

# Motivations and Framework for a sustainable development policy

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The present draft of the supplementary planning document for sustainable design and construction includes an excellent account of the most important town planning issues. It is not as good on energy efficiency, which is one of the most crucial planks in designing for a sustainable society.

## **The urgent nature of the problem**

Energy usage is central to climate protection, as almost the entire current energy system is based on fossil fuels. Burning fossil fuels in turn is the main contributor of global CO<sub>2</sub> emissions, which as a greenhouse gas is the major driving force for global warming. Since the beginning of the industrial revolution, concentrations of atmospheric CO<sub>2</sub> have risen from about 280ppm to 380ppm. Rigorous scientific analyses have shown that this man-made alteration of the earth's atmosphere has already caused the global climate to warm, and will continue to do so for some time. CO<sub>2</sub> emissions are currently rising and this will drive an additional warming which has been estimated and described in the recent IPCC 2007 review whose summary has just been published [IPCC: Intergovernmental Panel on Climate Change, Assessment Report 4 (AR4), 2007]. The projected warming falls in the range +1.1 to +6.4 °C by 2100; the upper figure is huge and exceeds the difference between the last ice-age and today. This warming is expected to have a very serious impact on supplies of water and food, at just the time when a rise in demand continues to be driven by the increasing global population (see e.g. projected rainfall in summary report AR4).

There is no acceptable warming but a kind of consensus has arisen around the value of 20°C. It is usually agreed that warming above this value would be exceedingly dangerous [Stern Review on the Economics of Climate Change, HM Treasury, 2006] to many populations. Much of the uncertainty in the projected warming is due to different possible future choices about limiting greenhouse-gas emissions. In order to stabilise the atmospheric greenhouse gas concentrations at levels that would prevent

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the most catastrophic consequences of climate change, CO<sub>2</sub> emissions will have to be cut by 80-90%, knowing that the earlier these reductions are realised, the less will be the total CO<sub>2</sub> emitted and the less will be the rise in global temperature. One can estimate that for every decade of inaction, we commit to an additional temperature-rise of 0.4°C. It has also been shown that delays will be very costly [Schlesinger, Stern].

## **The need to cut CO<sub>2</sub> emissions**

The potential for absorption of the Earth's biosphere and oceans is about 7 Gigatonnes of CO<sub>2</sub> per annum. Since global emissions amount to 42 Gigatonnes 1 per year, the excess accumulates in the atmosphere. To stop this accumulation we need to reduce this emission from about 42 to about 7 Gigatonnes per year. This gives an idea of the cuts required. As industrialised countries contribute most of today's emissions, their cuts are required to be even deeper in order to accommodate the possibility for developing countries' economies to expand and satisfy the most essential needs of the poorest third of the global population.

Accordingly, climate activists call for a cut of CO<sub>2</sub> emissions in the UK of 90% by 2030 [George Monbiot, *Heat: How to Stop the Planet Burning* (2006)]. The British government remains less demanding with a planned cut of 60% by 2050, but even reaching this aim requires massive actions to be taken. Delayed cuts have to be much steeper than cuts taken now [Monbiot, *Heat*, p. 18] to have a similar effect. Delay raises the spectre that the required cuts will become impossible.

## **Where can cuts in greenhouse gas emissions be made?**

Energy consumption occurs across all sectors of the society, to roughly 1/3 in each industry, transport and housing, such that all sectors have to contribute to achieve the goal of cutting emissions. Unfortunately this is a most difficult problem especially in some areas. An exception is housing, where reductions are rather easy to achieve, given that most of its energy requirement is in terms of heat, a low-quality form of energy.

## **Why should Cambridge contribute its share towards the cuts?**

The first point to note is that by default, new building schemes involve an increase of CO<sub>2</sub> emissions because there will be more houses emitting CO<sub>2</sub> than before. This increase could be largely reduced, and therefore it would be appropriate to set high standards for new buildings. This is where the SPD and similar documents can help. A common objection is that Cambridge is only a small part of the UK, which only emits a fraction of the world's CO<sub>2</sub>. The main answer to this objection is that

Cambridge can set an example of good practice in particular towards solving the problem of achieving a carbon neutral design, which is a government target for 2016. We must also not forget that the main target is to make deep cuts of CO<sub>2</sub> by 2050 (the government's target is 60%). The problem with the *10% savings* required by the *Merton type of design* is that they demonstrate how to achieve a very modest goal but may actually be *incompatible* with the imposed targets. If Cambridge is to set an example it should facilitate the final step towards carbon-neutral designs not block it by locking the buildings into an energy inefficient future. This involves making the right strategic decisions.

Crucially, impressive improvements in the energy-efficiency of buildings are possible by the use of passive solar design and rigorous insulation. By taking such measures at the start, it should be possible to reduce CO<sub>2</sub> emissions by as much as 90% throughout the lifetime of the house.

Any other technologies should only be considered if they are consistent with a carbon neutral future. A good example of such a technology is the use of district heating that has been installed from the start of a project. There are various versions e.g. district heating fuelled by wood chips (available in Cambridge and renewable), district heating with gas fired combined heat and power (CHP), or district CHP with renewable fuel (as in the Southampton development) that might offer solutions. The common feature is the district heating infra-structure which does away for the need for gas pipes and individual boilers. The inferior versions have the advantage that they can be up-graded later towards the Southampton type of design which saves the most CO<sub>2</sub>.

This kind of up-grade would be much less practical for the Merton designs which tend to combine lower quality thermal insulation, individually installed central heating and some sort of technological add on. These designs tend to rely on gas boilers which are very probably incompatible with a carbon neutral future.

Although there are a variety of proposals for producing electricity without emitting CO<sub>2</sub>, involving windfarms, nuclear power and solar thermal generation, the outlook for replacing natural gas looks much bleaker. The only technology which has been proposed is a speculative proposal to replace natural gas with hydrogen; this would be incompatible with the existing infra-structure since the pipes would have to be 50% wider. It follows that condensation gas boilers which might be an improvement for old houses would be an impediment for new ones. It follows that the Merton 10% regulations risk to favour *dead end designs*. Certainly, these will not stimulate models for newer building projects aiming at the carbon neutral target.

## The Passive House

The passive house is a design for which Cambridge could really set an example for the whole UK.

The principle is to optimise the building hull in terms of insulation and airtightness to such an extent that the remaining heat requirement can be supplied

via the built-in ventilation system. Since these houses can exist without a separate *active* heat dispensing system, this has led to adopt the term of *passive house* to describe this form of dwelling [see CEPHEUS study: “Cost Efficient Passive Houses as European Standards”, 2001]. The heating and ventilation system of these houses is based on a small amount of electricity, which will in the medium term be supplied by renewable sources much more easily than would be possible for gas fired heating systems. In conjunction with the use of energy-efficient household appliances, this freely available design achieves the required 90% cut in emissions. Even reaching carbon-neutrality becomes possible by supplying the remaining energy-requirement of households from renewable sources. As this requirement is fairly low, there is a prospective of achieving this by installations on site.

Although there is an initial supplementary investment for the improved energy efficiency, the additional cost is kept to a minimal level in passive houses by savings made over the installation of heating and cooling systems. Furthermore, the running costs are considerably reduced because of the enhanced energy efficiency. Assuming that energy prices were to remain at the current level (this estimate is rather cautious because energy prices are expected to rise), the initial supplementary investment typically pays for itself through economies in fuel-usage in 20 years — the average payback time obtained for the 200 passive houses located in Sweden, Germany, Austria and France that were examined in the CEPHEUS study [CEPHEUS]. Projecting these savings over the lifetime of the building, the improved efficiency incurs massive savings for the occupants. In addition, passive houses feature dramatically improved air quality inside the building via its built-in ventilation system, as a health advantage for its occupants.

The tried and tested passive house concept proves that a 90% reduction of the energy requirement in buildings is possible at present market prices. The CEPHEUS study concludes that the necessary information to design such buildings is freely accessible and that “every architect in Europe can access this information and implement passive houses”.

## **Why policy intervention is necessary**

Modern housing concepts such as the one described above undeniably have numerous advantages compared to usual building standards. However, policy guidelines must intervene to establish up-to-date standards and trigger the deployment of new technologies. This need is based on the current building practice, where developers erect houses that are then sold to the occupants. Whereas the occupant would derive outstanding benefits from improved housing, the developer will design the buildings he delivers such as to maximise his own financial benefit. Efficiency does not occur in his balance as reduced running cost, but as an additional investment, and as a potential difficulty to apply new concepts that might require more development work of his part. This is why a more stringent policy requirement for efficient housing can be regarded as an act of consumer-protection.

There is also another benefit that this type of housing offers as it reduces fuel poverty, which in turn reduces the need for spending by agencies that offer support to people experiencing social and medical problems caused by such poverty.

More rigorous housing regulations on the national level are on their way (see the new building code, available at [http://www.planningportal.gov.uk/uploads/code\\_for\\_sust\\_homes.pdf](http://www.planningportal.gov.uk/uploads/code_for_sust_homes.pdf)). These regulations will initially be voluntary, but will be converted into mandatory standards afterwards. Cambridge could be established as one of the avant-garde cities demonstrating the feasibility of these new standards, and acting as a driving force for new innovations. Should the developer appeal against having to comply with these higher standards, the relevant government office would find it difficult to support their appeal without appearing to dismiss the government's own targets for housing.

## Design of the policy implementation

As pointed out above, and illustrated with the example of passive houses, highly energy-efficient buildings can be constructed at a reasonable cost. We consider it to be vital that the Cambridge City Council should establish the highest economically viable energy efficiency as a required standard for all new buildings.

Such a policy implementation should not privilege a specific design approach, but rather favour independent measures for energy efficiency to leave room for new innovations in construction and engineering. Such a measure is given by the annual energy consumption per square meter of heated residential surface, given in kWh/m<sup>2</sup>·annum of electricity.

The target efficiency should be around 15 kWh/m<sup>2</sup>·a, which has been shown to be technologically feasible and economically viable in the CEPHEUS study. Even for the current British energy mix with a large fraction of coal-fired power generation, this value converts into CO<sub>2</sub> emissions of less than 10 kg CO<sub>2</sub>/m<sup>2</sup>·a, which could serve as an alternative target efficiency.

This number is necessarily subject to revisions, as future technology may well be able to exceed even this target. Furthermore, the requirement may be slightly less stringent in the initial years of taking action, so as to enable local construction industry to train their employees and acquire experiences with the new technology.

While it is an obvious policy goal to trigger an improved planning and design for new buildings, it is no less important to improve upon current practice of inspection of completed buildings and the enforcement of regulations. It is frequently pointed out that a large number of buildings fail to comply even with the weaker present building standards [see e.g. a recent article at [www.cabe.org.uk/default.aspx?contentitemid=1769](http://www.cabe.org.uk/default.aspx?contentitemid=1769)]. The standard of inspection has declined; is it not possible for the council to take this back into its control or at the least to regulate it far more strictly?

## Ideas for possible mechanisms

In the present document, we cannot develop the local policy to the degree of detail provided in the initial draft of the SPD, however, some possible mechanisms for increasing energy efficiency shall be discussed now, and some specific comments about the draft document added in the following section.

As technologies are available today, standards for energy efficiency can be raised quickly to their target-value of  $15 \text{ kWh/m}^2 \cdot a$  (or  $10 \text{ kg CO}_2/\text{m}^2 \cdot a$ ), say in 5-8 years. Essentially, the design and all components required to realize such constructions are available today, so the fastest possible route to achieving a full marked penetration should be taken. One advantage of such a rapid progression of local standards is that the Cambridge initiative could act as a model and stimulator of innovation on the national level. Given that these plans are totally in line with current national government plans, it would be embarrassing for the government to object to an outstanding local quality initiative.

While the efficiency target can be introduced in several steps, it is important that first efficient designs are built immediately. We therefore recommend that some fraction of the houses in every new development should be built according to the highest standard from the very start.

To speed up the development of new concepts, the council could establish an annual competition for the new building with the highest efficiency. The prize should be given to buildings that were constructed the previous year and which can provide a year's worth of data on the actual energy consumed in the dwelling. A price of some £1000 would be a cost-effective measure to stimulate innovation. Alternatively, the price could be granted in terms of a reduced council tax for buildings satisfying the highest standards.

This contest could be used to gather example designs for efficient houses that could then be made available by the council to spread these concepts more widely. Such a library of best practice could prove very valuable to local developers, and possible followers in other communities. It should be kept in mind however, that such information is already available elsewhere, which can be pointed out in the final version of the SPD already now.

It could then be mandated that all future constructions should remain within some tolerance of the efficiency demonstrated in the contest in the previous year, in order to affirm progress achieved so far.

As the current policy proposition mainly deals with new developments, we have not dealt with the task of improving the existing building stock before. However, a similar contest could also be established for the renovation of existing buildings. In general, we recommend that the Council encourages refurbishments that improve energy efficiency. It has been reported by house-owners that some local regulations actually *inhibited* them from pursuing such projects. Given the high priority of reducing our carbon footprint, such barriers should be eliminated where possible.

## Other amendments

So far, this discussion has focused on the energy efficiency of new buildings, as the most crucial point to be amended in the initial draft of the SPD. This is a list of further remarks to be made.

*Essential and Preferred Standards (7.3):* The very careful wording employed in this section could be understood as an invitation to disregard the proposed measures on their whole. We propose that Preferred should be replaced by Essential or at the very least it should be emphasised that the council might withhold planning permission if these measures are ignored. It also ought to be made clear that essential standards have to be complied with in order for planning permission to be accorded. For the trade-off of preferred standards, one could adapt the point system given in the recent government code on sustainable housing, and set a minimum acceptable limit for granting permission.

*Enforcement (8):* It seems inevitable that the enforcement of these regulations should be extended to the verification of executed building measures. A possible wording for a note 8.3 would be “The City Council shall designate an independent body to verify the executed building fulfils the requirements that were agreed upon in the planning permission.” A clause for non-accordance should specify the expected fine.

*Adaptation (12):* Why does this carry a “preferred” standard? The implication is that climate change is a remote possibility which need not be taken seriously. There are more projections now for local climate change which must be taken fully into account for new buildings. We have not studied this problem in detail but it should be noted that the Clay Farm proposals have dismissed the risk of flooding for that area even though it is on the existing flood plain. This issue needs to be explored more carefully for all the Cambridge developments because climate change is expected to multiply the risk of future floods.

*Energy (13):* Again, energy usage should be a core criterion for deciding upon planning permission, not only for new developments, but also for refurbishments. Guidelines for refurbishments naturally have to be less stringent due to the higher degree of difficulty of such measures. In addition to the main discussion above, the use of district heating in conjunction with combined heat and power (CHP) deserves to be mentioned in this section. The existing method of producing electricity allows about two thirds of the energy to go up the chimney as heat. Instead of wasting this energy CHP uses it to heat houses. Micro-CHP for individual houses is not looking very promising but using it on a larger basis for a few hundred or thousand houses is now well established and in widespread use on the continent. The government target that 10 GW of “good quality CHP” should be installed by 2010 is very unlikely

to be met. An example of biomass fuelled CHP is the Millbrook project see e.g. <http://www.operis.com/ojec070112/070112i.htm> and from Peter North at 01403 224 254 and at [peter.north@poyry.com](mailto:peter.north@poyry.com); more information on CHP can be obtained from the combined heat and power association at <http://www.chpa.co.uk/>.

*Waste (15):* Biological waste can be used for the generation of electricity in anaerobic digestion processes. This should be pointed out in this section, not only in the glossary at the end of the document.

*Water (17):* Establishing rain water trapping systems, in conjunction with grey water usage in places where drinking water quality is not required can drastically reduce drinking water requirements. This is both easy to establish and cost-effective. Why not demand it as a required standard?

*Materials (18):* From the point of view of climate protection, another important point worth mentioning is the usage of materials. The current best practice for the optimisation of emissions throughout the lifetime of a material is based on life cycle analysis (LCA). For instance, a major source of CO<sub>2</sub> emissions in buildings is also due to the cement used in construction. With alternatives to common cement, huge reductions can be achieved, for example through the use of geopolymers cements [Z. Li et. al. “Development of Sustainable Construction Materials”, Proc. Int. Workshop on Sus. Devt. and Concrete Technology, Beijing China, 2004]. It should be part of the application procedure to supply a basic LCA of the employed materials. The council could establish a database for materials commonly used in construction to facilitate this task. It would also be sensible to establish a materials white-list that provides information about particularly suitable material choices.

A recent project entitled reuse of foundations in urban sites (RUFUS) deals with the problem that foundations often have to be renewed when new buildings are constructed on old sites. This could be avoided if there were proper documentation about the existing foundations. It could be demanded that such documentation is required for all new buildings.

## Bibliography

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