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10 the Sustainable URBAN NEIGHBOURHOOD Initiative

This special issue of SUN Dial has been produced to describe the interim results of the Urban Autonomy Project. With funding from BRECSU and the European ALTENER Programme we have been working on a project to explore the feasibility of autonomous urban development. This was discussed at a workshop organised jointly by the Building Research Establishment and URBED on 10th November 1999. In this SUN Dial Special David Rudlin, Nick Dodd and Charlie Baker outline the thinking behind the research and describe the systems that are being explored.

Above: The Blue House in Aalborg built as a test bed and demonstration project for water saving and restoration.

Right: An urban villa in Amstelveen, Netherlands incorporating superinsulation and communal solar heating

Urban AUTONOMY

Why is it that the image of sustainable architecture has tended to be of vernacular buildings in a rural Arcadia? Somehow 'greenness' and cities just don't seem to go together. Cities after all are noisy, dirty, congested, resource hungry and - even in the post-industrial age - polluting. Cities are surely the very antithesis of sustainability?

But sustainability is about far more than a 'back to the land' lifestyle choice. It is about facing up to a century in which, to take just one example, CO_2 emissions may need to be cut not by the 12% agreed at Kyoto but by 60% on 1990 levels by 2020 if global warming is to be reversed[1]. Yet much of the work on eco-housing has concentrated on individual homes or small resident-inspired eco-villages. As Margrit and Declan Kennedy say in their review of ecological settlements in Europe:[2] 'There is no shortage of concepts, planning and proposals. However concrete examples of the magnitude required - i.e. anything over an above a detached house or a small settlement of 10 to 20 dwellings – are still few and far between'. We will not fundamentally change the pattern of resource consumption if we concentrate on individual houses for the committed minority. We must build for the majority and this majority is overwhelmingly urban.

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There has been much talk over recent years about household growth and the 3.8 million extra households projected by 2021. The implications in terms of greenfield development have been widely explored but less attention has been paid to the wider environmental consequences. Resource-use, after all, is related as much to the number of households as it is to population. A one-person household will use less resources than a family of five but not five times less. The effect of household growth even with a stable population could therefore easily eclipse improvements made elsewhere as demonstrated by recent work in Swindon[3]. Household growth therefore makes it even more important that we tackle the resources use of the urban majority.

Over the last 4 years URBED has been working through the SUN Initiative to explore new models for urban development which reflect changing environmental, demographic, social and economic trends. Our work has mirrored and hopefully influenced that of the Urban Task Force and is part of a rapidly emerging urban agenda in many parts of the UK[4]. In the last 12 months we have been able to take this further through the *Urban Autonomy Project* funded by BRECSU (The DETR's Energy Efficiency Best Practice Programme) and the European Altener Programme. This follows a BRECSU project last year undertaken by Robert and Brenda Vale[5] that brought together research on autonomous homes. The aim of the *Urban Autonomy Project* has been to explore autonomy at the scale of the urban neighbourhood. This is something that has never really been done in the UK which is why we have linked up with Professor Rob Marsh at the Aahus School of Architecture in Denmark to draw upon European experience. This special issue of SUN Dial summarises the interim conclusions of the work which were discussed at a special BRE/URBED conference on 10th November 1999. These ideas will be developed by the SUN Initiative over the next six months as we further test the feasibility of these ideas.

1. Intergovernment Panel on Climate Change First Assessment Report – Cambridge University Press 1990
2. Margrit Kennedy and Declan Kennedy (Editors) – Designing Ecological Settlements: Ecological planning and building – experiences in new housing and in the renewal of existing housing quarters in European countries – European Academy of the Urban Environment – Dietrich Reimer Verlag, Berlin
3. Ricaby Associates and Manchester University – EPSRC study of Swindon - 1998
4. The Urban Task Force - Towards an Urban Renaissance - E&FN Spon – June 1999
5. DETR, Robert and Brenda Vale – Building a sustainable future: Homes for an autonomous community – General Information Report 53 – October 1998

1.

Sustainability and the URBAN RENAISSANCE

The Urban Autonomy Project has been driven by two imperatives: the Urban Renaissance and environmental issues. **David Rudlin** describes the overlap between sustainability and urban renaissance but asks why there remains little eco-design that has embraced the urban agenda

The Urban Renaissance

As we have described in detail elsewhere[1] anti-urban attitudes in the UK date back to the Industrial revolution. Prior to that British towns and cities, like those on the continent, had been magnets for population and the most fashionable addresses were those in the centre of town. However the appalling conditions of the industrial city reversed the polarity of the magnet and started a process of dispersal that has continued ever since. The exodus was led by the affluent middle classes but, with the collusion of, amongst others, the Garden City pioneers, the planning profession, the housebuilding industry and council housing depart-ments the exodus gathered momentum and expanded to include all but the most disadvantaged members of society. With the exception of parts of London, success in the 20th century success has been measured by how much distance you can put between yourselves and the city. As a result urban areas have sprawled over the country-side leaving town and city centres marooned in a wasteland of inner city decline. Inner cities have declined as they have been drained by an exodus of people and investment and left as the home for those least able to escape.

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This, at least, is the story of the Anglo-American city - what Joel Garreau[2] has called the growth of the 'Edge City'. We need only look across the Atlantic to the social polarisation of a city like Washington DC or the phenomenal sprawl of a city like Phoenix to see our future if we allow this process to continue unchecked. The Urban Task Force looked in the other direction, to continental Europe, where very different forces have been at work and where urban areas have retained their vitality.

It is not possible for the UK to simply import urban forms from continental Europe (our his-tories are too different). There is however reason to believe that the conditions may be right for an urban renaissance in the UK. The forces of change are gathering at the start of the century just as they did at the birth of the modern suburb a century ago. The SUN Initiative has summed up these forces of change as the Four Cs – Conservation, Choice, Community and Cost. The Task Force covers similar ground when it describes three 'drivers of change':

- **The information age:** The way in which the transition from a carbon based economy to a knowledge economy has caused the decline of industrial areas and the social exclusion of urban communities and yet has also reinforced the importance of cities as information hubs.
- **The ecological imperative:** The increasing recognition of the importance of environmental issues and the realisation that while urban areas may be an important source of environmental problems they are also part of the solution.
- **Changing lifestyles:** The way that lifestyles are changing as people spend more years of their life in education and retirement and less in work. Linked to this is the growth in household numbers and the increase in single and childless households who may have very different views about urban living to the families for whom suburbia was built.

The phrase 'drivers of change' is well chosen. It implies that these issues are not just challenges and opportunities for the future but trends that are already at work shaping urban areas. It also suggests that the city centre development and loft apartments of the recent past are not just catering to a niche market but are the first evidence of these 'drivers' at work. In our work for the Urban Task Force[3] we suggested that this fragmenting of the housing market could be the start of a process that will affect the 21st century city as fundamentally as the garden city influenced the city in the 20th century. The beginning of the century therefore sees a confluence of environmental, demo-graphic, economic and social factors that are creating conditions ripe for the urban renaissance.

Sustainability and an urban society

According to the Urban Task Force almost 90% of the UK and 50% of the world population live in urbanised areas. This has led people like Herbert Girardet[4] to argue that, while cities may be environmentally damaging, they are a fact of life and must be reformed. While this may be true, we should remember that it is not cities that damage the environment but the people within them.

Take London for example. When we look at the pall of pollution that hangs over London, the barges burdened with waste bound for landfill sites, its arteries clogged with traffic and its use of the equivalent of a super tanker of oil a week, it seems hard to imagine a less sustainable form of development. However, London is home to 7 million people and it is doubtful whether those people would tread any more lightly on the environment if they were to be dispersed at garden city densities across southern England. Even if this were possible and politically acceptable – which it is not – and even if everyone was to live in super green housing – which is unlikely - the environmental impact of travel, distribution, infrastructure and waste would cancel out most of the benefits.

It is therefore possible that urban areas are not just a fact of life to be tolerated but are potentially the most environmentally efficient form of human settlement. If we are going to build 'super green' housing, as we must, then we should be doing it within urban areas and not isolated in the countryside.

Density and travel: The most important reason that has been used to justify the environmental benefits of urban development is its effect on car-use. Transport is the only sector of the economy where CO_2 emissions and pollution are increasing. While car makers have been no less active in improving the efficiency of vehicles, the growth in car-use has been far greater. As a result, in addition to congestion, car-use now threatens our ability to meet targets for CO_2 reductions and has replaced power generation as the main cause of poor air quality.

The link between urban development and transport is based upon research in the US[5] and UK[6] which demonstrated that the denser the urban area the less people travel by car. While this research has been extensively challenged, it has been remarkably influential with governments across the western world. However, while it makes sense not to build in locations that can only be reached by car, the importance of density as a means of reducing car travel may have been overstated. As Michael Breheny has demonstrated[7], if we were able to reverse the dispersal of urban areas that has taken place since the war – which would be a tall order – the reduction in transport energy use would be little more than 2%. The national reductions in travel possible through more compact urban development are therefore insignificant compared, for example, to an increase in fuel tax.

This however misses the point. One need only look at the projections for future car use to see that they are simply not sustainable. It is therefore inevitable that car use will be constrained in the future - if not by taxation or

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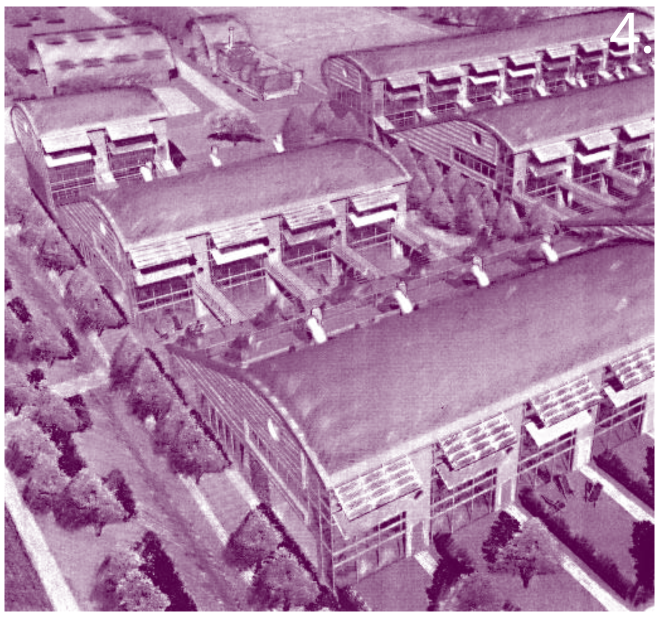

regulation then by sheer congestion. As car use becomes more difficult it is possible that people will increasingly shun car-dependent locations. While compact development may not on its own reduce car-use it has an important role to play in promoting the alternatives of walking, cycling and public transport. Densities of at least 100 persons/hectare are required to sustain a bus services more for a tram service[8]. Compact urban development may therefore be the result of restrictions on people's ability to use their car rather than the means by which traffic reductions are achieved.

Urban resource-use: Car-use is not however the only reason for making a link between sustainability and urban development. Urban areas help to reduce distribution distances for goods and services because of the proximity of large numbers of people to transport hubs. This allows the greater use of rail freight and the potential use of bikes for local deliveries[9]. Urban areas also support local shops and markets as an alternative to the trend of car-borne out-of-town shopping.

Building in urban areas also makes use of existing infrastructure. Quite apart from denuding the countryside, greenfield development requires the provision of new roads, services, transport infrastructure and even schools, shops and community facilities. This infrastructure consumes resources in its construction and use while perfectly serviceable infrastructure lies underused in the inner city.

Urban buildings are also more resource efficient than detached structures. Heat is lost through the external walls and roofs that are minimised in terraced housing and flats. Like-wise with mixed-use development where – rather than loosing heat though the floor housing can benefit from the heat of commercial occupiers. While it is true that urban areas may reduce solar gain due to overshadowing the compensation may be the sheltering effect of surrounding buildings which can also reduce heat loss.

Urban economies are also very efficient at converting linear resources flows into circular ones. Jane Jacobs talks of a future in which we will mine our urban waste for resources[10], a concept picked up by the Urban Mines group in the UK[11]. There are many examples of this from commercial recycling operations, to small scrap yards and second-hand shops, and even to the skip on the urban street corner. We will return to the importance of urban economies later in this article.

Sustainable Urban Models

Given the importance of compact urban development to the sustainability debate it is surprising how little effort has been put into urban-eco-development. There is now fairly widespread agreement of what we mean by the word urban. It implies a compact urban form, based on traditional streets, perimeter blocks, a density of population and a mix of uses. There is however still a significant gulf between these urban forms and the nature of most eco-development.

The best examples of the latter include schemes like the Vales houses for North Sheffield Housing Association, the group of six earth-sheltered houses at Hockerton, the Gledhow Bank eco-houses in Leeds, the Environment Trust's houses in Mile End Park or the high-profile BRE Integer House. These schemes have broken some useful ground and provide attractive models but they are largely based on individual homes rather than neigh-bourhoods and provide no real insight into the delivery of more efficient services.

At a larger scale there is a long tradition of environmentally conscious housing schemes, particularly in new towns like Milton Keynes. More recent examples include some excellent developments by Gwalia Housing Society in Swansea and the planned Newark Energy Village. Perhaps the most important current schemes in this tradition are Bioregional Devel-opment Group's scheme for Sutton by Bill Dunster Architects. This is a brownfield development of 90 homes which links low-energy design with district heating, CHP and grey water systems. While this is an important scheme that does incorporate neighbourhood systems it is difficult to see how it would fit into an area based on traditional, dense, mixed-use streets.

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There are other examples of more urban environmental design. Three of the most sig-nif-icant schemes are Scottish - the Canmore Housing Association car-free scheme and the Comely Green Place scheme, both in Edinburgh, and the Shettleston Housing Association scheme in Glasgow. These are brownfield developments incorporating CHP and grey water systems. The Shettleston scheme also includes a geothermal heat pump and solar systems. In all three cases it is easier to imagine the housing fitting within a mixed use urban area.

Urban eco-design has also been an important element of the two Millennium Village competitions in Greenwich and Allerton Bywater. Both the winning and running up schemes illustrate a synthesis of advanced eco-design and urban forms. There are however doubts about how far the concept will be implemented in Greenwich and the Aire Design scheme for Allerton Bywater will be difficult to judge fully until it is published.

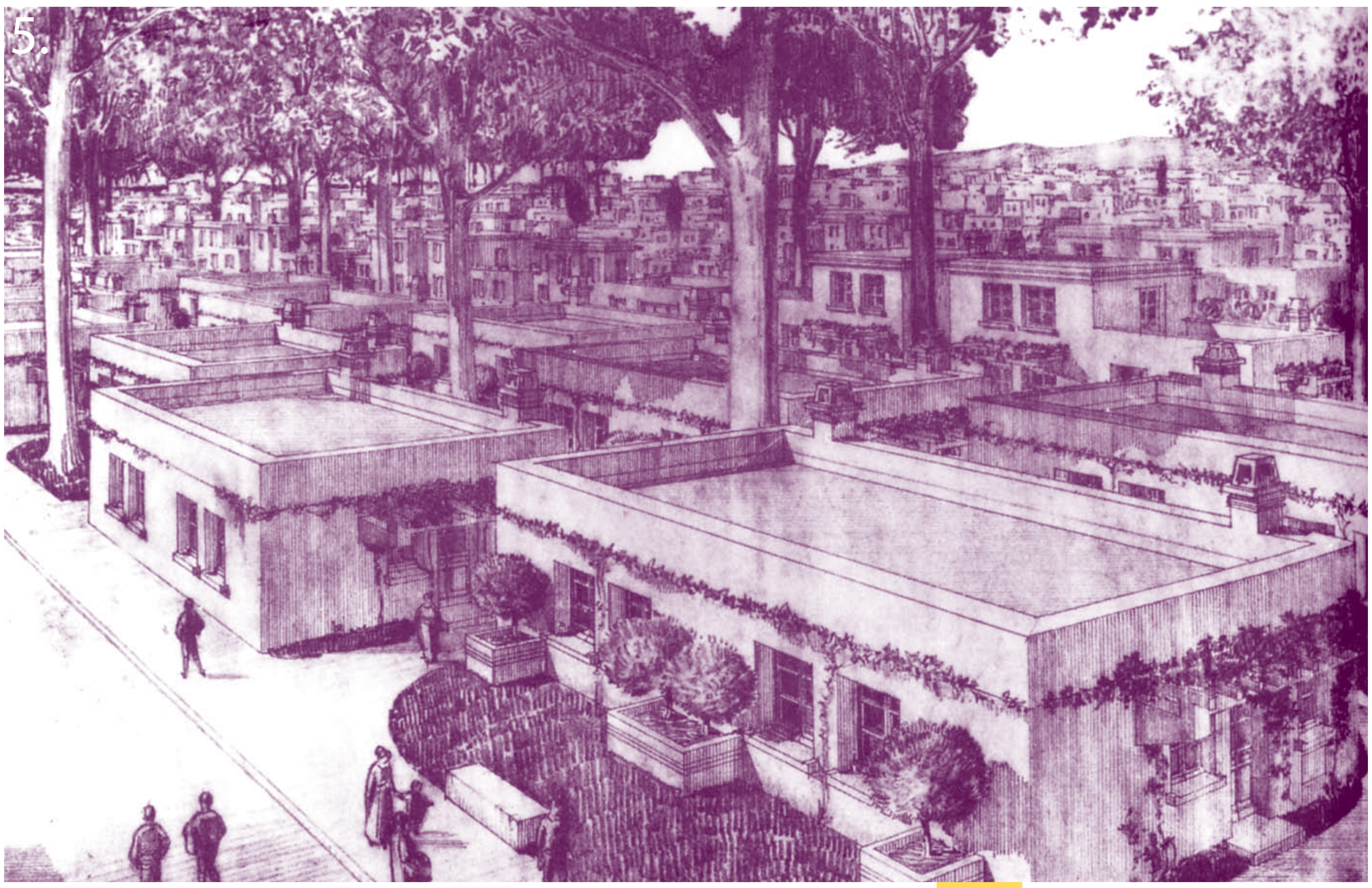
There is also a more utopian tradition of sustainable urban development. This includes Garnier's Ville Industrielle, Corbusier's Ville Radieuse and Frank Lloyd Wright's Broadacre. This tradition is alive and well and includes examples like Halifax Eco City in Australia, the recent work by The Martin Centre at Cambridge with Future Systems and Bioregional Develop-ment Group's proposals for Velo City. These concepts tend to extrapolate from a relatively limited number of issues to illustrate how they could influence built form. So just as Broadacre illustrated the form of a city in which mobility was not a constraint, the Martin Centre/Future Systems schemes illustrate the effect on buildings of making them entirely self-sufficient. In the latter case the form is determined by the desire to minimise surface area and create sufficient airflow for a centrally mounted wind turbine. Such visions bear even less relationship to the urban agenda that we have described above. They are valuable in illustrating and exploring ideas but potentially dangerous if seen as a prescriptive model for future development.

It is clear that there remains a gap between the generally accepted principles of urban development and much of the practice of eco-development. It is true that this gap is closing and that the more recent developments have concentrated on brownfield land and increased densities. However many of these schemes are based on forms that are determined by environ-mental considerations (be it solar gain or surface area) rather than urban principles. Indeed on occassions they suggest that eco-development is incompatible with urban form.

Our aim through the SUN Initiative and specifically through the Urban Autonomy project has been to explore a synthesis between eco-design and urban form. We have taken the latter as our starting point and set out to explore whether it is possible to build a dense mixed-use urban neighbourhood that is as resource efficient as the most radical eco-housing scheme.

ILLUSTRATIONS

1. **Solgaarden, Kolding (Denmark):** Photovoltaic array on the roof of a block generating 100 KW.
2. **Freiburg (Germany):** Where integrated transport and measures to reduce car-use have reduced the distance travelled by car despite increasing car ownership.
3. **Project ZED:** An experimantal design by Future Systems in conjunction with the Martin Centre in Cambridge exploring buildings with minimal surface area and a centrally mounted wind turbine meeting 50% of the buildings electrical requirements.
4. **The Beddington Zero Energy Development:** Designed by Bill Dunster Archiects and Ove Arup for the Bioregional Development Group and the Peabody Trust in Sutton.
5. **La Cite Industrielle** by Tony Garnier from the 1920s showing that a concern with environmental utopian design is nothing new.



1. **David Rudlin and Nicholas Falk** - Building the 21st century Home: the Sustainable Urban Neighbourhood – The Architectural Press 1999
2. **Joel Garreau** – Edge City: Life on the new frontier – Anchor Books - 1988
3. **URBED, MORI and University of Bristol** – But would you live there? Shaping attitudes to urban living - Urban Task Force, DETR - February 1999
4. **Herbert Girardet** – The Gaia Atlas of Cities – Gaia Books 1992
5. **Newman P. and Kenworthy J.** - Gasoline consumption and cities: A comparison of UK cities with a global survey - Journal of the American Planning Association 55 24-37 - 1989
6. **ECOTEC** - Reducing transport emissions through planning - HMSO 1993
7. **Michael Breheney** – The compact city and transport energy consumption – Institute of British Geographers – NS 20 81 101 - 1995
8. **H. Barton, G. Davies & R. Guise** - Sustainable Settlements - A guide for planners, designers & developers – University of West England & The Local Government Management Board – April 1995
9. **Andrea Casalotti** - Workbikes in London - SUN Dial 9 1999
10. **Jane Jacobs** - The Economy of Cities - Vintage Books 1989
11. **James Horne** - Urban Mines - SUN Dial 6, 1998

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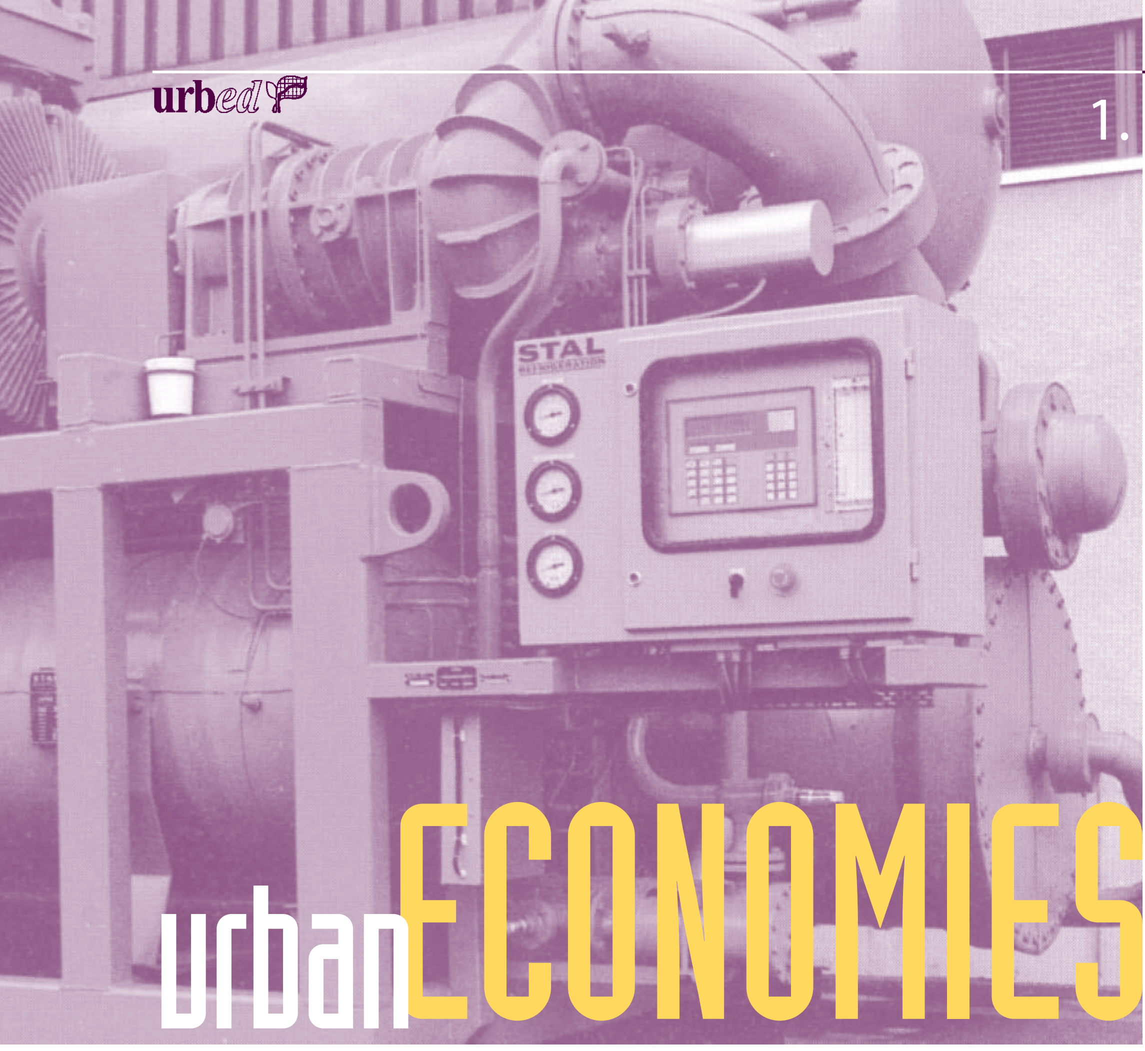

1.

urban ECONOMIES

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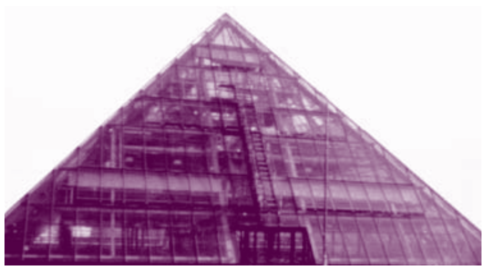
There are two sides to the idea of autonomous development. The first is the minimisation of resource-use and the second is the supply of these resources from renewable sources. Individual autonomous homes seek to supply resource needs from the rain, sun and wind available to the house and from the recycling of water and waste. This is a very difficult trick and has been achieved on only a few occassions such as the Fraunhofer Institute's self-sufficient solar house in Freiburg or the Vale's autonomous house in Nottingham. The limited availability of resources means that such housing can only work by optimising the resource efficiency of the house to an extent that is difficult within current budgets and modern lifestyles. The question that we have been asking is whether this trick becomes easier at the scale of the neighbourhood rather than the individual home. There are a number of reasons why this might be the case:



- **Neighbourhood-based systems:** The starting point has been to think about systems for the provision of heat, power and water at the neighbourhood scale. So, rather than each unit having its own separate boiler, heating system and water supply, these systems are organised at the neighbourhood level.

- **Sharing infrastructure costs:** This allows the costs of these systems to be shared between a larger number of units potentially making water systems, renewable energy, or CHP units viable in a way that could never be the case on an individual home. Such urban economies of scale would also allow the use of larger, more efficient systems.

- **Integration of different systems:** Organising systems at the neighbourhood level also allows links to be made between different systems such as the use of surplus power from solar systems for charging electric car-share vehicles or the combination of the district heating and grey water systems.

- **Reconciling demand and supply profiles:** One of the problems with renewable energy is that it is rarely available when it is needed. Solar energy, for example, is most plentiful during the day and in the Summer whereas the energy is needed in the evening and the winter. This is exacerbated by the growth of single-person households, likely to be out during the day. This issue becomes easier to deal with at the neighbourhood level where the larger number of units and the greater mix of uses will start to even out demand profiles. Urban economies of scale may also make viable energy storage systems such as heat stores and electrolysis.

- **Flexibility and future proofing:** A further advantage of neighbourhood-based systems is that different components can be changed and updated over time. It may not be viable to build autonomous neighbourhoods now, just as it is not viable to build autonomous individual homes. However if you build in neighbourhood heat, power and water systems there is the potential to upgrade them over time more easily than with individual homes. Initially it may be that the system is powered by gas but when the boiler comes to be renewed the viability of a fuel cell may have changed. It is also possible with a district system to bolt-on different combinations of elements such as wind turbines and solar arrays to retain flexibility in the system.

- **Neighbourhood management:** Urban development at the neighbourhood scale also allows greater scope for neighbourhood management. In both the private and rented sectors it is normal for developers of appartments and mixed-use schemes to retain a much more active management presence than the developers of individual homes. They will often retain responsibility for communal spaces and systems or subcontract these to a local organisation (such as the resident controled condiminim schemes in the US). Not only does this provide a framework to manage neighbourhood energy and water systems but it makes it viable to employ professional managers therefore allowing the use of systems which may be too complex for individual householders.

- **Capital/revenue links:** One of the great problems with eco-design is that, despite the arguments of some of its exponents, it inevitably increases capital costs. If these additional costs cannot be reflected in increased values or higher rents - which is generally the case - then there is little incentive for developers. However neighbourhood-based management and the associated service charges has the potential to transform this equation. We have been exploring scenarios whereby residents pay one service charge covering communal area management, power, heat, water and membership of the car-share scheme. The total home services package may represent a saving to residents on normal utility bills as well as being more convenient. However the real advantage is the use of a local Energy Service Company (ESCo) to manage this local billing and to make it possible to use the revenue to finance the initial capital investment.

These seven factors are the basis of the hypothesis for the Urban Autonomy project. This suggests that while some elements of urban development make autonomous design more difficult - such as the inability to optimise solar orientation - this is more than cancelled out by urban economies of scale and the advantages of neighbourhood resource systems. Our hypothesis is therefore that urban autonomy is possible at the urban scale, that it can be achieved without such extreme measures to reduce the resource consumption of individual homes and that, while it may not currently be viable, it is likely to be more viable in the future than single autonomous houses.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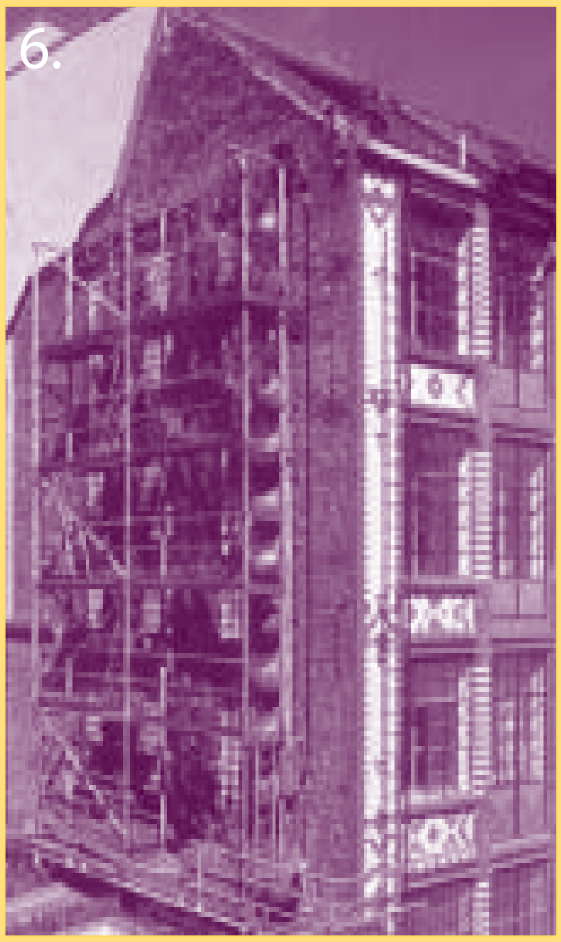
6.

-urban development

The aim of the Urban Autonomy project has been to explore whether it is possible to match the standards of the most advanced eco-housing within the context of mixed-use, urban, high density development. **Nick Dodd** explores a synthesis of eco-design and urban development – what might be called eco-urban-development.

At the start of the projet we set for ourselves the notional objective of urban autonomy for a mixed-use, urban neighbourhood of say 300 homes and 10,000m^2 of commercial uses. By autonomy we mean a neighbourhood that is self-sufficient in terms of energy and water. We realise that this is a somewhat artificial notion. Urban areas are, by their very nature, stitched into an intricate fabric of urban systems and it would be neither likely nor particularly sensible for any one neighbourhood to cut itself off completely from these surrounding neighbourhoods. The same however could be said for autonomous housing. The purpose of our work, as with previous work on autonomous housing, is not to suggest that all housing should be built this way but to set an notional objective in order to push the boundaries of eco-urban design.

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In order to do this a good deal of our work has involved the development of a pallet of technical options for eco-design at the neighbourhood level. We describe these technical options in this section in the three broad areas of energy, water and mobility. We realise that these are not the whole picture and omit, for example – recycling and food growing. However these three areas do encompass the most important environmental issues and serve as good examples of how these issues might be addressed at the neighbourhood level. We describe below a series of technical responses to each of these issues. These are addressed at three levels:

1. **Current UK good practice:** This refers to measures that might commonly be taken by developers concerned about the environmental impact of their developments.

2. **Current European best Practice:** This refers to more radical measures at the neighbourhood scale that have nevertheless been incorporated at least once into a scheme often on the Continent or in Scandinavia.

3. **Blue sky technology:** This refers to technical options that are under development and may have been used in other sectors such as industry but have not necessarily been incorporated into a housing scheme.

These three categories could be seen in another light when considering the autonomous neighbourhood. The first category of current UK good practice is largely confined to demand reduction. On the whole the issues here, if not the responses, are broadly the same whether you are dealing with an individual home of a whole neighbourhood – (i.e. construction, design, lights and appliances).

When we move to the second category we start to deal with supply-side issues and recycling such as renewable energy, combined heat and power and water restoration. Such issues are difficult to deal with at the scale of the individual home since the level of use does not justify the capital investment. Once the house has been built and occupied it is also difficult to go back and retrofit new technology as it becomes available. As we have already described, this viability equation is potentially transformed at the neighbourhood scale. Here capital investment in, for example renewables, can be spread over a larger number of units and can also be renewed and updated over time as technology improves. This however is only possible with systems and services that allow issues to be addressed at the neighbourhood scale. Once these neighbourhood systems are in place a whole range of possibilities open up including our category three 'Blue sky' technologies. Without them we are left with a handful of inspiring but hopelessly unviable autonomous homes and a mass of new homes which improve little on current good practice. This is best illustrated by reference to the issues of energy, water and mobility:

Energy

Current good practice is largely confined to demand reduction through energy-efficient design and construction and the reduction of electricity-use through efficient lights and appliances and good natural lighting. At the neighbourhood scale we can however introduce a network distributing hot water and electricity. At present it is likely that this network would be fed by a CHP plant, probably burning gas – an improvement on current UK good practice but still a falling short of European best practice.

1. **A heat pump** using either electricity, gas or waste heat to extract heat from groundwater or sewage.
2. **Kolding (Denmark)** Ecological urban renewal project incorporating the 'bioworks', an ecological sewage treat-ment plant and rainwater collection for use in washing machines and toilets.
3. **Hedebygarde, Copenhag en (Denmark):** The refurbishment of an urban block exploring solar air heating, hot water and ventilation systems and day lighting using solar reflectors. The common house in the foreground includes a laundry, recycling facilities and district heating works.
4. **Freiburg Flats (Germany):** Solar PV, thermal panels and rainwater collection for 'green' water.
5. **The Yellow House, Aalborg (Denmark):** Low energy solar design with photovoltaic panels integrated into balconies.
6. **Block 103, Kreutzburg, Berlin (Germany):** Vertical reedbeds providing block-based grey water treatment
7. **Nieuwland, Amersfoort (Netherlands):** A neighbourhood incorporating one megawatt of photovoltaic panels.

Once this neighbourhood system is in place all sorts of things become possible. We can, for example cover the roof with hybrid solar thermal and photovoltaic panels heating the water in the system and generating electricity to feed into the network. We might think about a seasonal heat store linked to the district heating network or indeed about appliances like fridges that run off thermal energy rather than electricity. We might even consider electrolysis using surplus photovoltaic electricity in summer to produce hydrogen from water that can be burned to produce electricity in winter or even Stirling engines which generate electricity using thermal energy. We have looked at all of these options - some of them 'clear blue sky' – that open up the prospect of urban autonomy. The main point however is not the choice of a particular system but the fact that it is the neighbourhood heating and power system which makes them all possible. What is more this neighbourhood district heating system is low-tech, tried and tested technology that, viability permitting, can be implemented today.

Water

The same principle can be applied to the water system. Water-use is an important component of resource-use partly because of the scarcity of water resources in parts of the country and also because of the energy used in purifying water, treating waste and, of course heating water for many domestic uses. As with energy current good practice is largely confined to demand reduction measures such as low-flush toilets and appliances, spray taps and showers with some minor penetration of individual home grey water systems into the market. At the neigh-bourhood scale key systems are dual supply for potable and restored grey water possibly with a dual drainage system. This clearly adds to the cost of the scheme but is not technologically demanding. However once it is in place a range of autonomous technologies become possible such as block grey water treatment (likely to be more efficient than single house systems), living machines to treat sewage, or even systems to purify rainwater for drinking. Such systems make it possible in a city like Manchester to reuse grey water and rainwater before turning to the mains supply making autonomy theoretically possible. These systems may not presently be viable in a city like Manchester although the equation will change in more arid parts of the country. However it is only by the provision of the neighbourhood dual supply system that the future possibility of installing such systems is retained.

By broadening our horizons from the home to the neighbourhood level an entirely new dimension can be added to the sustainability debate

Mobility

The use of the car is another good example of the step change that could occur by thinking about issues at the neighbourhood scale. It is accepted that urban density can have a limited impact on car usage. However the cost of owning a car (road tax and parking charges) as well as running a car (fuel tax and road pricing) is likely to increase in the future. It is already the case that a residential parking place in city centre Manchester or Leeds can cost more than £1,000 a year (far more in Central London). Yet in these areas it is probably more convenient to walk or use public transport for most trips. In these circumstances the car becomes more of a luxury than a necessity. However once you own a car, the marginal cost of each trip is minimal so that it makes economic sense to use it as much as possible to get the most from your money.

The key neighbourhood scale innovation is therefore the car-share service. Rather than paying all of the fixed costs of car ownership the car share service makes it possible to obtain access to a car on a pay-as-you-use basis, providing vehicles as 'fit for purpose' such as small efficient cars for trips around town, large cars for long journeys and even a van when required. All of this is possible for less than the annual cost of owning a car. This also means that the marginal cost of each journey reflects the true costs of car use thus making people think more carefully about their journey. The experience in Europe, where car-share schemes are becoming common is that they are effective in reducing the car use of most people (except, of course, for people who did not previously have access to a car). However like the district heating system or the dual water supply, the key thing about the car share scheme is the possibility that it opens up for the future. Once a service is in place it becomes possible to introduce a range of vehicle technologies that would be too difficult and costly to sell on an individual basis. This might include electric vehicles for the small run-around cars, fuel cell hydrogen engines for longer ranges, or even vehicles which run on ethanol produced from waste paper or biomass.

Neighbourhood management systems

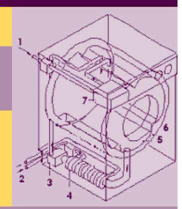
In each of these cases the introduction of relatively simple systems at the neighbourhood scale open up a range of technical options both now and in the future. However just as relevant as the technical systems are the financial and management systems that transform the viability equation. In the past environmental systems have only really been incorporated into social housing. This is partly because of the commitment of certain housing associations but also because it is possible to make a link between capital costs and higher rents offset against lower running costs. This has never been possible with housing for sale because the increased costs have not been reflected in higher values so that savings in running costs have not benefited the developer. However with urban development it is common for developers to maintain a management presence and to charge a service charge for the upkeep of communal areas and equipment such as lifts. It might be possible to extend this so that residents were able to pay for their energy, water and use of the car share scheme as part of one home service charge. This would represent an overall saving to residents because of the efficiency of resource-use and, crucially, the revenue would become available to finance the capital costs. This indeed is recognised by many utilities as the way forward for service provision and a number of power and water companies are actively developing such systems as indeed are car hire companies such as Budget with regard to car-share schemes.

We have dealt here with just energy, water and mobility but it would be possible to work through other examples such as waste collection, recycling, household appliances, food production etc… These examples show that by broadening our horizons from the home to the neighbourhood level an entirely new dimension can be added to the sustainability debate. All of the lessons that have been learnt about reducing resource-use on individual homes are still relevant but to this can be added the economies of scale of urban areas to supply energy, water and services in ways that are more efficient and responsive to the end-user, and with greater use of more integrated and renewable resource systems. It may never be possible or sensible to make an urban neighbourhood entirely autonomous. However it should be possible in the near future to create neighbourhoods where many of the resource flows are circular rather than linear and where the neighbourhood's net environmental impact is neutral or even positive.

technology and services

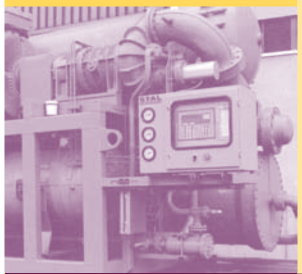
Energy Demand

End Use	Key Issues	1. Good Practice	2. Best Practice	3. Blue Skies	Service Provision	Design Issues
Cooking	Fuel efficiency	Gas cooker	Electric induction[1]	Gas 'catalytic' hob[2]	Biogas mains supply[3]	Heat main plumbing
Refrigeration		EU A Star Rating[4]	A+ Rating[5], Gas heat pump	Gas boiler/heat pump[6]		
Washing machine		EU A Star Rating	EU A+ Star Rating	District heat exchanger[7] 'Cold' wash detergents[8]	Communal laundry Product market testing	
Lighting		Compact fluorescents	Solar reflectors[10]	Fibre optic daylighting[12]		Overshadowing Overheating



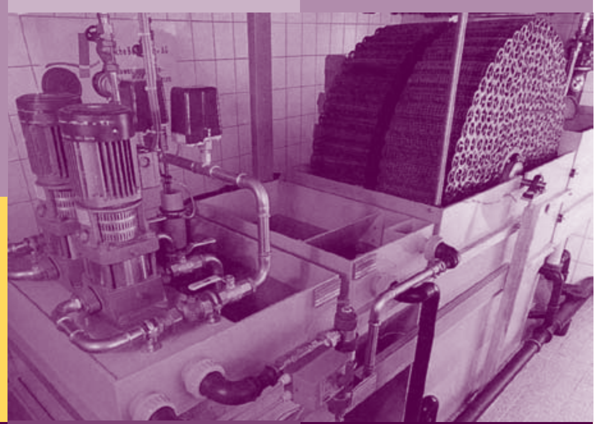
Energy Supply

End Use	Key Issues	1. Good Practice	2. Best Practice	3. Blue Skies	Service Provision	Design Issues
District Heating	Heating network Solar thermal energy Building integration Seasonal energy storage	Individual gas boilers Individual flat plate solar collectors	District Heating network[14] Heat exchangers / meters Evacuated tube solar collectors[15] Distributed Control System[16]	Seasonal heat storage[17] Heat 'batteries'	District Heating network is fundamental	Roof integration Heating network Sizing and locating the heat storage
Space Heating	Air tight, insulated, low emissivity building fabric Heating system Passive solar gain Ventilation heat recovery	SAP 100 / NHER 10[18] Double glazing Passive solar design	'Zero heating' <10 KWh/m^2 [19] Super-insulation Triple glazing Low °C heating Thermal mass Mechanical heat recovery[20] Ground/solar pre-heating[21] Workspace heat recovery[22]	Passive heat recovery[23]		Knowledge, detailing and quality control Structural cold bridging Urban microclimate[24] Block heating systems Ventilation ducts
Power Supply	Renewable energy Building integration Generating efficiency Short term and long term energy storage	'Green tariff'[25]	Neighbourhood PV cladding[26] Biofuel / hydro-gen CHP plant[27] PV roofing and cladding[28] Embedded generation, Distributed Control System	Urban wind power Vertical / horizontal axis[29] Building as wind concentrator[30] Water cooled PV's[31] Vacuum flat plate collector /low °C Stirling engine[32] Flywheel / ultracapacitor[33] Hydrogen fuel cycle[34] Zinc fuel cycle[35]	Utility owned and maintained roofing, cladding and turbines[36] 'Intelligent' real- time metering: source, efficiency and cost Fuel handling and risk management	Cladding of buildings and car ports Structural supports Microclimate modelling Efficiency hierarchy: direct supply, short store and long store.



Water

End Use	Key Issues	1. Good Practice	2. Best Practice	3. Blue Skies	Service Provision	Design Issues
Drinking	Efficiency measures Local supply Treatment systems Energy consumption	Spray taps Low-flow showers[37] Rain / borehole water[38] 'Point-of-use' treatment Gravity feed and slow sand filter treatment systems	Rooftop urban rain catchment system & storage[39] Neighbourhood or district 'point-of-entry' treatment and mains distribution	Grey water treatment for bath/ shower or all other uses[40]	Regional supplier inset appointment/private supply[41] Embedded benefits of reduced losses and resource efficiency	Aqueduct design Seasonal storage provision
Green (recycled grey water)	Acceptable end uses[42] Wastewater drainage Treatment systems Distribution mains	Washing machine Low flush toilets Individual grey / rainwater treatment	Green water for showers Dual drainage with block grey water treatment[43] or single drain with modular ecological sewage works[44] Block / neighbourhood treatment and green water mains distribution	Vertical reedbed[45] or biofence ecological grey water treatment[46]	User perception	Treatment works
Black Water (sewage)	Risk management – separate grey and black	Composting toilets	Modular ecological (tertiary) sewage treatment works	Vacuum toilet waste (and household solid organic waste) feed anaerobic Digestor producing biogas[47] Biofence modular ecological (tertiary) treatment plus biomass production		



Mobility

End Use	Key Issues	1. Good Practice	2. Best Practice	3. Blue Skies	Service Provision	Design Issues
Private car use	Living / working patterns Comfort and convenience Renewable energy Vehicle technology	Mixed use neighbourhood with good public transport links[48] and flexible work patterns[49]	Location Efficient Mortgages[50] Car share services[51] Electric vehicle hire[52]	Battery / fuel cell electric or biofuelled car service[53] Neighbourhood fuel supply[54]	Service logistics and customer charges Refueling infrastructure	Car port/refuelling locations

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Gelsenkirchen, Ruhr Valley (Germany):
High level aquaducts to capture rainwater from

the autonomous neighbourhood MODEL

To test our hypothesis that autonomy is easier to acheve at the neighbourhood scale we have constructed a model to test some of the technologies set out on the facing page. **Charlie Baker** describes the thinking behind this model and some of the initial findings

Cities are polluting, cities are unsustainable – all 6 billion of us should go and live in the countryside – Malthus would have been proud. Of course this is not feasible, we must make the best of our unsustainable cities. But maybe we can go further than this – it may be that cities are actually the most sustainable settlement form. While the evidence to support this view is thus far patchy, the SUN Initiative's Urban Autonomy Project has been seeking it out. In this article we outline some of the initial findings.

The task that we set ourselves was to assess the practicality of building urban neighbourhoods that are self-sufficient for all their basic resources – including water, heat, power and mobility. In doing this our first step was to set out a balance sheet of the energy and resources consumed by the neighbourhood and the resources naturally available from rainfall, sun and wind, as well as the wastes that it produces.

As part of the research we have used this balance sheet to rethink the service provision of a hypothetical urban neighbourhood. Our target has been to achieve self-sufficiency without degrading the surrounding environment, achieving a net balance of CO2 emissions, and by providing energy from on-site renewable energy systems. In doing so the neighbourhood would meet the standards for Zero CO_2 and Autonomous housing recently set out by the DETR[1]. This work has been guided by several parameters.

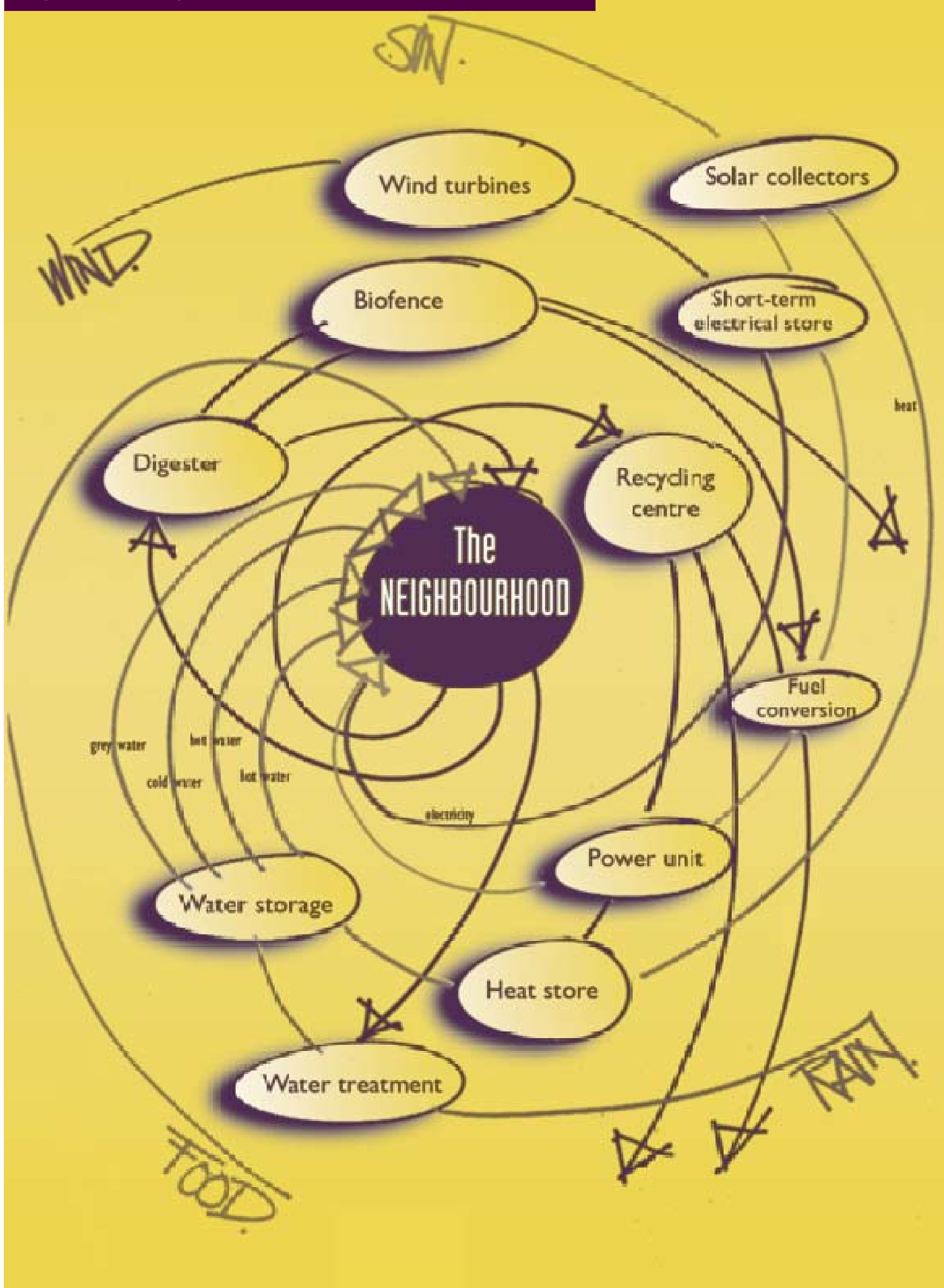
1. We did not want to achieve autonomy on a one-off basis, but sought to develop a model that could be applied across the country. For example solar cells will produce a surplus of electricity in the summer which can be sold to the grid. However if every neighbourhood did this the national grid would be overloaded every time the sun came out. We therefore set ourselves a target of reconciling energy demand and the intermittent supply of renewable energy within the bounds of the scheme.

2. The second parameter was that the measures adopted to achieve self-sufficiency should not compromise urban design principles. The work of the SUN Initiative and indeed the Urban Task Force has set out a vision for an Urban Renaissance in the UK. We were concerned that our proposals should be compatible with this. This immediately questions one of the 'givens' of eco-housing - namely passive solar gain. Development based on urban blocks will inevitably mean that some units face east-west and others north-south. This means that some housing in high-density developments will get insufficient direct sunlight to contribute significantly to space heating needs.

3. We were also concerned that, unlike some autonomous housing, our neighbourhood should be easy to live in. The system should not come crashing to the ground if someone opens the wrong window. Heating systems should be controllable, toilets should flush and new products or services should be feasible and user-friendly.

4. We did not want to dabble in science fiction and have therefore mapped out realistic technological options into the future. We have therefore confined ourselves to technologies of which we have at least been able to find prototypes if not production models.

Figure 1: Neighbourhood Resource Flows



The neighbourhood model

The principle advantage of looking at a neighbourhood rather than a house is that while per-capita waste production is the same, there is sufficient quantity to be worth treating. When we look at the neighbourhood as closed system we find an impressive array of useable resources, both primary resources from the sun, wind and rain and secondary resources from the neighbourhood waste streams and the by-products of different processes. If we are to stand a chance of autonomy then as few as possible of these resources and by-products should be wasted and where possible, the product of one process should form the fuel for another.

Figure 1 attempts to represent the swirl of interacting processes involved in achieving this. First comes the primary resources - wind, sun, and rain, to which are added to and subtracted from, various forms of waste and resource use. Feeling like Harry Beck when he first sought to make sense of the London Underground, the flow of resources around the system soon became impossible to follow making it difficult to try out different options.

To simplify the model we therefore took advantage of our closed system and adopted a resource balance sheet approach. In this way the precise linkages between the different proposed systems did not need to be worked out first. All the useable resources in the area were totalled up and matched with the resource requirements. Systems could then be devised to link the two although, of course, these systems also produce by-products. We put each process onto a different page of the balance sheet so that, as the system evolved, we were able to replace or adjust different processes without having to track changes through the whole model. The model, illustrated in Figure 2 (back page), has allowed us to study different scenarios and to evaluate them in empirical terms. We have also been able to adjust parts of the system to optimise efficiency and also to produce data to size the infrastructure and plant.

> We adopted a resource balance sheet approach. The precise linkages between different systems did not need to be worked out first but all useable resources could be totalled up and matched with the resource requirements

So what does this model tell us? It shows that the autonomous urban neighbourhood is, in theory, possible. With a grey water recycling, for example, along with standard water-saving measures, there is enough rainwater landing on the roofs of the buildings to supply the entire neighbourhood with its water needs. This rain water can be purified for drinking, cooking, bathing and washing. These in turn produce waste 'grey water' which is cleaned to create 'green water' to for toilets, washing machines and showers, (but not baths because, as most parents know, children drink bath water). The waste from these processes then drains as black water that goes to the neighbourhood sewage processing plant.

This sewage plant produces enough methane by digesting sewage and organic kitchen waste to supply all the neighbourhood's gas powered fridge/freezers or all the gas hobs (using a mix of existing and 'second generation' appliances) and nearly half of the ovens. There may however be a sales problem if people think too hard about what they are cooking with!

Those with a stereotypical view of Manchester will not be surprised that we are self-sufficient in water. It may however surprise you that with only 70% of the roof covered in solar cells we are also self-sufficient for heat and power. Research into the most efficient solar collectors has uncovered a product based on a Stirling (heat) engine linked to a high temperature vacuum flat plate collector, rather than photovoltaics. This has the potential to produce electricity at the same or greater efficiency as a PV but also produce heat as a by-product at a rate comparable with the most efficient evacuated tube solar thermal collector.

> Those with a stereotypical view of Manchester will not be surprised that we are self-sufficient in water. It may however surprise you that with only 70% of the roof covered in solar cells we are also self-sufficient for heat and power

In theory this means that there is no need for a central Combined Heat and Power [CHP] unit. However it is likely that a CHP plant would form part of an energy storage system. Surplus electricity in the summer would be used to produce hydrogen that would be stored for use in a CHP unit (or mixed with biogas) when it is needed. It has even been suggested that the Stirling engines could use hydrogen as well as heat from the solar collectors, which would cut costs for capital equipment. Excess heat produced throughout the summer would then be stored to provide for winter heating and hot water, possibly in the form of hot water storage. As the losses involved in long term energy storage are quite high we have also assumed that there will be some form of short term power storage to remove the peaks and troughs. There are various products (such as fly wheels) designed to produce uninterruptible power supplies for industry, which we have been investigating.

Harnessing the wind's energy in an urban environment is another area we have looked at. However, on the basis of current information, it would appear that even with the most efficient turbines and careful building design the contribution from the wind is likely to be minimal.

We have calculated that there could also be sufficient electricity to power the neighbourhood's car pool. Waste paper can be converted to ethanol to power a limited number of converted traditional internal combustion engines for flexibility on longer journeys while short journey needs are catered for by a pool of electric vehicles with a range of up to 125 miles. We have looked at fuel cell vehicles although the losses involved in converting electricity to hydrogen are likely to make it more efficient to use electrical energy directly.

Next steps

Autonomy is therefore possible, if not maybe yet viable. It is however likely to be no less viable than individual autonomous homes. In the next part of the research we will be testing the practicality and viability of these systems. The first part of this will be the design implications of these systems. Collecting rainfall and solar energy will affect the outside of the building while the storage of water, heat and energy will affect the interior. We are going to need a substantial amount of infrastructure and a central plant. Should this form a central feature to raise awareness of environmental systems in the neighbourhood?

This design work will allow us to assess overall costs. While there will be scope for some savings overall it is inevitable that the system will be expensive. But sunlight will always be free while the costs of oil and gas continue to rise both financially and environmentally. These costs also need to be offset against the benefits of more resource efficient on-site supply systems, the whole-life costs of maintaining and running these systems, and the added value of these new local services. Indeed practical experience with developers over the last twelve months suggests than we may be closer to viability that we first thought. The key to this is not the expense of a particular system or specification but the urban economies of scale and access to finance from revenue streams from utility bills. It is these innovations that will eventually make the autonomous urban neighbourhood a viable reality.

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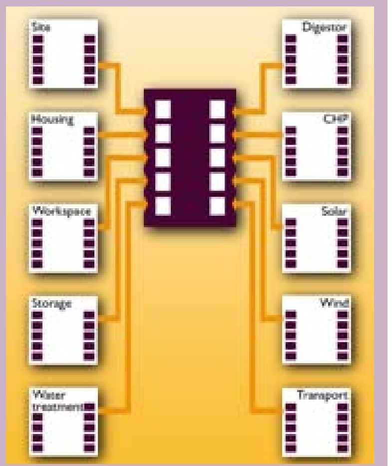
Figure 2: The Neighbourhood Metabolism

Site footprint	m²
Buildings	13,779
Landscape	639
C-yard&roads	21,870

Housing	units
5 bed	10
4 bed	20
3 bed	90
2 bed	120
1 bed	60
TOTAL	300
people/household	2.4

Workspace	area m²
live/work	750
retail	750
office	2,000
B1	2,800
B2	4,000
TOTAL	10,300
Workforce	300

Supply and Demand		Housing	Workspace	
Water:	white water	-9,423,220	-312,000	litres
	green water	-15,181,430	-234,000	litres
	grey water	17,490,917	234,000	litres
	black water	4,410,115	525,013	litres
Organics:	human solid organics	41,672	4,961	kg
	kitchen waste	50,100		kg
	Waste paper	55,500	8,400	kg
Energy/fuel:	Methane	-56,280		kWh
	electricity	-428,634	-488,150	kWh
	heat	-2,215,026	-955,000	kWh



As part of the research a computer model has been developed (illustrated above). This represents the balance sheet for resource-use in our neighbourhood.

Solar		
Energy/fuel electricity	1,036,743	kWh
heat	3,298,727	kWh
Energy Storage		
hydrogen	524,366	kWh
electricity	-160,266	kWh
t	-280,542	kWh
CHP		
Energy/fuel, hydrogen	-520,111	kWh
electricity	208,044	kWh

Transport		
Energy/fuel electricity	-149,780	kWh
Waste paper	-63,900	kg
Ethanol	-129,509	kWh

Water Treatment			
Water	rain	-11,160,990	litres
	white water	10,044,891	litres
	green water	17,724,917	litres
	grey water	-17,724,917	litres
Energy/fuel	electricity	-45,055	kWh

Digestor			
Water:	black water	-5,240,077	litres
Organics:	human solid organics	-14,016	kg
	kitchen waste	-12,525	kg
Energy/fuel:	methane	56,645	kWh
	heat	-16,993	kWh

Balance Sheet		total production	total consumption	% spare capacity in system
Water (litres)	rain	11,160,990	-11,160,990	
	white water	10,044,891	-9,735,220	3.00%
	green water	17,724,917	-15,415,430	13.03%
	grey water	17,724,917	-17,724,917	
	black water	5,240,077	-5,240,077	
Organics (kg)	human solid organics	47,304	-14,016	
	kitchen waste	50,100	-12,525	
	paper	63,900	-63,900	
Energy (kWh)	methane	56, 646	-56,280	0.65%
	ethanol	129,509	-129,509	
	hydrogen	524,367	-520,111	0.81%
	electricity	1,244,787	-1,271,885	1.92%
	heat	3,506,772	-3,467,561	1.12%

IN BRIEF

A New England in Brighton

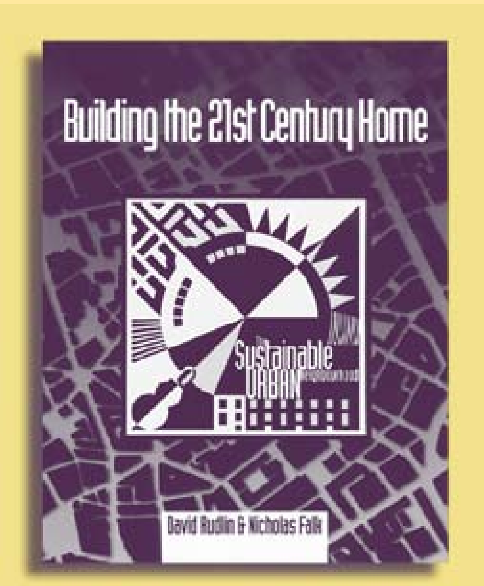
In the teeth of controversy the SUN Initiative has been working on a master plan for the Station Site in Brighton. Following the rejection of a Sainsburys supermarket at an appeal last year the SUN Initiative has been amending the scheme to include a smaller supermarket with housing on top along with a mix of high-density housing blocks, a hotel and workspace. The supermarket was opposed by a very effective local campaign organised by BUDD (Brigh-ton Urban Design and Development). Keith Taylor a member of BUDD and a local Green Councillor has said that the new scheme is 'miles better than the original one' but they remain implacably opposed to a supermarket in whatever guise. The SUN Initiative by contrast believes that this is exactly the sort of model that we should be developing as an alternative to out-of-town superstores.

Manchester Resource Exchange

Working in partnership with Manchester-based recycling company EMERGE the SUN Initiative has recently secured ERDF funding to work up plans for an urban resource exchange. Light industrial units will house businesses recovering, re-using, remanufacturing and recycling domestic and commercial 'waste'.

Uses are likely to include furniture, white goods and computer recovery, a kerbside recycling company, electric vehicle services, and metal and timber stockholding, fabrication and carpentry. Offices will house an enterprise centre delivering services such as a waste exchange network, eco-design consultancy, training programmes, as well as the research and development of new business opportunities.

Details of the project from Nick Dodd, URBED (tel. 0161 226 5078) or Paul Cobban, EMERGE (0161 232 8014)



Building the 21st century home: The sustainable urban neighbourhood
David Rudlin & Nicholas Falk
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The SUN Project is managed from URBED's Manchester office by David Rudlin, Nick Dodd and Hélène Rudlin. Additional material on this issue of SUN Dial has been provided by Charlie Baker

This news sheet has been researched, written (unless otherwise credited) and designed by URBED which is a not for profit urban regeneration consultancy set up in 1976 to devise imaginative solutions to the problems of regenerating run down areas. URBED's services include consultancy, project management, urban design and economic development. The SUN Initiative further develops URBED's involvement in housing development and continues the work of the 21st Century homes project.

Why NOT get involved?

The SUN Initiative has been established as a broadly based network of organisations and individuals interested in the sustainable urban development. We do not have a membership but if you do not normally receive this newsletter please contact us and we will add you to our mailing list.

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