE DEMAND SIDE AND THROUGH REGULATIONS

Hypothesis 5: building standards will make daylighting a mandatory feature of new buildings long before 2050. In Europe, the CEN standard for indoor lighting (BS EN 12464-1:2002) is being reviewed in 2009. A work group in CEN TC 169 is trying to include specifications for minimum daylighting performance. Integration of strict and ambitious daylighting requirements in new and existing buildings is highly probable before 2050. Various international bodies have launched action in the field: Commission Internationale de l'Eclairage (CIE), International Energy Agency (IEA). Furthermore, findings on the impact of lighting quality on health and well-being should increase constraints for daylight and view at work places in national and international standards.

Hypothesis 6: the value of commercial buildings with good daylighting and low energy consumption will increase. This trend can already be identified. In 20 or 30 years, buildings with low operation costs will have an even greater market advantage. Benefits of investments in energy efficiency measures will be higher than the simple return on investment. However, the high costs of refurbishment of existing buildings will be a barrier for significantly increasing daylight performance. There will be a better understanding of the Total Ownership Cost of various building components. In the field of lighting (electric and natural), daylighting could benefit once all its financial benefits (energy, building value, security, comfort) are taken into consideration. Let us mention as an example the benefit of a well daylit building in case of shortage of lighting electricity or power failures.

WORLD ROOFS: A LARGE SCALE POTENTIAL FOR LIGHTING AND ENERGY GENERATION

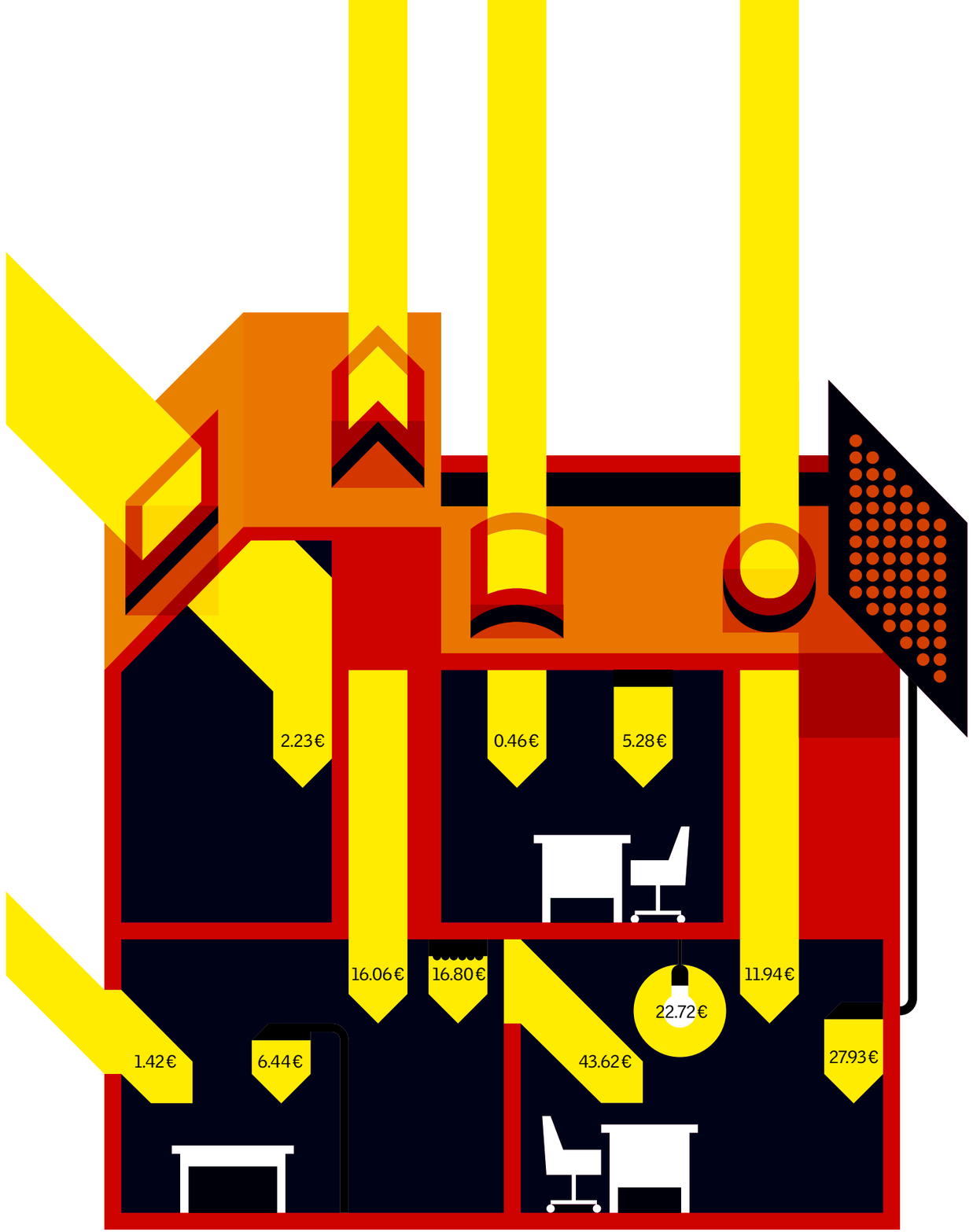
In Europe, the roof area of buildings is of 4 to 9 m² per capita depending on the population density of the area. Densely populated areas lead to less roof available per capita, since buildings tend to be higher. For the entire European Union (Euro 15), this corresponds to 4,571 km² of roof area, or the area of the Danish Island of Zealand. In France alone, the proportion is high (roof area of 750 km², due to lower population density). This area is equivalent to Paris and its suburbs. Each square metre of roof receives 1,000 to 2,000 KWh/m²/year of solar radiation (120 to 240 Mlmh/m²/year of daylight/Mega lumen-hours/m²/year), a quantity equivalent to the luminous energy supplied by 10 to 20 fluorescent tubes (length 1.20 m) during all daylight hours (4,000 hours/year). This demonstrates how powerful daylight is. Progress in insulating glass will continue but it is not clear if U-values below 1 W/m²K can become standard. The development of translucent insulation with U values comparable to insulated walls could be a major threshold in the generalisation of daylighting in buildings.

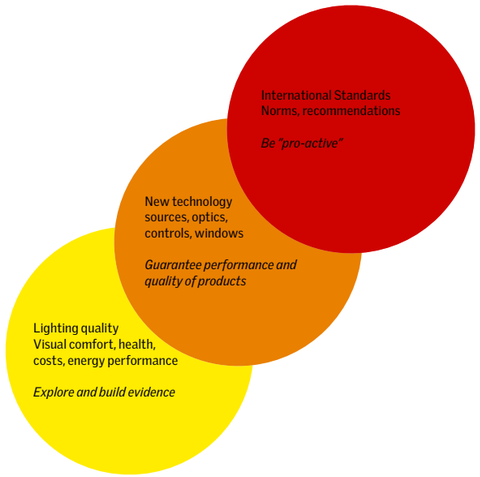
Roofs could also be used to generate electricity. By 2050, photovoltaics and organic photovoltaics (OPV) will have made considerable progress, leading to a cost reduction from 6 €/W to less than 0.5 €/W . The trend for cost reduction is clearly noticeable on the world market in 2009 due to increases in production capacity. Net zero energy consumptions will be achieved in homes with an area of PV of the order of one quarter to half of the floor area (for an energy-efficient home using less than 30 KWh/m² of electricity per year). Buildings with three to five floors could become net zero energy buildings through the use of PV panels on their entire roof surface.

PROGRESS IN ELECTRIC LIGHTING TECHNOLOGIES

The competition of daylighting and electric lighting of buildings during daytime will persist, and cost will be

Total ownership costs of lighting and daylighting, in €/Mlm*h (based on 2007 data). Such values are highly dependant on the cost of electricity, luminous efficacy of light sources and their duration.





Left **Key issues to master lighting in a highly competitive world: world competition and actors of large size should accelerate the whole process.**

Right **Especially in cities with a high urban density, the use of daylight often competes with other – primarily economic – interests that favour tall buildings.**

a major issue. The efficiency of electric light sources will keep on progressing. Today's tubular fluorescent light sources have an efficiency of about 100 lm/W. The absolute thermodynamic limit of luminous efficacy for white light sources is 300 lm/W. But there are technological limits in the conversion of electrons to photons. Various research organizations confirm that it will be impossible to produce more than 180 lm of white light per electric watt with commercial products. Such performances should however be available at reasonable cost by 2030. With additional improvements in the efficiency of optics, this means that lighting systems of 2050 should globally use half as much electricity as today's luminaires based on fluorescent tubes. The cost of light sources should be as low as 5 €/klm (Euro per kilolumen) for LED and OLED technologies (Source US Department of Energy). This would lead to a total cost of production of a light source, optics and power supply of about 10€/klm, a value which will be below the actual combination of fluorescent lamps and luminaries. The cost of electric lighting will thus be dominated by the cost of electricity.

OPPORTUNITIES FOR DAYLIGHTING AS A FUNCTION OF THE URBAN CLIMATE

The hypothesis of growing urban density, partly related to increased costs of transportation, will lead to less availability of daylight at street level, or on the lower floors of buildings. The collection of daylight through roofs will become more strategic, but competition with solar systems will require a global approach. We could reasonably expect solar systems to be installed on the periphery of cities, where roof spaces are large and obstructions limited. Old and dense city centres will probably be less concerned, although renovation programmes could benefit from increased daylight access.

City planning regulation may become more stringent with respect to daylight access but this is not extremely compatible with the evolution of buildings toward high-rise solutions: lower floors of high-rise buildings tend to suffer from poor access to daylight. Codes may suggest compensation approaches, such as more parks or large avenues in the vicinity of high-rise buildings.

Air pollution may change between now and 2050. On the one hand, increased density should lead to increased pollution but on the other, probable development of zero-emission automobiles should lead to a reduction of CO, CO_2, NOx, and particles. Air pollution tends to decrease exposure to UV radiation, and increase the percentage of diffuse skylight compared to direct sunlight. This could lead to a more even distribution of daylight, both over time and for the different orientations of buildings.

The global availability of daylight, however, will not be diminished.

EVOLUTION OF KNOW-HOW FROM ARCHITECTS AND ENGINEERS

To respond to a growing demand, lighting designers, engineering firms and architects are developing sophisticated lighting consultancy using advanced 3D light simulation software and various techniques to process data on daylight availability. All these techniques will rapidly become state-of-the-art. The opportunity exists for window manufacturers to provide similar assistance in daylight engineering to that the electric lighting industry is already providing in its field. This collaborative effort will have to furnish the best possible solutions for specific building uses and climates, as well as guarantee the performance of daylighting systems.

CONCLUSION

Despite all the uncertainties associated with our exercise, there are a few certainties: the cost of energy will increase, regulations will be tighter, and our desire for greater well-being and security will continue, even if our actions will not always be appropriate to meeting this desire. Most uncertainties are related to the speed of the changes to come. This is partly due to the international economic context and partly to the cost of resources.

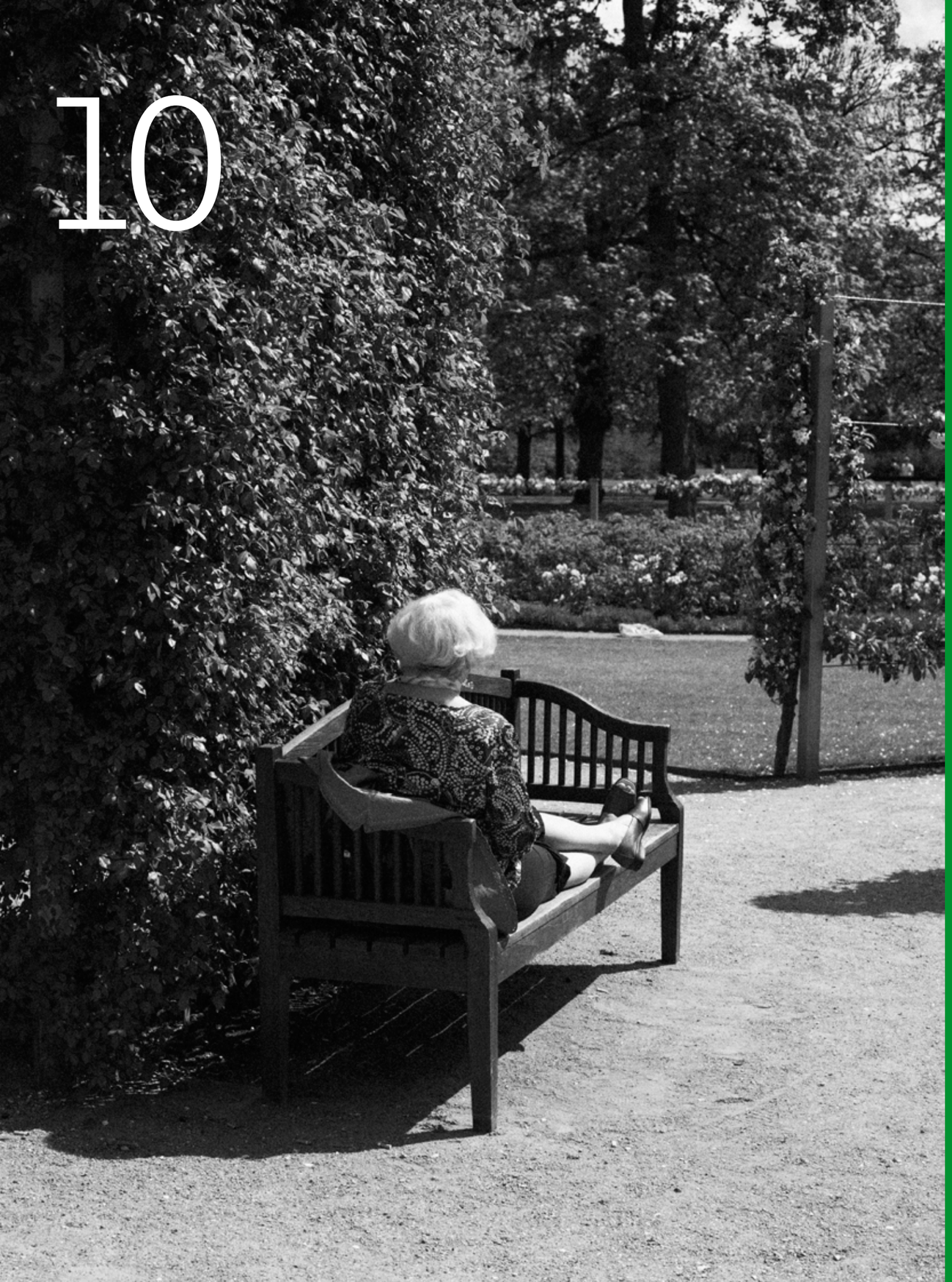
Above all, it is still difficult to anticipate the level of responsibility to the world around us that we, and the next generations, will demonstrate. It is quite astonishing to note how little responsibility we have shown in the XX th century. Will we be able to integrate more global interest into our choices? This is a fundamental question. The accelerating consequences of our impact on the environment may force us gradually but profoundly to modify our way of life.

Let us remember this sentence from Antoine de Saint Exupery (1900–1944):

"We don't inherit the world from our ancestors, we borrow it from our children".

Certainly, our task it to invent a more sustainable future, and to think globally.

Marc Fontoynont is Professor at the ENTPE (National Engineering School of State Public Works) in Lyon, France, where he heads the Building Sciences Laboratory. He has been working on daylighting and lighting since 1981, when he worked as staff scientist at Lawrence Berkeley National Laboratory in Berkeley, California. He is presently active is various organisations related to lighting, and contributed to the foundation of the French Lighting Cluster, bringing together industry and research to speed up development in lighting.



10

MICROCLIMATES
CAN ARCHITECTS CHANGE THE WEATHER?

By the year 2100, the world will be at least two degrees warmer than today. Add to this the effect of the 'urban heat island effect', with city centres being several degrees hotter than their rural hinterlands, and it becomes evident that city planning has to devise new methods to cope with overheating. A new approach is called for – one that not only considers the thermal conditions inside buildings, but also the urban climate as a whole.

By Peter Andreas Sattrup

WHY?

The extreme heat-wave in the summer of 2003 was only a foretaste of the weather events that will be experiencing increasingly frequently in European cities in the future. The fact is that temperatures are going to rise all over the world – by at least two degrees by 2100. Cities are disproportionately affected by this: their usually dark surfaces store heat, and there are often no green areas and corridors to enable air to circulate. And of course the waste heat from people, buildings, cars and industrial plant also contribute to the fact that cities warm up much more than the surrounding areas.

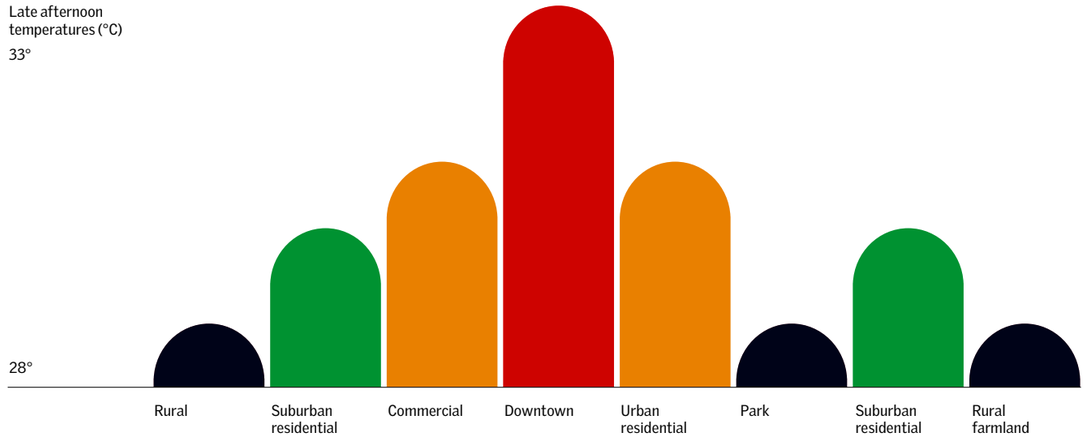
WHAT?

Cities contribute to climate change, but they are also affected by it to a considerable extent. The heat island effect is responsible for urban areas getting up to ten degrees warmer than the surrounding countryside, and not just in southern climes. Heat is literally 'held captive' in the canyons between the tall buildings. There is no evaporative vapour to alleviate the heat – there are two few plants in our cities, and rainwater is taken away in the sewers, rather than being stored in the ground.

HOW?

Climatic comfort will also become a key feature of town planning in future. Urban climates have to be planned in just the same way as interior air conditioning: cities cannot be artificially 'cooled down' from the heat island. Using a mix of lo-tech solutions (vegetation, shading, openable windows etc) and renewable energy sources for cooling purposes is a strategy crucial to handling summer overheating. Above all, the structures of buildings and cities must be much more thoroughly adapted to local climatic conditions (that are also getting warmer).

The Urban Heat Island effect changes wind patterns, humidity levels, precipitation and temperatures. It even prolongs the growing seasons of agriculture in the immediate vicinity of cities.



Schematic cross section through an urban "heat island". In large agglomerations like Tokyo, the temperature differences between the city centre and the surrounding area is up to 10 degrees Celsius.

In August 2003, Western Europe experienced an extreme heat wave. As temperatures climbed they reached levels up to 10 degrees higher than they did in the same period two years previously. It is estimated that more than 35,000 people lost their lives due to excess mortality caused by heat related illnesses, mostly among the elderly. France in particular was severely hit but the heat wave influenced all south-western European countries. Many of these deaths were blamed on the lack of emergency procedures for an event of this severity in some of the societies[1]. Along the Mediterranean, more forest fires were recorded, and agriculture experienced drought conditions. In the same year, harvests were excellent in Northern Europe. In 2002, Central Europe experienced severe flooding after heavy rains in the Alps caused the Danube and Elbe rivers to swell. Several thousand people were evacuated and several cities, among them Prague and Dresden, were severely damaged.

As temperatures increase, the warmer air can contain more humidity. Water that has evaporated from the surface of the earth somewhere is carried and dropped somewhere else. Global warming will change the patterns of precipitation too, "dry areas will likely get drier and wet areas wetter"[2]. Global moisture distribution will probably change, shifting and expanding the arid zones towards the poles. More extreme conditions of rain and drought are expected.

When trying to imagine what the climate of 2050 will be like, events like this heat wave and flooding can provide some clues, as such weather conditions will become increasingly normal. Our cities will have to change both in order to adapt to climate changes and to mitigate them.

URBAN HEAT ISLANDS – CITY GENERATED WEATHER

But we can also look to our cities, since cities create local weather conditions that are significantly warmer than those of the surrounding landscapes. This phenomenon is known as the Urban Heat Island effect. Since urban growth occupies land that was once forest or used for agriculture, the cooling capacities of vegetation is replaced by the heat storage capacity of urban materials – tarmac, concrete, brick etc. Heat from solar radiation is trapped in what is imaginatively called the 'urban canyons' – the narrow streets and gaps between buildings, from where it can only slowly be ventilated or radiated away. Humidity that would have been soaked up in the soil and could have cooled the air by evaporation is led to underground sewers and carried away. Another minor source of urban heat islands is waste heat from human energy use – transport, building services and industry – and pollution. Pollution increases as photochemical reactions between pollutants increase with rising temperatures and create smog, causing health problems[3].

The Urban Heat Island effect changes wind patterns, humidity levels, precipitation and temperatures. It even prolongs the growing seasons of agriculture in the immediate vicinity of cities. Recent research commissioned by the Greater London Authority after the 2003 events indicate that the intensity of the Urban Heat Island effect in London – famous for its overcast skies – can reach 6 degrees Celsius in the city centre, with peak occurrences even reaching 9 degrees. It is not just a phenomenon of southern cities[4].

LOCAL WARMING INCREASES ENERGY DEMAND FOR COOLING

While temperatures rise – the current goal of the European Union is to halt temperatures increase at 2 degrees in 2100 – Urban Heat islands intensify the local consequences of global warming. It will increase the demand for cooling in the future, which is already accounting for a big share of the estimated 40% of the world's total energy use that is consumed in buildings. And you cannot air-condition your city out of the heat island. For every cubic metre of cooled air you produce indoors, you will add the same heat outdoors and big carbon emission to top it off. The direct contribution of Urban Heat Islands to global warming as a result of change of land cover is small, however, compared to the consequences of greenhouse gas emissions. It can be argued that heat islands reduce the need for heating buildings during the winter season. The balance of heating and cooling demands will have to be considered locally, as it depends on latitude and local solar radiation levels. For the majority of cities worldwide, heat is a problem.

WHAT CAN WE DO TO REDUCE THE EFFECTS AND MITIGATE THE LOCAL WARMING TRENDS?

Paint your roof white and plant some more trees seems to be the popular answer today. Or growing green roofs and painting the town white. High albedo surfaces reflect much of the incoming solar energy without absorbing it as heat, and plants cool their surroundings by casting shade and by evapo-transpiration – they 'sweat'. These ideas promote cities and buildings that are not just metaphorically but literally green, taking advantage of the capacity of vegetation to clean air and soil, and keeping moisture levels balanced in cities that are predicted to have more extreme precipitation changes than we know currently. This also addresses the need for considering moisture as a climatic factor, and developing ways to handle water as a quality of urban spaces. As weather patterns will get more extreme, urban spaces can be developed to work as a way of regulating and balancing moisture[5]. Working with reflective surfaces takes careful consideration, as it may affect visual comfort adversely and does have implications for the thermal environment if used indiscreetly. 'Solar dumping', for instance, is what happens when you build a highly reflective building facade on the shadow side of an existing building in a hot climate – solar radiation bouncing off the facade creates a heat overload in the previously cool side of the neighbouring building. This has implications for design methodology for urban masterplanning and building design.

UNDERSTANDING URBAN COMFORT

When designing masterplans for new urban developments or intervening in already existing urban areas, it is a primary concern to establish a set of climatic and urban outdoors comfort criteria that are suited to the local climate of the city. There is no universal standard for urban comfort. Urban comfort is quite different from the standards of indoor climate, as it is more influenced by cultural perceptions, expectations and tolerances of local weather conditions. If we wish to change the carbon footprint of transport in our cities during the next few decades by promoting public transport, personal rapid transport systems, biking and pedestrianisation, we will have to consider how urban spaces and interventions create shelter, and how urban comfort can be created as a function of distances, travel times, programmes, activities, and tolerances to climatic exposures, be they hot or cold.[6] This is a field that requires further studies of local patterns.

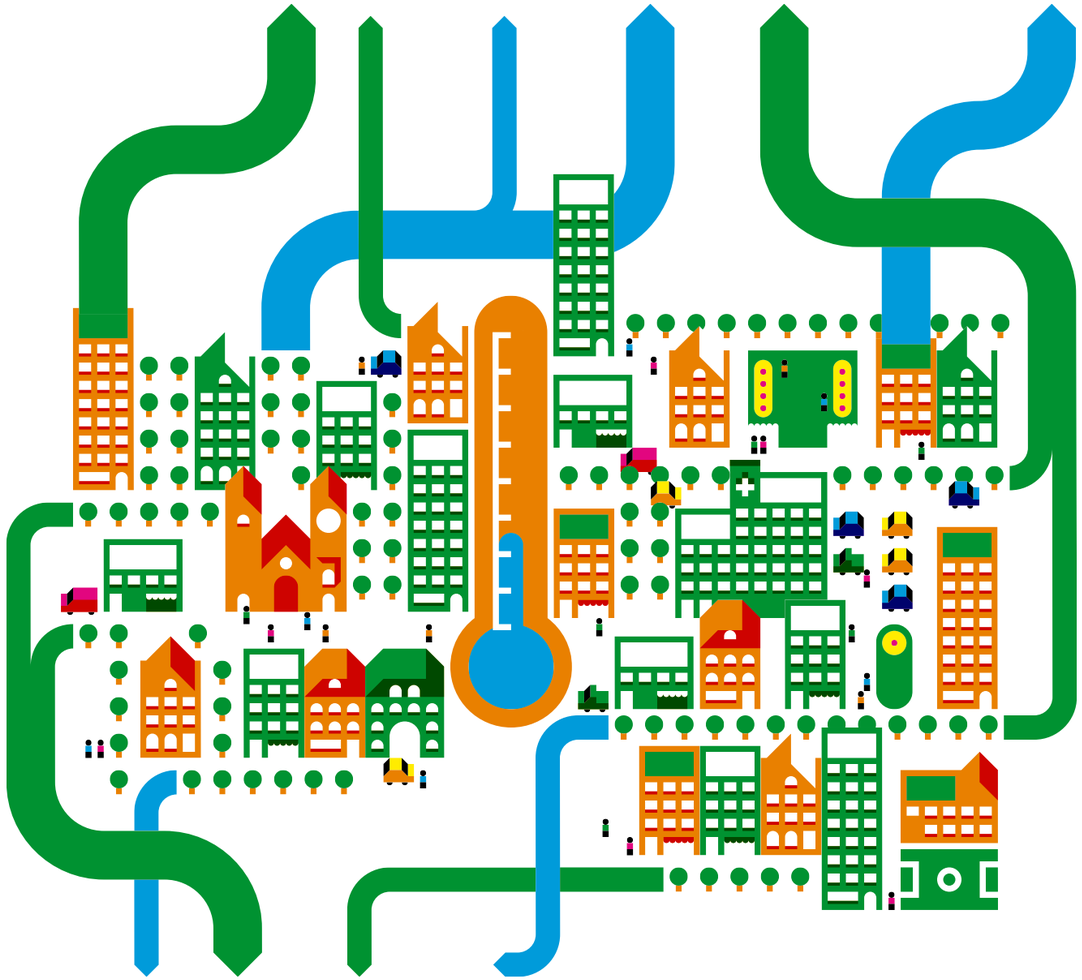
BUILDING PHYSICS FOR THE OUTDOOR ENVIRONMENT

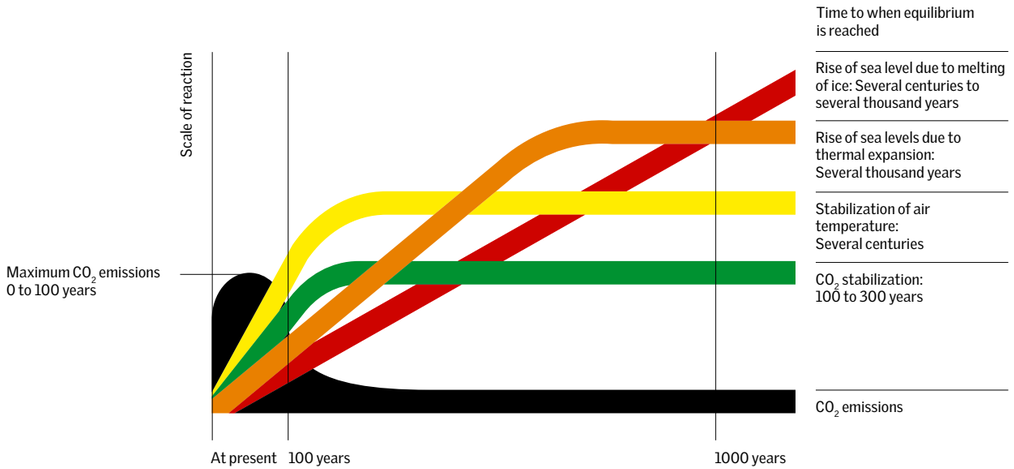
Getting the physics right is crucial. Mainstream architectural thinking is rapidly adapting to the idea that low-energy design must deal with local climatic conditions and use form and materials intelligently to achieve comfort strategies that are not only sustainable but actually improve the environment. The days of the air-conditioned glass-box skyscraper built anywhere from Vancouver to Dubai are over. Getting the balance right between daylighting and heat gains is basic in the new generation of architecture. But we can no longer focus on the indoors alone; we also have to consider what buildings contribute to their immediate urban environment, and what kind of urban spaces they create, not only in social, cultural and economic terms, but also in climatic terms. Sustainable buildings and urban spaces offer open possibilities and situations of choice. Urban life and activity is influenced by the microclimatic conditions created by the architecture of a city.

NEW TOOLS FOR FUTURE URBAN DEVELOPMENTS

Architects and engineers will have to work closely together to evaluate both quantitative and qualitative aspects of design decisions, both for the design for the building itself and

At the end of May 2009 the US Secretary of Energy, Steven Chu, went public with an unusual idea. If all roof and road surfaces in the world's cities were painted white, it would compensate 44 gigatonnes of CO_2 emissions. That would be equivalent to the projected world-wide increase in emissions for the next 11 years.





Even if mankind stopped all CO_2 emissions tomorrow, the global warming would continue. The inertia of our climatic system is one of the reasons why the fight against climate change is a very urgent one.

for the space that surround it. Planners will have to identify criteria for urban qualities to be developed for new areas of expanding cities and for changes to existing ones.

Much can be done by reinventing and developing traditional models. Think of Greek island cities – they are both white and dense and cooled by shadows, and their surfaces reflect the light away. Made for pedestrians, they provide all your basic needs within walking distance. Or think of the Islamic garden, a cool paradise of running water and lush greenery. Or the seasonal waterscapes of Indian Mogul architecture. What could be future developments of these models? And how could they be integrated into the increasingly complex metropolitan conditions that will soon be the living environment of the vast majority of the earth's population? How do they relate to scale, when one single building can house thousands of people, or even entire communities?

The future of urbanism requires negotiation of unprecedented complexity. As more buildings become dependent on passive and active solar energy to meet future energy requirements, the form of cities and urban spaces will become directly linked to the energy potential of the specific sites that the buildings tap into. Conditions of shade and solar exposure translate directly into the energy balance of a particular site. Since every new development will alter the energy balance and the urban microclimate of its site, new methods of evaluation and new regulative instruments will have to be developed to deal with future 'rights of energy' disputes, much as the traditional British 'right to light' legislation has tried to do. These will have to fit the properties and patterns of individual cities and building cultures. Simulation Modelling, Building Information Modelling – even City Information Modelling[7] will be the tools of tomorrow to quantify and qualify our visions of how to create sustainable places for enjoyable living.

METABOLISM – CHANGE

Cities change with time. Societies change. Demands change. Populations change. Perceptions change too. Architecture is often seen as static, as something that lasts a long time, if not forever. But architecture is dynamic, albeit changing at a very slow pace. I am not thinking of dynamism in terms of formal expression, or flow management of traffic or the like. I am thinking of the exchange of matter and of the changes in the patterns of materials and activities that constitute buildings[8] and cities. We sometimes forget that we continuously update our surroundings according to our changing needs. The schools of thought that tie together considerations of time, space and material properties in ways that enhance qualities of life might, therefore, hold the key for dealing with the climatic changes we are facing.

As designers we will have to deal with the long term implications of the choices we make at every level, from the chemical properties of materials to the climatic conditions we create in cities. This requires extensive collaboration across professional and cultural borders. We will also have to realise how powerful we actually are, making decisions every day that change the physical reality of the world. Last but not least, as visionaries of space and good life, we may be able to change the dominating cultural paradigm of wasteful consumption that is leading us in the wrong direction. We will have to grow cities that are adapted and integrated in technical and natural cycles[9].

Peter Andreas Sattrup is an architect and educator. Since graduating in 1997, he has been involved in the design and construction of a number of housing and cultural building projects in Denmark and abroad. He is currently a Ph.D. student at the Royal Danish Academy of Fine Arts, School of Architecture, studying how daylight and solar heat contributes to energy-optimised sustainable architecture. He is an expert consultant to the curator and a contributor to the exhibition Green Architecture for the Future at the Louisiana Museum of Modern Art in Denmark opening in summer 2009.

11

ADAPTATION
ADAPTING TO A CHANGED WORLD: PERSPECTIVES FOR 2050

Whatever else may happen in the coming 40 years, one thing seems certain: in the year 2050 the world will be hotter and raw materials and fossil energy reserves will be much less abundant than today. The global population will grow, as will shanty towns, and flows of migrants increase. A smaller area of arable land will have to supply more people with food and there will be fewer forests to absorb the CO_2 produced by man. How mankind prepares for this changed world is in his own hands. The good news is: many of the ideas and technologies required to tackle the challenges of the future already exist. What is lacking is a categorical will to implement them. What do many of today's leading thinkers say about the future choices facing Operation Sustainability?

"Even if all global greenhouse gas emissions could be stopped today, the immense inertia in Earth's climate systems means that changes to our climate for the rest of this century are unavoidable. Preparing for these inevitable changes is not an alternative to reducing our greenhouse gas emissions, but a parallel and complementary action. International efforts to reduce global emissions are not so far making the drastic reductions required, so we may be heading for further, and potentially more profound, changes to our climate."

Boris Johnson in: The London Climate Change Adaptation Strategy, Draft report 2008

"Climate change has rightly [...] become a pre-eminent political topic, also involving powerful economic interests. Investment decisions taken today will have an impact on the infrastructure and energy systems of the coming decades. At least the latest political developments appear to indicate a gradual shift in the thinking of the largest emitters of greenhouse gases. A few groups of states have already set themselves ambitious goals to moving in the direction of a carbon-neutral society."

Prof. Hans Joachim Schellnhuber in: The Atlas of Climate Change, 2006

"The good news is that meeting human needs while becoming more resource-efficient can be more profitable and can deliver a higher standard of living than maintaining current practices. A new model of prosperity for an environmentally degraded and poverty-stricken planet may be found in efforts to lower consumption, in practices that increase resource efficiency, and systems that circulate materials through recovery and reuse."

Rachel Cracknell in: The Arup Journal 3/2008

"Nothing less than a secular reversal is called for: after two centuries in which capital and labour productivity continually increased, it is now time to focus on increasing the productivity of resources."

Wuppertal Institut in: Zukunftsfähiges Deutschland in einer globalisierten Welt, 2008

"We must urgently uncouple economic growth from energy consumption and CO_2 emissions."

Claude Mandil, International Energy Agency, quoted in: The Atlas of Climate Change, 2006

"The debate is over, the science is in, and the time to act is now."

Arnold Schwarzenegger, Governor of California, quoted in: The Atlas of Climate Change, 2006

"Even given the extraordinarily challenging situation we face, there is much to be upbeat about. First, virtually all the destructive environmental trends are of our own making. All the problems we face can be dealt with using existing technologies. And almost everything we need to do to move the world economy onto an environmentally sustainable path has been done in one or more countries."

Lester R. Brown in: Plan B 2.0, 2006

"The challenges that attempts at damage limitation and adaptation to climate change represent for us are unparalleled but not insurmountable. We can build on existing projects and institutions, nevertheless there is still much to do and delays merely serve to increase future costs. Serious international cooperation is absolutely essential to reduce greenhouse gas emissions to safe levels. No less important is offering help to those who are least able to protect themselves from the consequences of climate change."

Kirstin Dow, Thomas E. Downing in:
The Atlas of Climate Change, 2006

"I firmly believe that [...] working with nature's efficient organisms is the lowest risk way of moving quickly to the Ecological Age. Ecosystems have an amazing capacity to recycle materials and use the sun's energy to sustain development and withstand shocks and we should learn from them and get them to help us.

The eventual aim has to be to move to an optimal economic scale rather than continue to maximise scale and to force our own system relationships onto other organisms. We need to rebalance our systems and rediscover that our world is powered by the sun. This vision of the future is at a time well beyond 2050, but by 2050 we need to be well on the way in the transition."

Peter Head in: Entering the Ecological Age.
Brunel Lectures 2008

"In the end what makes us different from other creatures is our ability to collectively act on our understanding. This is the moment we can decide as a culture to listen to life, to echo what we hear and make the conscious choice to follow nature's lead."

Janine Benyus in: Biomimicry, 2002

"There is no excuse for inaction. We already have many tools and approaches – economic, technological, behavioural, management – to deal effectively with the climate change challenge. But they must be vigorously and widely implemented to achieve the societal transformation required to decarbonise economies. A wide range of benefits will flow from a concerted effort to alter our energy economy now, including sustainable energy job growth, reductions in the health and economic costs of climate change, and the restoration of ecosystems and revitalisation of ecosystem services."

From: Climate Change Congress, Copenhagen,
March 2009 – Key Messages

"We will have to create a civilisation that is running only on daylight – because ultimately daylight is the only infinite resource that we have. I call this a civilisation of dawn."

Tor Nørretranders at the VELUX Daylight
Symposium 2009

"We are like tenant farmers chopping down the fence around our house for fuel when we should be using Nature's inexhaustible sources of energy – sun, wind and tide. … I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that."

Thomas Alva Edison in a conversation with Henry Ford, 1931

COP15 IN COPENHAGEN MUST REACH AN AMBITIOUS CLIMATE AGREEMENT

PHOTO: KLAUS HOLSTING

When the countries of the world gather in Copenhagen for COP15 in December to negotiate a global climate agreement, the ultimate objective will be to ensure the stability of society as we know it today. But it must also create a sustainable society that will be the cornerstone of future economic growth.

192 countries will be represented in Copenhagen in December. Denmark's goal is clear and unambiguous – we must reach an ambitious global agreement that reduces the emission of greenhouse gases. It is a matter of great urgency – because everything points towards us having to find a more sustainable way of life. And the business community has a central role to play in finding concrete solutions.

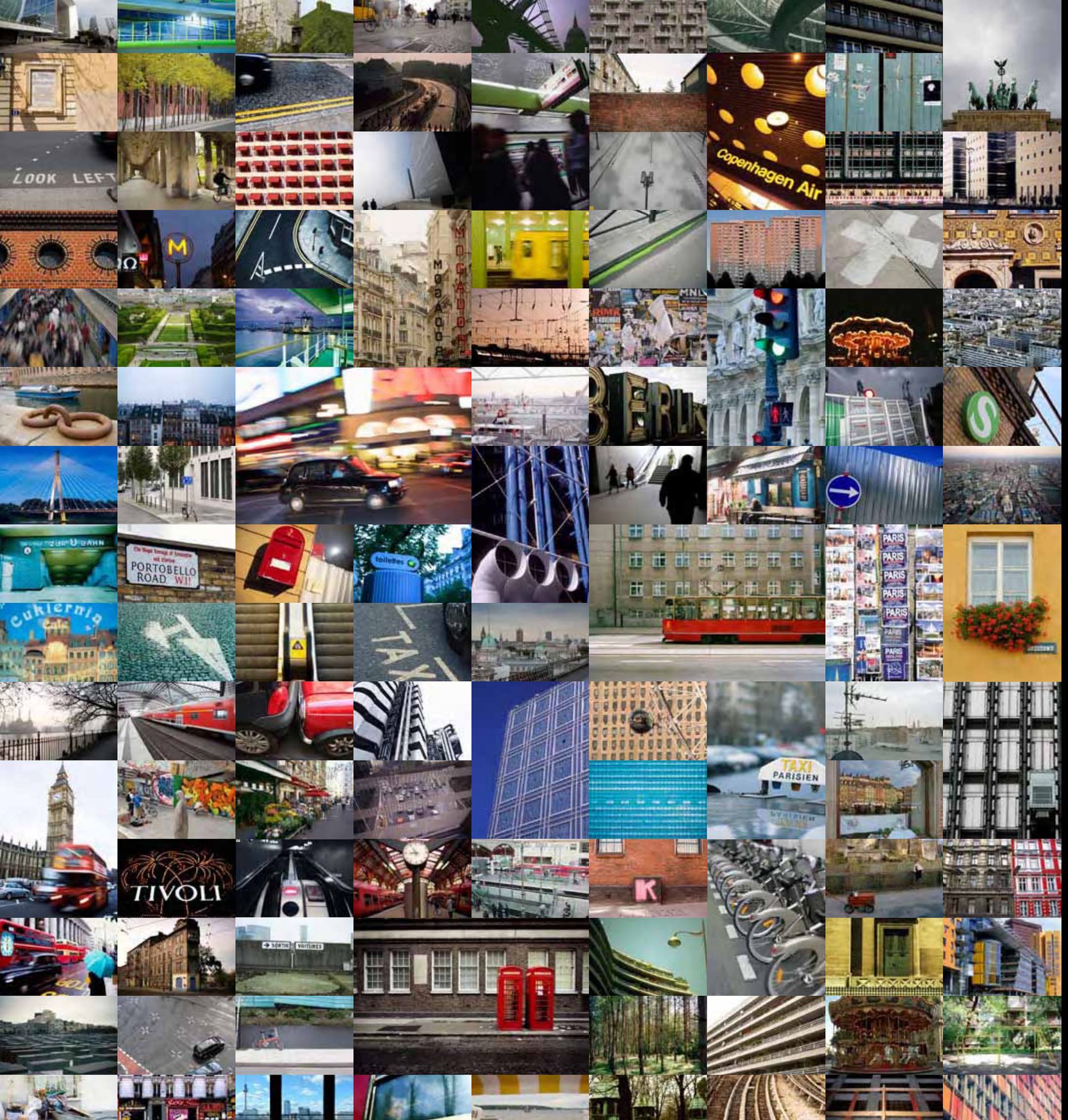
This will be of benefit to more than just the climate. The countries of Scandinavia cannot go on living off the polluting industries of yesterday. Because there are many other parts of the world that are more than ready to continue production, of clothes for example, under with a disregard for the environment and under conditions that we would never permit. So we have no option but to develop new green products and production forms if we want to stay at the forefront of international commerce. And we will earn money from brainwaves and innovative solutions.

The Scandinavian countries have always been good at developing innovative products and coming up with technological answers to problems - we are on the cutting edge in both design and new ideas. So it is only natural that we take advantage of the demand for a solution to the climate problem by continuing that development and ensuring that Scandinavian products are part of the cure for our dependency on fossil fuels.

Denmark's green business sector sets a good example to follow, here in the midst of a financial crisis. The latest figures from 2008 show that Danish export of technology rose by 19 per cent – more than four times the level of conventional exports. This is proof that it does pay for trade and commerce to take the green route – now and in the future.

By 2050, there will be nine billion people living on Earth, eight billion of them in what we call the developing countries. If they are all to have access to the same resources and economic growth, we simply must find better ways of using our resources. We cannot go on polluting our planet and using fossil fuels to exhaustion as we do today. It is simply not viable, not sustainable – say the researchers. They also say that we must act now, because if we do nothing today it will only become more expensive to do what must be done tomorrow. In other words – the price to be paid for delaying action on climate change will just go on rising the longer we sit on our hands and do nothing.

Connie Hedegaard has been the Danish Minister for the Climate and Energy since November 2007. In previous years, she served as Minister for the Environment and Minister for Nordic Cooperation (February 2005 – November 2007) and Minister for the Environment (August 2004 – February 2005). Mrs. Hedegaard is a member of the Danish Parliament for the Conservative Party.



CITIES AND CLIMATE CHANGE

"THE BATTLE AGAINST CLIMATE CHANGE WILL BE WON OR LOST IN OUR CITIES"

Cities have a central role to play in tackling climate change, particularly as cities bear a disproportional responsibility for causing it. In fact, cities and urban areas consume 75 per cent of the world's energy and produce up to 75 per cent of its greenhouse gas emissions.

So what are cities doing to reduce emissions and promote renewable energy sources? How do they motivate their citizens to practice climate protection? What are their hopes for the climate summit in Copenhagen? And how do cities coordinate long-term climate strategies with daily politics? Daylight & Architecture has asked around: in London, Paris, Berlin, Copenhagen and Warsaw, as well as at the C40 Cities Initiative, an organisation in which the world's major cities discuss and coordinate climate protection.

C40 CITIES
CLIMATE LEADERSHIP GROUP

C40 Cities is a group of the world's largest cities that has committed to tackle climate change. Simon Reddy from the C40 Cities secretariat in London talks about how world cities canshare knowledge and foster innovation towards emissions reductions and better energy efficiency.

D&A Mr. Reddy, why is the C40 Cities initiative important in combating global warming?

SR Essentially, cities account for over 75 per cent of green house gas emissions, and therefore, if we don't crack carbon emissions in our cities we are not going to succeed in combating climate change. The rationale for setting up the C40 was that many of our cities that have already pioneered innovative policies and practices for reducing green house gas emissions, and we should use that knowledge and share it among these other cities in order to accelerate the rate in which we can reduce these emissions.

For example, Bogota has developed a bus rapid transit (BRT) which, for many developing cities, is a far more efficient and low carbon way of transporting people around the city. Copenhagen is famous for its heat networks, decentralised energy and combined power stations that are far more efficient than coal-fired power stations. Stockholm is powering buses with biogas from human sewage. This is something all of us should be doing. Cities with large concentrations of people produce a lot of sewage. If you use biogas in your buses rather than using petroleum products, this is a step in the right direction.

So, firstly cities are 75 per cent of the problem and they must be part of the solution, secondly they already have a massive knowledge base about how to reduce greenhouse gas emissions, and we should start sharing that out and make that happen all over the world.

D&A C40 was founded in 2005 in London. What led to its foundation, whose initiative was it based upon?

SR The C40 was an initiative by the former mayor of London, Ken Livingstone and the former deputy mayor Nicky Gavron. They recognized that cities had pioneered initiatives that had reduced green houses emissions. So the idea was to get cities talking to each other, and sharing their experiences. Cities, and in fact human beings in general, are bad at sharing experiences – we all replicate each others' mistakes over and over again because we don't go and find out what works and what doesn't. So the idea of the C40 was: let's set up a network of large cities that are committed to reducing greenhouse gas emissions, let's share their best practices, so we don't all make the same mistakes.

D&A Can you give some examples on how knowledge about climate action is exchanged between cities, especially between cities in 'developed' and 'developing' nations?

SR In some cases we can actually help developing cities leap frog. Some developed cities went down routes in the last 100 years, which in hindsight we probably should not have done. We are now faced with climate change, and a different set of problems that require a different set of solutions. So, now that developing cites have not made the decisions developed cities have made in the last 50, 60, 70 years, we can look at 'leap frogging' technologies so they become more advanced than some developed cities currently are.

D&A Beyond knowledge transfer, what can C40 cities do? What are their main fields of climate change action when – supposedly – the larger framework has to be set by national governments within a Kyoto-like agreement?

SR C40 cities have demonstrated that we can develop more efficiently and more effectively. The current economic situation emphasizes that we need to be more efficient. So even if you put the climate change argument to one side, cities will still need to be more efficient, they need to use less energy, and they need to use energy better.

Denmark is a good example. The oil crisis of the 70s, created a situation in Denmark, whereby the government said: we need to treat oil as a much more precious resource, we need to get more energy and more efficiency out of it. The Danes went down a different path than the UK for example, who had North Sea oil and carried on business as usual. And we are in a situation now, where the Danish systems run far more efficiently and effectively than our systems do, because they prepared 30 years ago for a low carbon future. The point is that making our cities more efficient both makes economic sense and makes environmental sense, because being more efficient means using less energy, using less petroleum products and therefore producing less CO_2-emissions.

D&A In May 2009, the C40 Cities came together in Seoul to their third summit since their foundation. What were the main outcomes of this congress?

SR One of the first plenary discussions in Seoul was on the economic crisis. We all very much feel within the C40 that it is a terrible economic crisis that has created an appalling situation for many cities to deal with, but it also, if anything, emphasizes that we have to be more efficient and also look at the possibilities that will present themselves to us as low carbon cities. Firstly we are better placed to deal with the economic downturn, but secondly we also have the opportunity to create new low carbon industries that will create jobs in our cities for the future. The economic crisis could provide us with an economic model that is far more sustainable. It is the same narrative that we hear from President Obama and many other leaders at the moment, the low carbon future is the new economy of the 21st century.

The C40 was very much created with the focus on delivery. We could become the C120, we could become the C1000, if we wanted to, but we don't. What we want to do is to lead by example and act as a catalyst for change. Our delivery partner – the Clinton Climate Initiative (CCI) employs city directors in each of our 40 cities. We work with the CCI to ensure that we get projects and action up and running in those cities and then they can act as a catalyst for others. If we were to keep expanding, we would spend more time on administering the numbers than we would on actually delivering the projects. We want to stay focused on delivery and lead by example.

In terms of our wider political agenda, we are part of an initiative with the Mayor of Copenhagen, Ritt Bjerregaard's office to conincide with COP15. We don't want to get involved in the climate negotiations in relation to targets, because politically we are going to leave that to national governments – but what we do want our governments to do is to engage, empower and resource our cities. We want governments to engage more with their cities, because cities are 75 per cent of the problem, we want them to empower us, i.e. give us more responsibility so that we can find the solutions working with the national government. In order to do that, we need more resources.

D&A There are an impressive number of cities among C40 which, in the meantime, have adopted Climate Change Action Plans. To what extent are these different from one another? How far do the means by which 'poorer' cities combat climate change, for example, differ from those of 'richer' cities?

SR Obviously different C40 cities are at different stages of development, and sometimes cities will change with a change in political leadership. But there is a very real commitment from the C40 cities to take action. One thing we have realized is that finance is a major problem. We have developed an initiative with the World Bank and the city of Basel on carbon financing, and are currently looking at how we can help a number of cities – initially six developing cities – to use carbon financing and, where possible, the Carbon Displacement Mechanism to seek funding and kick-start greenhouse gas reducing projects in their cities. So yes, we are all at different stages, but to some extent that helps. If some cities are more pioneering than others, we can use them to help others further down the line.

D&A Cities represent, amongst other things, also huge flows of goods, materials and wastes. What initiatives are there among the C40 Cities to make these flows more sustainable, by setting up recycling systems, for example?

SR Waste is one of the biggest areas that we need to do work on, especially in our developing cities. A good example comes from a the city of Sao Paulo, which moved from having very little waste system, to now having a collection of 15.000 tonnes of waste per day, some of which does go into landfill, but they then collect the biogasses, which are used to produce 7 per cent of the city's energy needs. That is a major achievement for a city the size of Sao Paulo to have waste that formerly was just being discarded, now captured and reused to generate energy.

But we want to go further than that. We want to look at advanced integrated waste systems in a number of our cities. This comes back to how we can work differently with developed and developing cities. When it comes to something like waste, we could envisage putting in more advanced waste systems in some of our developing cities than we currently have in our developed cities – simply because here we have a blank sheet. We had an adaptation workshop in Tokyo in the autumn, and we looked at adaptation in terms of where there is a cross-over between adaptation and mitigation. I will give you an example. Tokyo has one of the world's most efficient water delivery systems. For a city of 33 million people, they only lose 3.5 per cent to leakage. London is a city of 7 million people and loses 25 per cent of its water to leakage. So you imagine the energy needed to pump water around the city of 33 million people, when you lose 3.5 per cent or the energy wasted, as compared to losing 25 per cent. And in terms of technology transfer Tokyo is very keen to talk to and work with other cities that want to develop water delivery systems that are as efficient and advanced as their own.

"If anyone said to you and I, look it costs the same amount of money, do you want to hire a green taxi or do you want a smelly old diesel one, you hardly have a choice, do you?"

Simon Reddy

D&A In the preface to the London Climate Action Plan, former mayor Ken Livingstone wrote in 2007: "The simple message is this: to tackle climate change you do not have to reduce your quality of life, but you do have to change the way you live." What is the C40 doing to get this message across to citizens?

SR Paris is a C40 city and has its 'Velib' bike scheme [a street-based rent a bike scheme], and this is something that a number of other cities have learnt about from Paris at C40 events. Several C40 cities, such as London, are looking at introducing similar schemes.

On the issue of travel demand management we brought as many cities as possible together to discuss issues about behavioural change in relation to transport. We looked at how you get model shift away from private car to public transport, and exchanged experience on congestion charging, which is a stick approach to changing people's behaviour as opposed to a carrot approach. We discussed how you make it easier for people to make more sensible decisions in relation to their travel.

Stockholm airport has introduced a new taxi rank, for green taxis only. This has not been done anywhere else, as far as I know. It is a very clever idea. They put a sign up saying: taxi rank this way, green taxi rank that way. Now 35–40 per cent of travel to and from the airport is by green taxi. They don't cost more, but they gave them their own priority taxi rank, so people can make a choice. If anyone said to you and I, look it costs the same amount of money, do you want to hire a green taxi or do you want a smelly old diesel one, you hardly have a choice, do you?

D&A What is your organization's experience on how to change peoples' environmental behaviour most effectively?

SR With our partners the Clinton Climate Initiative, we just launched the Climate Positive Initiative, which is about new developments being carbon negative. We are always at pains to point out that most of the programmes we have running within the C40, such as the retrofitting programme, or the LED lighting programme – a lot of these will save you money. So even if you don't want to get involved in the climate change policy aspect of it, the reality is that by converting street lighting to LEDs will save you money. Los Angeles is about to change all their street lighting to LED, and they will save over a million dollars a year in energy bills, which is of benefit to the tax payer in Los Angeles. The project has a seven year payback, but once these seven years are out, they then make a one million dollars a year saving. That is based on today's calculations, and with the way we expect energy prices to increase, it will probably be even more. So what is good for the economy is in many cases good for the environment and vice versa. By being more efficient, we are saving money and reducing green house gas emissions.

D&A The world leader will convene in Copenhagen in December to – hopefully – sign a post-Kyoto agreement. What are the messages of the C40 Cities Initiative to these leaders?

SR The message is that we want to work with national governments. We are 75 per cent of the problem. The battle against climate change will be won or lost in our cities. If you do not deal with cities, you cannot possibly achieve the reductions you are talking about. So we are simply asking national governments to engage, empower and resource their cities. We want them to engage with us as cities in how we reduce greenhouse gas emissions and to empower us – give us the statutory responsibilities. Give us the policies that we need and the powers that we need in order to be able to do the best that we can to help national government meet their targets. The resource is essentially the money, but it is also resources in terms of people or in terms of policies.

Help us to help you, is what we are saying. We are 75 per cent of the problem therefore we are 75 per cent of the solution. We will deliver, and we will help you deliver your targets, whatever they will be, but you need to engage, empower and resource us.

Simon Reddy is Executive Director of the C40 Cities, based at the organisation's global secretariat in London. David Miller, the Mayor of Toronto, has been the Chair of the C40 since June 2008

"I hope that the Climate Conference in Copenhagen will help to move us forward again"

Klaus Wowereit
Governing Mayor of Berlin

"We are witnessing a major shift in thinking."

Ritt Bjerregaard
Mayor of Copenhagen

"What I really want is action to cut emissions, not warm words"

Boris Johnson
Mayor of London

BERLIN

"Climate protection must combine forward-looking thinking with a pragmatic approach on a day-to-day basis", says Klaus Wowereit, the Governing Mayor of Berlin. If cities were to take the effects on the climate into account in all their political decisions, then climate change could gradually be contained. He believes that even international climate negotiations are more likely to produce gradual progress than a major breakthrough.

D&A What action do you believe cities can take in order to avert climate change?

KW We can take concrete action by incorporating climate policy as a factor in all the measures we adopt.

D&A What kind of exchange of experiences does your city foster with scientists and other cities in order to learn more about climate change and their experiences with countermeasures?

KW Berlin is a city that is involved in the scientific world, and we place emphasis on innovation in our economic policies. One concrete example is that we are committed to solar power. So Berlin promotes the direct implementation of new concepts and technologies designed to combat climate change.

D&A What do you personally believe to be the most important aspect of the battle against climate change?

KW Taking responsibility for future generations.

D&A Do you see the current economic crisis as an opportunity or an obstacle when it comes to implementing measures designed to prevent climate change?

KW The economic programmes of the national and state governments focus on environmental policy concerns. We use funds from the economic programme to implement energy-related improvements to schools. Even the car scrapping bonus, despite its problematic effects, ensures that we get more environment-friendly vehicles on the roads. But in principle, the crisis could trigger the resurgence of an ideology that demands growth at any price, with less concern for climate-related topics.

D&A Measures designed to combat climate change must be long-term in nature. But local policy is often more concerned with day-to-day business and short-term results. How do you tackle this potential conflict?

KW This is indeed a factor that needs to be acknowledged and given consideration on a long-term basis.

D&A What messages would you like to send to the world leaders when they meet in Copenhagen in December 2009?

KW I take a pragmatic view. I hope things will move forward. The major industrialised nations need to move gradually closer. I very much welcome the fact that the new US Government under President Obama is making it clear that it is abandoning the oppositional attitude of its predecessors.

D&A What progress in the battle against climate change do you consider to be realistic by 2050?

KW It should be possible for the vast majority of countries to be in a position to implement a joint climate protection policy – one that achieves a huge reduction in CO_2 output.

Klaus Wowereit has been Governing Mayor of Berlin since 2001.

COPENHAGEN

The outgoing Mayor of Copenhagen, Ritt Bjerregaard, is hopeful and sees the economic crisis as a chance of changing the economy towards more sustainability and more social justice. Right now she is planning for her successor to host a meeting in December for 100 fellow mayors of big cities from all over the world. This will provide them with the opportunity to make a direct 'city input' to the COP15 climate conference that will take place in her city at that time.

D&A Mrs Bjerregaard, what role can cities like Copenhagen play in combating climate change and reducing CO_2 emission?

RB Cities are indispensable actors in the climate change issue. The state governments are responsible for making a deal at the December meeting in Copenhagen. But when it comes to the implementation of the deal, it is in the cities that the targets are to be met. Cities account for close to 80 per cent of CO_2 emissions on a global scale and half of the world's population live in cities. Fortunately, many of my fellow mayors are as committed as I am to finding concrete solutions - for example, by promoting sustainable building and road pricing. And then we big cities work with things such as the C40 Cities Climate Group.

D&A What kind of exchange does your city maintain – with scientists, with other cities – to continually find out more about climate change and about how to overcome it?

RB We have had a very good collaboration with the University of Copenhagen on their climate planning. The University really moved ahead by hosting the international scientific congress on climate change in Copenhagen in March this year. So, the scientists are indeed making their contribution to the COP15. I do hope they will continue to take part in the debate and to offer their expertise.

D&A Do you consider the current economic crisis a chance or a challenge when it comes to implementing measures against global warming?

RB: It is a chance, for sure. We have the possibility of changing our economy towards more sustainability and more social justice.

D&A Fighting climate change is an extremely long-term endeavour. How would you describe the challenge that exists in combining political leadership and long-term strategies?

RB In the city of Copenhagen, we have made a huge effort to ensure that our long-term climate investments will pay off. We make sure that there is focus on energy efficiency when we are renovating public buildings, and we provide financial support for climate-friendly green courtyards, solar cell modules and green roof terraces in housing renovation projects. In this way, we combine the housing policies of the city with the climate policies. These two areas are inseparable.

D&A What key messages do you have to the world's leaders when they convene in December 2009 in Copenhagen for the next Climate Summit?

RB First and foremost, a binding agreement endorsed by as many countries as possible and with concrete targets must be reached. And by concrete I mean something that is turned into action. As EU Commissioner for Environment, I was chief negotiator for the EU during the Kyoto talks, and I find it embarrassing how few of the participating countries have since met the targets they committed themselves to.

D&A In your opinion, what progress in terms of climate change mitigation can we really expect by 2050?

RB I believe that we can expect substantial progress. It seems to me that we are witnessing a major shift in thinking about this. More and more people have stopped seeing economic and sustainable growth as two separate things. But everything takes time, and I believe we will know a lot more about how much progress we will be able to make when we see the result of the new climate protocol coming out of the Copenhagen meeting. Fortunately, many of the big cities are very ambitious and we trust them to make an input to the negotiations. That is why we are hosting a meeting in Copenhagen for nearly 100 mayors from the big cities all over the world on 14–17 December.

Ritt Bjerregaard Mayor of Copenhagen (Social Democrat) ends her second term in office in November this year. She has served several times as Minister in Social Democrat cabinets in Denmark and is a former EU Commissioner of Environment.

LONDON

London is currently busy preparing for the 2012 Olympic Games – and, according to Mayor Boris Johnson, the same year will also be a "real deadline" for climate change action. Despite the current crisis, city officials are confident that even the economy will benefit from climate change action in the long run: According to Isabel Dedring, Director of Environment for the Mayor of London, 10–15,000 new 'green collar' jobs could be created in London alone by 2025.

D&A Mr. Johnson, what is the most important aspect to you personally in fighting climate change?

BJ Climate change is a major threat and protecting our environment is one of the key issues we face today. That is why I am committed to cutting carbon emissions in London by 60 per cent by 2025. In London we have a real deadline – when the world comes to the capital for the 2012 Olympic and Paralympic Games. I want visitors to find a cleaner city with cycle superhighways and cars generating no fumes and less noise. Thousands of new trees will have been planted and Low Carbon Zones will showcase the best and latest in environmentally sound products and practices. What I really want is action to cut our emissions, not warm words.

D&A Mrs. Dedring, what possibilities do cities have to take action against climate change?

ID Close cooperation between cities across the world is absolutely key to us cracking the mutual threat of climate change and cities have a real responsibility to act as consumers of 75 per cent of the world's energy and producers of 80 per cent of its climate change emissions. But what we don't want is warm words and promises – we need real action and large scale programmes actually delivering carbon reductions if we are going to make a difference.

As part of the C40 Large Cities summit in Seoul, cities from around the world came together to make real emissions reductions. In London we have already saved ourselves £1m a year on our energy bills and 25 per cent carbon savings by implementing the Building Energy Efficiency Programme – improving the energy efficiency of Greater London Authority group buildings. We are extending the scheme to all public sector buildings in London. The Mayor is working with London Councils to develop a home efficiency programme which will include a retrofit academy to train people to deliver the scheme.

In Seoul the Mayor also announced that he is working with other cities to accelerate the global market for electric vehicles – including the procurement and promotion of electric vehicles in city fleets and the development of charging infrastructure. The Mayor published a detailed delivery plan outlining how London will become the electric car capital of Europe by achieving at least 100,000 electric vehicles on the capital's streets as soon as possible, helping to stimulate the UK's electric vehicle market.

D&A Do you consider the current economic crisis a chance or a challenge when it comes to implementing measures against global warming?

ID The Mayor is committed to doing everything in his power to see London through the downturn and one of the strongest ways to do so is to grasp the international opportunities afforded by the challenge of climate change and to cut the capital's energy usage. A recent study we commissioned by Ernst and Young showed our plans to reduce energy use and tackle climate change could bring 10–15,000 jobs and contribute £600m a year to the capital's economy by 2025. The Mayor wants to generate 'green collar' jobs and believes that if we champion retrofitting, for example, not only can we cut our emissions – we have a target of 60 per cent by 2025 – but also provide thousands of jobs and help reduce people's fuel bills and cost of living. At the C40 summit, the Mayor reinforced the message that London is alive and kicking and still an unrivalled place to pursue business, specifically for 'green-collar' companies. The Mayor wants to ensure London remains ahead of the game at the dawn of a low-carbon economy. Ernst & Young's latest Country Attractiveness Survey shows that, for the seventh year in a row, London has retained its position as Europe's most attractive city to invest in. One of the reasons for this is that London is positioning itself at the forefront of a low-carbon economy. In times of recession, there are relatively few sectors of the economy that can boast sustained growth of upwards of 10 to 20 per cent growth per annum; the low-carbon opportunity is one such sector.

Boris Johnson has been Mayor of London since May 2008.

Isabel Dedring is Environment Advisor to London Mayor Boris Johnson.

PHOTO: GETTY IMAGES NEWS

"Not tomorrow but today."

Bertrand Delanoë
Mayor of Paris

"We need a follow-up agreement to the Kyoto Protocol"

Leszek Drogosz, Deputy Director of the Infrastructure Department of the Warsaw City Hall

PARIS

At the Local Government Climate Change Leadership Summit in Copenhagen on 2–4 June 2009, the Mayor of Paris, Bertrand Delanoë emphasised in his opening session speech that the challenge of global warming is "more than just important. Our planet is mortal and the countdown has begun," Delanoë said.

"In view of the urgency, there is no place for indifference or negligence: the only possible response is action." As half of the world's population lives in cities, they have a special obligation. So for Paris, environmental planning is more than just one policy field among others – it constitutes the policy area that inspires all the others," said the Mayor of Paris at the summit.

The Magistrate of Paris plans to reduce the city's greenhouse gas emissions by 25 per cent before 2020. This cannot be done, however, without challenging the domination of the car in a city infamous for its traffic and its inhabitant's love of driving – and driving fast and a lot.

Thus, in addition to the 'Velib' rent-a-bike scheme, a new car hire scheme, 'Autolib', offering 4,000 self-service compact electric cars has recently been introduced.

According to Delanoë, diversifying the choice of means of transport in the city with trams, river shuttles and so on has already produced quite significant results. Between 2002 and 2007, the volume of traffic in Paris dropped by 20 per cent, pollution by 32 per cent, and CO_2 emissions by 9 per cent.

A comprehensive energy efficiency plan for buildings has also been launched, including measures to reduce the energy consumption of 600 Paris schools, and the creation of 62 hectares of additional green space in the city.

In his speech, on behalf of the world's local governments Delanoë underlined the need for "real decisions" from the COP15 summit in December:

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the "adoption of challenging goals for reducing CO2 emissions" with "tough legal penalties" and "funding commensurate with the urgency of the situation"

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recognition of the "hands-on contribution of local governments"

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a "real effort by national decision-makers" in order to enable "research, innovation and eco-technologies".

"Without state-level buy-in," he said, "nothing will be achieved." However, the role of the big cities in this was made painstakingly clear. According to the Paris Mayor, "in the world's large cities, it is time to change the way we travel, consume and generate our energy. Not tomorrow but today."

Bertrand Delanoë, Mayor of Paris (Socialist) has been in office since 2001. Delanoë was first elected to the Paris City Council in 1977 and has also served in the French Senate.

WARSAW

Leszek Drogosz, Deputy Director of the Infrastructure Department of the Warsaw City Hall, is not alone in hoping for a breakthrough during the negotiations on climate change to be held in Copenhagen in December of this year. His city is pinning high economic hopes on the development of energy efficient technologies: "The future competitiveness of Europe will be measured by the effective use of energy resources and raw materials," Mr Drogosz believes.

D&A Mr Drogosz, what opportunities do cities have to combat climate change?

LD Climate change is a fact, even though not everybody is aware of that yet. Cities have both the opportunity and the duty to increase the general awareness of society about this, because urban areas contribute almost 80% of global CO_2 emissions. We should not forget that climate is an important factor that decisively influences the functioning of entire ecosystems, as well as economic and welfare systems. For this reason, the City of Warsaw is promoting sustainable development in many areas. Only a harmonious and coordinated cooperation will allow us to achieve our goal of reducing CO_2 emissions by at least 20% by the year 2020.

We will be focusing particularly on the energy efficiency of municipal buildings, on climate-friendly modes of transport and on the development of renewable energy sources. Cities play an important role in the battle against global warming because the measures they implement must have measurable results for the reduction of emissions. Only cities with suitable skills and funds will be able to help achieve the ambitious goals set by international policies.

D&A How does your city exchange experiences and ideas with researchers and other cities to learn more about climate change and others' experiences with countermeasures?

LD Cooperation with scientists and other cities is a valuable source of information for us to learn about the global application of technological solutions. They also allow us to exchange opinions and experience. Warsaw takes an active role in climate protection – both at local and global level. Since 2002, we have been a member of the organisation EUROCITIES, which represents the interests of European cities in relation to the EU, and since 2007 have been part of the C40 Cities Climate Leadership Group. Cooperation with other cities all over the world and the exchange of practical experience have had a perceptible impact on the implementation of climate protection programmes. Moreover, reports from research institutes give us the opportunity to learn the views of the scientific sector.

D&A What is the most important aspect of being involved in climate protection for you?

LD The reduction of CO_2 emissions, particularly those stemming from the transportation system and energy production, is a clear priority for Warsaw. The most difficult area involves private transport, which is responsible for 80% of the city's traffic emissions. So Warsaw is directing its efforts towards modernising public transport and its infrastructure in order to make it a more attractive alternative to cars. Such measures ensure the development of our country's capital at the same time as improving the cityscape and quality of our public spaces, particularly in the centre of town. Another priority is the utilisation of renewable energy. This allows us simultaneously to protect our environment and promote development of the city. Green technologies create space for innovation and the development of new commercial areas, based on cooperation with research institutes. Of course, it is not possible to satisfy the energy demands of the entire country using green energy alone – so traditional forms of energy production have to be maintained and intensively modernised.

D&A Does the current economic crisis present an opportunity or a challenge for the introduction of measures to combat global warming?

LD The ecological crisis that may arise if we do not radically change our approach to climate protection will have significantly more serious consequences than the current financial crisis. The economic crisis should therefore not be taken as an excuse to stop investments and measures to promote climate protection. Rather it should be used as a motor to spur on the development of ecological technologies, which would help create new jobs and contribute to im-proving technological progress. The European Union expects advantages to emerge from low-emission industrial production, which is why the EU Member States have agreed to reduce CO_2 emissions by 20%, to improve energy efficiency and to increase the proportion of renewable energy to 20% of all energy consumed in the EU by the year 2020. Thanks to this energy package, the EU's economy will become a trendsetter for energy efficiency. This will support the expansion of alternative sources of energy and create the basis for the development of new technologies.

D&A Measures to combat climate change must be designed for the long term. But municipal policies often focus more on day-to-day affairs and short-term results. How do you deal with this tension?

LD Sustainable development must always take priority. The introduction of radical changes (e.g. a ban on cars in the city centre without providing comfortable public transport) would annoy the inhabitants of the city. Change should not take them by surprise; instead, the reasons for any change must be explained to them and the advantages of such change must be demonstrated. This is the short-term approach when attempting to implement long-term strategies.

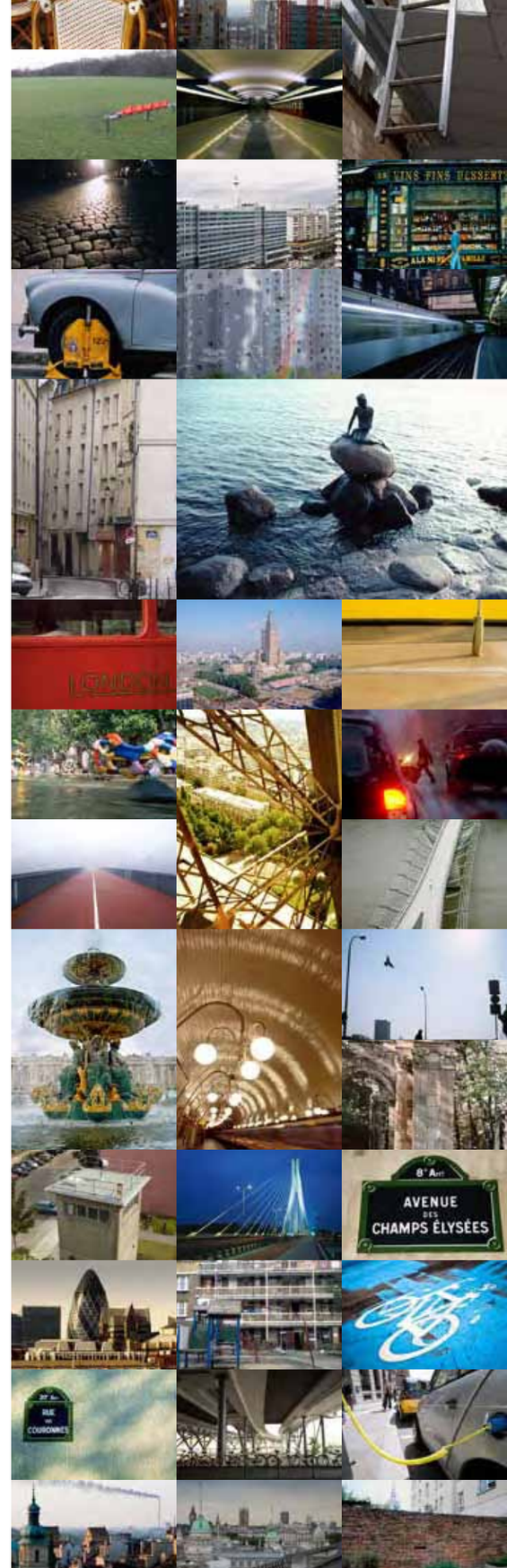
D&A What message does Warsaw have for the leading global politicians who will be meeting at the UN Climate Change Conference COP15 in December?

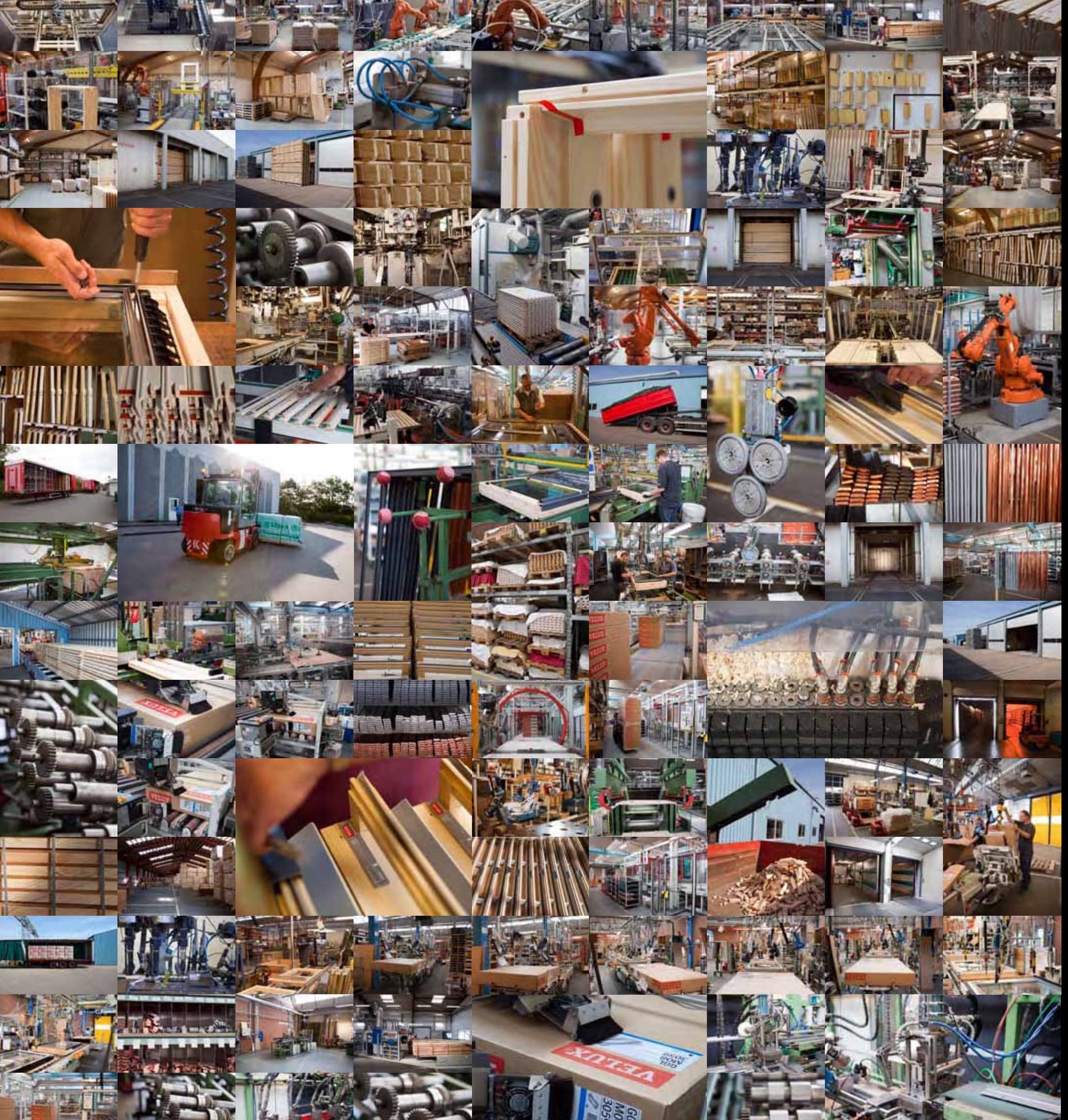
LD To agree on a follow-up strategy to the Kyoto Protocol that could trigger the global battle for climate protection. The role of cities needs to be taken into account in all measures for climate protection. Because cities cannot escape the responsibility resting on them – and they are willing to get involved in the battle against climate change. That is why Warsaw is supporting the plea directed at the world's statesmen to acknowledge the role of cities and their contributions to climate protection in the agreements to be reached during the COP15 summit.

D&A What changes can we expect to see in the area of climate protection by the year 2050?

LD In view of the leading role that the European Union plays in climate protection measures, we can expect to see very restrictive environmental protection policies in the future as well. Thanks to Europe's determined policy, the economy will develop on the basis of innovative technologies that will help create new jobs. The future competitiveness of Europe will be measured by the effective use of energy resources and raw materials.

Leszek Drogosz is responsible for climate protection, and energy and water management in Warsaw municipality.





BUILDING MUST BE GIVEN TOP PRIORITY IN THE CLIMATE DEBATE

The UN Climate Conference in Copenhagen must find new ways to bring about dramatic cuts in global CO_2 emissions.
The VELUX Group wants to see building given top priority on the political agenda.

"We support the concept of Active Houses, buildings developed with the focus on the interaction between low energy consumption, a healthy and comfortable indoor climate and adaptability to the special character and climatic conditions."

Jørgen Tang-Jensen, VELUX CEO

The VELUX Group believes the climate challenge should be tackled out of concern for the health and well-being of the global population. Quality of life must be designed into the initiatives that will limit energy consumption and cut CO_2 emissions.

"We in the VELUX Group believe it is of immeasurable importance that an ambitious climate agreement, with widespread support, is reached at the December meeting. Companies need a framework within which they can operate on their work in developing new technologies that will help in achieving the goals set. Buildings must be on the agenda – they represent 40% of all energy consumption. As a responsible company, we strive constantly to optimise our products and develop solutions for sustainable, climate-neutral buildings. If we are to put these proposals into practice, we are going to need legislation and political support," says VELUX CEO Jørgen Tang-Jensen.

There is a need for the political will to introduce incentives for embarking on energy-renovation projects on homes that can improve their energy performance by supporting sustainable energy sources such as solar energy. Part of our effort must be devoted to ensuring that homes have a better indoor climate, with more daylight and fresh air. This is particularly important at a time when activity in the building sector is falling drastically because of the financial crisis.

Political incentives must be long-term in conception and effect and provide some sort of predictability for home owners. This could be done through schemes such as linking property tax to domestic CO_2 emissions or introducing favourable loans to home owners who replace their windows, modernise their energy equipment or install solar heating.

How does the VELUX Group want to influence the agenda?
Europe's energy consumption reflects the way we have constructed buildings up to now. The VELUX Group very much wants to help set a new agenda for building in the 21st century, so that buildings of the future can become CO_2-neutral and have the best living conditions for human well-being. We spend 90% of our time indoors but many of our buildings have a poor indoor climate.

So we need to put much sharper focus on the importance of a healthy indoor climate, with daylight and fresh air, in tandem with energy-efficient building components and sustainable energy sources. This will meet the requirements of climate, economy and public health at a stroke – and not just when we plan new buildings but also when we renovate the existing building stock. There is absolutely no point in having an energy-efficient house if it is unhealthy to live in.

This focus must be applied in close cooperation between good architects, engineers and building companies who must ensure that our day-to-day surroundings become not only healthier and more climate-friendly but also contribute to better quality of life through attractive and functional design.

Why is the VELUX Group, as a window manufacturer, putting the focus on buildings in their entirety?
Because buildings consume enormous amounts of energy – about 40% of all energy in Europe. If we are to reduce their CO_2 emissions, we have to look at their overall qualities, properties and functions in terms of energy efficiency, healthy indoor climate and sustainable energy. If we bundle together all the points mentioned above, we have what we in the VELUX Group call Sustainable Living – our ability to improve the quality of our homes continually and maintain high levels of comfort at the same time as reducing energy consumption and eliminating CO_2 emissions.

Would you explain what you mean by Sustainable Living?
The VELUX Group communicates its active participation in global warming issues under the umbrella of Sustainable Living, which is based on:

1. Maximised energy efficiency and minimised carbon dioxide emissions
2. Visionary architecture combined with improved health, well-being and comfort for people
3. Renewable energy sources, with focus on thermal solar energy

1. Energy efficiency: Consider the building as a whole, not just the sum of its components; good daylight levels save electricity. Solar gain through windows can be exploited in the heating season. Intelligent use of windows with exterior roller shutters can insulate from cold, protect from solar heat and provide ventilation. In the parts of southern Europe where cooling is extensively used, a home owner can save up to 33 % on the electric cooling bill simply by intelligent use of roof windows with shutters for natural ventilation and shading.

2. Healthy indoor climate: Maximum daylight and ventilation requirements in legislation are needed to ensure optimal indoor comfort. The indoor climate is an essential factor to be considered when designing a house. In Europe we spend 90 % of our time indoors. Studies document that 30% of the building mass does not contribute to our health in a positive way. Indeed, it has been proved that daylight and fresh air has a positive effect on health, productivity and learning abilities. And fresh air via natural ventilation is vital for minimising the risk of allergies.

3. Renewable energy: Solar energy offers a great potential for decreasing CO_2 emissions in our homes. By integrating renewable energy in the building, a house can be an energy contributor instead of an energy consumer. Hot water can be produced by solar energy collected through solar panels – and new technologies are emerging that will allow solar energy to cool buildings. Solar collectors can provide up to 70 % of the energy needed to produce domestic hot water. The sun is the most powerful source of energy we have and we should be making maximum use of it.

How do VELUX products effect the environment?
Buildings are major consumers of energy and we all have a responsibility to ensure the energy consumed for heating and cooling buildings are minimised in future. Simultaneously, we must not forget that houses are built for people and our product development therefore considers the impact on the environment and the comfort of the building occupant. Our products can optimise energy efficiency, minimise impact on the environment while simultaneously ensuring that consumers get maximum comfort, maximum daylight levels high natural ventilation rates and utilise the power of the sun.

There are two aspects of environmental impact – the first being the energy used for manufacturing. It takes 50 kilos CO_2 to produce and dispose of a typical VELUX roof window, taking into account its entire life cycle. That is the energy equivalent of a 15 W energy-saving bulb burning for 200 hours or less than one hot meal per year over the lifetime of the window.

We believe that the energy contained in materials should be considered when planning windows application, alongside costs. Energy will be a scarce resource in the future and as such a valuable currency. The other aspect to consider when talking about environmental impact of our products is the technical abilities the window represents when applied to a building – new or existing. It is not enough to designate only the u-value – the number informing about the product´s ability to minimise loss of heat from the inside to the outside through the product. The solar contribution, that is the heat gain from the sun bringing energy from the outside to the inside through the product, should also be considered – this is called its g-value. Connecting these two values will tell us the energy balance of the product (eref), and enable us to make optimal energy use of roof windows.

On an overall basis, we believe that it is necessary to take a holistic approach by considering construction as well as consumption, heating as well as cooling and to make as much use of the abundant energy source – the sun – as possible.

What is the VELUX Group doing to combat the climate problem?
Responsibility for the environment is firmly anchored in the VELUX values and our commitment to behave like a model company. We are committed to closely considering our use of resources, and for a number of years have enforced a corporate environmental policy. We go to great lengths to reduce the environmental impact of the production, use and disposal of our products.

Why is sustainability important to you as a building component manufacturer?
We focus on sustainability in our products because the concept deals with design based on larger environmental considerations, diminished use of resources and social responsibility. We affect the environment in everything we do – and the environment has an effect on us. This is inevitable - but we can make a difference by focusing more on sustainable design. This can be done in all areas of the value chain – from the early design phase to choice of materials, production methods, transport and branding. All of this is incorporated in our VELUX climate strategy that was launched in January 2009.

We all have a responsibility to contribute to alleviating global climate problems – and that is a responsibility we take very seriously. So we have drawn up a global climate target:

The VELUX Group will achieve a 20% reduction in the Group's global CO_2 impact by the year 2012 and a 50% reduction by 2020, both relative to 2007. This goal will be reached primarily through a number of VELUX initiatives and with a total investment budget of DKK 400 million.

The reduction and documentation of VELUX climate impacts is a key element in our corporate social responsibility. But achieving more efficient and economic production and operations is also integral to VELUX business strategy and we believe that investing in energy efficiency is essential in joining forces to combat the current climate challenges.

How will VELUX reach this climate target?
VELUX commitment to CO_2 reduction will proceed along two tracks:

One is that we as a company want to save energy and thereby reduce our own CO_2 emissions in order to achieve our objective. The other is that the basis of our business is to supply products that can help our customers to save energy so that their own CO_2 emissions are reduced. These two goals are linked.

What are you doing to reduce your own CO_2 emissions?

Each of our factories has its own investment plan and its own targets. We have already implemented optimisation of wood-chips suction and compressor technology and have commissioned several wood-chip fired boiler units. And in Poland we have carried out a complete energy review of our factories and produced an extensive report that makes 11 concrete proposals that could reduce consumption by 1,000 tons of CO_2 a year, partly by introducing demand supply of wood-chip suction (a cut of 320 tons CO_2/year) and compressed air (a cut of 150 tons CO_2/year).

What does VELUX have to contribute as a global building component manufacturer?
VELUX has a vision for the sustainable buildings of the future. To demonstrate our vision, over the next two years VELUX will collaborate with a number of building components manufacturers in constructing six CO_2-neutral houses intended for experimentation with technological solutions; real-life experiments in five countries. The houses will be monitored for their energy consumption and indoor climate conditions and the experience will be used in future VELUX product development. The concept is called Model Home 2020. Its objective is to create carbon-neutral buildings with maximum comfort for the users – also defined as high liveability. We support the concept of Active Houses, buildings developed with the focus on the interaction between low energy consumption, a healthy and comfortable indoor climate and adaptability to the special character and climatic conditions of the location.

Active Houses respond to environmental and climatic changes through a holistic approach – and show the way to future standards through experimentation. With central focus on health and comfort Active Houses are designed and constructed to achieve a balance between the three parameters: energy, indoor climate and environment.

ACTIVE HOUSE – A HOLISTIC APPROACH

Energy
An Active House is designed with a focus on low energy consumption. It is, as far as possible, self-sufficient in energy for heating, hot water, ventilation, lighting and installations, using renewable energy sources to become CO_2 neutral. Low energy consumption is reached through a holistic approach where the orientation and design of the building is used to make maximum advantage of solar energy. Intelligent and dynamic window solutions with optimised shading and screening will create a building that can be controlled according to the rhythm of the year and day.

Indoor Climate
An Active House has a healthy and comfortable indoor climate and requires optimal use of daylight and natural ventilation. The house will be built of materials that have a minimum effect on the indoor air quality. The house must be flexible so it can be adapted to changing needs. The daylight conditions must be optimised by strategic placement of windows. Intelligent operation will provide the windows with sun screening on warm days, and dynamic elements in the building envelope can reduce the heat requirement of the house during wintertime. Natural ventilation, with windows opening automatically when needed, will contribute to a good indoor climate.

Environment
An Active House is designed with focus on adaption to the special character and the climatic conditions of the location. The choice of energy system for the house must be optimised in relation to local energy supply availability and structure.

An Active House must relate to the topography, landscape and surrounding buildings; local building tradition and use of local materials are considered as architectural design parameters. The specific site will be decisive for the design of the building – by maximising use of sunlight and daylight potential, by ensuring views to the exterior and by the interplay with its surroundings.

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VII. MIT/INEL The Future of Geothermal Energy – Impact of Enhanced Geothermal Systems [EGS] on the U.S. in the 21st Century http://www1.eere.energy.gov/geothermal/egs_technology.html. Note that geothermal is treated here as a renewable resource, with a yearly production rate based on projected installed capacity in 40–50 years exploiting current recovery technologies. The resource is indeed finite (since contained within the earth) but its ultimate potential is considerable and has been estimate at several 10,000 TW-yrs. However its exploitation is contingent on capturing the heat reservoirs stored very deep under the earth's crust and on humanity's willingness to do so.
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X. Solar energy received by emerged continents only, assuming 65% losses by atmosphere and clouds
1. One exajoule = 1 billion billion joules or 277 billion KWh
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7. The best photovoltaic arrays on the market already deliver nearly 20% efficiency, while solar cells in the laboratory now approach 45%, with an expectation of 30% modules in the 15–20 years horizon. DARPA, the US agency that spearheaded the internet in the 1980's, has outlined a long-term objective of 50% conversion
8. Electric vehicles (EVs) carry a substantial electrical storage capability that could be used interactively with the power grid to absorb or supply energy when not in use. This concept is known as PV-to-Grid.
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10. Wind energy generation is considerably more site-specific than solar energy, because wind power varies as the cube of the wind speed. Therefore very large differences in potential yield (i.e., economics) exist within most countries, with the best spots generally located on hill-tops, seacoasts and offshore, hence the need to concentrate wind generation in these regions and to carry the power to points of utilisation.
11. A Feed-In-Tariff (FIT) is the negotiated price paid by utility grid operators to renewable energy generators by adding a small premium on all retail electric rates.
12. A FIT legislative proposal discussed in the state of New York would bring two to three times higher revenues for residential or small commercial systems than large open-field solar farms.
13. http://www.betterplace.com/
14. E.g. see personal rapid transit concepts at http://www.personalrapidtransit.com/ , or see ongoing deployment plans in Abu Dhabi at http://www.npr.org/templates/story/story.php?storyId=90042092
15. (wind installed cap approaching 120 GW and PV 15, solar thermal taking off fast with projects totaling several GW in the design or construction phase)
16. As a quick order-of-magnitude check, installing overnight the 40 terawatts of the intermittent PV, CSP, and wind resource necessary to power the planet indefinitely after strong conservation measures could cost anywhere between 50 and 150 trillion of US dollars using current technological costs – a huge number, but 'only' 2–3 times larger than the wealth currently held by the planet's top 0.15% richest people. Together with anticipated technology cost reductions between now and 2050 by a factor of 2 or 3, this expense, stretched over 40 years, would amount to ~1–2% of the world's GDP, i.e. the estimated price to pay to prevent run-away global warming – and much less than fixing it.
17. Looking at the fuel deletion cost for instance, a simple calculation shows that the insurance of protecting oneself against oil (this doesn't make sense. Protecting against oil what? And what does per bbl stand for? Does it mean $500 billion?) at $500/bbl in 2040 (and by extension all the electricity-generating fossil fuels) is worth 25 US cents per kWh today (i.e. about twice the current retail price of electricity).
18. The German experience, where well over 200,000 solar-related jobs have been created since the onset of its incentive programmes, shows that renewables create 2–3 times more jobs per unit of energy than conventional resources.

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09 DAYLIGHT

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2. PV-Group: www.pvgroup.org
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10 MICROCLIMATES

Notes:
1. In France excess mortality was directly linked to urban heat islands: "Case-control studies carried out in France found that loss of autonomy and social isolation played a major role in the risk factors for the elderly, as did living directly below the roof of a building, in a heat island, particularly in cities.", and: "Air pollution played an undeniable role in 2003." See http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=551
2. See http://www.ipcc.ch/ipccreports/tp-climate-change-water.htm A graphic representation of global weather change physics based on research done by the US National Oceanic and Atmospheric Administration is found in Kolbert E: Outlook: Extreme, National Geographic Magazine April 2009.
3. A website with information on urban heat islands and references for scientific publications is made available by Lawrence Berkeley National Laboratory: http://eetd.lbl.gov/HeatIsland/ see also http://science.nasa.gov/newhome/headlines/essd26apr99_1.htm
4. Greater London Authority: London's Urban Heat Island: A Summary for Decision Makers, 2006 Greater London Authority. http://www.london.gov.uk/mayor/environment/climate-change/docs/UHI_summary_report.pdf
5. In Curitiba Brazil, Mayor Architect Jaime Lerner made the city acquire low lying areas susceptible to flooding, turning them in to public parks. A presentation of the planning experiences of Curitiba is on display at the Louisiana Museum of Modern Art in Denmark May 29th – October 4th 2009. www.louisiana.dk
6. The Masdar City masterplan by Foster + Partners is a state-of-the-art study of climatic design for a large urban area. It uses sophisticated simulation modelling to develop urban design guidelines aimed at cooling hot urban environments. http://www.fosterandpartners.com/Projects/1515/Default.aspx
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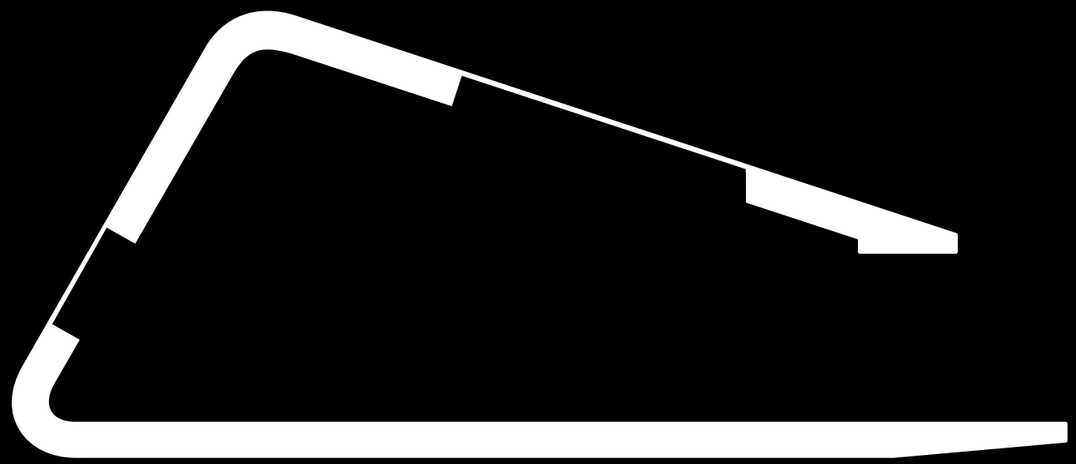

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