Cold Comfort for Kyoto: the link between air-conditioning in commercial buildings and consumer lifestyle choices

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Abstract

Although energy efficiency in commercial buildings is becoming more of a recognised issue for property professionals, the requirement for active air-conditioning is still seen as a “must have” in order for a property to be judged to be of “investment quality”. Air-conditioning in the residential sector is extremely limited in Europe, but as experience of air-conditioning in the commercial sector grows it can affect consumers’ lifestyle expectations beyond the workplace, which may act as a driver for more US-style patterns of adoption of cooling systems for the home.

This paper examines the scenarios for cooling growth and reports on a model of the effects on energy consumption and carbon dioxide (CO_2) emissions. It shows that, in the UK, unconstrained rise in air-conditioning use would negate 60 per cent of the efficiency gains from changes in building regulations since 2000, even though adoption is modelled only for the southern parts of England that are most affected by climate change. The paper then considers the policies that might be needed to persuade the consumer to adopt different cooling solutions. These in turn suggest that options in commercial buildings need to be reconsidered in a consistent and coherent manner.

Introduction

Employment in Europe is increasingly concentrated in what is termed the tertiary sector – commercial, retail, governance and ancillary services, rather than manufacturing and industrial processes. So when a European Directive focuses on the energy performance of buildings, that focus falls on the buildings within which the majority of people actually experience the result of energy used for internal temperature controls and other services, rather than on buildings where energy is used in direct proportion to production. Internal comfort becomes an important issue in the determination of the quality of a building by valuation surveyors (Gibson 2000), as it is related to productivity in the workplace and the image that the organisation using the building wishes to present to its clients, an important factor in maintaining its reputation.

Internal temperature control has become synonymous with air-conditioning in the minds of many facilities managers. In many countries, building a new prestige commercial building without air-conditioning is seen as a risky, if not foolish, business practice. During our previous research (Wade *et al* 2003) one property developer cited the difficulties experienced in letting a non-air-conditioned office, even in the UK, with a temperate climate that only occasionally experiences heat-waves. This is because such a building is not seen as being of investment quality (Pett & Ramsay 2003). Consequently, there is an inexorable rise in air-conditioned commercial buildings in Europe, with 27% of commercial buildings having air-conditioning in 2003 (Waide 2004), anticipated to exceed 55% in most European regions by 2020 (TNO 2007).

The question arises: what effect does the experience of air-conditioning in the workplace have on the demand for air-conditioning at home? In the US, growth was rapid between 1951 and 2001, when 76% of homes had some type of air-conditioning, compared with 80% penetration in commercial buildings (Waide, op.cit.). In Japan, 85% of homes are air-conditioned, and 100% of commercial buildings (*ibid.*). If the commercial sector continues to adopt air-conditioning in Europe, what could we expect the residential consumer to do? What impact would that have on CO_2 emissions?

This paper reports on an analysis of this problem for the UK, taking into account the forecasts of climate change for the 2020s and beyond, using the models from the UK’s Climate Impacts Programme. Although the UK is expected to experience only slight summer and winter temperature increases, the main impacts will be felt in the southern parts of the country, where not only do the majority of the population live and work, but the majority also work in the tertiary sector.

First, we present the approach to the model and the scenarios of behaviour that would influence rates of adoption of active air-conditioning. This is followed by the results of the modelling, showing the impact on CO_2 emissions. We then discuss the implications of this rise in emissions compared with the constraints imposed through other policies for CO_2 emissions reductions, and discuss the policies needed to ensure that the lowest carbon cooling options are adopted. Finally, we discuss the impact of those policies on the workplace, and the parallel policies and cultural changes needed in the workplace to lead to the adoption of low carbon solutions for commercial buildings.

Modelling increase in air-conditioning and its impacts in the UK

Employment in Europe is increasingly concentrated in what is termed the tertiary sector – commercial, retail, governance and ancillary services, rather than manufacturing and industrial processes. So when a European Directive focuses on the energy performance of buildings, that focus falls on the buildings within which the majority of people actually experience the result of energy used for internal temperature controls and other services, rather than on buildings where energy is used in direct proportion to production. Internal comfort becomes an important issue in the determination of the quality of a building by valuation surveyors (Gibson 2000), as it is related to productivity in the workplace and the image that the organisation using the building wishes to present to its clients, an important factor in maintaining its reputation.

Forecasts of increased adoption of air-conditioning in the home have to take into account not only economic and market factors, but also climatic influences and perceptions of comfort. In addition, with the growing awareness of the impacts of climate change, together with policy approaches to reducing CO_2 emissions, some allowance needs to be made for segments of the market that would be slow to adopt air-conditioning as a result of policy instruments but also principles.

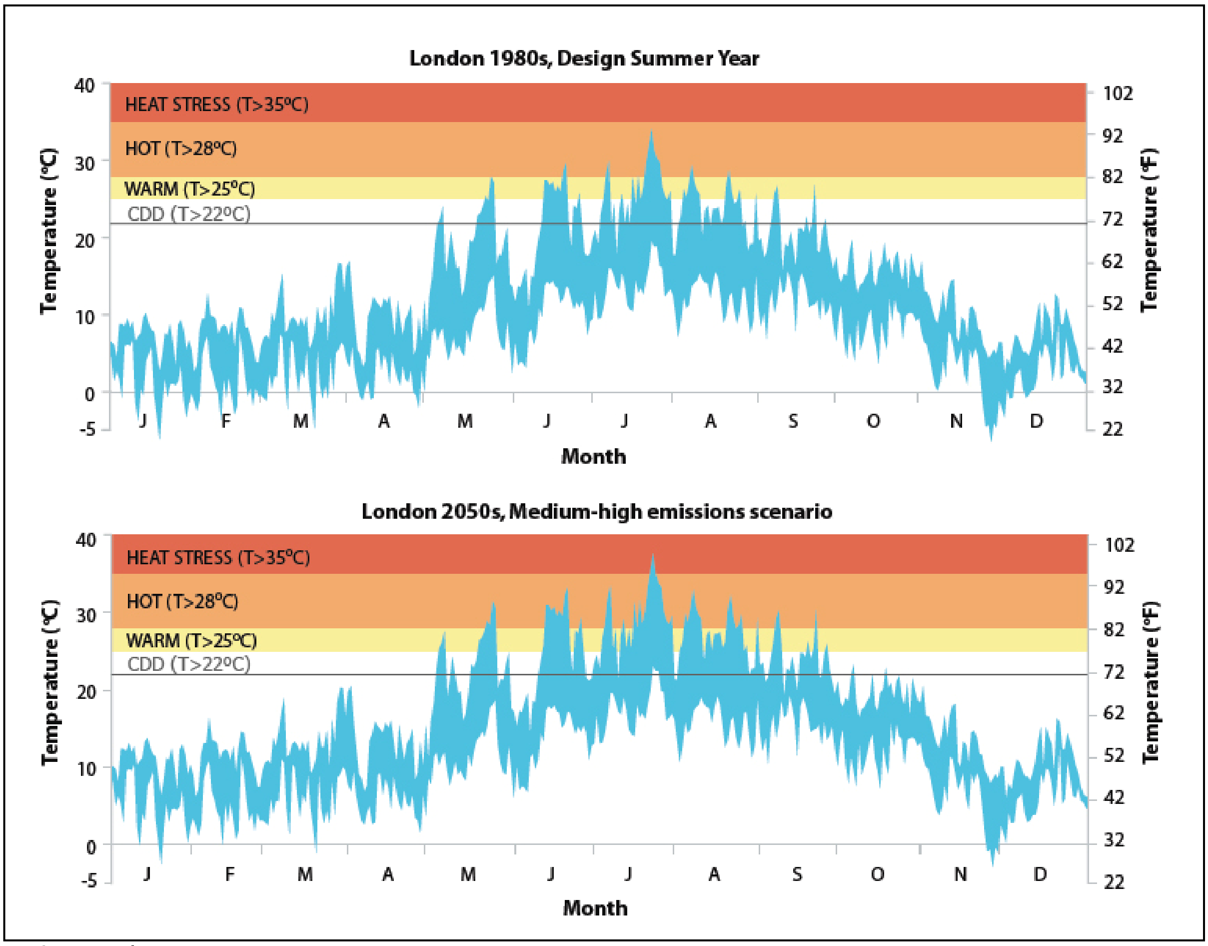
The main thesis relating to use of air-conditioning was that once it was switched on, it would remain on until it reached a standard temperature setting, such as 21˚C. Just as heating degree days (HDDs) are well established to assess the number of hours heating is needed over the course of a year, so cooling degree days (CDDs) can be used for the same effect for air-conditioning use. One problem in doing this is that there is no agreed standard for the base temperature for cooling degrees to be measured from. Another is that climate change predictions suggest that using historic records is unrealistic, since 11 out of the last 13 years have been the hottest on the global record. In the UK, with no heatwave, and flooding across the country in May and June, 2007 still averaged one degree higher than the long-term average, so that the year was the third warmest since UK-wide records began in 1914. In this 94-year series, the last six years (2002-2007) have become the six warmest (Met Office 2007).

For these reasons, the model used the UK Climate Impacts Programme's (UKCIP) climate models to provide input on climate scenarios for 2020s, 2050s and the 2080s compared to the present. These show that under any of their three emissions scenarios, it is the south-east, other southern areas and the eastern regions that are most affected by seasonal temperature increases, with hot summers becoming a regular occurrence. New models have recently been published, but the work in this model is based on the 2002 reports. Mean temperature changes do not really describe the impact for people in terms of likelihood of buying air-conditioning, or using it. Peak temperatures and heatwaves are the key drivers in this respect.

The UKCIP scenarios measure peak temperature by counting the number of days where the daily-average temperatures exceed the baseline temperature. This baseline is defined at the 90th percentile of the 1961-1990 temperature data. The peak temperature therefore captures the hottest remaining 10%, i.e. the average temperature of the hottest 9 days in a 90 day summer. For southern England in winter this is 11°C and in summer it is 23°C. By comparison, for Scotland these figures are 7°C and 17°C. The scenarios show that the peak temperatures will vary around the country and with the emissions scenario. In general, the change in the 2020s is only about 1.5°C in the south, but in the 2050s it is up to 4°C. By the 2080s, temperatures increase by 4-7°C in the Southwest, and around 2°C in Scotland. The number of days that these high temperatures occur is also calculated: around the country, except in Northwest Scotland, the number of days exceeding the baseline changes from 9 days by definition (10% of 90 days) to about 20 by 2080. In SW England, the daily-average temperature is likely to exceed 30°C about once every ten days instead of two or three times over the summer as a whole (Hulme et al 2002).

However, these are average-daily temperatures and only hint at the peak temperatures experienced in the day time. Further work by the Chartered Institute of Building Services Engineers (CIBSE 2004) models future 'hot' summers using hourly temperatures instead of daily means. Hot summers are used for worst case scenarios, indicating future risks from extreme temperature which can be hidden in mean forecasts. Figure 1 shows the historical temperature record from the 1980s and its projection in 2050. This graph is useful because we can see both peak temperatures and how long was spent at or above a particular temperature over the course of a year. Under the medium-high emissions climate scenario, it can be seen that temperatures in a hot 2050s summer will peak in the heat stress zone (T>35°C) and the time spent above 25°C has risen dramatically (Hacker et al 2005).

Figure 1: Design Summer Years for 1980 and 2050



Hacker et al 2005

The period above 22°C increases even more so, to include half the period between July and September and also parts of May. This directly influences the number of cooling degree days.
We use the UKCIP-selected 22°C as the maximum temperature above which cooling is needed on the basis of standard building engineering practice. CDDs are then calculated in the same way as HDDs, where the day's average temperature above 22 becomes the degrees of cooling that is summed for the year. Under the UKCIP baseline conditions, between 2100 and 2300 HDDs are required in southern England (3000-4000 in Scotland). CDDs are 310-330 in southern England, 20-50 in Scotland (Wu & Pett 2006).

The next challenge to the model is to determine how to model adoption and use of air-conditioning in response to these temperature changes.

In evidence to the House of Lords Select Committee on Science and Technology (2005), representatives of the Institute of Refrigeration made a number of points about the size of the market and its rate of growth, including that its split is approximately 95% commercial and 5% residential. In homes, market penetration is less than one per cent, probably less than half a per cent as a best estimate, and end-users commonly either buy very cheap equipment rather than the best on the market, operate the equipment badly and tend not to maintain it in an optimum fashion. The Institute representatives went on to compare market growth in buildings with the market for air-conditioning in cars: ten years ago the penetration in that market was probably about 10% of new cars, mainly in the luxury segment of the market. In 2004 about 75% of new cars had air-conditioning. They pointed out differences in the markets' characteristics. For cars the turnover is relatively short — replacement for cars is every few years — and in the residential situation it is quite complicated to retrofit air-conditioning (ibid.). The Institute therefore would not expect dwellings to reflect transport air-conditioning growth, but they were alert to a growing trend.

There is a fear that adoption will mirror US trends where it is perceived that air-conditioning is a 'must have' in any household. In fact, where retrofit is concerned, and comparing use against the north-western US, which has a similar type of climate to the UK, use of air-conditioning 'all summer' increased from 6.7% in 1981 to 14.7% in 1997, and using it 'not at all' dropped from 7.3% to 3.7% in the same period (EIA 2000 in Wu & Pett 2006). However, there is a significant trend to install central air-conditioning units rather than wall units — which would be expected to be the main purchase in the UK. Once purchased, the theory is that people will use them and grow more accustomed to controlling their environment to provide a high degree of comfort.

What drives this use in the UK and how can it be incorporated into a model? To answer this we calculated the proportion of people who would choose to use air-conditioning in the home for a given temperature range. The factors involved in this were:

- The 'personal comfort zone'. Although work on dynamic adaptation provides increasing understanding of thermal comfort (e.g. Lopes *et al* 2007), we developed an approach by setting the mean temperature and comfortable temperature range for the population, and assuming a normal distribution.
- Cost, which should include both upfront and running costs with the former probably being more critical.
- The degree to which air-conditioning outside of the home (such as at work) defines individuals' personal comfort zone.
- Fashion or social status, which could imply more or less cooling requirement.

Four model population groups were defined to represent each influence:

A. The whole population.
B. The population who can afford air-conditioning. We have used the distribution of households paying higher rates of council tax (bands D to H), assuming they adopt air-conditioning as a lifestyle option[1].
C. Assumes that rural dwellers experience a 'fresher' temperature and are more resistant to air-conditioning than urban dwellers. The distribution of urban and suburban dwellers is taken from the English House Condition Survey 2001 regional data (ODPM 2003).
D. Assumes that people decide to use air-conditioning based on whether their work environment is air-conditioned. Air-conditioning incidence is principally high in the commercial sector, including offices, retail and leisure. The data on professional occupation is taken from the 2001 Census (ONS 2006), and uses an assessment of office quality variation by region previously developed by ACE (Pett & Ramsay 2003).

These groups are used to determine the population size, in South England, who will buy air-conditioning. Because the aim is to identify the scale of unconstrained growth it is assumed that a mature market exists, i.e. everyone in the group who is uncomfortable has purchased air-conditioning. It must be noted that the population groups show considerable overlap and cannot be added together

[1] This may be correct in the early years, but data from the USA shows that in practice there is little difference in uptake of air-conditioning between socio-economic classes (cited in Waide 2004)

– high-income, urban-dwelling office workers are not uncommon. Groups C and D both represent different aspects of experience of air-conditioning in respect to their residential choices, but with potentially different population sizes. The groups are not adjusted over time and therefore it is assumed that the population is stable with respect to the four groups.

One factor was left, though, which was the individual choice (or peer pressure) of whether to turn the air-conditioner on or not — the Comfort Scenario.

For this we made extensive use of the work done by Elizabeth Shove and Heather Chappell at Lancaster University (2004). The Future Comforts project worked with stakeholders to define four Comfort Scenarios. It addressed both heating and cooling issues, examining the relationship between climate change, conventions of thermal comfort and the built environment. In it, Shove and Chappell describe a matrix of attitudes to thermal comfort (Table 1) and conclude that there are four possible scenarios:

I. **The comfort zone extends** — People are comfortable in a much wider range of indoor temperatures, and they expect to be colder during the winter and warmer during the summer. Seasonal fashions would be geared towards providing comfort indoors without contributing to climate change. Building designs would only need to maintain temperatures within more ‘elastic’ definitions of comfort so that resource consumption would be significantly reduced.

II. **Indoor climates diversify** — In this scenario, regional climate differences are positively valued through, for example, local cultural reinvention. This would massively reduce the environmental cost of comfort for a moderate climate and we can expect people to accept and adapt to rising temperatures. This scenario is less probable since standards are presently anticipated to converge globally.

III. **Standardised efficiency** — In this case conventions of comfort and clothing stabilise but far more efficient ways of providing and delivering precisely defined conditions of ‘comfort’ are developed, such as new forms of technology, better controls, or climatically sensitive passive design strategies.

IV. **Escalating demand** — Interpretations of comfort will develop in ways that are even more demanding than those of today. People, for one reason or another, expect to be even warmer during the winter and even cooler during the summer. The energy demand will increase as a result along with associated emissions.

Table 1: Theories of Comfort

	Theory	**Concept**	**Temperature characteristic**	**Achieving comfort**
Physiological	Biological heat balance	Natural climate as the threat to human productivity – a threat to be kept at bay	22°C ‘thermal monotony’	More efficient air-conditioning
Adaptive	Physiological / behavioural adaptation	Modify the external climate: mediate and transform but do not exclude	Indoor conditions ‘float’ with external ones and provide variety of experience	Natural ventilation exemplars and adaptive standards
Social Convention	Social and cultural experience	Mediated indoor climates; thermal needs and thermal conditions defined by socio-cultural and socio-technical worlds prevailing	From 6 to 30 °C depending on society	Promote diversity in meanings, experiences and expectations

adapted from Shove and Chappell 2004

The first two Comfort Scenarios suggest that air-conditioning does not become a major threat, and the level of use will be linked to the frequency of ‘hot’ days. In scenarios III and IV however, the assumption is that not only will air-conditioning be used all the time to maintain indoor temperatures within the range defined by cooling degree days, but it could be used to deliver unreasonably low indoor temperatures during peak heat periods.

These four Comfort Scenarios were used in the model to define the average daily-mean temperature levels at which the populations would turn on and turn off their air-conditioners — their Comfort Zones.

The Comfort Zone is a normal distribution which specifies the comfort range of the population. Most of the population is comfortable at the average temperature whilst fewer are comfortable at the extremes. We define the normal distribution using the mean comfort temperature and the standard deviation, the temperature range within which a fixed proportion of the population is comfortable.

The modelling takes Scenario III as the baseline to set the mean comfortable temperature and temperature range. We use outdoor temperatures because this is the basis of the CDD and HDD. The mean comfortable temperature is set halfway between the HDD (15.5°C) and CDD (22°C) limit, ie 19°C. We must assume that most of the population will be out of their comfort range at the CDD or HDD limit and therefore switch on their system. For simplicity we set the CDD limit at one standard deviation, which is 84% of the population.

Comfort Scenario I specifies a much wider range of comfortable temperatures but the same comfort mean. We therefore move the first standard deviation to 26°C, an increase of 4°C from the 22°C in Scenario III, which we believe is realistic.

Comfort Scenario II has no mean temperature or range. This is because people have adapted to whatever climate changes have occurred, however unrealistic this may be.

Comfort Scenario IV demands even lower summer temperatures and therefore the mean temperature has dropped to 17°C. Since the range does not change, the 84% limit (1 SD) falls to 20°C.

Table 2: Population comfort zones

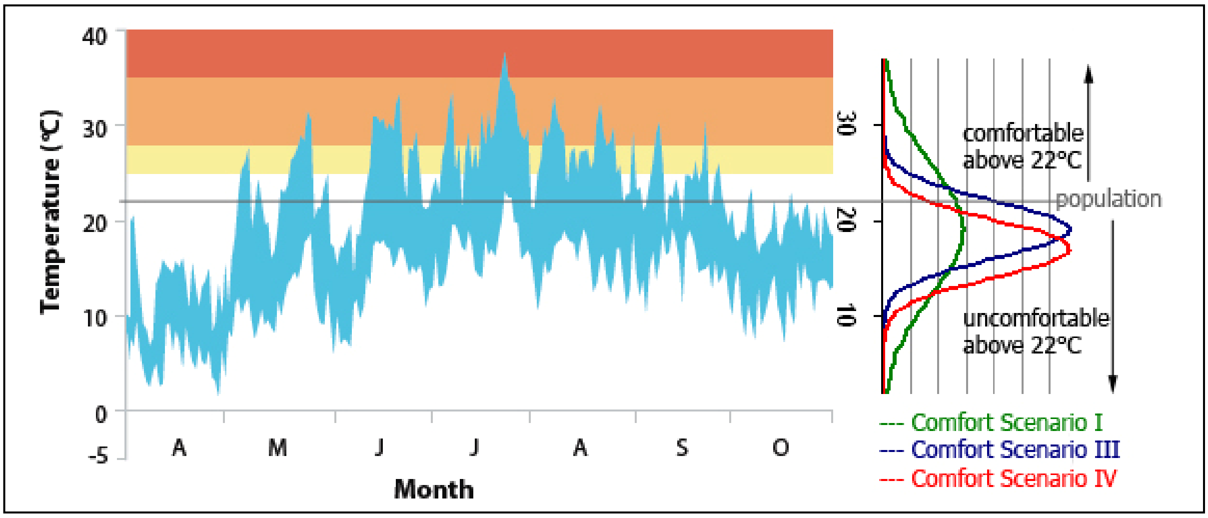
Comfort Scenario	Mean temp [°C]	SD [°C]
I	19	±7
II	n/a	n/a
III	19	±3
IV	17	±3

The following paragraphs quantify two methods for analysing the cooling demand. We can assume cultural lock-in of the 22°C limit and the uncomfortable population proportion changes, or move the temperature limit so it represents 84% of the population and recalculate the CDD.

Cooling demand at 22°C limit for varying population proportions

By plotting the population against the Design Summer Year (DSY) chart (Figure 2) we can see what proportion of the population is uncomfortable at a given temperature and how long they will stay in it. Comfort Scenario III is drawn in dark blue and the population below the 22°C line is uncomfortable at any temperature above 22°C. This is the majority of the population (defined at 84%). However, in Scenario I (shown in green), a smaller proportion is uncomfortable (66%) and would need cooling. In Scenario IV (shown in red) 95% of the population demands cooling. The CDD can be adjusted accordingly to give the proportional population weighted CDD (PCDD, Figure 3).

Figure 2: Population comfort zone illustrated against a DSY

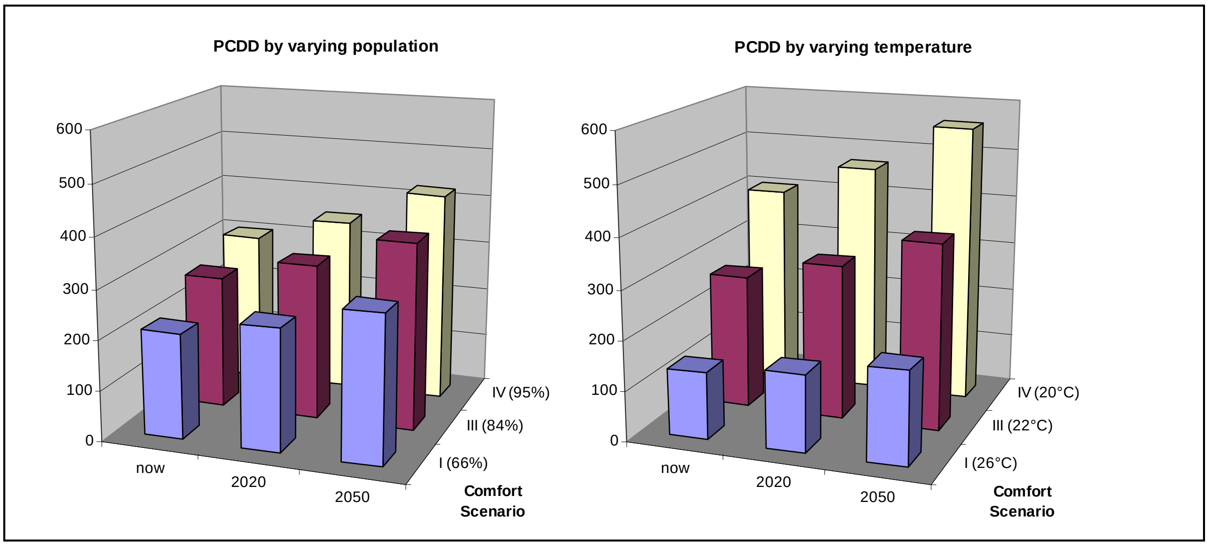


Cooling demand for 84% of the population at varying temperatures

The comfortable temperature limit for 84% of the population is 26°C, 22°C and 20°C under Scenarios I, III and IV. As we have seen above, however, the CDDs do not change linearly with temperature.

From the DSY, we estimate the CDD halve when the limit is 26°C and multiplies by 1.5 at 20°C. This is applied to 84% of the population (Figure 3).

Figure 3: PCDD variation



These initial results suggest the greatest risk, and most effective method of reducing air-conditioning use arises from changing the expected temperature, rather than limiting the population demanding cooling at 22°C. However, a number of critical assumptions are made which need further research.

The final air-conditioning demand indicator is calculated by multiplying the PCDD by the population size of each group. The results of this are fed into the calculation of electricity demand and climate forecasts to produce the energy demand and CO_2 emissions under current forecasts.

Results of modelling using scenarios

As shown in the previous section, a comprehensive demand model in which a population cooling degree demand can be calculated from outdoor temperature increases and personal comfort zones under four Comfort Scenarios has been developed. It assumes that all those who wish to purchase cooling technologies do so, and that electricity demands of those technologies follows the predictions of the Market Transformation Programme and others, which models energy consumed for a household of three people with one C rated (EER=2.3) 10,000 BTU single unit air-conditioner sufficient to cool a south facing 25m2 living room2. Because the house is not occupied during the hottest period of the day, the air-conditioner is only used for 8 hours of each degree day (Wu & Pett 2006).

Four Population Groups were considered under four Comfort Scenarios. However, Population Groups C and D were very similar in size, so the difference between the energy use and emissions was negligible, and the results are intermediate between Population Group B (those who can afford it) and the population as a whole (group A). Comfort Scenario II assumed no take-up of air-conditioning, so uses no additional energy and produces no modelled emissions. The results are shown in Table 3 where the mean daily temperature trigger point is shown in brackets.

Table 3: Estimated residential air-conditioner use: Population Group A

	Scenario I (26°C)		**Scenario III (22°C)**		**Scenario IV (20°C)**	
Year	**Energy /TWh**	**Emissions /$MtCO_2$**	**Energy /TWh**	**Emissions /$MtCO_2$**	**Energy /TWh**	**Emissions /$MtCO_2$**
2020	3.8	1.6	7.6	3.3	11.0	4.9
2050	4.6	2.0	9.1	3.9	14.0	5.9

Population Group B

	Scenario I (26°C)		**Scenario III (22°C)**		**Scenario IV (20°C)**	
Year	**Energy /TWh**	**Emissions /$MtCO_2$**	**Energy /TWh**	**Emissions /$MtCO_2$**	**Energy /TWh**	**Emissions /$MtCO_2$**
2020	1.7	0.7	3.5	1.5	5.2	2.2
2050	2.1	0.9	6.9	1.8	10.0	2.7

These figures agree in magnitude with the Market Transformation Programme (MTP) projections (MTP 2006) but not in detail, as the MTP include in their model neither growth in residential use nor climate change drivers. The free market (total population) group shows energy consumption varying by as much as 7.2 TWh to a maximum of 11 TWh in Comfort Scenario IV by 2020. However Scenarios I (shown in the table) and II (no adoption of active air-conditioning, so zero emissions) suggest some adoption of air-conditioning can be absorbed within the system as, in winter, a reduction in Heating Degree Days is expected. Population Group B, where purchase is constrained by affordability, shows a similar pattern.

The UK Building Regulations in the residential sector are predicted to save 5.5 $MtCO_2$ (1.5 MtC) across this period, assuming that the latest zero carbon building targets do not change the market before their introduction date of 2016 (ref and check dates). From our analysis, free market purchase of air-conditioning could negate 15% to 90% of these Building Regulations savings. Emissions from residential air-conditioning could be as high as 5.9 $MtCO_2$ in 2050, allowing for improvements in energy efficiency but using the MTP's assumption for medium-term carbon intensity of electricity (i.e. for 2020; MTP 2007a). By 2050, depending on power supply policy and the resultant energy mix, carbon intensity ought to be lower, but could be similar, or perhaps higher – of course with corresponding implications for air-conditioning emissions. In the next section we examine the policy implications for the residential sector, and consider whether there are interventions that could be made to persuade the consumer towards the lower carbon options of Scenarios I and II. We then ask what these approaches imply for policies for cooling in the commercial sector, which continues to drive the market for improvements in air-conditioning (MTP 2007b).

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[2] Calculated using manufacturers sizing guide
http://www.delonghi.co.uk/feature_pages/air_conditioners_feature/air_conditioners_microsite.php
An EER 2.3 10,000 Btu air-conditioner uses 0.8kW.
Energy =air-conditioning demand *# hours unit is on in a degree day*energy consumption of unit/people per house
=air-conditioning demand*8*0.8/3 (in kWh)

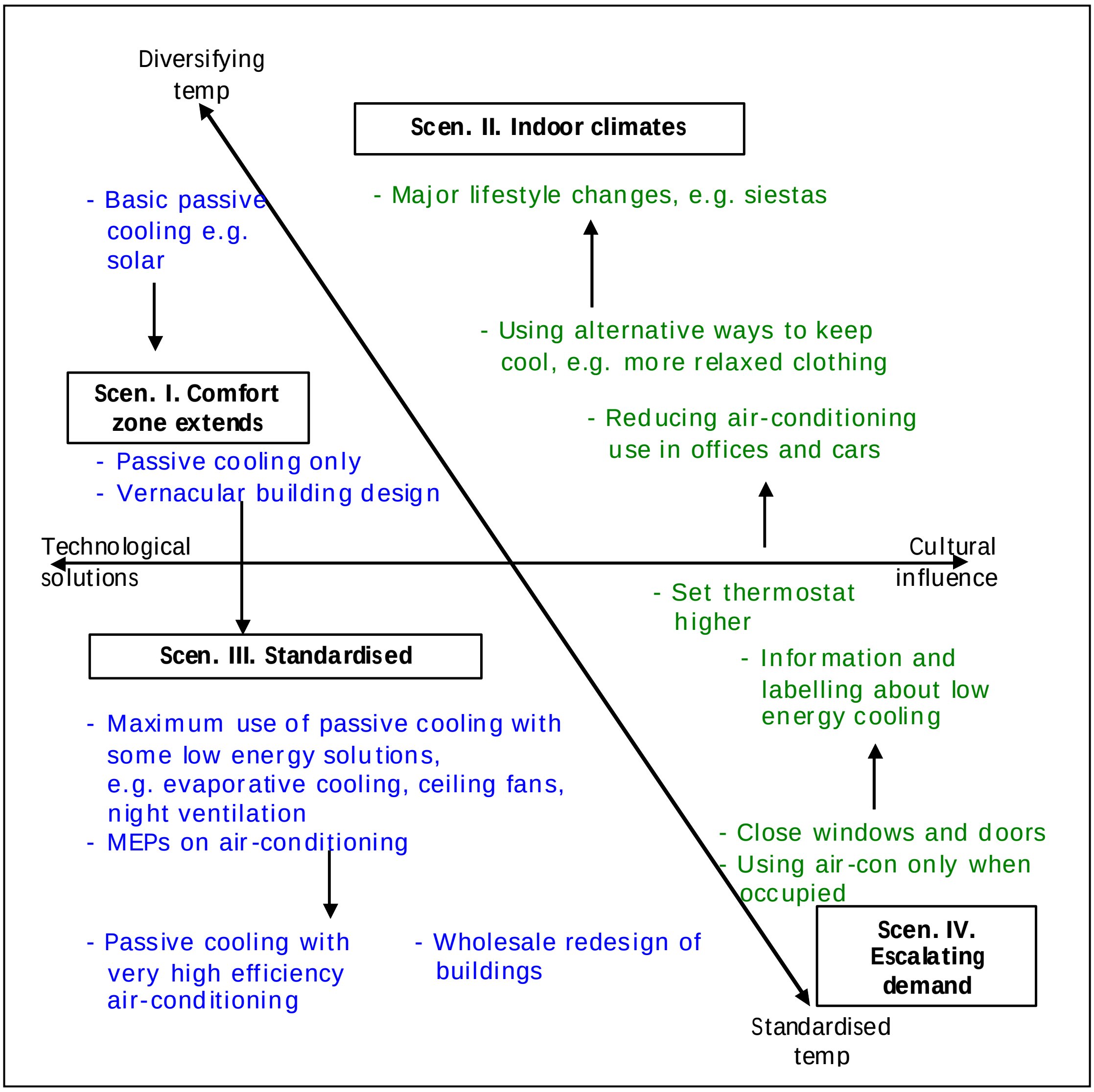
Policy implications for the residential sector

The approach to cooling demand can be made from two different angles — changing our environment and changing our attitude to the environment. The two approaches intersect, and policies combining the two, such as minimum energy performance standards (MEPS) and labelling, have proven effective. The main decision, therefore, is the point of intersection which will determine at what level CO_2 emissions are controlled. This in turn may determine whether more effort needs to be expended in developing a comfort scenario more akin to I or II, which are strongly behavioural, or III or IV, which rely more on technical achievements and their market penetration.

Policies must be revisited regularly based on the most up-to-date climate change scenarios. For example, if temperatures of 42°C occurring twice a week were predicted moving towards 2080, it is clear much stronger policies would have to be adopted to improve buildings. Deadlines for reviewing and acting on the information should be drawn up now to ensure the policies are introduced sufficiently early to be effective, particularly as, unlike commercial sector, residential buildings generally have a much longer life expectation, so that lifecycle emissions take place over typically 60 years or more, compared with as little as ten years in the office sector (Pett & Ramsay 2003).

In Figure 3 we express the policy focus diagrammatically to show the relationship between diversifying attitudes to temperature versus standardised temperatures on the one axis, and technological versus cultural solutions on the other.

Figure 3: Schematic of scenarios, and attitude and policy responses



It can be seen that for Scenario I, the focus is on passive cooling measures, including adoption of vernacular design for new buildings, and solar shading or use of solar energy to drive active systems where they must be used. Such technologies may offer less control and are unable to lower temperatures by as much but still within the range of comfort for all but the most extreme temperatures — e.g. taking the lower and upper limits for comfort at the 10% and 90% deciles rather than at the current standard.

Scenario III focuses on standardised efficiency, using passive and low-energy solutions wherever possible. Achieving this Comfort Scenario can be attempted through best practice usage, such as setting thermostat temperatures for cooling at 25°C. Campaigns which highlight the huge increase in energy use and its climate impacts could persuade people to raise the temperature slightly.

Scenario IV, 'escalating demand' is based upon the premise that air-conditioning offers the greatest control over the environment and is a silver bullet for achieving closely defined temperatures in a wide range of situations. This scenario would mean air-conditioning is perceived not only as a necessity, but an opportunity to provide relief against outside temperatures. The energy consumption must therefore be reduced by minimising the air-conditioning load, through passive building measures, and maximising systems' efficiency. Because demand is so high building designs must be re-examined and the highest efficiency standards set through ambitious MEPS and labelling. Maintaining and servicing cooling equipment also becomes a priority and legislation such as the Energy Performance of Buildings Directive's Article 9 would need to be extended to smaller units.

Finally, in scenario II, the solution is to value regional climate differences since very little climate control or cooling is allowed. This requires a strong element of 'return' to non-technological solutions, and will be difficult in countries where the majority of the buildings are already built in a style that does not allow for adaptation to vernacular cooling technologies such as those found in Mediterranean and African climates. Alternatives could include societal changes to work and education patterns, such as adopting a siesta, which has already been mooted in a light-hearted way. This would actually be easier than adapting buildings wholesale, as less investment is needed, provided there is agreement by all sectors of business and industry. Further analysis is needed as other factors are involved, including child care and traffic patterns. The fashion industry could receive a boost, as a wider range of clothing would be required to fit the new acceptance of temperature ranges.

Policy implications for commercial sector

One of the key issues for our study is that the rise of cooling demand in the home is largely influenced by what people experience at work, when shopping, during entertainment, and so on. Therefore none of the policies suggested in the previous section can be introduced without a parallel and even vanguard of policies for commercial buildings so that residents can experience and see changes for themselves.

Research in this area is already quite advanced, with Glass For Europe sponsoring work from TNO on the options for reducing emissions in air-conditioned buildings using solar glass (TNO 2007), and Aebischer's work at CEPE on the implications of climate change on commercial sectors in different European regions, where emissions are strongly influenced by the carbon intensity of the electricity supply (Aebischer et al 2006). However, these and others tend to focus on a business-as-usual perspective for active cooling systems. Only TNO include an option where substitution of passive systems for active ones is a realistic solution. Thus, through our assessment, policies for the commercial sector to achieve satisfactory cooling under Comfort Scenario III are the ones currently under scrutiny for reducing CO_2 emissions to achieve Kyoto commitments and the targets considered at the UN climate change conference in Bali (December 2007). The approaches on MEPs, top runner solutions and, importantly, research on adaptive indoor comfort and its relationship with outside temperatures, do no more than accept an engineered solution to a narrow range of indoor temperatures. The challenge would be to implement and increase in that range, following the Japanese example of relaxing the office dress code through the Cool Biz programme and raising the thermostat setting to 28˚C (JLGC, 2005).

However, the more we move towards the diversifying temperature/cultural solutions axis, the more policies will need to be integrated with others. For example, a move towards Comfort Scenario I would require a review of workplace statutory health and safety temperatures, and towards Scenario II a review of workplace practices including hours of work, flexible working, school and transport co-ordination, and much more. A return to vernacular architecture in city centres, where air quality is also a serious issue, provides a technical and architectural challenge, but buildings such as the Commerzbank Tower Frankfurt and 30 St Mary Axe London (the 'Gherkin'), both designed by Sir Norman Foster & Partners, are intended to provide cool air circulation through natural airflow inside the building envelope. However, in a speech to the BRE annual conference 2005 Sir Norman regretted that British executives still wanted to keep the air conditioning on. Clearly cultural issues play a major part here. These are issues which require further research, not only technological and behavioural but also wider cultural issues.

Summary & Conclusions

Taking into account the likely development of the UK's climate, particularly in the South and East of England, there is a high risk of increased take-up of active air-conditioning solutions to indoor comfort, spear-headed by users' experience in the commercial sector, which for many is their place of work.

The expectations of comfort play a key part in determining the approaches that may be needed if electricity demand from active air-conditioning are to be contained. There are already attempts being made to build commercial buildings which do not rely on active air conditioning, but societal preferences, at least in the UK, seem to require the technology fix rather than an adaptive response. Policies which recognise that societal response is a function of our everyday experience appear to hold more promise for a change of perceptions of comfort, but these need to be addressed across all our everyday experiences, integrating workplace, school, travel, recreation and home, in order to enable influences in one area to take root. Barriers to policy implementation may be way outside the narrow focus normally taken by the policy maker.

There are numerous ways in which the market for air-conditioning, both residential and commercial, could develop. To minimise the risk of this contributing significantly to CO_2 emissions, particularly in the potential growth market represented by the residential sector as informed by the commercial sector, an integrated policy approach is required. This must be an approach that views the demand for comfortable indoor environments as a whole, a system which is informed by everything on the spectrum from the external climate at one end, to individuals' internal perception of comfort at the other, regardless of the type of indoor environment.

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