Reducing UK residential carbon emissions by 60%

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Abstract
The Royal Commission on Environmental Pollution (RCEP) has identified that the UK needs to reduce its carbon dioxide emissions by 60% by 2050 if it is to play its part in preventing catastrophic climate change and to go down the road of sustainable development. This paper will summarise a UK government funded project, "The 40% house", which aims to identify the main policy implications for the domestic sector if the challenging reduction in carbon dioxide emissions is to be achieved by 2050.

The study considers both reduced demand and household-level new and renewable energy supply technologies. The assessment will be in terms of total energy consumption and power demand levels. The first task is to establish likely levels of consumption, as a result of trends in household numbers, equipment ownership, effects of climate change (on heating and cooling) and known policies. The potential for reductions will incorporate changed levels of building and demolition in the housing stock, decision trees on technology choices to avoid incompatibility, new Building Regulation standards, more efficient appliances and so forth. Consumer attitudes to, and choices from, lower carbon options will be investigated through focus groups, together with the impact of in-house energy supply (pv, micro-chp, etc). The main policy avenues will be identified partly through backcasting from the RCEP scenarios, as well as forecasting from the housing and domestic energy and carbon stock model. The project takes a broad, but thorough overview in order to identify the main issues for immediate action and more detailed analysis to enable faster progress towards the 40% house.

Context

In 2000, the Royal Commission on Environmental Pollution produced a report *Energy – the changing climate* that recommended:

The government should now adopt a strategy which puts the UK on a path to reducing carbon dioxide emissions by some 60% from current levels by about 2050 (RCEP 2000, p199).

This was a revolutionary proposal and much of the subsequent debate on energy policy within the UK has been focused on the implications of this suggestion. The government's White Paper on Energy Policy (2003) has given a strong endorsement of this objective with the aim of making a 60% reduction in carbon emissions by 2050 official European policy.

The RCEP identified four scenarios for the way in which the 60% reduction could be achieved, using varying proportions of energy conservation, renewable energy and nuclear power (or fossil fuel with carbon dioxide recovery). In all cases, the level of fossil fuel consumption stays the same, at 40% of present levels, mainly for transport (Table 1). The demand reductions are in comparison with 1998; in reality there would have been a 30% increase, so even to keep demand level, as in scenario 1, represents a substantial effort. Obviously, the greater the amount of energy conservation, the less the amount of new supply. Equally, if there is a desire to avoid new nuclear construction then there must be more effort put into renewable supply and energy conserva-

Table 1: Four scenarios for 2050.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Demand (%) – reduction from 1998 final consumption	0	36	36	47
Supply (GW) – fossil fuels	106	106	106	106
- renewables	53	45	25	20
- baseload stations (either nuclear or fossil fuel with carbon dioxide recovery)	52	0	19	0

Source: RCEP 2000, p. 173

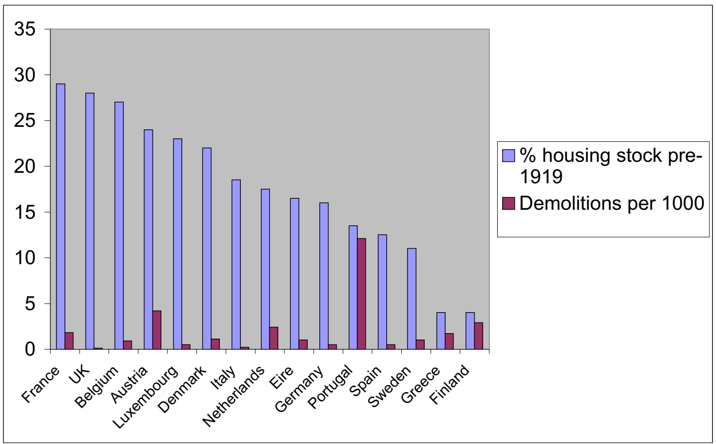


Figure 1. *Demolition rates and proportions of older housing in the EU, 1996 Source: Revell and Leather 2000, pp137-8 (EC housing statistics).*

tion. If carbon is to be reduced, all countries have to face choices about the relative balance of renewables, nuclear (or fossil fuelled with carbon capture) and energy conservation.

The RCEP report provides the broad overview and justification, but very little detail about how any one of these scenarios might be achieved. The ECI's Lower Carbon Futures group is researching how major changes to energy consumption within the domestic sector could be achieved if we are to get the 60% reduction and achieve *The 40% house*. The underlying assumption is that each sector achieves its own savings – there would have to be even greater reductions in the domestic sector, if it is confirmed that transport, for instance, can not reduce by as much as 60%. The study covers all use of energy in the home – for heating, lighting, cooking, hot water etc. The coverage is the whole of the housing stock in the UK. The solutions being explored include the integration of clean and renewable energy supply into the building fabric, for instance photovoltaics to produce electricity and solar thermal for hot water. The wider provision of cleaner supply (eg wind farms) is incorporated into the model through the carbon emission factors used for electricity. The research started in October 2002, so that the following is only an initial perspective on some of the issues we are examining.

The demand figures in Table 1 are in comparison with 1998. The assumption that demand would only have increased by 30% between 1998 and 2050 is conservative and is based on final energy demand continuing to rise by just over 0.5% pa – the mean rate over the last 40 and 10 years. The Department of Trade and Industry's (DTI) latest energy projections show final energy demand rising by 0.9% a year between 1998 and 2010 (RCEP 2000, para 9.9). In scenario 1, no energy is available from fossil fuels to provide low-grade heat (for space heating); the shortfall is made up from electricity (para E28).

In scenarios 2 and 3, the overall reduction in final demand to 36% below the 1998 level is, in reality, 50% of what it would have been in 2050 had the trends of previous decades continued (para 9.17). This would have been achieved partly through the price of energy rising gradually, but substantially through taxation. Also, in these scenarios, a large proportion of the population work from home, or in workplaces close to their homes (para 9.18), to avoid transport costs. In both these scenarios, a substantial proportion of the requirement for low-grade heat has to be met by electricity (half of that through the use of heat pumps), but a higher proportion in scenario 3 (para 9.23). If the demand for energy can be reduced, that makes it easier to avoid large programmes of new nuclear power stations or other technologies that might prove controversial (p. 180).

The amount of energy from nuclear power indicated in Scenario 1 is four times greater than at present (para 9.37). This is not to suggest that it would be politically acceptable nor economically justified, only that this is probably the upper limit that could ever be envisaged. Similarly, it is unlikely that the amount of renewable energy could be increased beyond Scenario 1 levels. Therefore, there is a clear policy conclusion for the UK: unless we can reduce consumption by at least 30% we cannot reduce emissions by 60%.

There are six components to energy reduction with this approach, each of which will be considered:

- Removing the least efficient buildings from the stock;
- Ensuring that all new construction is of a very high standard of efficiency;
- Upgrading the fabric of the remaining buildings;
- Reducing the carbon emissions from energy consumption in space and water heating;
- Integrating renewables into the building fabric to provide zero-emission electricity or hot water;
- Reducing consumption in domestic lights and appliances.

Demolition and energy efficiency

In the UK, we have one of the oldest housing stocks: over a quarter of all dwellings were built before 1919. Only France has a slightly higher percentage within the EU (Figure 1). This is coupled with an extremely low demolition rate: in the UK we are demolishing around 25 000 properties a year, which is half the rate of the next lowest EU country – Italy.

Table 2. Effect of demolition rates on energy reductions in 2050, in comparison with 1998 consumption, England.

Scenario	Current average SAP*	2050 Average SAP*	Demolition rate pa (dwellings)	Average lifespan** (years)	% over 100 years old in 2050	Carbon /energy change ***
Reference	44	65	20 000	1 300	31	+6%
250-year lifespan	44	77	150 000	250	25	-12%
120-year lifespan	44	84	234 000	120	19	-24%

*SAP – Standard Assessment Procedure, for auditing the energy consumed in providing adequate warmth and hot water in a house, normally varies from 0 (the least efficient) to 100 (the most efficient), though results outside this range can be obtained. The energy for lighting and appliances is not included in these figures.

**Average lifespan means that the stock would be replaced in this period, if it remained the same size.

***SAP is based on price, so that this is really a price reduction, for space and water heating

Source: The 40% house carbon model

There could be two relationships between these sets of figures:

- The stock is relatively new, because historically there has been a high rate of demolition, as may be the case in Finland;
- The rate of demolition has been increased substantially in the last few years, in recognition of the problem of an ageing housing stock, perhaps the case in Portugal.

If the average house is going to exist for 100 years, then the demolition rate should be 10 per 1000 dwellings. This rate is only exceeded in Portugal. Hence, the other 13 Member States have an ageing housing stock and are facing similar problems to the UK, although the UK is the most extreme example. In all these Member States, the average house must last for longer than 100 years and sometimes a lot longer.

The rate of demolition is only one of the factors that affects the energy efficiency of the housing stock, but it is a powerful driver. At present rates of demolition, the housing stock in the UK will only be replaced in 1 300 years (Table 2). There are numerous questions about 'How long does a building last?', but in this context there is the major worry that these old houses are increasingly energy inefficient in comparison with the standards of a new build property. It is not cost-effective to upgrade an old dwelling to the efficiency standards of a new one, for instance where this requires putting insulation under the floor or widening the cavity. There are numerous constraints on demolition, not least the issues of townscape and architectural heritage, but these are normally less than 10% of the housing stock – only 1.2% of the housing stock in England is listed as of architectural heritage. With low levels of demolition, the proportion of older houses (>100 years) in the stock will increase, as in the reference scenario.

In the reference case, the current SAP and the present demolition rate are given. An assumption is made about the standards of the new buildings being constructed and these are gradually improved from a present SAP of about 80, to a maximum level of 120 (theoretically possible) by 2020. This is a substantial improvement in the standard of new British buildings (from £1.47/m^2 to £0.59/m^2, 2.2-0.9 Euros/m^2, i.e. a reduction of 60% for space and water heating costs). The number of new buildings is determined by expected growth in household numbers (the same in all RCEP scenarios) and to replace demolitions. In Table 2, there are no changes or improvements made to the fabric or heating system in the existing housing stock, nor have any renewable technologies been incorporated into the buildings. These are fairly strong limitations, but they do provide some rough guidance on the size of the task. All other factors are outputs of the model.

There are two major scenarios in Table 2 as a result of increasing the rate of demolition. The result shows that, against 1998 consumption, a 12% saving of carbon and energy from space and water heating can be achieved, provided that demolition increases to 150 000 pa, and a 24% reduction with a demolition rate of 234 000 pa, under these assumptions.

Historically, in the UK, demolition has been as low as 13 000 in 1993, and was at 24 300 in 2001. The highest level of demolition was achieved in 1967, when 128 000 were demolished. This is still only just over half the level required to achieve a demolition rate of 234 000 pa, which, therefore, seems virtually impossible. A demolition rate of 234 000 is approaching 1% of the UK stock, whereas the highest rate ever achieved was around 0.73% in 1967. However, replacing the housing stock over 120 years may be desirable and to expect the average dwelling to last 250 years appears to be unrealistic. Therefore, the first major policy debate is about the trade-off between desirable demolition rates and the ideal life of a building.

Whatever energy efficiency improvements are undertaken to the existing housing stock, these will not alter the role of demolition. At some stage in its life, a building becomes obsolete or worn out. It is not clear when this occurs, but only one house in the UK has been lived in continuously for 1 000 years. It seems unlikely that the majority of British homes could survive this long and still provide good quality accommodation in sound condition – yet this is the implication of the present demolition rate. One policy recommendation is that the rate of demolition should increase, as quickly as possible.

Demolition averages mask a considerable variation between the different tenures: most of the property that is being pulled down belongs to local authorities and very little is owned by private individuals. For owner-occupied dwellings, the demolition rate is so low that the stock will not be replaced for nearly 5 000 years (Fawcett 2002). If individual property owners are to accept demolition, this is most likely to occur where they live on large plots of land and two buildings could replace the one, thus providing the owner with a substantial capital investment. Where this is not the case, the property may need to be purchased compulsorily by the local authority – an expensive, time-consuming and deeply unpopular process.

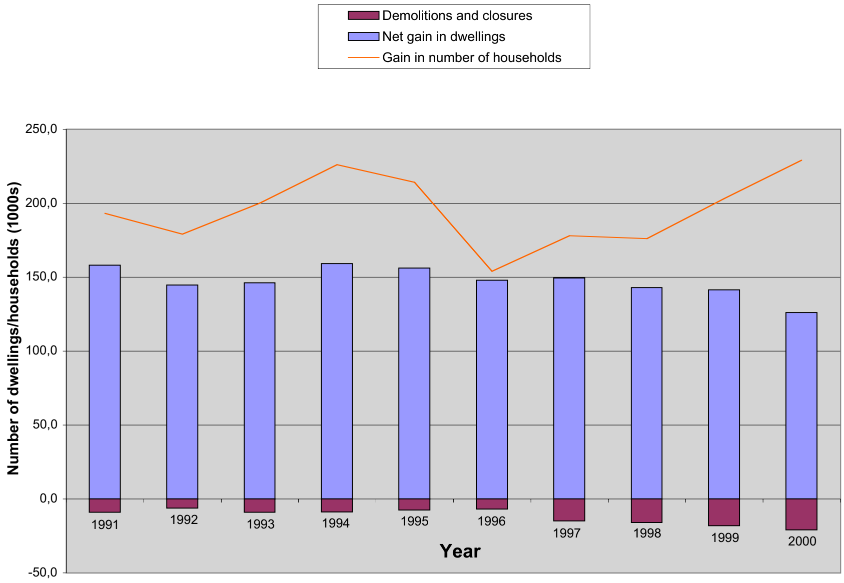


Figure 2. *Graph showing net increases in dwellings and households in England, 1991-2000.*

Standards of new construction

New construction is required both to replace the demolished houses and to provide additional dwellings for new household formation. The latter has been a major driver with English household numbers increasing by an average of 167 000 pa over the period 1971-2000. Some additional accommodation is provided as a result of conversions of large dwellings, but the majority of new household needs are met through new construction. 'Only some 10% of the new houses and flats completed in the UK each year replace existing homes; the remainder are additions to the stock' (RCEP 2000, para 6.88).

Building regulations for new construction and major refurbishment

The building regulations in the UK were updated in April 2002 and now cover both new build and major refurbishments. The standard is still low in comparison with those that exist in other countries (Table 3). The standard introduced is shown as proposed in Table 3. The new standard, on average, allows double the rate of heat loss to that permitted in the other countries shown. This is because our U-value calculation procedures are lax and the UK U-values – even if they were achieved in reality – are not as good as the overseas U-values. Thus a new wall in a UK house could easily have a real U value as high as, say, 0.42, whereas in Sweden, the legal maximum is around 0.17.

There is room for substantial improvement in the UK's Building Regulations and the Energy White Paper has declared that a new, tougher set of regulations must be introduced in 2005. One difference between the UK and the rest of central and northern Europe is that we construct dwellings with *two to four* times the air leakage of those in, for instance, France, Germany and Switzerland. The UK does not require a leakage test, to prove that the building has been constructed to a adequate standard. An air leakage test has been required in Sweden since January 1978. However, it was generally abandoned a decade ago as everyone had learned how to build tight. In the UK they have not yet even started to learn!

This confirms what the RCEP suggested: 'We recommend that government revise the Building Regulations to mandate much higher standards of energy efficiency in new homes... For new housing Regulations that deliver a SAP 80 rating should be introduced forthwith. We further recommend that government announce its intention to move to a higher standard, based on achieving a SAP 100 rating, by 2005. A 100 rating would cut the energy consumption of new homes by a further third compared to a SAP 80 standard. The five year delay would allow the house building industry tome to research and develop the most cost-effective and reliable ways of achieving the new standard' (RCEP 2000, para 6.97).

According to the RCEP: the 1995 version of the regulations were 'meant to achieve a cost-effective level of energy conservation, with the extra expenditure on construction being covered by reduced fuel bills' (RCEP 2000, para 6.93). However, the UK Government has not been monitoring the performance in reality of newly constructed dwellings, whether in post-1995 or post-2002 upgrades to the regulations. There is no certainty, therefore, that these theoretical savings are being achieved in practice.

Types of construction

One issue with regard to future construction is the extent to which the dwelling should be designed to have a significant thermal mass, as this provides a more even temperature for the building occupants: retains heat in winter and stays cooler in summer. This combines with the need, particularly in colder countries, to maximise the amount of passive heating obtained from the sun in winter. These are both ways to reduce the energy consumption of a house.

The new construction in the boom years of 1967 took the form of high-rise blocks or 'streets in the sky' and these have been extremely unpopular for families, resulting in prema-

Table 3. Relative new building standards.

	U-VALUE				1	2	3	4	5	6	7
	UK [1]	England and Wales, proposed		Ratio, England & Wales to regions 1-6	Sweden	Norway	Denmark	Switzerland [5]	Germany [6]	USA:	
	1995	2001-02	Trade-offs							Seattle	Los Angeles
Roofs	0.36	0.20	0.30 [2,3]	2.41	0.12	0.15	0.15	0.15	0.16	0.14	0.18
External walls	0.62	0.35	0.5	1.88	0.17	0.22	0.25 [4]	0.20	0.25	0.30	0.43 [8]
Ground floor slabs	0.61	0.25	0.30	2.45	0.15	0.20	0.20	[7]	[7]	[7]	0.50
Windows	3.3	2.2	2.2	1.67	1.3	1.3	1.8	1.5	1.8	2.0	3.0
AIR LEAKAGE [9]							ac/h at 50 Pa				
	8	<10			<2	<3	6 [9]	3 [9]	<3/1.5	6 [9]	[10]

NOTES:

1 Estimate of U-values actually achieved. More precise calculations are required in regions 1-6 and will probably be required here in the future.
2 Trade-offs refer to a 100 m^2 semi-detached house with glazing equal to 12% of floor area.
3 Assumes that insulation goes on the attic floor. The other European countries assume that it goes between the rafters. The UK plans to allow higher U-values here.
4 Average of timber-frame and masonry walls - maxima are U0.20 W/M^2K and U0.30 W/M^2K respectively but are under revision.
5 Zurich Canton.
6 The 2002 Building Code will require these U-values and set a limit to air leakage of <1.5(3) ac/h @ 50 Pa for dwellings with mechanical (natural) ventilation.
7 Ground floor slabs are uncommon; most houses in these regions have basements.
8 The mildest of California's 16 climate zones. It allows higher wall U-values in high-mass buildings; e.g., those with poured concrete or masonry walls.
9 Where air leakage is unregulated, current practice is quoted.
10 Unknown.

Source: Olivier (2001)

ture demolition. Thus, there are considerable fears that a major new spate of demolitions and the concomitant re-building will result in another set of inappropriate solutions. There is also concern that the most traditional method of building, with bricks and mortar (known as masonry), is too slow in the 21st century (Prescott, 2002). The debate is starting in the UK about whether timber-framed, steel-framed, or some other system approach should be adopted, so that buildings can be pre-fabricated in a factory and assembled on site quickly. The theory, well practiced in Sweden, is that this will result in higher quality, well-insulated buildings. 'The main objection raised by UK house builders to a substantial uprating of energy efficiency requirements is that it would require them to adopt alternative construction techniques. To achieve the necessary levels of insulation without resorting to extremely thick walls, they might have to abandon the traditional double masonry layer and move to timber or steel frame construction and single masonry layers instead. Some companies are wary about using timber frame construction after defects emerged in new homes built on this principle some years ago. However, almost half of new dwellings in Scotland are timber framed. The house building industry fears such major changes would prove unpopular with purchasers and might lead to problems emerging after the building has been completed and sold. The fact that is has to sell its products in competition with an enormous second-hand market of conventional homes increases its resistance to innovation' (RCEP 2000, para 6.96).

Another issue is that the effect of climate change, together with the long life expected of buildings, means that the best type of construction should be one that copes with warmer summer temperatures and, as far as possible, avoids the need for electrical air-conditioning. Under the climate change scenarios, by 2100, global mean temperatures could rise by up to 5.8°C (IPCC 2001). This might indicate that buildings with a high thermal mass would be most appropriate, rather than the lighter weight of timber-frame. Certainly the design should incorporate the maximum amount of natural ventilation, particularly from air currents that can move right through the building. To achieve this, the windows should face different directions to benefit from a range of wind directions.

Upgrading the existing stock

In this context, the primary reason for considering demolition is to replace the property with one of much greater energy efficiency. Obviously, a considerable improvement can be made to an existing property by upgrading the fabric and heating system, without demolition. Improvements to existing properties can be achieved (Table 4), although the optimum, cost-effective upgrade is rarely undertaken.

One policy stimulus in this direction would be for each house to have a mandatory energy label, but this is not yet on the agenda in the UK. However, the legal requirement for all house sellers to compile key information about their property (a Sellers Pack) should come into force by late 2005. The pack would have to include a home condition report and an energy audit, which could be used by potential house buyers to make an informed decision. However, this

Table 4. Progressive energy efficiency improvements to a typical house.

SAP	Energy for space and water heating (kWh pa)	Carbon dioxide emissions (tCO_2 pa)	Index	Cost of upgrade from previous level
42	29 675	5.55	100	
49	25 495	4.77	86	£200 (DIY*)
51	24 110	4.5	81	£300 (DIY)
65	17 720	3.31	60	£700
75	13 955	2.61	47	£950
99	7 930	1.48	27	£3 000
100	3 220	0.6	11	New build house

*DIY – Do-it-yourself, which means the cost of materials are covered, but no labour costs
Source: Borer and Harris 1998

energy audit would only provide a limited level of detail and would, probably, require building surveyors to be trained as energy auditors. The total package – known as the Sellers Pack – would be expected to cost £500-£700 (825-1 155 Euros). This is the first, tentative step towards making the value of the property reflect its efficiency. A step that is needed in preparation for a more widescale demolition of private properties over the next 50 years.

Another policy that would contribute to the revitalisation of the UK housing stock would be for each local housing authority (450 district councils) to be required to upgrade systematically the standard of the stock in its area. This builds on the Home Energy Conservation Act 1995, which requires an annual report on the energy efficiency of all the domestic properties, all tenures, in the authority's area. The average is 44 SAP points, as shown in Table 2. A policy approach would then require each authority to upgrade the level of its stock by a defined amount (say 5 SAP points) within an agreed period (say 5 years). It would be up to the local authority to achieve this by some mixture of:

- channelling nationally-available grants into the properties in a structured way;
- introducing its own grant support schemes;
- identifying the worst properties and, where appropriate, making these subject to procedures to declare them unfit for human habitation, on the grounds that they are too expensive to heat, to provide unhealthy living conditions;
- promoting a higher level of awareness amongst its residents of the need to invest in energy efficiency improvements, hoping to trigger private investment.

Newark and Sherwood is one local authority that has successfully utilised existing national grants to improve substantially the energy efficiency of its stock and to reduce the carbon dioxide emissions (Figure 3). The SAP rating (for 6 125 council-owned dwellings) improved from 23 points in 1985 to 64 points in 2002. Almost all residents can now afford to heat their homes to an adequate standard, whereas only 6% could do so in 1985 (NSDC 2002. p20). This demonstrates how both social and environmental objectives can be achieved by a dedicated approach to energy conservation. To replicate this philosophy across the whole country would require considerable funds, and a level of enforcement to ensure that all 450 districts were motivated to intervene and be innovative.

The Energy White Paper has suggested that the 13 UK regions should have sustainable energy targets (DTI 2003, pp116-7). This would incorporate the existing targets for renewable energy and add in energy efficiency. There are a lot of synergies between this approach and the integration of electricity supply to individual buildings: responsibility is becoming devolved.

Appliances, energy efficiency and energy conservation

All of the evidence based on SAP ratings, as described above, omits the energy used for lights and appliances. In the UK, the average household consumes 3 000 kWh pa on electricity for all uses except space and water heating. Across the whole EU, the figure is 3 120 kWh. There is an expectation that additional demand, especially from consumer electronics and home-office equipment, will result in this figure growing by 22% by 2020 (ECCP 2001). There is considerable policy and technical potential to reduce household consumption in this area, but are not being delivered, in practice, by the European Commission as yet. For instance, the revisions to the label on cold appliances were originally planned to occur in 2000 and can not now come in before the summer of 2004. In addition, the A category is to be extended to A+ and A++, rather than introduce a wholesale revision as expected – and as undoubtedly required. An individual Member State has a limited ability to introduce radical new policies, separately from the EC, because we are part of a single market.

The aim in *The 40% house* is to see whether the technology and policy combined could feasibly reduce average UK household consumption for lights and appliances from 3 000 kWh in 2001 to 1 500 kWh in 2050. This would be at the extreme end of what is likely to be technically feasible and way beyond the political will currently being demonstrated by Brussels. The UK Energy White Paper has, however, stressed the importance of energy efficiency improvements in domestic appliances.

Energy efficiency improvements do, eventually, result in energy conservation. How long depends on the rate of turnover of the appliance stock. For instance, the average refrigerator lasts 14 years, so that it will take this period before most of the new, efficient equipment has been added to the stock. It is only when the stock is comprised entirely of new efficient equipment, that the maximum level of energy conservation will have been attained. This level of energy conservation will be offset by increasing household numbers, greater levels of ownership and, perhaps, larger appliances. For instance, a 10% reduction in the electricity used in cold appliances by 2010, in the UK, would require an energy efficiency improvement in 2003 of 50%, mainly because there are only 7 years within which to achieve the savings.

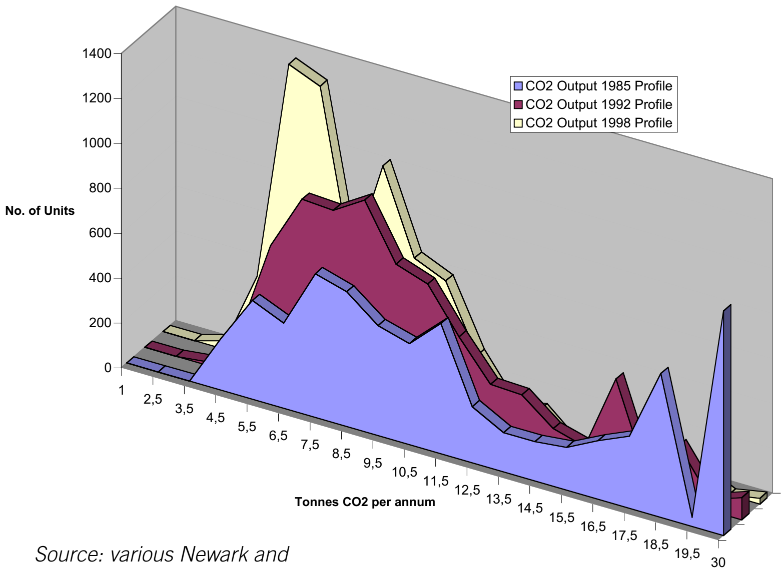
Integrating renewables

One reason that the electrical demand is important is because of the way this interacts with the new and renewable technologies, such as photovoltaics and combined-heat and power (chp). No detailed work has been undertaken yet on this within *The 40% house*, but some extracts are given in Table 5, to indicate the scale of the challenge. The RCEP has identified the number of photovoltaic and small scale combined heat and power installations required, in each of the scenarios. These are all in addition to the energy efficiency improvements shown in Table 1. Other, dispersed renewables, such as wind, wave and tidal, or community heating schemes fired by biomass and municipal solid waste are dealt with separately, through the emission factors for electricity and total heat or electricity demand. There is no clear discussion of heat-producing renewables, such as solar thermal water heaters, in the RCEP report. These will be assessed *The 40% house* project alongside other forms of space and water heating, particularly chp, to establish when and where they are most appropriate. There is no geothermal power in the UK.

The whole of the resources of renewable energy regarded as available are used in Scenario1. Scenario 2 assumes that there will only be half the level of installation of pv and onshore wind as is achieved in Scenario 1 (RCEP 2000, para E25). The photovoltaic panels cover many large flat roofs, the south-facing side of most pitched roofs on houses and the upper parts of the south-facing walls of multi-storey office buildings (para 9.15).

Carbon emissions

The RCEP considers carbon dioxide emissions only. The effect of the other greenhouse gases is assumed to be the same as in IPCC storylines. The reason for the 60% reduction in carbon dioxide is, therefore, to prevent the concentration of carbon dioxide in the atmosphere from rising above 550 ppmv (RCEP 2000, para 9.40); a concentration that included all greenhouse gases would be higher than this. To keep below 550 ppmv of carbon dioxide concentrations would require carbon dioxide by 2100 to be about 20% of the 1998 level (ibid, para 9.41) – Table 6. There is still a lot to do, beyond *The 40% house*.



Source: various Newark and Sherwood District Council documents and website.

Figure 3. *Distribution of carbon dioxide emissions, Newark and Sherwood dwellings, 1985 to 1998.*

Conclusions

The UK has accepted a target of reducing carbon dioxide emissions by 60% by 2050, over 1998 and is keen for this to be adopted as European policy. There are numerous challenges to meet if this target is to be achieved, for the domestic sector these include:

- Demand growth should be constrained, as quickly as possible;
- Unless demand is no more than the 1998 level, by 2050, the 60% reduction cannot be achieved through more renewables and nuclear power;
- The consumption of domestic lights and appliances in the home needs to be reduced from the present level of just over 3 000 kWh pa, whereas the expectation is that consumption could grow by 22% by 2020;
- It may be necessary to reduce the electricity consumption in domestic lights and appliances by as much as half;
- In the UK, and most of Europe, the present rate of demolition of houses is so low that the average property will have to last over 100 years, and up to 1 300 years;
- The first major policy debate is about the trade-off between desirable demolition rates and the ideal life of a building: a half-life of 120 years implies a demolition rate approaching 234 000 pa. If the demolition rate is reduced to a more realistic 150 000, then the half-life grows to 250 years;

Table 5. Numbers of installations, of integrated new or renewables (million).

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Roofs with 4 kWp photovoltaics (all buildings*)	15	7.5	0.75	0.75
Individual domestic chp (2 kW), gas fired	0	1.7	1.8	2.4

* out of 45 million buildings, of which about 30 million are domestic
Source: RCEP 2000 p261

Table 6. Contraction and convergence: implications for UK carbon dioxide emissions.

Maximum atmospheric concentration ppmv	Permissible UK emissions in 2050 % of 1997 level*	Permissible UK emissions in 2100 % of 1997 level*
450	21	11
550	42	23
750	56	47
1,000	58	61

*The RCEP took 1997 in this table, whereas most data refer to 1998. Source; RCEP 2000, p. 57

- The rate of demolition of old properties should be substantially increased, as quickly as possible. This could be achieved through regional targets to improve the energy efficiency of the housing stock, so that the least efficient properties are those demolished. In the UK, the legislative base for this could be the health and fitness regulations, but Government should provide additional funding, as compulsory purchase if often needed;
- The standard of the Building Regulations should be upgraded in the UK, in 2005 and this should represent a substantial improvement on the 2002 standard, including pressure testing of random properties to ensure that they have been constructed to a high standard;
- New properties should have renewable and cleaner energy sources incorporated, for instance the integration of photovoltaics and the installation of solar thermal water heating.

The next stages of *The 40% house* project will clarify, separately, the maximum saving that can be expected from:

- more efficient building fabric;
- lower carbon emissions from more efficient and new heating systems (including combined heat and power, heat pumps);
- the provision of more efficient lights and appliances;
- the integration of renewables (such as solar thermal, solar photovoltaics).

The maximum will be established by forecasting to 2050 and backcasting from the RCEP scenarios for 2050. In all cases, the technical potential will be limited by economic factors (though this is difficult over such a long timescale) and the result will be proposals for the policies required to deliver these savings in practice.

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