II

RESEARCH ARTICLES

TOWARDS A SUSTAINABLE CITY CENTRE: INTEGRATING ECOLOGICALLY SUSTAINABLE DEVELOPMENT (ESD) PRINCIPLES INTO URBAN RENEWAL

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ABSTRACT

This paper reflects upon a wide range of strategies focused on increasing sustainability of urban design beyond and within the scope of individual buildings. By examining the case study of the Australian city of Newcastle, the paper provides a context for a general debate about the urban design of a sustainable city centre, and discusses how urban design is affected (and can be expected to be even more affected in future) by the new paradigms of ecology.

In this context, the author presents the case study of 'SolarCity', which is based on a vision for the revitalisation of Newcastle's city centre. It is an in-progress research and demonstration project, involving Australian and German architects, engineers and industry partners. It deals with cross-cutting issues in architecture and urban design and addresses the question: How to best cohesively integrate all aspects of energy systems, transport systems, waste and water management, climatisation, etc., into contemporary urban design and the environmental performance of eco-buildings?

The 'SolarCity' project encapsulates a vision based on the belief that urban revitalisation can be achieved and facilitated through the use of sustainable urban design principles. Consequently, this paper addresses the fundamentals of urban sustainability, such as orientation to the sun, and general strategies for more compact communities. As we begin to fully understand the consequences of our dependency on fossil energy and the automobile, the cost of mobility, and ways to integrate sustainability systems into buildings, it becomes apparent that the common knowledge of aesthetics of urban composition is no longer sufficient.

KEYWORDS

urban principles for Ecologically Sustainable Development (ESD), energy consumption, global warming, density, solar orientation, eco-buildings, case study, Newcastle City Centre, the 'SolarCity' project

INTRODUCTION

Climate change and the growing demand for energy (despite limited fossil fuel reserves) is likely to be the major challenge of the 21st century and a serious problem facing humanity (Flannery, 2005; Kolbert, 2006). This issue can no longer be left to the evasions that currently characterise much of Australia's greenhouse policy (such as giving priority to coal-fired power stations). The author believes more commitment to green policies is needed, since Australia—as well as the United States—are the nations with the industrialised world's highest per capita greenhouse gas emissions (Energy Report Australia, 2005. The per capita emissions are estimated to be about 1.4 times higher than those per capita in Germany or Japan). Despite this, there is still no real move in Australia recognisable towards a significant policy to strengthen and further explore renewable energy sources.

This paper is divided in three parts: Firstly, it addresses some fundamentals of sustainability and defines the current question in urban design: where are we today? In this context, the value of urban density of Newcastle city centre is discussed. Secondly, the paper reflects on some innovative methods for ESD (Ecologically Sustainable Development) and their possible integration into urban design and eco-buildings, within the framework of the 'SolarCity' vision. And finally

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asks, where to now? This part evaluates the relevance of the suggested strategies and proposes some sustainable solutions for the future of our city centres.

NEW 'CONSTRUCTED ECOLOGIES'?

'Sustainable development' is defined by the Brundtland Report (Brundtland et al. 1987) as: 'Development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.'

Roughly half the energy consumed in the developed world is used to run buildings (in Australia, buildings consume around 44 per cent of all energy. Source: OECD Report, Challenges and Policies, 2003). A further 25 per cent is accounted for by traffic and transport. A large quantity of non-renewable fossil fuel is needed to generate this energy, and the process involved in the conversion of fuel into energy has a lasting negative effect. This threatening situation calls for a rapid change and a fundamental reorientation of our thinking about urban design and architecture, to base both on the renewable, inexhaustible energy potential of the sun, wind, water and geothermal heat. Layout, geometry and the form of the buildings should reflect possibilities for better harnessing these natural resources.

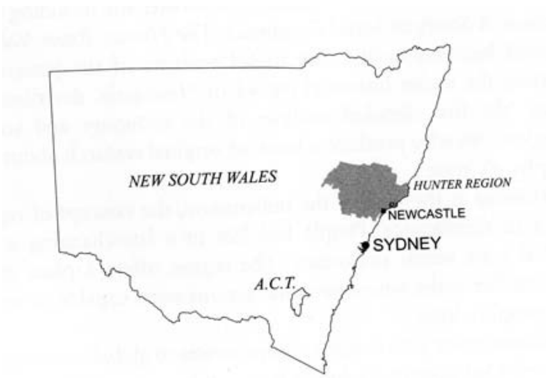
However, the relationship between available technology and urban design decisions has become a complex issue. In recent publications on urban design there has been much talk about 'The Compact City' and renewable energy sources (Hall, 2005; Forster, 2002; Herzog, 2001; Breheny, 1995), but what are some practical strategies that can be applied to facilitate the revitalisation of city centres? How can we design urban open spaces and buildings in such a way that only a minimum of energy is needed to light, ventilate and service them? And by doing so, can we find a poetic architectural response, where the building envelope is informed by simple and strong architectural ideas, rather than by being technologically driven? Doesn't sustainable building development mean first of all to apply technical aids sparingly and to make the most of all passive means provided by the building fabric? I believe so.

An issue emerging from discussions about urban design is the possibility of harnessing the energies manifested in the existing fabrics—for instance, through the adaptive reuse of former industrial sites and the upgrade and extension of existing building structures. A second level of exploration discusses the relevance of ESD principles for 'eco-buildings'—buildings that are designed to make the most of the environment by harnessing the sun and wind for power, and by collecting rainwater.

Over the last years, the City of Newcastle, a port city on the Australian east coast (approximately 80 miles north of Sydney) has explored various ways how the city centre could be revitalised, and—at the same time—turned into a model for sustainable development. The strategic move towards a "sustainable waterfront city centre" (Lehmann, 2006) is

FIGURE 1. The inner-city area of Newcastle is focus of the 'SolarCity' project, with the vision for a "sustainable waterfront city centre" (Lehmann, proceedings ICTC Conference 2006; *The Herald*, 2006). Newcastle is Australia's largest port, with over 85 mill. tonnes of trade throughput p.a., the world's largest coal export port. (*Source:* Report by Newcastle Port Corp., 2006)

FIGURE 2. Newcastle is approximately 80 miles north of Sydney. It is the second largest city in New South Wales, with a metropolitan population of around 150,000 and a wider catchment of 600,000 people; the city is located at the entry to the Hunter Valley. (Newcastle City Council website: www.ncc.nsw.gov.au)



work in-progress, and has received the working title: *the 'SolarCity' project.*

The following Figures 1 and 2 characterize the City of Newcastle more in detail.

COMPARING CITIES, LEARNING FROM OTHERS

Energy demand patterns depend on a number of factors including size and population of the city, its density, its composition of built form and its climatic location. Figure 3 illustrates how urban density and gasoline consumption vary widely from city to city. Automobile-based cities such as Houston, Sacramento or Phoenix, with very high CO_2 emissions, have, at the same time, the lowest population densities. However, the recent increase of huge amounts of automobiles and demands of oil and other resources in China and India is not yet reflected in this diagram (Sheehan, 2001).

It is assumed that we are now about half way through the 'age of oil', with oil supplies running out

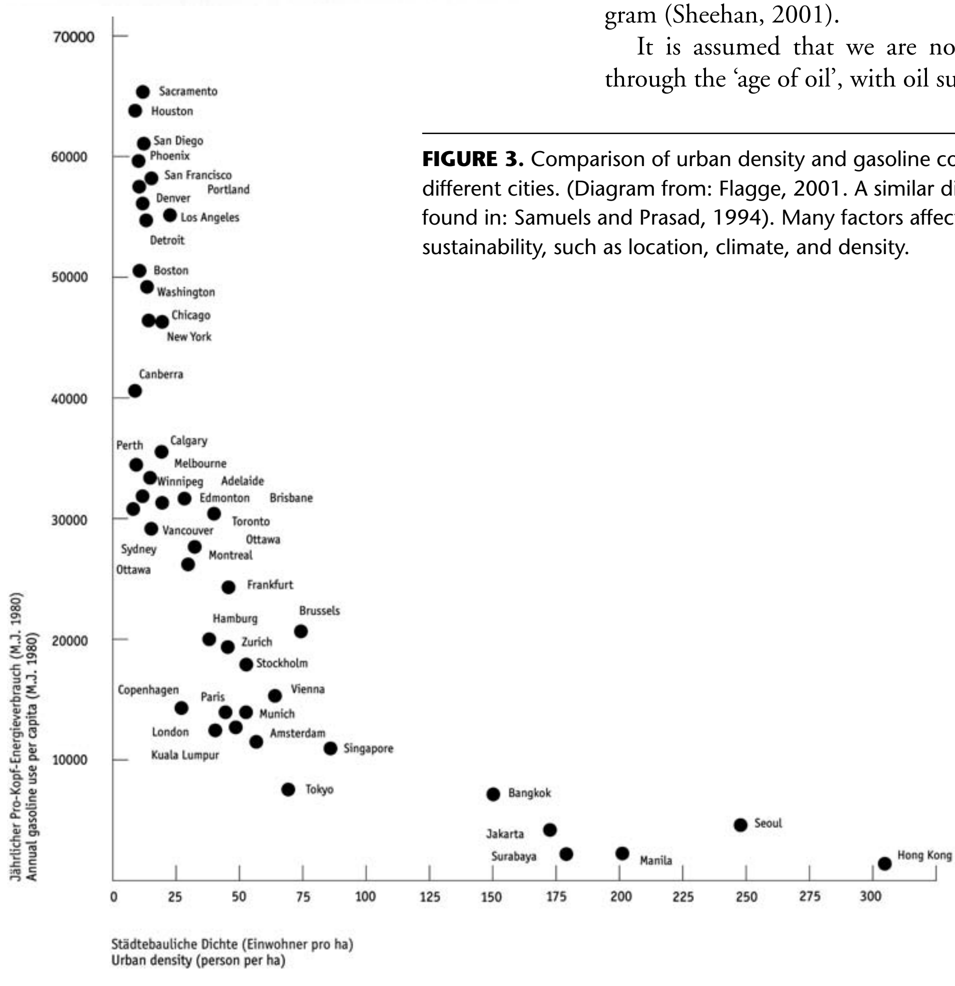


FIGURE 3. Comparison of urban density and gasoline consumption of 30 different cities. (Diagram from: Flagge, 2001. A similar diagram can be found in: Samuels and Prasad, 1994). Many factors affect urban sustainability, such as location, climate, and density.

or becoming unaffordable expensive within the next 15 to 20 years (Flannery, 2005). Further, the production, conversion and use of energy causes significant damage to the environment at local and global levels—acid rains and global warming are some examples.

Appropriate policy and decision making are essential for a sustainable development of the energy sector to fulfil its several conflicting goals. We can expect that any reform of the existing energy infrastructure will require large capital investment and long gestation periods. Full commitment to an appropriate research and development (R&D) policy for new energy technologies is needed to supplement the process. Most of the time, innovation is initiated by the leadership of individuals; government is rarely an innovator, but can facilitate such change. City councils and governments are starting to reflect on this dilemma: Why not have regulations and guidelines for developments, embedded in an overarching vision, that require innovation in sustainability?

Since the oil shock of the early seventies, a number of modelling tools have been used for planning and decision-making in urban design and the appropriateness of buildings. Let's have a closer look at the criteria which have emerged over the recent years.

INTEGRATION OF ECOLOGY IN THE URBAN DESIGN PROCESS

Urban design, and the fundamental principles of how to shape our cities, has barely featured in greenhouse debates in recent years. Much of the debate in related areas has circled around ideas about technology for 'eco-buildings'. This is surprising given that avoiding mistakes in urban design at early stages, could genuinely lead to more sustainable cities.

Urban design is affected—and can be expected to be even more affected in future—by the new paradigms of ecology (Kolbert, 2006). As we begin to fully understand the consequences of our dependency on fossil energy and the automobile, the cost of mobility, and potential of innovative ways to integrate sustainability systems into buildings, it becomes clear that traditional knowledge of aesthetics of urban composition and construction (as was suggested by Sitte, 1889, in his pivotal text on principals of urban planning), is no longer sufficient.

For a sustainable city centre, it seems imperative to develop an overarching vision that counters sprawl, curbs commuting and promotes increasing urban density. Hereby, it is less environmentally damaging to stimulate growth within established cities, rather than sprawling into new, formerly unbuilt areas (Rogers and Power, 2000). It helps reduce our automobile dependency; carbon dioxide emissions will not be reduced as long as we continue to build suburbs at low densities on the urban fringe, and as long as populations decline in the historical, inner city areas. The city centre offers good possibilities of harnessing energies manifested in the existing urban fabric—through the adaptive reuse of former industrial sites and the upgrade and extension of existing building structures.

Today, all aspects of the environment have to be considered. In an urban context, the quality of space and light, the compositional questions of urban form and grouping, the choice of materials, all have to be considered as an integral part of an ecological proposal. However, one of the greatest challenges in terms of sustainable building lies in the area of energy consumption. In the past, construction costs have been repeatedly identified as the major barrier to green design; but since the building components (such as the new generation of PV cells) have become much more efficient and are getting cheaper produced in high quantities, sustainability will be able to pay for itself over a period of 10 to 15 years. Therefore, it is operating costs of buildings, not so much construction costs that are increasingly problematic. A sensible trend to combat this problem is to shift away from buildings with intensive technical installations to either low-tech solutions, or to ones with structures using efficient new façade technology (e. g. using double-skin facades).

The exploitation of solar energy in particular has become a strong formal determinant in developing new architectural concepts and facades in which efficiency and sustainability are combined, and this results in a particular type of aesthetic for 'eco-buildings'.[1]

REDUCTION OF AUTOMOBILE DEPENDENCY AND VEHICULAR TRAFFIC

Sustainable architecture is only really effective when set in an urban planning context, which itself is based on sustainable principles. In future, more and more people worldwide will live in cities. However, urban design has not been much of a focal point in the recent greenhouse debate and there is, rather, a tendency for engineers to favour technology-based solutions for individual buildings (as the author has experienced in many occasions when collaborating with mechanical engineers and other expert consultants on new office building developments over the last 15 years). It is often forgotten that the placement of buildings, and how compactly they are grouped, has a direct impact on energy consumption, determines traffic patterns and, thus, the production of greenhouse gases.

To minimise greenhouse gases from transportation and traffic requires a reduction in automobile dependency, and this can be achieved through the increased use of renewable energy (see Figure 4 for an overview of the contribution we can expect from renewable forms of energy) and innovative urban design (rather than by returning to some "romantic semi-rural lifestyle" as, for instance, promoted in the work of urban theorist Leon Krier, 1984).[2]

In most cities in Australia and the US, there is a large disparity between where people live and where they work, resulting in longer commuting distances

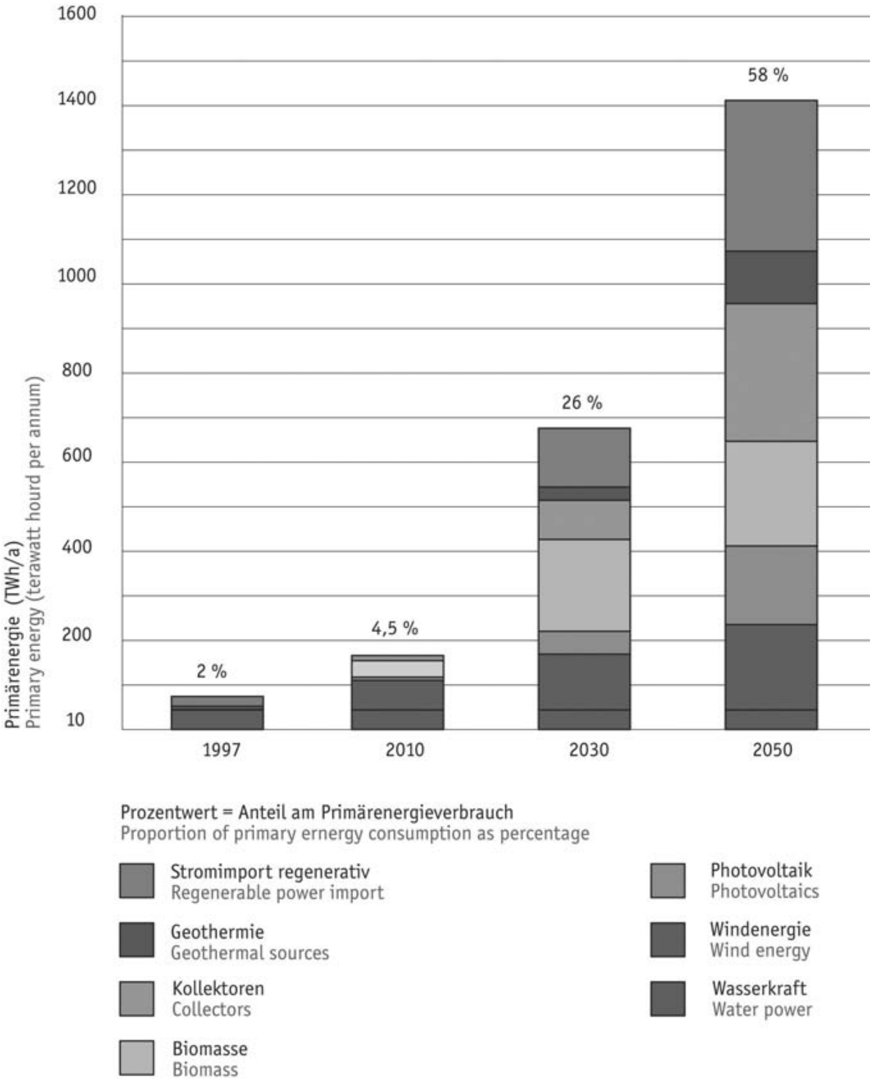


FIGURE 4. Contribution from renewable forms of energy up to 2050. It is expected that in Europe by 2050 more than 50 per cent of the energy will come from clean renewable forms of energy. (diagram from: Flagge, 2001). Interestingly, Sweden has recently made a commitment to be 'free of oil' and to achieve this percentage, not to depend on fossil energy anymore, as early as by 2020.

than in comparison for people in European or Asian cities. The author suggests that an answer to this problem is the revitalisation of the city centre, where a higher population density and more compact community would offer everything within walking and cycling distance. Such high density centres close to public transport nodes are also the aim of what is called Transport-Oriented Development (TOD); these communities can offer a large degree of self-sufficiency and, at the same time, good rail links to the rest of the city.[3] The author does not claim that densification and Transit-Oriented Design are appropriate for all contexts; however, with those strategies, some great improvements were achieved in several European cities, such as Rotterdam, Copenhagen, Barcelona, Lyon, and Freiburg (Hall, 2005). The question now is: what is 'best practice' in those cities, and which part of it can be transferred to the Australian or American context?

A VISION FOR NEWCASTLE CITY CENTRE: WORK IN-PROGRESS

Growing interest in the city centre and the increasing importance of regional cities started to bring more investment to Newcastle and transform and upgrade the city centre. Since 1996, residents have increasingly moved back to the centre and a process of urban renewal has started. In fact the urban renewal of the city centre started slowly ten years ago, from which time there has been a 15 per cent increase in population (NCC, 2005). People move back to the inner city area: Over the last decade, more than 3,000 people have moved to live in the city centre, and over 1,200 new residential units have been built.

The new city centre master plan currently being developed has the potential to shape the city in a way, which will affect all residents. Public discussion about what the residents want for the city has been conducted, and to this end, a reference group of architects, urban designers, planners and other professionals has been set-up by the state government. During this transparent, democratic process alternatives are developed, presented, discussed and critiqued.

The 'SolarCity' project is led by an international research network and involves experts from Australia and Germany. We are now at a point where we enter the implementation phase. The key stakeholders of the 'SolarCity' project are: The University of Newcastle, Newcastle City Council, a local developer, two industry partners (manufacturers of building components), New South Wales (NSW) state government—Department of Energy, Utilities and Sustainability, and the state government of North Rhine Westphalia (Germany).

The aim of the 'SolarCity' project is to develop a sustainable waterfront city centre, applying the mentioned principles in the context of the inner-city area of Newcastle, and test how well they are working in this context. The two driving questions for the consultation process over the last two years were: Which influences should define the architecture of a contemporary, vibrant city centre to take full advantage of its existing heritage buildings and its greatest asset: the waterfront? And: Is it possible to define, preserve and even strengthen the typical character of a port city such as Newcastle[4] in terms of sustainable urban design?

To make sustainability happen, it requires a vision, a robust master plan, and the involvement of the public. It also requires to make it all integrated: this means to integrate aspects of public space, jobs, residents, water management, energy-efficiency, affordable housing, urban renewal, public transport, infrastructure, tourism, waste management, public art, and so on.

Logical focal points for inspection were the water edges, the harbour, and the existing street grid, leading to a re-discovery of the urban ground plan and reorientation of the city to the harbour. In urban design workshops it was agreed that there is no need for 'radical new ideas of city' or for a 'nostalgic urbanity'. It was understood that new architecture in the city must be integrated in an overall 'Vision 2020' and relate to the specific Newcastle context and its distinctive topography, in order to reinforce the identity of the city (Lehmann, 2006).

The economic and cultural context of the 'SolarCity' study is shaped by the disappearance of heavy industry, which allowed Newcastle to develop in a new way. Much of this new image is based on tourism, which creates jobs. Newcastle has probably one of the most interesting histories of Australian cities, and it was understood by all stakeholders that there is a need to build on its unique character. For instance, the city benefits from a large number of beautiful historic buildings, and one of the objectives is to learn from this heritage how we should deal with new buildings.

PUBLIC SPACE MAKES THE PLAN

The aim of a significant amount of new developments is to get the right mix of usage, scale and density, to create a city centre with a compact and spatially complex model.

Great cities have identifiable characteristics, offering a high quality of public space, where it's enjoyable to walk around. A strong focus on quality public space is essential, since public space is the fundamental basic order of the city, and the city administration is responsible for the quality of these spaces. The city centre needs a rich mix of all types of inner-city uses: office buildings, hotels, department stores, university buildings, residential buildings, shops, cinemas, squares, good landscaping, and so on. With the initiation of a 'Public Space Program' it is believed we will raise the benchmark of Newcastle's urban quality. However, most public space still carries the industrial qualities of the former Newcastle, and the master development plan identifies a need to make those spaces more charming and memorable. An increase in density requires a well-designed network of such inter-connected public spaces. A fine grain pedestrian network will deliver many sustainable benefits, and Newcastle's historic street network with relatively small city blocks (only 90 metres length), and the associated historic frontage lines of the streets need to be respected. Those existing heritage buildings offer precious authenticity and character, and many structures are waiting for creative re-use (see Figure 5 for such an example of vacant heritage buildings in Newcastle).

A new focus on public transport and well-designed urban infrastructure is part of the forthcoming master plan. Rather than putting more car parking space in the city centre, the intent is to offer a good public transport system: the investment of an efficient light railway (running in the 'green corridor' of the removed heavy railway; see Figure 6 to illustrate how this would look like, and was successfully done in Karlsruhe, Germany) is now getting seriously investigated. However, running an economically-viable mass transit system in an Australian city is continuously a challenge due to the large distances and low population densities. Sydney for instance, at 690 persons per square kilometre, contrasts markedly with London (4,300) and New York (9,300) (Source: Brown, 2004).

As a next step, the question of the right parking ratio in the City Centre will need to be further assessed very carefully. The new master plan does not want to encourage increased automobile use, but instead promotes travel on foot, bicycle and public transport.

FIGURE 5. Historically important buildings can offer an exciting opportunity for creative re-use, such as the former Northern Railway Hotel in Newcastle. These vacant buildings are still waiting for appropriate adaptive re-use. (Photos: Steffen Lehmann)

FIGURE 6. After removing the heavy railway tracks, a 'green corridor' is available to reconnect the city centre with the harbour, and will offer space for an efficient, modern light railway system, as shown in the image.

INNER-CITY SITES: RE-USING 'BROWN FIELD' SITES AND EXISTING STRUCTURES

The last remains of Newcastle's heavy industry, the steel factories, closed down eight years ago. In our post-industrial era, the re-use of such former industrial sites and docklands offer much potential, since these 'brown field' sites are located in close proximity to the centre. Such economic re-use of land, with a reasonable population density, coupled with a program of mixed-use infill projects, would help to further reduce the need for more transport infrastructure.

Based on the 'Vision 2020', it was agreed that the master plan will need to limit the necessity of owning an automobile by implementing Transit-Oriented Development, combined with densification of the existing city.[5]

In previous years, many so-called 'eco-buildings' have been built in new office parks outside the city, to far to commute by bicycle, and far from the residences of the workforce. As such, all office workers are forced to commute to the workplace. Again, this is not ecologically sustainable planning as it increases our car dependency. By comparison, the adaptation of existing former warehouses, factories or storage buildings can lead to exciting architectural results, as many recent examples well illustrate. Let's take advantage of the fact that most 'brown field' developments are in immediate proximity to established public transport nodes and often well connected to a network of bicycle paths.

THE QUESTION OF DENSITY AND RESIDENTIAL LAND CONSUMPTION PATTERNS

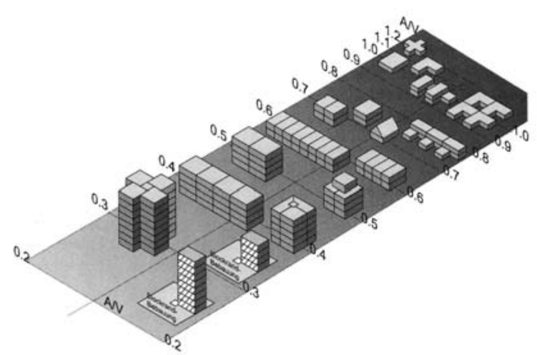
Better planning subdivisions and higher density automatically help reduce gasoline and energy consumption. It is estimated that a well-designed city could save its residents 30 to 40 per cent on their regular power bills (CSIRO study, 2005). Using solar hot water as well, especially in countries with plenty of sunshine (such as Australia), would see up to 60 to 70 per cent savings, resulting in a reduction of greenhouse emissions (ibid). By varying densities of neighbouring communities and encouraging mixed-usage developments, the much appreciated diversity of use for compact urban areas would be delivered, with a good balance between living and working spaces (Hahn, 1987; Moewes, 1995; Forster, 2002).

A sustainable transport system involves less use of cars and much more use of a public light rail, cycling and walking facilities. Much attention should therefore be paid to the way the lay-out of buildings constrains movement within cities. Most of the current urban transport systems use up too much in fuel resources produce high pollution levels and contribute to the break down of the social fabric (Brown, 2004).

A first step towards increased density and revitalisation is to move away from the detached suburban house, set on its own plot of land, and stop to increase the footprint of the city (Moewes, 1995; Sheehan, 2001; Herzog, 2001). The two architects Moewes and Herzog have done much exploration around the problem of 'sustainable density', and have developed diagrams such as Figure 7, comparing the building's envelope with usable space). Grouping residential units or townhouses together in compact volumes of around four storeys—similar to the 19th century 'city block' model, as we can find it in Paris, Barcelona or Berlin—would bring considerable environmental benefits, such as:

- smaller building envelopes, therefore less land use;
- less materials, therefore lower construction costs; and
- reduced energy consumption.

FIGURE 7. Comparison of the ratio of building envelope area and façade surface to volume and useable space, as a possible generator of building shape. The diagram shows: the lower the value, the more energy-efficient is the building. The aim is to combine a large surface area with the smallest exterior surface. (diagram from: Moewes, 1995).



GETTING THE RELATIONSHIP BETWEEN VOLUME AND FAÇADE SURFACE RIGHT

To a large degree, all urban strategies depend on the geographical location and the local climate. In a temperate climate there is a significant advantage in having long west and east facades, using the summer sun to create a stack effect that draws air from one (cooler) side of the building through to the other (warmer) side. This effect could further be supported by a wind roof such as a 'Venturi spoiler', which uses the prevailing winds to create negative pressure on the façade. A concrete structure provides good heat storage (thermal mass), while flexible solar shading protects the interior from too much light and heat gain in summer, and opens-up in winter to harness the sun's energy for heating (Daniels, 1998).

On the other hand, in a hot and humid (tropical) climate, there are other priorities. Here, it is much more important to ensure good cross-ventilation and to keep massive materials such as concrete floors or masonry walls fully shaded, to avoid storage of unwanted heat in the building mass (Koenigsberger, 1973; Szokolay, 2004). But in both cases, from the standpoint of energy consumption and avoidance of heat gain, it is generally seen as an advantage to have compact volumes with a reduced façade surface area (see Figure 7) (Moewes, 1995; Samuels and Prasad, 1994).[6]

SOLAR ORIENTATION: MAKING THE FACADES SPECIFIC TO THEIR ORIENTATION

Well laid-out subdivisions are ones where homes and offices face the right way for passive solar heating and cooling, for the use of solar hot water heaters, for maximum natural day light, and for taking advantage of the local wind direction to catch cooling breezes. When the building facades are made specific to their orientation, with the intentional placement of closed wall surfaces and small window openings, it results in substantially lower energy consumption (Herzog, 2001).

However, as we can frequently see in the recent new town developments along the Australian East coast, routine planning practice looks unfortunately more like this: combining as many blocks as possible into a poor urban plan, with many narrow east-west running land parcels, leading to dominating north and south facing facades. Thus, the desired result becomes impossible to realise.

URBAN DESIGN AND ECO-BUILDINGS: SOME CRITERIA FOR THE 'SOLARCITY'

With the study of Newcastle's city centre, we have explored achievable methods for ESD while assessing their potential as a framework for the design of 'eco-buildings' in urban design. In urban design workshops (2005, 2006), it was agreed the future designs for the Demonstration Projects should incorporate as many as possible of the following criteria. The following strategies have emerged from the project and are considered as valuable components for similar eco-designs:

- Demonstrate ecological and cultural sensitivity and be more in harmony with nature;
- Accord with climate by better considering the different conditions in summer / winter and day / night;
- Consider siting, orientation and density issues, with a focus on public space and good landscaping;
- Consider concepts of sustainable urban transport, integrated transport and land-use planning, with a focus on environmentally friendly public transport systems (light rail or tram);
- Install more cyclists' facilities (eg. bike storage);
- Re-use 'brown field' sites, incorporating existing structures;
- Be more cautious in material selection, reflecting on prefabrication, assembly, and embodied energy; thinking of the life cycle assessment of materials and considering minimal transportation approaches;
- Use alternative, renewable sources of energies (solar, wind power, geothermal heat, and biomass—all these need to be explored);
- Use solar energy for air-conditioning and hot-water systems (possibly combined with a Solar Hot Water Rebate Scheme); and have photovoltaic (PV) collectors integrated in the façade and on the roof.
- Consider wind direction, natural ventilation, sun shading devices, double-skin facades, innovative glass technology; and rethink the building opera-

tion and management concepts in general, including passive and active solar-efficient design;

- Consider naturally ventilated spaces; making better use of cooling breezes and cross-ventilation (no more fully air-conditioned interiors); and have mixed-mode systems with operable windows. Office buildings should consider grouped conference and office rooms around a central, naturally ventilated atrium.
- Have indoor-outdoor loggias, verandas and 'filtered' passageways, creating more varied, naturally ventilated spaces, to create a richer transition from exterior to interior.
- Consider shading devices (fixed or moveable), that do not spoil the daylight or view, and avoid the need for artificial lighting.
- Include storage areas to facilitate the recycling of waste during the building's operation, and have a central garbage recycling area.
- Consider material choices, e.g. recycled newspaper for insulation; rammed earth walls inside, as thermal mass; use of recyclable timber. Explore prefabricated, modular units for standardised systems, for instance natural terracotta elements as façade cladding system.
- Use environmentally friendly materials and low-emission products (avoid paint, carpets and adhesives as much as possible);
- Use green roofs to collect rainwater and have grey water pipes. Water from rainwater collection tanks could be used to flush toilets and irrigate the gardens, to reduce water consumption;
- Use biogas, a product of fermented household waste. The gas can be burnt to produce heat or electricity.

EXAMPLE FOR A DEMONSTRATION PROJECT: THE APPLICATION OF SOLAR AIR-CONDITIONING TECHNOLOGY

Cooling loads and solar gains coincide, at least on a seasonal scale, as we need more cooling the more the sun shines. Therefore, a thermal-driven cooling process would be of significant benefit.

One of the key projects embedded in the 'SolarCity' vision is a housing project in Hunter Street where the innovative technology of Solar Cooling will be explored and demonstrated. It will be the first time in Australia this innovative technology is used to cool a building. Over the next three years, a 7-storey, inner-city housing project with 36 units will be build as a demonstration project for solar air-conditioning. Solar radiation in New South Wales, Queensland, and other parts of Australia, is relatively high (approx. 40 per cent higher than for instance in Spain), and there is a huge potential for solar assisted cooling technology to find wide application, once market introduction has been achieved.

How does the solar cooling technology work? There are different ways how it can be done. The solar cooling technology selected in our case works on absorption chiller technology. It uses a closed-cycle for dehumidification and condensation cooling, by using water and lithium bromide (LiBr) as liquid sorbent for the heat-transformation process. High performance flat-plate collectors on the roof (this requires a field of around 250 m2 for this project) collect the solar energy and transform it into chilled water, which cools the apartments via chilling ceiling panels, air handling units, or fan coils.

Figure 8 explains the principle of this solar cooling system. A typical flat plate collector is illustrated in the diagram on the top left. As we can see in the diagram, the chiller is driven by hot water, which is generated in the flat plate collector field (temperature of the hot water: around 90°C). The process has to be re-cooled, and therefore, a cooling tower, or a suitable heat sink, is necessary (temperature of the re-cooling water: around 30°C), which is illustrated in the diagram at top right. This process results in chilled water of about 7°C temperature, which is connected to conventional (water driven) air handling units or decentralized fan coils installed in the apartments (as illustrated in Figure 8, at the bottom right).

Such a solar air-conditioning system can be used for all applications with a trivalent usage for solar energy, like:

- cooling in the summer;
- heating in wintertime;
- domestic hot water or process water all over the year.

The re-cooling of the absorption chiller has a significant impact on the efficiency of the system, and the possibility to use the rejected heat can improve the overall performance. A reasonable use for the rejected heat would be, for instance:

- heating a swimming pool, or
- heating up domestic water for large users (such as a canteen).

The COP value (the value that determines the overall thermal efficiency of the system) is estimated at a nominal load of around 0.7 to 0.75, which points to the high quality of the system. However, it is important to mention, that solar air-conditioning technology is still in a development state and current plants are pilot plants. Therefore, the system will be equipped with a monitoring unit and control engineering devices to optimize its performance. The relatively high cost of such a solar air-conditioning system is mainly due to its development state, production of small series, and the complex monitoring the system still requires.

A NEW AESTHETIC OF 'ECO-BUILDINGS'?

The performance of buildings is improved by optimising their shape, to follow the sun's path and maximising daylight input and solar energy gain. Density studies have revealed (see: density studies and other data for the 'SolarCity' in Linz, Austria), that four-storey and naturally cross-ventilated buildings with west-facing balconies offer a good typology for energy-efficient residential buildings, e.g. as townhouses.

Substantial saving is achieved by passive systems such as natural ventilation, summer shading and winter solar heat gain. Thus, eco-buildings reveal a particular refinement in their sectional arrangement. But a good sectional diagram and eco-intentions are not sufficient yet to guarantee an energy-efficient building (Danner, 1998; Oesterle, 1999).

The popular use of large-format glass in contemporary architecture, and the resulting problem of solar over-heating and winter heat loss through these large glass surfaces, has frequently forced the architects and engineers to install a mechanical air-conditioning system. From time to time, such an air-conditioning system for rooms where windows cannot be opened at all, has resulted in the so-called 'sick building syndrome' (SBS). The author does not claim that mechanical air-conditioning systems do automatically result in SBS, however, lack of humidity control, tight building envelopes and poor choice of building materials that harbour mould can easily increase the prevalence of SBS in a hot and humid climate such as in Sydney or Newcastle.

According to researcher Katharine Logan, indoor levels of air pollutants may be two to five times higher than outdoor levels, occasionally reaching levels 100 times higher (Logan, 2001). With most modern office workers and residents spending a large amount of their time indoors, indoor air pollution has a significant impact on public health.[7] Until the early 1990s it was a common perception that 'green' building methods could not be reconciled with high aesthetical standards in architecture, and were seen by many as unavoidably inelegant or dull. This has now changed. Today, a new generation of 'eco-build-

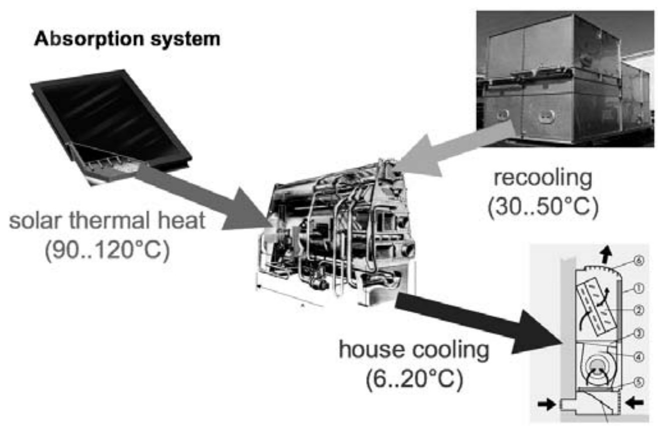


FIGURE 8. Principle of Solar Cooling system for the housing demonstration project in Newcastle city centre, using solar thermal heat to run the air-conditioning system (Arch: Steffen Lehmann). This is relatively new German technology, imported to Australia, and developed in interdisciplinary collaboration between industry partners, engineers and architects.

ings', some of our most creative designers, are able to provide imaginative and expressive solutions (Figures 9, 10, and 12 illustrate three recent examples, and the diversity of this fascinating new architectural language, which was developed out of the need to include principles of energy-efficiency into the design of office buildings). It's now possible to have an ecologically acceptable result that is both elegant and refined aesthetically, as recent buildings by leading designers Norman Foster (London), Renzo Piano (Genua), Thom Mayne (Los Angeles), Francoise-Helene Jourda (Lyons), Shigeru Ban (Tokyo), Christoph Ingenhoven (Duesseldorf), and Thomas Herzog (Munich) have shown.[8]

FIGURE 9. An example for double-skin façade: the administration building for Deutsche Messe, Hanover (Arch: Thomas Herzog, 1997-99); looking into the intermediate space between the double-skin façade, which acts as a buffer zone and passive solar collector. Such facades lead to a new aesthetic characterised by layering and transparency. Most office buildings with double-skin facades have been built over the last 15 years in Germany, where we can currently find around 35 realised projects where this façade technology was applied.

EMBODIED ENERGY: LIFE CYCLE ASSESSMENT OF MATERIALS

Are buildings only an interim storage for future waste? With the increasing need to carefully consider the selected building materials based on their energy requirements and environmental impact, the architect and designer faces an increasingly complex decision making process. The challenge is to use materials from renewable sources, and to minimise the energy used at each stage of the building's life cycle, including the energy embodied in the extraction and transportation of materials, in fabrication and assembly of the elements, and, ultimately, in recycling the material when the building's life cycle has ended. However, assessing the embodied energy of a material, component or whole building, is a very complex matter. It's not just the quantity of energy used; today, it's also the source of energy (Lawson, 1996).

The Gross Energy Requirement (GER) is the measure of all such energy inputs, including the en-

FIGURE 10. CalTrans District 7, headquarter building in downtown Los Angeles, rated as a 'green' building by the Leadership in Environmental and Energy Design (LEED) Green Building Rating System. The image shows the solar array of the south elevation; it is the largest vertical PV installation in North America. (Arch: Thom Mayne, Morphosis, 2001-2006).

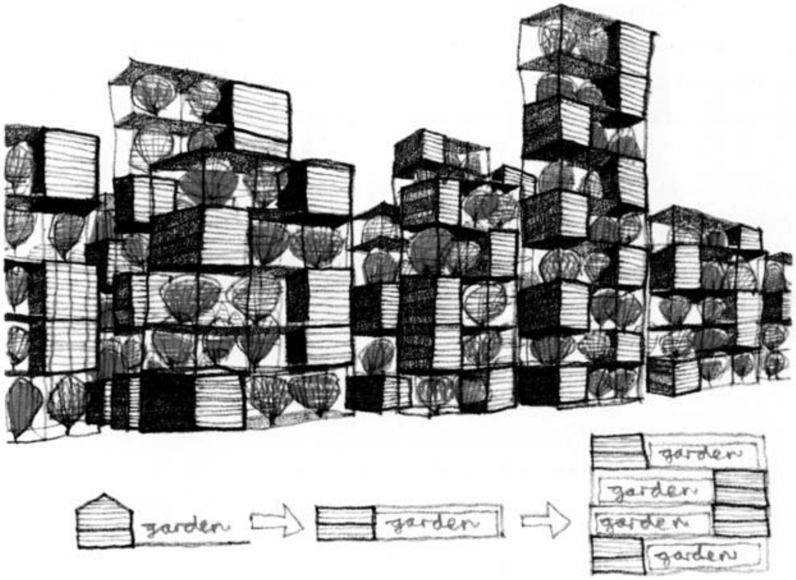


FIGURE 11. Dutch architects MVRDV developed the 'vertical garden city' as one way to sensibly use land while still re-incorporating nature and landscape. The green creates micro-climates inside the building and on roof tops, which helps to avoid the Urban Island Heat (UIH) effect. (image from: Johnson, 2000).

ergy consumed in extracting and transporting the original raw material; the energy input for manufacturing and transporting to the site; energy input into construction; and even the energy used to construct the plant used in the processing of the raw materials. The 'embodied energy' evaluates the energy costs of all components, including the shipping of the components to the building site (Lawson, 1996). In this exploration, buildings don't just have a wall, they have a list of wall components, and this list describes how each component can be broken down and recycled when the building is demolished or refitted.

During the last decade, such life cycle analysis has increasingly been applied to financial aspects of buildings, and has led to significant new appreciation of buildings as financial assets.

Given its renewability and availability in most locations, wood has environmental benefits in many contexts as a construction material. However, certain wood harvest practices are quite often not sustainable, and it would not be preferable to use wood if it is unsustainably harvested. The author believes we will see much change in this industry over the next decade. Improved methods of sustainable harvest of forest products will further reduce the impact on the environment, and the wood products' specifications as well as lumber selection process will need to take the availability of sustainably harvested timber types into account. At the other extreme, an aluminium curtain wall system has the most embodied energy of all possible wall construction systems and is thus a highly undesirable material from an embodied energy standpoint.[9]

LANDSCAPE VERSUS DENSITY: RE-INTEGRATING GREEN, MAINTAINING BIODIVERSITY

Is there a way to better incorporate landscape as part of architecture, to integrate new forms of green in buildings? Or, in other words, how can we achieve a closer symbiosis between a building and nature?[10]
Landscape can be understood as an urban edge where methods of water management and maintenance of biodiversity is crucial (Johnson, 2000). In recent years, we have seen exciting examples of new public landscapes being developed, combined with increased urban density, and new recreational landscapes utilising derelict urban sites. Even formerly contaminated sites have been re-naturalised.[11] Innovative ideas of vertical landscaping and the re-creation of ground conditions on roofs are now being investigated by many designers (as Figure 11 illustrates well). Today, many cities have established the principle that removal of potential green area at ground

level should be offset by planting the equivalent area at roof level.[12]

INTERDISCIPLINARY TEAMS AND INTERNATIONAL CO-OPERATION

It seems that multi- and interdisciplinary teams as well as practice-led research are leading the way in sustainability research. The synergy between research institutes and industry, and the application of sustainability knowledge on commercial developments as a result of this, can lead to real advances. Achieving sustainable buildings requires an interdisciplinary effort. In addition to architects and urban designers, it involves interdisciplinary teams that include engineers, psychologists, economists, landscape architects and other specialist sub-disciplines. Sustainability does not fit in a disciplinary box. Sustainability is interdisciplinary by nature, drawing on more than one discipline, and based on interaction between these disciplines. In this regard, sustainability shows similarities with the emergence of IT in the mid 1990s. Clearly, sustainability research provides a fertile environment for collaborative exploration, to go beyond the conventional intersections of disciplines. It's up to us to develop a collaborative approach, and to communicate and apply the knowledge gained.

Part of the 'SolarCity' project is the plan for the foundation of a new 'Competence Centre for Sustainable Living', with the aim: to apply research and consulting on various aspects of sustainable development, facilitating co-operation and research, to promote ecologically sustainable and socially just development, and to undertake demonstration projects based on a coherent and acknowledged body of knowledge.

FIGURE 12. Another example for innovative solar architecture: The town hall and Academy Mont-Cenis in Herne, Germany (Arch: Francoise-Helene Jourda, 1991-99). A part of the I.B.A. Emscher Park project, the conversion and regeneration of the industrial basin of the Ruhr area, this building introduces new thinking about micro-climate envelopes. The building resembles a controlled micro-environment, whose actual skin—a smart glass envelope, fitted with PV cells—generates its own energy. The photovoltaic panels are integrated in both the glass roof and the façade: 3,200 solar panels generate more than double the energy needed by the building itself. The PV-modules act as a power source and sunscreen. The enormous single-pane glass shell creates a protected 'interior outdoor space' with a controlled, naturally ventilated interior. This innovative project illustrates how the roof of a building has become increasingly important in environmental strategies. (image from Schittich, 2003).

WHERE TO NOW? SOME CONCLUDING REMARKS

Among the most significant environmental challenges of our time are global climate change and excessive fossil fuel dependency. Related to this are rising greenhouse gas emissions and water, soil and air pollution, all of which have significant environmental, social and economic consequences.

While the development industry must take a big share of the responsibility for contributing to the current state of our environment, the same industry is now also in the position to do something about it. We need to invest in sustainability to get new technologies, like the 'Apollo Program'[13] once did forty years ago. Over time, new systems need to be developed that will not only stop some of the damage that has taken place, but will also contribute to repairing it. Interestingly, developers and contractors started to embrace this paradigm shift, and are increasingly changing their practices to incorporate these ideas as financial investors value ethical and environmentally friendly projects. Such sustainable designs need to go far beyond concerns of aesthetics. Cities are built resources with high primary energy content. Renewable forms of energy, and the strategies outlined earlier in this paper, present an opportunity to make inner-city life more attractive.

The 'SolarCity' project delivered already significant findings, as described earlier, and has the potential to deliver benefits to the whole Newcastle community. The project has been planned from a holistic point of view and is governed by the following three bioclimatic factors: orientation of streets and buildings to the sun; topography and direction of wind to shelter public space and ensure good cross-ventilation; planted areas, vegetation and water for dust consolidation are to be integrated. In the Newcastle case, there will be programs in place to monitor the performance of the sustainability system and to collect relevant data over the coming years.

Sustainability today is affordable and profitable—seen over the lifetime of a building.[14] Given the increasing necessity for environmental sustainable design to be part of regulation and planning requirements, Australia's architects and urban designers have clearly accepted the need to deal more critically with environmental issues. With all the mentioned key elements embedded in the overarching strategy, central Newcastle is on the way to be turned into a model of a 'Sustainable City Centre'. The series of catalyst projects, the Demonstration Projects, have a huge potential to introduce further change (Lehmann, 2006). In the case of Newcastle, the time is right, and the recent trend towards an urban renaissance, re-valuing the urban lifestyle, will help to deliver the objectives of a sustainable 'Vision 2020'. This will ensure that the city centre can continue to make a leading contribution to the region: a notion of a socially-inclusive, sustainable and accessible waterfront City Centre.

Where to now? It's up to us to decide how sustainable our cities should be.

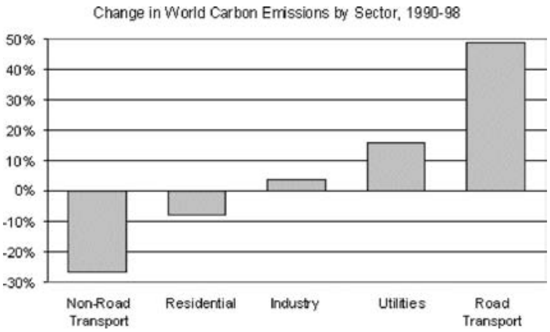
APPENDIX

The Worldwatch Institute, a Washington, D.C.-based non-profit research organization, has conducted some interesting research into urban sprawl and density (for instance, the study *'Curbing Sprawl to Fight Climate Change'*, published in June 2002; www.worldwatch.org). This body of research shows that sprawl already wreaks havoc on people's health; and by making driving necessary and walking and cycling less practical, sprawling cities widen waistlines by depriving people of needed exercise.

Following are some excerpts from the Worldwatch Institute research study.

> (...) Cities in the United States have been sprawling for decades, spreading out much faster than population growth. Chicago, for example, saw a 38 percent increase in population from 1950 to 1990, but the city's land area grew more than three times as fast, a 124 percent increase. But U.S. citizens are increasingly dissatisfied with sprawl. A recent national poll found that sprawl topped the list of local concerns. And in the year 2000 election, U.S. voters approved some 400 local and state ballot initiatives addressing sprawl-related problems. At least 38 U.S. states have passed laws creating incentives for more compact development.
>
> "The United States has the world's most car-reliant cities," said Molly O'Meara Sheehan, author of *City Limits: Putting the Brakes on Sprawl* (2002). "U.S. drivers consume roughly 43 percent of the world's gasoline to propel less than 5 percent of the world's population. The big question facing the United States today is whether we can turn away from a car-cantered model and develop better land-use practices and less destructive transportation systems."
>
> By the end of the decade, the majority of the world's people will live in urban areas. The urban design decisions made today, especially in cities in the developing world where car use is still low, will have an enormous impact on global warming in the decades ahead. Adoption of the U.S. car-cantered model in these places would have disastrous consequences. Thirty years from now, for example, China, excluding Hong Kong, is expected to have 752 million urban dwellers. If each were to copy the transportation habits of the average resident of the San Francisco area in 1990, the carbon emissions from transportation in urban China alone could exceed 1 billion tons, roughly as much carbon as released in 1998 from all road transportation worldwide.

FIGURE A.1. Road transportation is the fastest-growing source of carbon emissions.

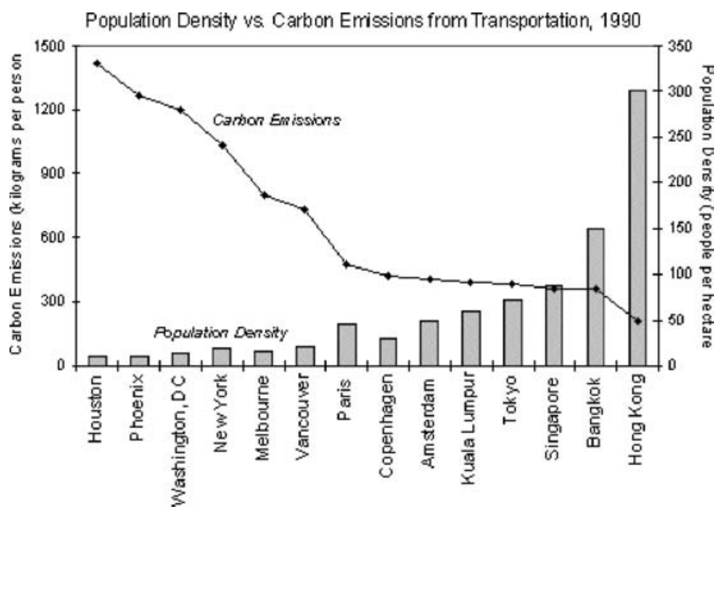


"Some cities in developing countries have already proved that a strategy of de-emphasizing cars and providing public transit instead can work," said Sheehan. One outstanding example is the city of Curitiba, Brazil. Starting in 1972, Curitiba built a system of dedicated bus ways and zoned for higher-density development along those thoroughfares—and is now enjoying better air quality and more parks for its 2.5 million people.

Today, other Latin American cities are adapting elements of Curitiba's system. Bogotá, Colombia, has recently launched a similar bus system, the *TransMilenio*, expanded its bike paths, and tried a bold "car-free" day, where in the middle of the work week, the city of 6.8 million functioned as normal—but without cars. Bogotá's story also illustrates the importance of higher population density to support buses and cycling: if Bogotá sprawled like a typical American city, it would cover more than 20 times as much land area. Another indication of the reaction against sprawl is the growth of light rail and other forms of public transit. A surge in light rail construction has brought the total number of systems in Western Europe to over 100 in 2000, the highest point since 1970. In the United States, public transportation use has increased for five straight years, following decades of decline. Planners in Portland, Oregon, estimate that a new light rail line there has saved the region from building eight new parking garages and two extra lanes on major highways.

Sources: Figure 1 based on International Energy Agency, *CO_2 Emissions from Fuel Combustion, 1971.*

FIGURE A.2. Denser cities tend to have lower carbon emissions from transportation.



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REFERENCES

Australian Bureau of Meteorology, Report for the Hunter Region. (2006). See: www.bom.gov.au. See also: web site of the Hunter Valley Research Foundation, www.hvrf.com.au for further details.

Banham, Reyner. (1969): *Architecture of the well-tempered environment*. Architectural Press, London.

Breheny, Michael. (1995): *The Compact City and Transport Energy Consumption*. Transactions of the Institute of British Geographers, Vol. 20, 1995, p. 81-101.

Brundtland et al. (1987): *The Brundtland Report*, also known as *Our Common Future*, alerted the world to the urgency of making progress toward economic development that could be sustained without depleting natural resources or harming the environment. Published by an international group of politicians, civil servants and experts on the environment and development, the report provided a key statement on sustainable development, defining it as: '*[Development that] meets the needs of the present without compromising the ability of future generations to meet their own needs*.' (1987). The Brundtland Report focused primarily on the needs and interests of humans, and was concerned with securing a global equity for future generations by redistributing resources towards poorer nations to encourage their economic growth. The full text of the report can be downloaded at: www.en.wikipedia.org/wiki/Brundtland_Commission.

Brown, Susan. (2004): *Solutions for a sustainable Future*., Sydney, p. 68.

CSIRO study (2005): *Reshaping cities for a more sustainable Future*, by Peter W. Newton et al. CSIRO is the Australian Commonwealth Scientific Research Organization. This study examined several alternative urban forms to evaluate their capacity to minimise both energy consumption and atmospheric pollution, including greenhouse gas emissions. The study predicts, that if Australia's cities continue to grow as urban sprawl, in just 10 to 15 years air pollution in our cities will increase as much as 70 per cent compared to 1990 levels. See: www.csiro.au/csiro/content/standard/psaq,,.html.

Daniels, Klaus. (1998): *Low-Tech. Light-Tech. High-Tech. Bauen in der Informationsgesellschaft.* Birkhaeuser, Basel / Berlin.

Danner, Dietmar (Ed.). (1999): *Die klima-aktive Fassade.* A. Koch, Stuttgart.

Detail. (1992): *Detail* magazine (Munich) No. 6, 1992. *'Experimentelles Bauen: F.-H. Jourda'*, p. 564-565.

Energy Report Australia. (2005): This report is a useful source for supply, demand, and policy. See: www.enerdata.fr/enerdatauk/products/demo/profiles/australia.html. According to the report, the Australian Government's Mandatory Renewable Energy Target commenced on 01 April 2001. The *Renewable Energy (Electricity) Act 2000* requires the generation of 9,500 giga watt hours of extra renewable electricity per year by 2010, enough power to meet the residential electricity needs of four million people.

Flagge, Ingeborg (Ed.). (2001): *Thomas Herzog. Architecture + Technology*. Prestel, Muenchen, p. 204-210.

Flannery, Tim. (2005): *The Weather Makers. How Man is changing the Climate*. Atlantic Monthly Press, Sydney.

Forster, Clive. (1995; reprint 2002): *Australian Cities. Continuity and Change*. Oxford University Press, Melbourne.

Hahn, Eckhart. (1987): *Oekologische Stadtplanung* (paper on ecological urban planning). H&H, Frankfurt a.M. (Germany).

Hall, Peter. (2005): Keynote speech by Sir Peter Hall for the L'Enfant Lecture on City Planning and Design, on the 15 December 2005 in Washington DC, organized by the American Planning Association and National Building Museum.

Herzog, Thomas, and Schreiber, Mathias. (1992): *Thomas Herzog Bauten | Buildings 1978-1992 (Band 1)*.

Hatje Verlag, Stuttgart 1992. See also: Thomas Herzog's 'Manifest for a sustainable architecture', in Flagge, Ingeborg (Ed.), (2001): *Thomas Herzog. Architecture + Technology*. Prestel, Muenchen, p. 220ff. Munich-based architect Thomas Herzog has been internationally renowned for two decades as a pioneer of ecological and energy conscious building and as one of the foremost innovators of building design. For Herzog the use of solar energy is a design principle, which stimulates him to develop innovative architectural forms. See also: www.herzog-und-partner.de.

Johnson, Chris. (2000): *Greening cities. Landscaping the urban fabric*. GAP, Sydney; T & H, Australia, p. 91.

Koenigsberger, OH; et al. (1973): *Manual of Tropical Housing and Building, Part One: Climatic Design.* Longman Group, London

Kolbert, Elizabeth. (2006): *Field Notes from a Catastrophe. Man, Nature, and Climate Change.* Bloomsbury, New York.

Krier, Leon. (1984): *Houses, Palaces, Cities*; edited by Demetri Porphyrios, Academy Publications, London.

'Kyoto Protocol', a result of the Kyoto Summit of 1996. The protocol sets levels of reductions in CO_2 emissions and five other greenhouse gases for 38 of the industrial nations. The US and Australia have both not ratified the protocol.

Lawson, Bill. (1996): *Building materials, energy and the environment.* RAIA, Canberra; and UNSW, Sydney.

Lehmann, Steffen. (2006): Paper in proceedings for 7th ICTC International Cities and Communities Conference, Australia, June 2006. 'A Vision 2020 for the City Centre', presented at the ICTC Conference and at the 'Hunter Lunch' of the Property Council of Australia (August 2006). www.ictcsociety.org/conf2006/index.htm.

Lehmann, Steffen. (2006): article in the newspaper *The Herald*, 04 August 2006, *'Plan for sustainable waterfront city centre'*, p. 9.

Lehmann, Steffen. (2006): Paper in proceedings for 2nd International Conference on Environmental, Cultural, Economic and Social Sustainability, in Hanoi, Vietnam, Jan. 2006.

Conference proceedings appeared as refereed journal: *The International Journal of Environmental, Cultural and Social Sustainability* Vol. 1, No. 4/2006, CG-Publisher, Melbourne. www.SustainabilityConference.com.

Logan, Katharine. (2001): Research study *'Breathing Easy'*. USA, published at: www.architectureweek.com.

Moewes, Guenther. (1995): *Weder Huetten noch Palaeste. Architektur und Oekologie in der Arbeitsgesellschaft.* Birkhaeuser, Basel / Berlin.

Newcastle City Council (NCC), website: www.ncc.nsw.gov.au. Also: Business Newcastle, (2005): *Newcastle Prospectus,* published by NCC.

Newcastle Port Corporation (2006): NPC Report 2005/06. www.newportcorp.com.au.

Organisation for Economic Co-operation and Development OECD. (2003): OECD Report, *Challenges and Policies.* See: www.oecd.org.

Oesterle, Eberhard. (1999): *Doppelschalige Fassaden*. Callwey, Muenchen.

Radford, Anthony; and Williamson, Terry. (2003): *Understanding Sustainable Architecture*. Spon Press, London.

Richards, Ivor. (2001): *Hamzah & Yeang. Ecology of the sky.* Images Publishing, Melbourne.

Rogers, Richard; and Power, Anne (2000): *Cities for a small Country*. Faber & Faber, London.

Rogers, Richard. (1986): *London as it could be*. London (planning study by Richard Rogers Partnership).

Samuels, Robert; and Prasad, Deo (Eds.). (1994): *Global Warming and the Built Environment.* E & FN Spon Press, London.

Schitich, Christian (Ed.). (2003): *Solar Energy—Strategies, Visions, Concepts*. Birkhaeuser Verlag, Basel. This book has been produced in association with the journal Detail. It discusses means of improving sustainability and energy conservation in buildings, but unlike many ecology books, which advocate a return to traditional materials and methods, it proposes the application of innovative facade technologies.

Sheehan, Molly O'Meara. (2001): *City Limits: Putting the Brakes on Sprawl.* Washington, D.C., Worldwatch Paper no. 156.

Sitte, Camillo. (1889): *'City Planning According to Artistic Principles'*, Vienna.

Steele, James. (1997): *Sustainable architecture. Principles, paradigms and case studies.* McGraw-Hill, New York.

Szokolay, Steven V. (2004): *Introduction to Architectural Science, the basis of sustainable design*. Architectural Press, Oxford.

VicUrban; Haycox, Mark. (2004): *The Melbourne Docklands ESD Guide—A step towards an urban and sustainable future*. Melbourne City Council, Australia.

Worldwatch Institute, www.worldwatch.org. See also: www.urbansource.org

Yeang, Ken. (1996): *The skyscraper bio-climatically considered. A design primer.* Academy Editions, London.

NOTES

1. It's worthwhile to study some of the fundamental diagrams, to fully grasp the seriousness of the situation. Those diagrams would include, for instance: rising energy demand; population growth; long travel times; comparison of surface areas to volume; building operation costs; time span for fossil energy vs. renewable forms of energy; sunshine duration in different climatic zones; definition of comfortable interior climate; life cycle consideration; urban density and energy / gasoline consumption.

   The Potsdamer Platz Project by Daimler Chrysler, Berlin (1993-2000) is a good example of such an urban renewal project. In large urban design projects like this, developers are increasingly changing their practices, as investors and users want to be seen at the environmental forefront, valuing ethical and environmental impacts in their projects. More info at: www.potsdamerplatz.de. At Potsdamer Platz, 48,000 m2 green roof area collects rainwater which is used for flushing toilets and irrigation of the gardens. Furthermore, a 12,000 m2 size artificial lake ('Urbanes Gewaesser') has been created in the centre of the development.

   Part of the 2005 International Union of Architects (UIA) 2005 Worlds Congress in Istanbul, in July 2005, was the 'People Building Better Cities Symposium' and the 'Future Directions Forum'. Both events explored the idea of 'compact communities' and 'urban renewal' in a wider context. See: www.uia2005istanbul.org
2. Urban theorist Leon Krier published some controversial ideas in: 'Houses, Palaces, Cities', London, 1984. However, Krier has also argued—and I believe this is a much more appropriate way: "A large or small city can only be organized as a collection of autonomous urban quarters. The dimensions of a quarter are determined by the comfortable reach of a walking person."
3. Compare graph: 'Figure 3: Urban density and gasoline consumption in 30 cities.' It was recently found that the average North American citizen spends around 10 years of his/her lifetime commuting in a car. What could these people have done more usefully with their time! City sprawl increases travel distances. Is it possible to design a city based on pedestrian movement? Recently, the city of Karlsruhe (Germany) re-introduced an effective urban tramway system (light railway) and an integrated rail passenger network, in preference to buses.

   Some useful links: Data for sustainable materials at www.ecospecifier.org See also: www.agenda21.de and www.urbanclimate.net; www.wwf.org.uk/sustainablehomes/oneplanetliving.asp and www.bioregional.com/news%20page/news_stories/OPL/OPL_to_China_02.05.htm
4. The City of Newcastle is located in the Australian state New South Wales (NSW), in the south east of Australia, with the Pacific Ocean to the east. NSW is the fourth largest state and has an area of 801,600 square kilometres. The topography of the seaboard and costal lowlands borders 1460km coastline broken by few inlets of varying sizes. Population: NSW has a population of approximately 6,5 million, with the majority of people living in the three main cities Sydney, Newcastle and Wollongong. NSW leads Australia in manufacturing production and is the largest trading state. Climate: Newcastle lies in the temperate and slightly humid zone (oceanic climate) of the Hunter Region, with warm summers, and its climate is generally free from extremes of heat and cold. The

average amount of daily sunshine is about 6.7 hours. Mean number of rain days: 135 p.a.

According to the Australian Greenhouse Office, NSW has produced 168 million tonnes greenhouse emissions from deforestation since 1989—equivalent to 16-times the current annual emissions from all of Australia's passenger vehicles (see: www.greenhouse.gov.au/ncas/dataviewer/examples/nsw.html).

According to the latest report of the Australian Bureau of Meteorology (2006), the Hunter Region is becoming hotter and drier in line with climate change predictions. To quote from the report: 'Minimum and maximum temperatures at Newcastle and in the Upper Hunter are rising, and less rain is falling in both areas, particularly in the last 20 years. The region's weather is consistent with state-wide patterns that show this century has begun in a significantly dry phase which mirrors lower than average rainfall in the first half of the previous century. It is beyond doubt that rising temperatures, since around 1970, can be attributed to human-influenced climate change rather than natural variability.' (The Bureau's climate information manager, Louise Tilley). According to the report, Newcastle's mean annual maximum temperature has risen about 1 degree Celsius since 1910, to 21.8 degrees Celsius, and Newcastle's mean annual rainfall since 1862 (start of register) has dropped about 200 millimetres to 1130 millimetres. The Bureau's historical rainfall study shows the five years to the end of last year (2005) were the warmest on record since 1910 for the entire state NSW, and the driest five-year patch since the mid 1960s.

The Worldwatch Institute analyses and presents environmental data from around the world on the website: www.worldwatch.org. In Aug. 2006, Worldwatch Institute confirmed that: '2005 was Australia's hottest year on record, based on average temperatures, day and night, for the entire country during the entire 12 months of 2005. The earth's five warmest years since records began in 1880 have all occurred since 1998'.

5. Of all European capitals, Berlin has probably the most experience in urban renewal. In this context, the re-used historical structures and the many interesting examples of the 'loft living' trend are particularly of interest. This trend has also arrived in Australia, for instance, with the re-development of Melbourne Docklands, Australia's largest urban renewal project. See the 'ESD-Guide' developed for this project, at: www.vicurban.com. Hereby, developers in Melbourne can claim points for varying degrees of environmental performance.
6. The use of solar energy depends much on the location. Spain, for instance, has around the double of sun radiation compared with Germany. A good example for urban design based on the sun is the 'SolarCity' by architects Thomas Herzog, Norman Foster, and others (1995-2005), a new residential area outside Linz (Austria). Initiated as a model estate for ecological urban development, with 1,300 units—using solar energy and new ecological methods for sewage treatment—the 'SolarCity' is giving priority to pedestrians and cyclists. See: www.linz.at/solarcity and www.ecology.at . As recent example of residential architecture, see also: 'BedZed', Bill Dunster's project for south London (2002 -). See also: Conference Proceedings. A Green Vitruvius (1999): Principles and Practice of Sustainable Architectural Design. James & James, London[0]
7. Katharine Logan commented in 'Breathing Easy' in 2001 (USA): 'Indoor levels of air pollutants may be two to five times higher than outdoor levels, occasionally reaching levels 100 times higher. With most US residents spending 90 percent of their time indoors, indoor air pollution has a significant impact on public health.' Refer to: www.architectureweek.com/2001/0822/environment_2-1.html.
8. Frequently, in 'eco-buildings', two different types of glass have been used in the façade- one type to reflect radiation from the sun, the other, a clear glass type to let maximum daylight in. An interesting example for use of geothermal energy is the new Umweltbundesamt (UBA, Ministry for Environment Protection, 2001-2005) in Dessau, Germany, by architects Sauerbruch & Hutton. The building uses the constant 16 degrees Celsius temperature of the air coming out of deep concrete tubes from underground. This circulated air stream cools the air of the offices in summer and warms it in winter. See: www.umweltbundesamt.de. Illustrating the sectional principles through atrium spaces, new façade technology for natural ventilation and double-skin façade systems (where cool air is sucked into offices by rising air in the façade) are the innovative generation of office buildings in Germany, such as: 'Stadttor' in Duesseldorf (Arch: P&P, 2003) and 'Doppel-XX' in Hamburg (Arch: BRT, 2002). So far, around 30 office buildings have been built in Germany using double-skin façade systems, and much knowledge has been gained to avoid the technical mistakes of the 'teething years'.

   In regard to renewable sources of energy, see also the valuable research findings of the Sustainability Centre in Sydney at: www.sustainabilitycentre.com.au.
9. In regard to embodied energy, see graph: 'Embodied energy of wall construction systems', in Lawson, Bill. (1996): Building materials, energy, and the environment. Published by the RAIA, Canberra; and UNSW, Sydney.
10. In this context, see new developments with lightweight green skins ('green rooftop tiles') supported by recycled water. Inner-city buildings with urban roof gardens help to ameliorate the heat island effect. If all new buildings collected roof water for site and landscape irrigation, an enormous load would be taken off existing water supplies. The world's most dense cities, like New York or Tokyo, have now introduced Greening Rooftop programs. Architects MVRDV's idea of the 'vertical garden city', like sky gardens, was recently picked up by Chris Johnson in Sydney, in his publication: Johnson, Chris. (2000): Greening cities. Landscaping the urban fabric. GAP, Sydney; T & H, Australia. The 'green road wall' in Sydney reduces traffic noise and help in cleaning the air. Compare also with the author's inner-city gardens at Potsdamer Platz and at Hackescher Markt in Berlin (both built in 2000).

11. For instance, in Barcelona: Northeast Coastal Park, designed by Abalos and Herreros, is a good example where a formerly contaminated rubbish dump was transformed into a new waterfront park (2004).
12. A group of researchers at the National University of Singapore, Dept. of Building, led by Dr. Wong Nyuk Hien, has widely explored the benefits of green roofs. According to this studies, planted roofs can effectively mitigate the so-called Urban Heat Island (UHI) effect in urban environments (2002): Study of Rooftop Gardens in Singapore; see: www.bdg.nus.edu.sg/events/skyriseGreening.pdf . 'The UHI effect occurs when city temperatures run higher than those in suburban and rural areas, primarily because growing numbers of buildings have supplanted vegetation and trees. Moreover, human activity itself generates heat. One possible solution to the UHI effect might lie in growing plants on rooftops and creating sky-rise gardens (...).'
13. The 'Apollo Program' by NASA (1961-75) was designed to land humans on the moon and bring them safely back to earth. Six of the lunar missions achieved this goal. Over years, a huge amount of resources went into the program, to achieve this one single goal. A similar extreme effort will now be necessary to develop technology to beat climate change. See: www.spds.nasa.gov/planetary/lunar/apollo.html
14. Refer to: Kats, Greg, et al (Oct. 2003): 'The Costs and Financial Benefits of Green Buildings'; a report to California's Sustainable Building Task Force. American scientist Greg Kats of Capital E is the nationally known author of the most widely referenced study of the costs and benefits of green buildings. This study has demonstrated conclusively that sustainable building is a cost-effective investment. See info on US Green Building Council website: www.usgbc.org