

# The compact city and transport energy consumption

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This paper challenges an emerging conventional wisdom: that transport energy consumption, and hence pollution, can be substantially reduced by promoting more compact cities. Such reasoning has quickly found its way from academic studies to official policy in many countries. Do the likely savings from such containment warrant the required draconian policies? An empirical assessment of transport energy consumption arising from decentralization is used to address this question. Two contextual reviews - of the compact city case and the strength of decentralization - precede the assessment. The conclusion is that energy savings will be minimal and that other policies might be more fruitful.

**key words** United Kingdom transport energy empirical assessment compact city decentralization policy

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## Introduction

There has been a remarkable consensus in recent years that planning for more compact cities is one of the most important ways of reducing energy consumption and pollution. This policy prescription has been adopted by the European Commission and by national and local governments in many western countries. The consensus arises because of a limited amount of academically produced evidence that such a policy - is an appropriate way of reducing environmental problems, and because governments are anxious to make their contribution to that most fashionable of causes: sustainable development.

The European Commission (Commission of the European Communities 1990) has promoted the 'compact city' on environmental and quality-of-life grounds; the UK government has prompted transport and land-use planning to reduce transport energy consumption (Department of the Environment 1990, 1992, 1994) and has made this a central element of the UK *Strategy for sustainable development* (Department of the Environment 1993) presented to the United Nations Commission on

Sustainable Development at the beginning of 1994; the Dutch government has made the compact-city notion a central element of its National Physical Plan (National Physical Planning Agency 1991); the Australian government has rejected the profligate, American-style use of land that has become an Australian tradition (Newman 1992); and, even in the United States, it is now fashionable to deplore urban sprawl and to promote growth-management policies (Wachs 1989/90; Chinitz 1990).

Given the normal reluctance of governments to adopt new, largely untested policy initiatives, this consensus is remarkable. It reflects both genuine concern over environmental degradation and offers - at first sight, at least - a tangible way of contributing to international accords on the environment.

While there are many possible merits in the urban-containment approach - reduction of land loss, the preservation of habitats and valued landscapes (McLaren 1992; Council for the Protection of Rural England 1992, 1993), the economic and social revival of cities and, some would argue, the survival of civilization (Bourne 1992; Robson 1994 - a

major incentive for the adoption of this policy is that of reducing fuel consumption and, hence, of reducing harmful emissions. Thus, on the understanding that fuel savings will result, governments are introducing new - and for some of them radical - policies. These may, in the long run, change the very nature of western cities. At the very least, familiar local patterns of development may change. For example, in the UK there is the prospect that there will be no additions to out-of-town retailing; the dominant form of investment in retail outlets during the last 30 years. At most, the form and function of western cities could change dramatically. For example, the cherished high land-consuming, high-mobility lifestyle of many North Americans may be set for a fundamental change. The aspirations of many people for a suburban or ex-urban lifestyle - the very aspirations that in the past appear to have caused the problem - may be frustrated. Likewise, the desire of many-business interests to relocate or expand into such areas may be thwarted. The implications of the compact-city policy are, then, profound. Potentially they involve considerable collective disruption, the introduction of draconian policies and massive but unknown redistributions of gains and benefits. In short, the policies had better be worth it!'

But how valid is the evidence upon which this radical policy consensus is built? Although there have been some dissenting voices, the general drift of academic advice has been in favour of urban containment, and - recently at least - largely on the grounds of transport energy savings. Given the importance of these issues and the relative lack of substantiation for the policy prescriptions that are emerging, this paper asks the following questions:

- (i) What is the magnitude of the additional energy consumption that results from increasingly decentralized urban forms?
- (ii) Is this magnitude - the potential saving, if decentralization can be contained - such that it warrants the introduction of policies that require a reversal of the most powerful forces of urban change?

The fourth section of this paper - 'Urban decentralization and transport energy consumption' - will address these questions directly. However, this assessment will be facilitated by brief reviews of two areas of research which make up the next two sections of the paper. The first concerns the concept of the 'compact city'. There is now a considerable

body of literature on the merits and occasionally demerits of the compact city. The intention here is to review this only briefly, for detailed consideration is given elsewhere.' Some coverage is required here, however, because any answer to the above questions must draw on this research. The second, and closely related, set of contextual material to be reviewed concerns urban-decentralization trends. If past and continuing urban decentralization is the villain of the piece - leading to greater car use, greater petroleum consumption and greater levels of pollution - then it is important to know how powerful those trends are. Breheny (1994) has suggested that one major question not posed in the compact-city debate is whether the process of urban decentralization can be halted, regardless of whether it is desirable or not. Recent evidence on decentralization trends in the UK is presented here and is then used in addressing the questions posed above.

The approach adopted here is deliberately both generalized and specific. It is generalized because the intention is to gain a broad, even crude, feel for the validity of the energy-efficiency claims of the compact-city case. It is specific in that it focuses on one aspect - transport energy consumption - within a complex debate on planning and sustainable development. There are many aspects of the sustainability debate and its interpretation in an urban context that are not covered here. It is appreciated that, in considering appropriate policy prescriptions to promote sustainable development, a multitude of issues need to be considered together. This paper is presented on the assumption, however, that there is merit in identifying one important issue and investigating it in relative isolation. The results of this investigation can then be used when considering these broader issues. No attempt is made here to define or elaborate on the concept of sustainable development (see Breheny 1994). It is sufficient for the present argument to assume that the reduction of energy consumption and emissions is consistent with this concept.

### **Evidence for the compact city**

The term 'compact city' is used here as shorthand for a variety of approaches to the planning of towns and cities which stress the merits of urban containment. The idea is not new. It has been promoted over many years, with varying degrees of explicitness, as the corollary of rural protection which remains a major motive (McLaren 1992). The

current debate adds two new motives: the transport energy-saving possibilities and the quality-of-life implications of urban compaction. At the moment it is the energy issue that, arguably, most exercises politicians in their promotion of urban-containment policies. Certainly this is the case in the UK where two major government initiatives - the UK *Strategy for sustainable development* (Department of the Environment 1993) and the Planning Policy Guidance note PPG13 (Department of the Environment 1994) - invite planners to adopt a range of measures to reduce the need to travel. The major concern is the reduction of CO<sub>2</sub> emissions. Transport currently accounts for only 20 per cent of UK CO<sub>2</sub> emissions but it is the fastest-rising contributor to the problem. The UK government has international obligations to reduce CO<sub>2</sub> emissions to 1990 levels in the short term and to achieve further reductions over time.

Recent arguments supporting the compact-city solution to the urban energy-consumption problem come from a variety of sources and adopt a variety of lines of argument. Some are based largely on assertion. Arguably, this is the basis of the Commission of the European Communities' (1990) influential *Green Paper on the urban environment* which advocates higher-density cities on the grounds of both environmental and quality-of-life benefits. It goes so far as to suggest that all development should be contained within the boundaries of existing urban areas. Other advocates of the compact city derive their support from a mixture of ideological assertion and analysis. Thus, environmental groups such as the Council for the Protection of Rural England (Owens 1991; Jacobs 1993), Friends of the Earth (Sherlock 1990; Elkin *et al.* 1991; McLaren 1992) and English Nature (Jacobs 1992) have all argued for stronger policies of urban containment as part of relatively 'deep green' approaches to sustainability.

Academic studies of compact-city ideas range from idealistic prescriptions drawing on long-standing utopian notions, via mathematical modelling of urban forms, to empirical examinations of the energy efficiency of different urban densities and urban sizes. The idealistic line of reasoning is well represented by the work of Yanarella and Levine (1992) who have searched past urban forms and cultures to identify characteristics that might be a basis for modern sustainable urban structures. They alight on the medieval Italian hill town as having the most desirable mixture of form and function.

This conclusion has a lot in common with the implied ideal in the Commission of the European Communities' (1990) Green Paper. In the United States, a popular response to the compact-city debate has been the advocacy of 'neo-traditional' suburban developments with a small-scale, neighbourhood focus of daily life that will reduce travel (Handy 1992). The promotion of 'urban villages' in the UK (Urban Villages Group 1992) is intended to have similar effects. Questions of urban form, transport and energy consumption should also be seen within a broader debate about the contribution of transport to environmental problems (Banister and Button 1993).

A rather specialist but interesting area of work has been the modelling of urban structures with an explicit focus on the energy-consuming characteristics of different forms. Rickaby and associates (e.g., Rickaby 1987; Rickaby *et al.* 1992) have developed a model of an archetypal English town and have then modelled the relative levels of energy consumption of different forms of incremental growth to that town. Their conclusions tend to favour two types of growth: in the urban core or in a 'decentralized concentration' form, whereby sub-centres are developed while maintaining overall urban densities. This latter solution has received considerable support (e.g., Owens 1991, 1992; Barton 1992). This particular debate highlights the point that supporters of urban compaction do not necessarily advocate the one solution. For example, in addition to the promotion of the large-city solution and the decentralized concentration approach, new free-standing settlements have also been proposed as part of a general containment solution (Breheny *et al.* 1993).

Although much of the academic literature focuses directly on the possibilities of changes in urban form inducing changed transport patterns, there is a line of reasoning (e.g., Owens 1991, 1992) which suggests that such changes are unlikely to occur with current high levels of mobility. Thus, the increased accessibility that might arise from land-use policies will have little effect whilst the propensity to travel remains high; motorists will not be discouraged from choosing more distant destinations. The implication is that land-use policies need to be accompanied by other policies - such as fuel taxes - which reduce overall mobility.

Empirical assessments of containment have concentrated on the question of the degree to which localities which appear to have the appropriate

characteristics do in fact have lower rates of transport energy consumption. These assessments have focused on the two related issues of urban densities and urban size. The hypotheses adopted are that areas of high population density and large urban size will have lower rates of consumption on the grounds that (i) these areas have high levels of accessibility and hence require shorter journeys and that (ii) they induce provision and use of public transport.

#### *Urban densities and transport energy consumption*

One of the best known studies of urban densities is that by Newman and Kenworthy (1989a and b). They measured per capita petroleum consumption and population densities in a range of large cities around the world finding a clear negative relationship between the two: as densities rise, fuel consumption falls dramatically. The villains were identified as US cities which had consumption rates twice as high as those in Australian cities and four times as high as those in European cities. The cities with the highest densities were those with low car usage and high levels of provision of public transport. The obvious conclusion from this study was the need for stronger policies of urban containment and for investment in mass transport systems.

Although Newman and Kenworthy's work has been very influential in promoting the case for the compact city, it has generated considerable criticism on a mixture of ideological and technical grounds. Gordon and Richardson (1989) consider the work on both counts. Ideologically, they object to a reliance on public intervention, particularly on the grounds of what they see as a 'Maoist' planning system. They contrast the Australians' finding with some of their own in the United States where commuting distances and times have tended to fall in recent years because of employment decentralization and hence increased suburb-to-suburb work trips, and where the major growth in travel arises from non-work trips (see also Gordon *et al.* 1989, 1991; Bae 1993). They argue that the development of polycentric cities, through market pressure, is the most effective way of dealing with the energy-consumption problem. They are also sceptical about the realistic prospects for massive investment in public transport across the world. In reviewing Newman and Kenworthy's (1989a) sourcebook, Gomez-Ibanez (1991) has stressed the complexity of factors that determine rates of gasoline use in different cities and countries. He argues that,

in focusing on urban densities, Newman and Kenworthy have largely ignored the significant effect of household incomes and gasoline prices on consumption, and of incomes on densities. Their analysis is undermined, he claims, because of their obvious prior commitment to land-use policies in general and to policies of containment in particular. Interestingly, Gomez-Ibanez (1991) makes the point that the costs - economic, social and cultural - of radical containment policies have not been weighed relative to doubtful environmental gains. This paper tries to make a similar point.

Newman and Kenworthy (1992) have responded to these criticisms in technical terms and more generally by summarizing the ideological question posed by their critics: 'is there a role for physical planners? They defend their focus on density as the major determinant of gasoline consumption not on technical grounds but on the basis that economic determinants (price and incomes) are unlikely to be used seriously as policy tools by politicians. This leaves land-use measures, and hence the planning system, as the most effective means of reducing urban energy consumption. They cast doubt on some of their critics' data and analysis, suggesting that a focus on US cities alone, and on Los Angeles in particular, can be misleading. If Los Angeles is an ideal model, 'then heaven help us' is Newman and Kenworthy's (1992, 360) response. They suggest that the Americans are confusing polycentric cities with cities that are simply dispersing to low densities. They finish with a ringing defence of physical planning as the means to deliver a 'less automobile-dependent urban future' (Newman and Kenworthy 1992, 360). Bourne has entered the debate on their side, accusing Gordon *et al.* (1991) of 'sweeping and subjective generalisations'. He argues that the future of cities cannot rest on the judgement of pro-market economists, even if they can prove the economic merits of dispersal, which he doubts. He is concerned that the advocacy of dispersal may become a self-fulfilling prophesy, '... contributing to the evolution of future urban forms that are increasingly inefficient and socially inequitable' (Bourne 1992, 513).

A British study which provides evidence on the relationship between densities and energy consumption is the ECOTEC (1993) study carried out for the Department of the Environment. Table I is taken from this study. This table seems to confirm the general findings of Newman and Kenworthy (1989a and b): it shows a neat inverse correlation between

**Table I. Distance travelled per person per week, by mode and population density, 1985/6**

Density (persons per hectare)	All modes	Car	Bus	Rail	Walk	Other
<1	206.3	159.3	5.2	8.9	4.0	28.8
1-4.99	190.5	146.7	7.7	9.1	4.9	21.9
5-14.99	176.2	131.7	8.6	12.3	5.3	18.2
15-29.99	152.6	105.4	9.6	10.2	6.6	20.6
30-49.99	143.2	100.4	9.9	10.8	6.4	15.5
>50	129.2	79.9	11.9	15.2	6.7	15.4
All areas	159.6	113.8	9.3	11.3	5.9	19.1

Data exclude all trips less than 1.6 km and refer only to the main mode used for a trip

Source: ECOTEC (1993, Table 6)

**Table II. Distance travelled per person per week, by mode and urban size (km)**

	Car	Bus	Rail	Walk	Other	Total
Inner London	76.1	12.0	34.1	2.5	16.6	141.3
Outer London	113.3	8.9	23.3	2.6	18.5	166.6
Metropolitan Areas	70.6	16.9	4.7	3.4	17.1	112.7
Other Urban over 250 000	93.6	11.2	8.3	4.2	23.9	141.2
100 000-250 000	114.8	8.6	11.3	3.2	22.6	160.5
50 000-100 000	110.4	7.2	13.0	3.7	20.2	154.5
25 000-50 000	110.8	5.7	12.5	3.7	18.2	151.0
3000-25 000	133.4	7.2	8.0	3.0	24.1	175.7
Rural	163.8	5.7	10.9	1.7	28.9	211.0
All areas	113.8	9.3	11.3	3.2	22.0	159.6

Source: ECOTEC (1993, Table 9)

total distances travelled per week and population density. It is car travel that accounts largely for the difference with people living at the lowest densities travelling approximately twice as far by car each week as those living at the highest densities. This is one of the findings that led ECOTEC (1993) to recommend to the British government a package of land-use and transport policies that amount to a compact-city solution.

#### *Urban size and transport energy consumption*

In addition to densities, much of the empirical research has focused on the relationship between urban size and energy consumption. This issue will be elaborated here because some of the findings will be used later to consider the energy-consumption characteristics of different urban types. The major studies of urban size and energy consumption in the

UK are by Banister (1980, 1992) and ECOTEC (1993). Banister's first effort focused on transport energy consumption in villages in Oxfordshire, and hence is of little direct use in considering the full range of urban sizes. His 1992 study did consider such a range but with very crude size bands. This work is now being pursued further with international comparisons of local transport energy consumption (Wood *et al.* 1994). The ECOTEC (1993) study overcame the problem of size bands by using a special tabulation from the 1985/6 National Travel Survey. Using these data, ECOTEC have produced a tabulation of urban sizes against average distances travelled per week, by mode. The results are shown in Table II. In this table, Metropolitan Areas are treated as one group; in the ECOTEC report, details are given for each of the major Metropolitan Areas in the UK.

**Table III. Primary energy consumed per person per week, by mode and urban size (megajoules (MJ))**

	<i>Car</i>	<i>Bus</i>	<i>Rail</i>	<i>Walk</i>	<i>Other</i>	<i>Total</i>
Inner London	99.7	7.0	20.1	—	13.6	140.4
Outer London	148.4	5.2	13.7	—	15.2	182.5
Metropolitan Areas	92.5	9.8	2.8	—	14.0	119.1
Other Urban over 250 000	122.6	9.8	4.9	—	19.6	156.9
100 000–250 000	150.4	5.0	6.7	—	18.5	180.6
50 000–100 000	144.6	4.2	7.7	—	16.6	173.1
25 000–50 000	145.2	3.3	7.4	—	14.9	170.8
3000–25 000	174.7	4.2	4.7	—	19.8	203.4
Rural	214.6	3.3	6.4	—	23.7	248.0
All areas	149.1	5.4	6.7	—	18.0	179.2

*Source:* calculated from data in ECOTEC (1993)

Table II demonstrates that there is an increase in average distance travelled with decreasing urban size. Outer London seems to be an exception to the rule, with a high overall level of travel based on high car travel. The lowest level of travel is not in central London, as might be expected, but in other Metropolitan Areas. ECOTEC's (1993) conclusion from this analysis is that large urban areas - by virtue of higher urban densities, shorter travel distances and mass-transit facilities - are much more sustainable. Smaller urban areas, and particularly rural areas, they conclude, are more fuel inefficient and hence relatively unsustainable.

Surprisingly, the ECOTEC (1993) report does not go on to produce estimates of energy consumption by urban size. And yet, their report makes this possible because they supply primary energy-consumption rates for different modes at different levels of vehicle occupancy. These rates were originally derived from a European Commission study (Commission of the European Communities 1992). Using a 50 per cent occupancy consumption, Breheny (1994a) has adopted the following rates from the ECOTEC study car, 1.31; bus, 0.58; rail, 0.59; walk, 0.0; and other, 0.82 megajoules (MJ) per passenger kilometre. The 'other' category, which includes two-wheeled vehicles, taxis, domestic aeroplanes, other public transport and other types of buses, has been given a value which is the average for car, bus and rail rates. The modal categories have been chosen to coincide with those in Table II.

These consumption rates may be multiplied by the per capita weekly travel distances in Table II. This gives primary energy consumption from

transport per week per capita by urban size bands. The results are shown in Table III. The general result of this exercise to measure energy consumed is to increase the urban-rural difference relative to the travel distances shown in Table III. Thus, rural areas have average consumption levels 108 per cent higher than the most energy-efficient Metropolitan Areas, compared to an 87 per cent difference on travel levels alone. This widening results, of course, from the use of modes of travel to arrive at the energy-consumption measures. The greater dependence of rural and small-town dwellers on the car is the major source of their greater energy consumption.

#### *Policy responses to evidence*

As explained earlier, despite some reservations about the compact-city idea<sup>2</sup> it has gained considerable academic and political support. In the UK this political support has been profound. It has resulted in guidance being issued to local planning authorities urging them to both adopt policies and make development control decisions which promote stronger urban containment. This is part of a concerted effort to promote sound environmental policies (but at the same time promoting economic growth). The major guidance has been issued in the form of Planning Policy Guidance notes (PPGs). The latest detailed guidance is in PPG13 on *Transport* (Department of the Environment 1994). Amongst other policies, PPG13 proposes (para 1.7) the following under the heading of 'Planning for less travel':

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'Development plans should aim to reduce the need to travel, especially by car, by:

- influencing the location of different types of development relative to transport provision (and vice versa); and

- fostering forms of development which encourage walking, cycling and public transport use.

In order to achieve these aims, PPG13 (paras 3.2 and 3.3) proposes specific local initiatives. On housing, it proposes to:

- allocate the maximum amount of housing to existing larger urban areas (market towns and above) where they are or can be easily accessible to facilities . . . and to a range of transport provision . . .

- . . . promote land for housing in locations capable of being well served by rail or other public transport . . .

- avoid any significant incremental expansion of housing in villages and small towns . . .

- avoid sporadic housing development in the open countryside, but promote appropriate development within existing communities . . .

- avoid the development of small new settlements . . . especially where they are unlikely to be well served by public transport and are not designed to be capable of being self-contained.

- concentrate higher-density residential development near public transport centres, or alongside corridors well served by public transport . . .

- set standards to maintain existing densities and where appropriate increase them . . .

- juxtapose employment and residential uses, where feasible, through mixed-use development.

On employment, PPG13 (paras 3.5 and 3.6) proposes to:

- focus the opportunities for development of travel-intensive uses (such as offices) in urban areas in locations well served . . . by public transport.

- avoid major developments in locations not well served by public transport . . .

- allocate sites unlikely to be served by public transport solely for uses which are not employment- or travel-intensive;

- reallocate accessible land designated for activities which are not employment- or travel-intensive uses to more intensive uses . . .

PPG13 goes on to promote policies for retailing, leisure, tourism and recreation, and education which also stress the intensive use of urban sites and particularly sites served by public transport.

These policy proposals, many of them taken from the recommendations of the ECOTEC (1993) report, show clearly how one government has responded radically to the environmental-sustainability problem by focusing on the role of the planning system and by adopting initiatives that, collectively, promote the compact city. This line of reasoning is also contained within the Department of the Environment's (1993) *Strategy for sustainable development*.

## The strength of urban decentralization in the UK

The idea of the compact city has, then, been given a considerable academic and practical consideration in many countries. The end result has been a remarkable and rapid academic and political adoption of the idea. However, throughout this debate, at least one fundamental question has not been posed: given the apparent power of the forces of urban decentralization can the idea be implemented?

This question has been addressed more fully in Breheny (1994a). It will suffice here to demonstrate that in the UK, at least, the process of urban decentralization remains very strong; sufficiently strong to cast doubt on the feasibility of seriously implementing tougher containment or compact-city policies. This brief review will cover first, the empirical evidence of decentralization; secondly, the explanation of continuing decentralization; and thirdly, the policy context in which decentralization is taking place.

Before demonstrating the strength of decentralization trends in the UK, it may be useful to clarify terms and concepts. The term 'decentralization' is used here to refer to all forms of population and industrial growth taking place away from existing urban centres. Such growth might arise from relocations or from indigenous change. For some years geographers have been disputing the nature of these changes. Some argue that growth has been occurring as a result of continuing suburbanization which is sometimes discontinuous - where

**Table IV. Population change, 1981-91, for OPCS urban types**

<i>Urban type</i>	<i>1981 population (000s)</i>	<i>1991 population (000s)</i>	<i>Change 81-91 (000s)</i>	<i>Percentage change</i>	<i>Natural change (000s)</i>	<i>Net migration (000s)</i>
Inner London	2550	2627	77	3.0	112	- 35
Outer London	4255	4263	8	0.0	130	- 122
Metropolitan Districts: Principal Cities	3550	3451	- 99	- 2.8	59	- 158
Metropolitan Districts: Others	7804	7716	- 88	- 1.1	155	- 243
Non-Metropolitan Districts: Cities	4578	4676	98	1.3	100	- 2
Industrial Districts	6710	6852	142	2.1	167	- 25
New Towns	2187	2382	195	8.9	116	79
Resort and Retirement	3369	3626	257	7.6	- 159	416
Mixed and Accessible Urban/Rural	9500	9964	464	4.9	236	228
Remote, Largely Rural	5131	5544	413	8.0	- 31	444
England and Wales	49 634	51 100	1466	3.0	885	582

Rounding errors in columns

Source: Office of Population Censuses and Surveys (1993, 1994); components-of-change data obtained directly from OPCS

development is hindered by green belts, for example. Others argue that the process has been one of 'counterurbanization'. This view suggests that growth has been focused, not on the periphery of existing urban areas but in the least urban areas. Thus, households and companies have been consciously relocating to small towns and villages in a distinct, anti-urban movement. These issues are important but the concern here is simply whether these processes are continuing and, if so, what are the prospects that they can be reversed?

#### *Evidence of continuing decentralization*

The decentralization of population in the UK may be most conveniently observed using the standard classification of urban areas adopted by the Office of Population Censuses and Surveys (OPCS). These urban types (shown in Table IV), derived from a cluster analysis, generally range from large urban areas to remote rural areas. Analysis of population change for each of these urban types since 1945 shows a consistent process of decentralization. Throughout all periods, the biggest losses have tended to be in traditional industrial areas: in London and in the other Metropolitan categories. The areas of highest population gain, however, move to successively smaller urban areas over the years. In all periods, the New Towns have seen substantial population growth, as have the Mixed and Accessible areas, both inside and outside the South East. Resort and Retirement and Remote,

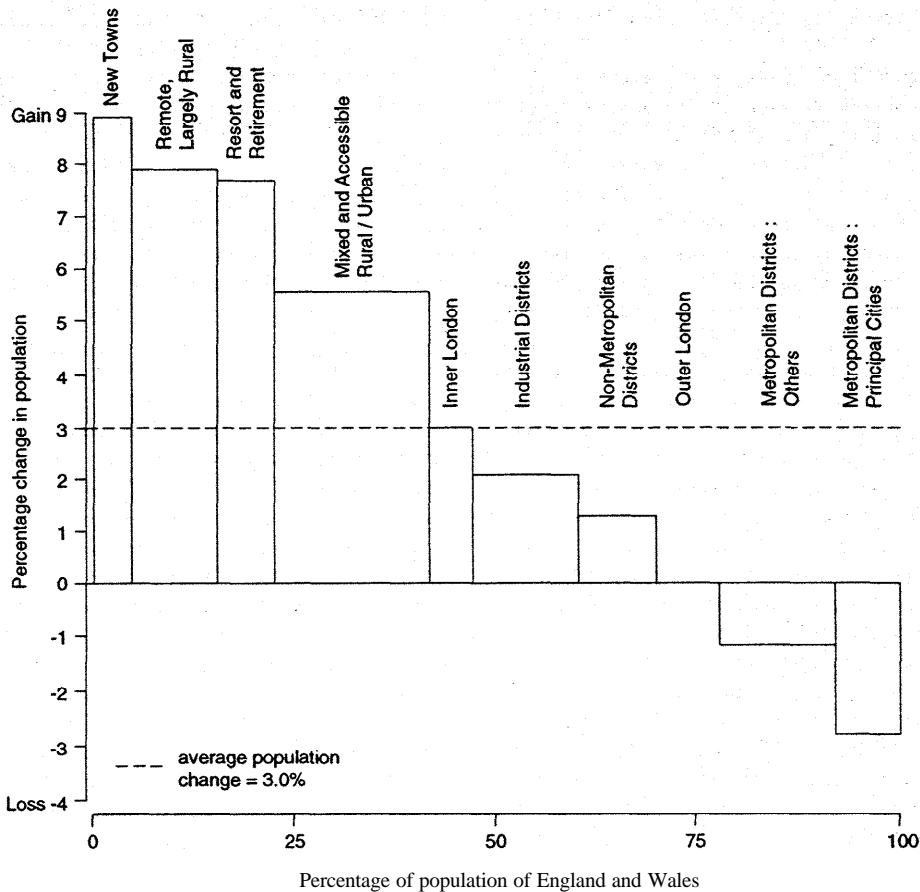
Largely Rural areas have gradually gained a larger share of net gains over the years. It is the large gains - both in absolute and percentage terms - in the Remote, Largely Rural category that led to the view that the changes are evidence of genuine 'counterurbanization' rather than simply suburbanization.

Table IV shows details of population change by the OPCS urban types for 1981-91. Some commentators (Champion 1987; Champion and Congdon 1988) had anticipated a 'return to the city' during the 1980s. However, the evidence clearly shows that the decentralization process has continued. As Townsend (1993, 217) has stated,

Any belief that the urban-rural shift was a passing phase of British economic geography is amply dispelled . . . The directions of net change of the 1960s and 1970s resumed fully in the 1980s with almost law-like regularity.

The losses are in the industrial cities, although these are much lower than in previous decades. Inner London does show a significant change in its fortunes. Substantial losses in previous periods have been converted to a 3 per cent gain in population. According to OPCS mid-year estimates of population (Office of Population Censuses and Surveys 1994), most of this gain appears to have occurred during the two years prior to 1991. The largest gains in Table IV are in the New Towns, Resort and Retirement, Mixed and Accessible and Remote,





**Figure 1. Population change, 1981-91, by OPCS urban types**

Source: calculated from Office of Population Censuses and Surveys (1994)

Largely Rural areas. Over a 10-year period, these four urban types gained nearly 1.4 million people, 1.2 million by migration. The components of population change in each type are interesting. In the Remote, Largely Rural category all of the net change resulted from migration. In the decade, nearly 0.5 million people migrated into this type of area. The Resort and Retirement areas also gained population largely from migration. In contrast, the rapidly growing Mixed and Accessible areas gained equally from natural increase and migration, perhaps reflecting a young age structure arising from previous rounds of work-related migration.

In considering the feasibility of stronger urban-containment policies, the nature of population change is important. Planners can have little prospect of influencing the geography of population

change where gains result largely from natural increase. However, where in-migration is the cause of population growth, then restrictions on housing and job increases, for example, might be used to constrain such movements. The Remote, Largely Rural areas, with large net in-migration, might be the most susceptible to constraint policies.

Figure 1 shows the percentage population change figures from Table IV in graphical form. This demonstrates very clearly the ongoing process of urban decentralization in England and Wales. At its extreme, the compact-city argument implies converting what is clearly a top-left to bottom-right trend into one that will in future run from top-tight to bottom-left. Viewed in this way, the task looks formidable.

### *Explanations for decentralization*

The aim here in reviewing urban decentralization in the UK is simply to demonstrate the strength of the trend - and hence the difficulty in reversing it - not to elaborate on explanations of the trend. Nevertheless, some mention of possible causes may be in order because some explanation of decentralization processes will help to determine the prospects for changing them. Cross (1991) proposes alternative explanations for what he calls 'counterurbanization'. He suggests five groups of theories, based on: longer-distance commuting; residential preference for non-metropolitan areas; economic change in favour of peripheral areas; employment decentralization; and integrated theories. He concludes that all of these explanations have some merits and hence that an integrated theory is probably appropriate. However, the dominant causes of counterurbanization within an integrated theory are likely to be residential preferences and economic changes which favour decentralized locations.

The most promising explanations, according to Cross (1991), relate to the role of employment decentralization. It is suggested that the forces determining the way that capital uses space, and hence the resultant economic geography, have shifted dramatically in the postwar years. Arguably, two specific shifts have taken place. The first was the move from regional sectoral specialization, in which regions specialized in a particular industrial sector and held all of the operations of companies involved in that sector. This, it is argued, has changed, such that there is often a spatial separation of those operations into clear spatial divisions of labour. This newer geography of economic activity tends to separate core functions of a company - administration, R & D, marketing - from routine production. The former, core functions have tended to locate in major cities and in decentralized but accessible locations. Production has tended to focus away from traditional urban locations to cheaper peripheral locations, aided also by demands for new industrial property at lower densities (Fothergill and Gudgin 1982). Similar trends are also discernible in the service sector, with the splitting of small, centralized functions from large-scale 'back offices' in decentralized locations.

The second shift suggests that the spatial division of labour explanation of changing industrial geography may now itself be inadequate, as the hierarchical divisions of labour developed in the postwar

period break down. The new imperative, it is argued, is flexibility. Theories, under the label of 'flexible accumulation', suggest that pressures to compete on the basis of production flexibility (including 'just-in-time' production) mean that companies will tend to locate functions together that were previously separated. Thus, new concentrations of economic activity are being established. These are not located in the former industrial areas but in new 'clean' locations, such as the fringes of the South East region - which tend to equate to the Mixed and Accessible Rural urban type discussed earlier - that have witnessed substantial population increase in recent years. The preference of companies for these types of locations has been confirmed in survey work by Prism Research (1991). Fielding (1991), in a study of migration to and from the South East of England, has attempted to relate population movements to the changing locational preferences of industrialists.

Simple observations of employment change in England and Wales are consistent with these theories. Table V demonstrates a clear pattern of job losses in the older, industrial cities and substantial gains in small town and rural locations. This table is a direct equivalent of Table IV, showing job change rather than population change. The trend in job change is more marked than that of population change: percentage losses in the larger cities and gains in rural areas are higher in the case of jobs.

The consequences of these various pressures for industrial and population changes have been continued decline in the older industrial cities - albeit at a slower rate in recent years - and further substantial growth in decentralized small town and rural areas. In the recent past, then, urban decentralization in the UK has continued. For the containment debate, the important question is whether it is likely to continue. What are the prospects that the process will slow down? What are the prospects for slowing or reversing the trend through planning or other policies? There is some evidence that in the future the pressures for decentralization will lessen. For example, the national growth in the service sectors that fuelled some decentralization in the 1980s has disappeared. However, many of the forces determining the nature and scale of decentralization are deep-rooted. There is no evidence that the problems of the older, industrial cities - the 'push' factor - are being resolved. Indeed, some would argue that in many cases they

**Table V. Employment change by OPCS urban areas, 1981-91**

<i>Urban type</i>	<i>1981 jobs</i>	<i>1991 jobs</i>	<i>Change 1981-91</i>	<i>Percentage change 1981-91</i>
Inner London	2 021 290	1 824 807	- 196 483	- 9.72
Outer London	1 536 631	1 430 073	- 106 558	- 6.93
Metropolitan Districts: Principal Cities	2 131 209	1 940 272	- 190 937	- 8.96
Metropolitan Districts: Others	3 028 483	2 910 590	- 117 893	- 3.89
Non-Metropolitan Districts: Cities	2 821 868	2 859 375	37 507	1.33
Industrial Districts	2 628 043	2 629 003	960	0.00
New Towns	1 035 600	1 152 656	117 056	11.30
Resort and Retirement	1 063 430	1 166 419	102 989	9.68
Mixed and Accessible Urban/Rural	3 226 375	3 607 930	381 555	11.82
Remote, Largely Rural	1 806 631	2 047 332	240 701	13.32
England and Wales	21 299 560	21 568 457	268 897	1.26

Employees in employment

Source: NOMIS

are getting worse (Robson 1994). There is nothing to suggest that the basic desire of industrialists for 'clean' - in terms, for example, of new sites, compliant labour and uncongested infrastructure - decentralized locations is any less now than in the past. The recession has reduced the scale of change but not the general geographical thrust. The Prism Research (1991, 131) study of company moves in the South East concluded:

Of course, the future is uncertain, but there is nothing in recent data to suggest that this underlying cycle will not be repeated some years hence . . . a new cycle of business growth, with sufficient strength to catch up on ground lost in the recent recession, is likely to continue to push economic activity out of London and over the South East Regional boundary, in Western and Northern directions.

An interesting, but neglected, question in the decentralization debate is the degree to which the established patterns reflect community choice, and hence the degree to which containment policies would thwart that choice. Clearly, what may appear to be freedom of choice is restricted or directed by government or private agencies. For example, government housing subsidies and transport policy, and housebuilders' land-purchase policies have a considerable effect on changing urban structure. However, in turn, both parties would argue that these policies reflect consumer choice. Given this conundrum, the assumption here is that much, if not all, of urban decentralization can be explained by householders and businesses 'voting with their feet'.

The evidence suggests that they will continue to do so.

#### *The policy context for decentralization*

When contemplating the scale of past and future change, it must be remembered that the prevailing planning context has been and will remain one of urban containment. A basic tenet of the British planning system over the past 50 years or more has been the restriction of urban encroachment into the countryside. The scale of decentralization shown in Tables IV and V occurred in a period when political and popular support for urban containment was probably stronger than at any time in the UK. Although it has been tempered to some degree by the pro-market philosophy of governments since 1979, the prevailing ethos has been one of environmental protection. Through the 1970s and 1980s approximately 50 per cent of all new housing was built within existing urban areas (Breheny *et al.* 1993). The compact-city policy would obviously seek to increase this surprisingly high figure still further. However, some commentators suggest that it will be difficult to maintain the 50 per cent figure in the future. For example, Grigson, reporting on work for SERPLAN (1988), suggests that with the redevelopment of the best urban sites and new worries over 'town cramming', a figure of 40 per cent might be more realistic in future. Recent concerns over the contamination of urban sites might also decrease the prospects for urban redevelopment.

Breheny *et al.* (1993) have estimated that, even assuming a 50 per cent figure for urban infill, the South East of England will see some 300-400 000 houses being built on green-field sites over the 20 years from 1991. These could, of course, be built as suburbs to the largest cities and towns but the likelihood is that market demands will dictate that they be built in locations further down the urban hierarchy.

This brief review - of empirical evidence, theoretical explanations and the policy context - suggests that in the UK at least, urban decentralization remains a powerful force. The prospects are that it will continue. The implications of this evidence are either that the policies currently being promoted will have little effect in reducing decentralization, or that much more draconian policies, with very serious social and economic ramifications, will be required.

### Urban decentralization and transport energy consumption

The logic of this paper has implied that the evidence in favour of urban compaction is likely to be valid but that the major policy required to bring it about - a reversal of urban decentralization trends - will be difficult or impossible to implement. This latter finding, alone is important, given the strength of support for the compact-city idea and the neglect hitherto of the question of feasibility. However, the evidence reviewed in arriving at this finding allows some analysis that questions the very validity of the basic arguments in favour of the compact city. The questions posed at the beginning of this paper suggest that the evidence presented earlier on the energy efficiency of the compact city, and generally assumed to be valid, is suspect. To what degree has urban decentralization - apparently the villain of the piece - actually increased overall energy consumption from transport? Most of the evidence reviewed earlier concludes that it does increase transport energy consumption but it does not explain the size of the increase, nor whether it is significant.

Sharpe (1982) is a rare sceptic on this issue, suggesting that a tripling of the density of Melbourne would yield only an 11 per cent transport energy saving. Newman and Kenworthy (1989b, 28) take a more familiar line. They have suggested that

... there is a potential fuel saving of some 20 to 30 percent in cities like Houston and Phoenix, if they

**Table VI. A matching of OPCS urban types and ECOTEC's urban-size categories**

<i>OPCS urban types</i>	<i>ECOTEC size categories</i>
Inner London	Inner London
Outer London	Outer London
Metropolitan Districts: Principal Cities	Metropolitan Areas
Metropolitan Districts: Others	Other Urban over 250 000
Non-Metropolitan Districts: Cities	100 000-250 000
Industrial Districts	50 000-100 000
New Towns	25 000-50 000
Resort and Retirement	25 000-50 000
Mixed and Accessible Urban/Rural	3000-25 000
Remote, Largely Rural	Rural <3000

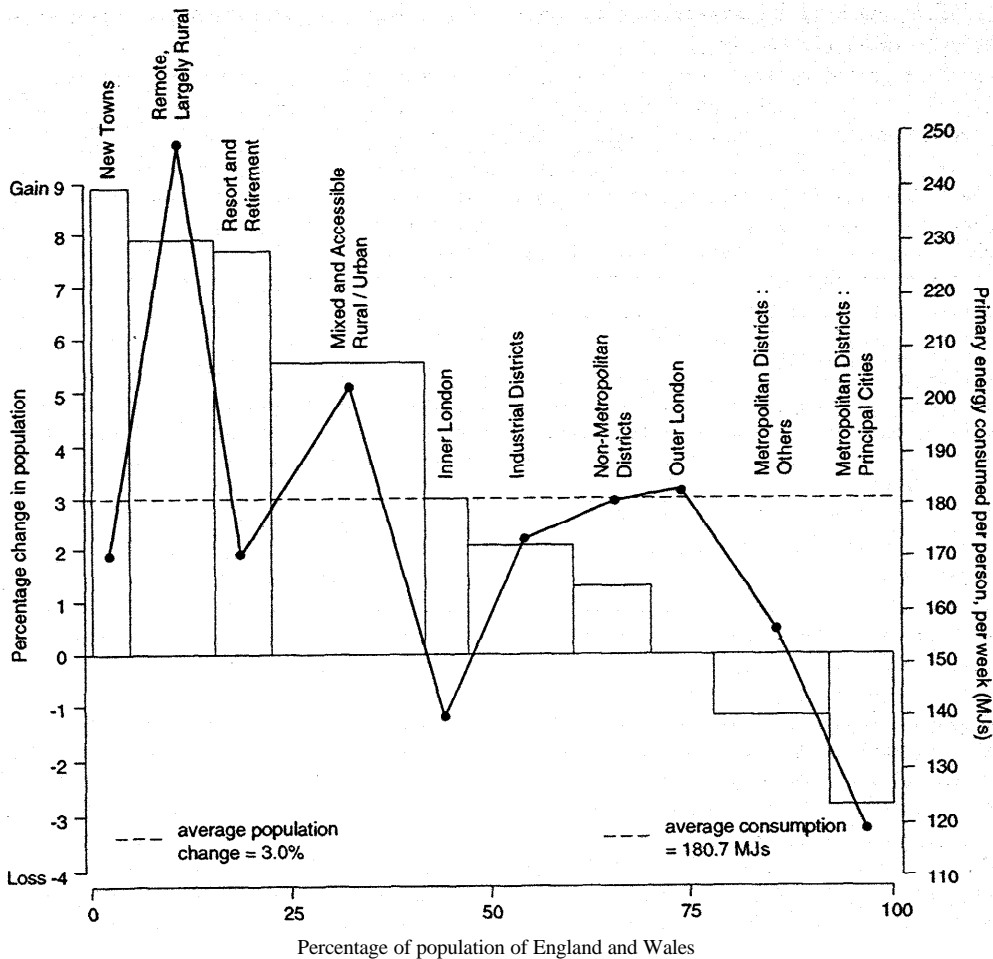
were to become something more like Boston or Washington, in urban structure . . . With more extreme changes in land use, such as increasing the density of population and jobs to the level of inner areas of New York, much higher fuel savings would seem likely.

Nothing is said about the strength of policies that would be required to bring such changes about.

#### *Deriving consumption rates for urban types*

An attempt to answer questions about the energy-consumption effects of urban decentralization can be made by putting together the information on population decentralization and energy consumption presented above. Unfortunately, the two sets of information are not directly comparable because that on decentralization is presented by OPCS urban types, and that on energy consumption is available from ECOTEC (1993) by urban size bands. It is possible, however, to arrive at a reasonable cross-matching of these two sets of categories. OPCS do provide some guidelines on the size of average settlements within each urban type, allowing a matching of urban size bands. Breheny (1994a) suggests the matching shown in Table VI. A finer matching might be facilitated by 1991 Census data for urban areas not available at the time of writing. These provide Census information for settlements, rather than administrative areas.

The matching in Table VI allows an assessment of the degree to which people are leaving areas of low energy consumption and moving to areas of high consumption, as the conventional wisdom suggests is the case. Figure 2 plots 1991 energy-consumption rates, taken from Table III, over levels



**Figure 2. Population change, 1981-91, and transport energy-consumption rates for OPCS urban types**

of population change for each OPCS urban type, taken from Figure 1. It can be seen that there is a general correlation. Areas of population loss - the major metropolitan areas - do have lower consumption rates, and areas of population gain - largely the more rural areas - have higher rates. Despite some interesting exceptions such as New Towns and Resort and Retirement areas, decentralization moves are generally to high energy-consuming areas. The most interesting of the urban categories are the Mixed and Accessible and Remote, Largely Rural areas. These have been the major recipients of decentralization and have the highest energy-consumption rates, suggesting they are playing a major role in increased transport energy consumption.

This simple assessment suggests, then, that decentralization is exacerbating energy consumption from transport. This finding is consistent with most previous research assumptions and with what is now becoming a conventional policy stance. It suggests that tighter urban containment, or the compact-city solution, is an appropriate means of reducing energy consumption. What this simple assessment does not reveal, however, is the scale of the problem. By how much has decentralization increased energy consumption? And is the additional energy consumption significant? Does it warrant the draconian measures that would be required to reverse the deep-rooted process of decentralization from our cities?

**Table VII. Estimate of the transport energy saving if all urban types had the same consumption rate as the most efficient type, 1991**

<i>Urban type</i>	<i>1. 1991 population (000s)</i>	<i>2. Energy consumption rate (MJ's per person per week)</i>	<i>3. 1991 total energy consumption (GJs person per week)</i>	<i>4. Lowest energy consumption rate (MJ's per person per week)</i>	<i>5. Energy consumption using lowest rate (GJs per week)</i>	<i>6. Difference between actual and lowest consumption levels (GJs per week)</i>	<i>7. Percentage difference between actual and lowest consumption levels</i>
Inner London	2627	140.4	368 831	119.1	312 876	- 55 955	- 15.2
Outer London	4263	182.5	777 998	119.1	507 723	- 270 275	- 34.7
Metropolitan Districts: Principal Cities	3451	119.1	411 014	119.1	411 014	—	—
Metropolitan Districts: Others	7716	156.9	1 210 640	119.1	918 976	- 291 664	- 24.1
Non-Metropolitan Districts: Cities	4676	180.6	844 486	119.1	556 912	- 287 574	- 34.1
Industrial Districts	6852	173.1	1 186 081	119.1	816 073	- 370 008	- 31.2
New Towns	2382	170.8	406 846	119.1	283 696	- 123 150	- 30.3
Resort and Retirement	3626	170.8	619 321	119.1	431 856	- 187 878	- 30.3
Mixed and Accessible Urban/Rural	9964	203.4	2 026 678	119.1	1 186 712	- 839 966	- 41.4
Remote, Largely Rural	5544	248.0	1 374 912	119.1	660 290	- 714 622	- 52.0
England and Wales	51 100	180.7	9 226 807	—	6 086 128	- 3 140 679	- 34.0

1 GJ=1000 MJ's; rounding errors in columns; column 2 total calculated from column 1 and 3 totals

Two rough estimates of the scale of the additional consumption that arises from decentralized urban structures can be made. Using information presented above, it is possible to calculate the degree to which:

- (i) absolute differences in energy consumption between different urban types affect overall energy consumption. This can be measured as the difference between actual overall consumption and that which arises if all areas had consumption rates as low as the most efficient urban type. This 'lowest rate' approach might demonstrate the savings that would arise from the extreme policy stance of re-urbanization; and
- (ii) marginal changes in decentralization - over, say, a given number of years - affect overall energy consumption. This 'marginal change' approach might demonstrate the benefits of the less extreme - but still radical - case of halting further decentralization for a given period.

*The 'lowest rate' approach and additional energy consumption*

Table VII shows the reduction in energy consumption that would arise if all urban types had the same per capita rate as the area with lowest rate: the 'Principal Cities' of the metropolitan districts, with a

rate of 119.1 MJ's per person per week. Columns 6 and 7 show the degree to which total energy consumption would be lower in all urban types (with the obvious exception of Principal Cities) if the lowest consumption rate applied. Summing column 6 gives the total national saving that would arise from this lower consumption rate. The overall effect would be to reduce consumption by 34 per cent. This implies, then, that if it were possible to redesign the UK's urban structure to have the consumption characteristics of Principal Cities - higher densities, high public-transport provision, lower average journey lengths, trip mix, etc. - the transport energy saving would be in the region of one-third.

The adoption of the lowest consumption rate for this analysis does not mean, of course, that in principle still lower levels could not be achieved. There is no reason to assume that, with more careful land-use planning and better provision of public transport, the average consumption rate for Principal Cities should not be lower than at present. Thus, again in principle, all settlement types could also achieve a consumption rate below the 119.1 MJ's per person per week. In practice, however, the effort required to bring all urban types to something like the rate for Principal Cities would be enormous. It would require a long-term commitment to reverse

decentralization trends; it would need drastic action in areas such as Outer London where consumption rates appear to be very high; it would mean, in effect, the abandonment of many smaller rural settlements; and many other restraints that would doubtless be deeply unpopular with businesses and households alike. In reality, of course, it would be impossible to restructure settlement patterns in such a way as to give all urban types the characteristics of the most energy-efficient areas. Even if it were politically acceptable, it would take generations to achieve through land-use change.

Given that any initiatives to achieve greater urban containment will fall well short of the savings that, in principle, could be gained by this 'lowest rate' approach, the question arises as to whether the realistic gains are sufficient to warrant the effort. If the 'lowest rate' approach would give gains of 34 per cent, it is likely that any more realistic interventions - of, for example, the kinds being proposed by the advocates of the compact city - would yield gains well below this. A 10 per cent saving would require an average consumption rate of approximately 160 MJ's per person per week; a 15 per cent saving would require an average rate of about 150 MJ's per person per week - a rate a little lower than that prevailing in the Metropolitan Districts: Others category.

Would advocates of the compact city be so forceful if they knew that the likely gains from their proposals might be a modest 10 or 15 per cent energy saving achieved only after many years, and unprecedentedly tough policies? Although proponents of the compact city have not generally specified expected levels of energy saving, it is to be assumed that they have in mind levels considerably higher than this.

This analysis is, of course, static. It does not take into account future increases in car ownership and overall travel levels. Even if trend forecasts of a doubling of cars in the UK over the next 20 years can be reduced by government policies, the likelihood nevertheless remains that the kind of transport energy savings resulting from greater urban containment will be swamped by increased levels of travel.

#### *The 'marginal rate' approach and additional energy consumption*

A second attempt can be made to measure likely savings in transport energy consumption from urban-containment policies. Here the aim is to look

at the additional consumption of energy that arises from marginal changes in urban decentralization. Realistically, containment policy, even if applied much more forcefully than in the past, is likely to make marginal changes to urban forms rather than restructure them entirely. Thus, estimates of the additional energy consumption arising from past marginal change may give a reasonable clue as to possible future savings if decentralization is halted or slowed. Specifically, the question posed is: if no urban decentralization had taken place over the past 30 years, what would have been the transport energy saving? This might give a crude guide as to the effect that a tough - no further decentralization - policy might have over the next 30 years.

The chosen period for analysis is 1961-91. Decentralization has occurred in the UK throughout this period. Estimates have been made above of energy consumption in each OPCS area type at 1991. Estimates can be made of the equivalent energy-consumption levels on the assumption that no decentralization occurred over the 1961-91 period. The difference between the two should then represent the urban energy consumption that has occurred because of decentralization. The 1991 'non-decentralization' population is calculated by allowing the 1961 population in each urban type to grow by the national growth rate (+ 10.8 per cent) from 1961 to 1991. This, in effect, gives a rough estimate (neglecting differential natural increases, etc.) of the 1991 population in each urban type as if no population movement had taken place over the previous 30 years. Calculations are shown in Table VIII. The important figures in Table VIII are given in columns 6 and 7. Column 6 shows the absolute energy saving or loss in each urban type if decentralization had not taken place. Thus, the larger cities show positive figures, reflecting higher overall energy consumption without decentralization whilst the more rural areas show negative figures, reflecting lower energy consumption without the population gains from decentralization, Column 7 gives the appropriate percentage changes. The total in column 6 demonstrates that 234 899 GJ's (1 GJ= 1000 MJ's) of energy are consumed per week in transport in England and Wales because of the decentralization of population over the last 30 years. This suggests that the decentralization changes over this period now mean that weekly transport energy consumption is about 2.5 per cent higher than it would be had those changes not taken place. It also implies that any policy of urban

**Table VIII. Estimates of fuel consumption arising from decentralization changes, 1961-91, by urban types**

Urban type	2. Energy consumption rate		4. 1991 'non-decentralized' population since 1961		5. 1991 total energy consumption from 'non-decentralized' population		7. Percentage difference between columns 3 and 5
	1. 1991 population (000s)	(MJ's per person per week)	3. 1991 total energy consumption (GJ's per week)	(000s)*	6. Difference between columns 3 and 5 (GJ's per week)	6. Difference between columns 3 and 5	
Inner London	2627	140.4	368 831	3869	543 348	174 517	47.3
Outer London	4263	182.5	777 998	4986	909 945	131 947	17.0
Metropolitan Districts: Principal Cities	3451	119.1	411 014	4680	557 388	146 374	35.6
Metropolitan Districts: Others	7716	156.9	1 210 640	8307	1 303 368	92 728	7.6
Non-Metropolitan Districts: Cities	4676	180.6	844 486	5159	931 715	87 229	10.3
Industrial Districts	6852	173.1	1 186 081	6659	1 152 673	- 33 408	- 2.8
New Towns	2382	170.8	406 846	1719	293 605	- 113 241	- 27.8
Resort and Retirement	3626	170.8	619 321	3139	536 141	- 83 180	- 13.4
Mixed and Accessible Urban/Rural	9964	203.4	2 026 678	7879	1 602 589	- 424 089	- 20.9
Remote, Largely Rural	5544	248.0	1 374 912	4682	1 161 136	- 213 776	- 15.5
England and Wales	51 100	—	9 226 807	51 100	8 991 900	- 234 899	- 2.5

1 GJ=1000 MJ's; rounding errors in columns

\*1961 population multiplied by national population change (+ 10.8 per cent) for 1961-91, i.e. an estimate of the population had there been no decentralization

containment implemented now for, say, the next 30 years, would - assuming that other policy devices, such as fiscal measures, remain the same - also yield transport energy savings of this kind of magnitude.

This result is quite remarkable. Across the world, international, national and local agencies are wedded to the notion that prevention of urban decentralization will make the major contribution to the reduction of energy consumption from transport. These agencies are willing to introduce the draconian measures necessary to bring this about, with all that implies in terms of social and economic change, without any serious knowledge of whether the desired result will ensue. The evidence presented here suggests that over the last 30 years decentralization has made a trivial contribution to additional energy consumption, implying that efforts to prevent further decentralization - if successful, which is doubtful - will also be trivial in their effect.

It is possible that policies currently being proposed in addition to containment - such as high densities at transport nodes and mixed-use developments - will make cities more transport energy efficient than they have been over the last 30 years. The potential savings from such schemes is unknown. However, the assumption at the moment

is that such policies are expected to yield marginal savings relative to the more fundamental policy of containment, which we now see would itself deliver only trivial benefits.

One way of putting this 2.5 per cent finding in perspective is to consider other policy measures that might produce similar levels of transport energy saving. These alternatives have tended to be relegated in the urban-sustainability debate in favour of planning-led containment policies. Three obvious options are changes in vehicle technology, changes in driver behaviour and fiscal measures. Bae (1993) reviews these options alongside land-use possibilities, assessing the merits of all approaches, both in principle and in the specific case of reducing air pollution in southern California. She suggests that all approaches have merits but concludes that

The automobile emissions problem is much more amenable to technological solutions . . . than to remedies that rely on transportation planning and policies based on radical changes in travel behavior. (1993, 73)

Even assuming continued reliance on petroleum, it is possible to envisage governments promoting yet further technological improvements in vehicle fuel consumption and in other 'tailpipe solutions', as the Americans call them. The range of measures aimed



The compact city and transport energy consumption

at affecting travel behaviour, discussed but then rejected by Bae, such as vehicle sharing and flexible working hours, have hardly been discussed in the UK, let alone implemented. Technological and behavioural measures, then, might yield modest fuel and emissions savings relatively easily. Certainly 2-3 per cent savings by these means do not seem unreasonable. They might also take effect relatively quickly.

Fiscal measures may also yield similar savings relatively easily. The apparent confidence of the advocates of the 'compact city that planned urban containment will reap substantial energy savings has had the effect of taking attention away from the possible use of fiscal measures, particularly petroleum tax, to achieve such savings. Having said this, it should be pointed out that some advocates of compaction policies (e.g., Owens 1991, 1992) have argued that policies will not work unless the propensity to travel is also reduced, by fiscal or other measures. But the general assumption has been that because of the high price inelasticity of demand for petroleum, fiscal devices for reducing energy consumption are politically unacceptable. However, there is evidence that these elasticities are not so extreme as to make the idea redundant- Bae (1993) suggests that the price elasticity of demand-for-work autotrips is between - 0.3 and - 0.6, suggesting that a 10 per cent increase in the price of petroleum would reduce demand by 3-6 per cent. MuConsult (1992) have found that in The Netherlands, a 10 per cent price increase reduces car-kilometres by a little less than 2 per cent. Again, if we are looking for savings equivalent to the 2.5 per cent discussed above, it seems that they could be found by relatively modest fuel price increases. Furthermore, it could be achieved virtually overnight, compared with the 30-year time period considered above or the generally long time horizons required to induce change through the planning system.

Viewed in the context of these alternatives, the use of urban-containment policies to achieve transport energy savings does not seem to be a very fruitful route to take.

### *Improving the analysis*

Presentation of earlier versions of this paper at seminars generally elicited three responses. First, there was indignant surprise at the apparently small scale of potential energy savings, reflecting the general assumption that urban containment is a

good thing. Secondly, some respondents felt convinced that if only the paper covered chapter and verse on all aspects of cities and sustainability, then the case for compaction would remain unblemished. The reply to this had to be repeated then and may warrant repetition now. This analysis has been deliberately narrow and isolated, with the intention of getting to grips with one specific issue rather than continuing to flounder in complexity. It must be stressed that there are other environmental - as well as economic, social and cultural - motives in pressing for urban-containment policies, albeit themselves controversial. Obvious examples are the prevention of losses of open land and destruction of habitats. Limiting further decentralization might help to ameliorate these problems. However, by far the strongest motivation for the compact-city protagonists has been the prospects of substantially reduced transport energy consumption. If the analysis presented above gives anything near to a reasonable estimate of the additional energy consumption arising from decentralization, then this motivation may be grossly misplaced.

The third response was to argue that if only the analysis presented here had taken account of various detailed factors, the results would be very different. This criticism is the most direct and hence deserves some further consideration. As explained at the outset, the approach adopted here has been consciously generalized and aggregate. However, it is possible to conceive of improvements to the analysis in principle. In practice, they would prove very difficult to implement. Nevertheless, there is merit in rehearsing what form such improvements might take and, importantly, assessing the degree to which they might change - and in what direction - the results obtained above. Would improvements give greater negative percentage figures, thus implying that decentralization has had a greater effect on transport energy consumption than suggested here? Or would improvements lower the figures, suggesting that the estimates made here overstate the energy-consuming effects of decentralization? Or would improvements have no clear effect on the analysis? A set of possible, but by no means exhaustive, improvements will be discussed briefly and an indication given of their likely effect on the results of the 'lowest rate' and 'marginal' analyses presented above.

*Taking account of social structure:* This additional analysis concerns the question of the degree to

which different rates of travel in urban types is solely a function of accessibility. It is possible that social structure will also be a determinant of relative travel rates. If, on average, higher social groups are well represented in small town and remoter areas, their higher incomes, higher car ownership and specific lifestyles are likely to increase average rates of travel in those areas. Controlling for social structure would thus reduce the differences in energy-consumption rates between urban and rural areas, Decentralization to rural areas would thus have a lower overall effect on consumption than in the analysis presented above.

*Inclusion of short trips in the analysis:* The ECOTEC (1993) data upon which the above analysis is based omit short trips of less than 1.6 km. It can be assumed that many of these trips would be by foot or bicycle. The effect of including such trips in the ECOTEC data would be to increase the length of total trips per person per week. This would be the case most especially in larger cities and towns. Thus, the gap between the shortest and longest total trip lengths in Table I would be narrower. However, this would have no effect on relative energy consumption between urban types as walking/cycling trips have a zero consumption rate as shown in Table III. The shorter distances travelled in larger cities and towns reflects, to some extent, the greater opportunities for walking and cycling journeys.

*Assuming differential population growth in urban and rural areas:* It might be argued that the assumption adopted in the 'marginal' analysis above of a constant 10.8 per cent population growth in all urban types from 1961 to 1991 is unrealistic. It might, therefore, be more reasonable to adopt natural increase rates appropriate to each urban type (they do differ considerably, as Table IV has shown), so generating a lower population growth in urban areas than the 10.8 per cent and a higher rate in more rural areas; an 'unstoppable decentralization' effect. With regard to the 'marginal analysis, this would have the effect of less energy consumption in urban areas and more in rural areas over the 30 year period. However, as Table IV shows, there is no obvious pattern in rates of natural increase, at least during the 1981-91 period. It is not obvious that such changes would tend to increase or decrease the - 2.5 per cent figure.

*Changing consumption rates for urban types:* The current levels of transport energy consumption in urban types relative to 30 years ago is a function of both changing population movements - decentralization - and changing rates of consumption in each type. Ideally, the effects of each of these changes on consumption would be separated out. Thus, the 'pure' decentralization effects would be available. Unfortunately, consumption rates for 1961 are not available and hence the effects cannot be separated. In reality, of course, it would be difficult to separate the two because they are interrelated. Decentralization is likely to have changed the relative consumption rates of urban types by, for example, changing their social composition.

Although it is not possible to account for a different set of consumption rates in 1961, it is possible to speculate about the implications of such rates having been different from those in 1991. In particular, it is possible to consider the effects if the variation in the 1961 rates between the most efficient and most profligate urban types had been greater or less than the variation at 1991. For the purposes of considering this question, it is assumed that the relative profile across urban types would have been similar in 1961 to that in 1991; that is, large urban areas had the lowest per capita rates and remoter rural areas had the highest rates. The question is whether the variation between the extremes would have been greater or lesser.

If the 1961 rates had shown a lesser variation, then a larger proportion of the overall change in consumption from 1961 to 1991 would have been due to changes in rates rather than decentralization. Thus, the percentage figures calculated here overstate the case. In other words, if the 1961 rates had been used in this analysis, they would have given a lower percentage result, indicating yet lower levels of additional consumption arising from decentralization. The opposite case, then, also applies. If the 1961 rates had shown a greater range than the 1991 rates, then the implication is that the analysis here understates the extra energy consumption that has arisen because of urban decentralization.

The logic is clear but is it likely that 1961 consumption rates would have shown more or less variation than 1991 rates? Some possible reasons why the 1961 rates would have shown more variation are as follows:

- The social structure of decentralizing households, as mentioned above, is such as to increase travel in remoter areas. It is the case that many

migrants to remoter rural areas are more affluent, and hence travel more, than the indigenous population of those areas. Decentralization is thus likely to have increased per capita travel rates in remoter areas. Thus, energy consumption rates in 1991 are likely to be higher - relative to other urban types - than they would have been in 1961.

- Urban decentralization has encouraged government to upgrade and build new roads in decentralized locations, thus facilitating more travel in such areas. There is little doubt that this has been the case over the last 30 years. Rural and semi-rural areas have been the recipients of major road investment. If the same road pattern existed now as 30 years ago, presumably people in rural areas would now travel less (and, of course, some of them might not have migrated).

Effects that imply less variation in consumption rates in 1991 relative to 1961 include:

- The decentralization of some work and service facilities has increased the average mileage of urban residents. Urban rates might thus have been relatively low in 1961, suggesting wider variation in rates at that time.
- Car ownership rates, although lower overall in 1961, are likely to have shown a greater urban/rural variation in 1961 than in 1991, with considerably higher rates of ownership in rural areas because of the necessity of private travel.

If these additional factors were built into the quantitative analysis of the lowest rate' and 'marginal' cases presented here, it is not obvious that they would have any significant effect on the results. Indeed, the minor variations on the results that each would give might well cancel each other out, leaving the results more or less intact. This suggests that the crude analysis presented here may also be a robust analysis.

## Conclusion

This paper has examined the remarkable political consensus in a number of countries in favour of urban-containment policies - the compact city - as a way of reducing transport energy consumption and hence of contributing to the achievement of sustainable development. Some of the academic evidence to support this view has been reviewed. The general drift of this evidence supports the policy stance. The implications of this policy

approach are profound. Major changes in the form and function of cities, towns and villages are implied. Inevitably such changes will have significant social and economic consequences. Given that many people and businesses have consciously chosen decentralized environments - creating the very problem now being confronted - these consequences will be unpopular. In order for these consequences to be acceptable, containment policies with need to be demonstrably successful in reducing transport energy consumption.

Politicians, it seems, are expecting great things from the compact city. But what are their expectations? What have they been led to expect by the academics? The answer seems to be that there are no explicit expectations. Certainly only very rarely have academics promised levels of energy saving or reductions in emissions. But the implicit assumption of both politicians and academics must be that-the benefits are significant. Otherwise, why would radical policies - and in the context of all that has gone before, they are very radical - be so fashionable in so many places?

It has been suggested here that, despite considerable attention, the compact-city debate has failed to address two fundamental questions: can urban decentralization be halted or significantly slowed? And, more importantly, does urban decentralization really increase transport energy consumption to the degree that is supposed? The first question has been dealt with only briefly here, having received fuller attention elsewhere (Breheny 1994a). The conclusion, however, is that decentralization remains a powerful force, at least in the UK, and may be difficult to contain beyond existing levels of restraint. The second question - the major focus of the paper - has been-considered through a crude, but probably robust, empirical analysis. This suggests that energy savings from urban containment are likely to be disappointingly low. Indeed, even modest savings could only be achieved through draconian policies of containment. Given the implicit expectations of politicians about the benefits of containment, realistic savings from this approach are likely to be trivial.

It has been suggested that the levels of energy savings likely to result from even quite tough compact-city proposals could be achieved in other, much simpler and relatively immediate ways. The promotion of improved vehicle technology and the raising of fuel costs have been suggested as two such ways.

This paper is not intended as the last word on the merits of urban containment as a device for reducing energy consumption. It is intended to raise doubts about the validity of a political and academic movement that has now gained considerable momentum. There are, of course, environmental benefits of containment, other than energy efficiency. Indeed, there may be much broader economic, social and cultural benefits. These are important and need to be included in the debate. Nevertheless, the focus of the environmental debate has been on energy consumption, and it is on this fundamental issue that the proponents of the compact city must demonstrate - rather than simply assert - its merits. The statement was made earlier that, given the radical and probably unpopular nature of the containment policies now being proposed, 'they had better be worth it'. The evidence presented here suggests that they will not be.

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### Notes

1. Newman and Kenworthy (1989a); Breheny (1992a and b); McLaren (1992).
2. See, for example Gordon and Richardson (1989); Breheny (1992a); Blowers (1993).

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