Ken Dale Travel Bursary Report 2010

Area Energy Strategies

Becca K O Warren

CIBSE Ken Dale Travel Bursary report 2010

“It is particularly ironic that the battle to save the world’s remaining ecosystems will be won or lost not in the tropical forests or coral reefs that are threatened but on the streets of the most unnatural landscapes of the planet”

Worldwatch Institute, 2007

CIBSE[1]

The Chartered Institution of Building Services Engineers received its Royal Charter in 1976. It is the professional body that exists to: *'support the Science, Art and Practice of building services engineering, by providing our members and the public with first class information and education services and promoting the spirit of fellowship which guides our work.'*

Ken Dale Travel Bursary

The Ken Dale travel Bursary gives a building services engineer the opportunity to travel outside of their home country for up to a month to study a matter of interest to themselves, their employer, their clients and the industry. Applications are open to members in the 'developmental stages of their career'. Applications are requested by the end of February and winners are expected to present their findings to the CIBSE council in October and submit a technical report of around 5000 words. More information regarding applying and about Ken Dale can be found at http://www.cibse.org/index.cfm?go=page.view&item=949.

Disclaimer

This report is the result of research carried out during a month's travel around Northern Europe. As such it is a relatively subjective, 'snapshot' view of each area and based to a degree on anecdotal evidence. Therefore it may not accurately describe the reality – only my own, brief, experience of it. Also the projects chosen were those that were available to view and those that people had promoted. There are surely many more projects deserving of inclusion in such a study and if I have offended anyone by their omission then I apologise and ask that you please get in touch so I can come and visit you on my next trip. Every effort has been made to double check facts and figures and include references for sources of information. Where errors or omissions do occur they are entirely my own.

Trip Statistics

Over four weeks I visited five countries and travelled a total of 5027 kilometers. I did the majority (5273km) by train, 400km by folding bicycle, and the rest on ferries, cars, buses and trams. The overall carbon emissions resulting from my trip came to 273 $kgCO_2$[2]. Had I done the four longest legs of my journey by plane – London to Hamburg, Malmo to Stockholm and back, and Copenhagen to Amsterdam the effective travel emissions would have been 1,349 $kgCO_2$, roughly five times as much. More to the point I would have spent ages sitting around airports waiting to check in, been cramped into small seats, with awful food, missed out on travelling through the countries I was visiting and arrived in the middle of nowhere. Instead I had comfy seats with a great view and was able to breathe the air on the way. I arrived in the middle of the towns and cities which were my destination and was immediately mobile as I was able to take my bike with me.

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[1] www.cibse.org

[2] Based on Defra figures of $kgCO_2$ per passenger km as follows: international rail=0.0534, national rail = 0.0611, bus=0.1339, car = 0.2235, tram 0.0611, ferry=0.1152, flights = 0.1715 (multiplied by 2.7 radiative forcing effect multiplier, as calculated by the IPCC, to account for the greater impact that emissions have at altitude)

Thanks To:

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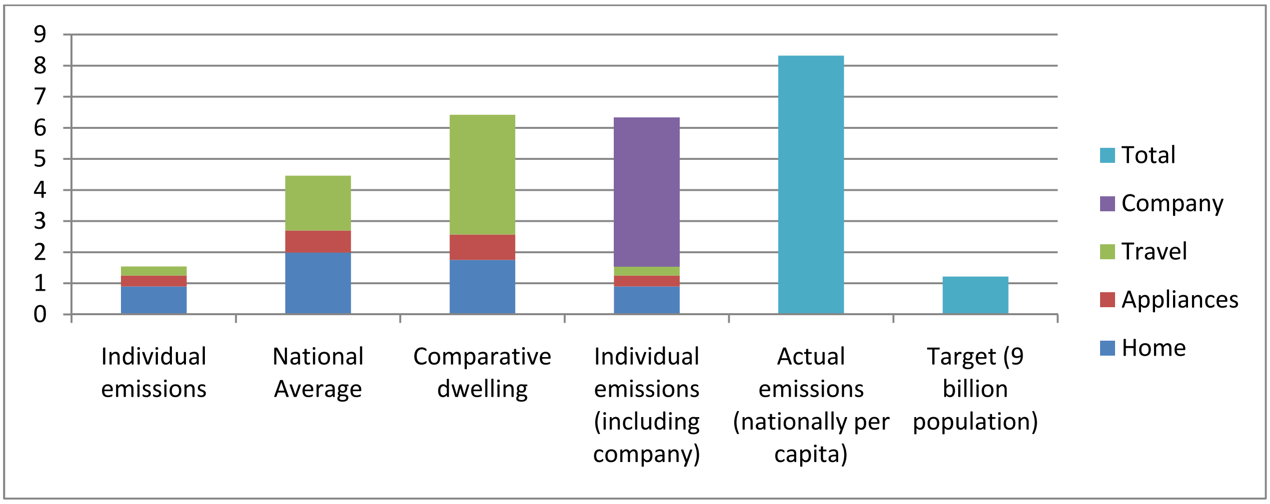
A Question of Energy?

In the past few years there has been an increased interest in district energy in the UK. This has been driven by the low carbon agenda, by legislation dictating requirements for on-site generation and by the combination of rising fuel prices and reducing technology costs. We are now at the point where it is discussed at master planning stage for most developments. During these early stage discussions the entire scope of a developments sustainable aspirations is laid out from biodiversity action plans, site waste and water management to community ownership and energy strategies. These are then translated into reality by the design team, albeit with varying degrees of success.

Given the prevalence of district energy schemes in Northern Europe I was interested to examine the procedure by which these had come into being. I wanted to understand how and why the decisions to were made to address energy locally and how schemes were implemented.

I was also keen to understand the part that energy plays in the bigger picture of sustainability, especially, given the nature of the study, transport. Although buildings are our biggest users of energy transport comes a close second. This is clearly illustrated in the chart below:



Comparisons between my overall carbon footprint (tonnes of CO_2 per annum) and national averages

The above was based on the 'Act on CO_2' carbon calculator[3] with my emissions from this journey added on. The company emissions which are added onto the fourth column are per full time employee and, although they more than treble my emissions, are 18% lower than they were two years ago following an in-house reduction programme. Also the national average quote by the website is based on those emissions within our control – taking services and government emissions into account adds another four tonnes on per person to the figures shown here.

Given our ultimate target, for one planet living of 1.22 tonnes of CO_2/person/annum we are surely looking at a reduction in what most people would currently view as an acceptable standard of living and widespread uptake of alternatives to our current technology. District energy may be one part of this.

[3] Available for anyone to use online at: http://carboncalculator.direct.gov.uk/index.html this is the 'government-preferred' carbon calculator

Introduction

The Global Increase in Urban Living

In 1800 only 3% of humanity lived in cities but in 2008, that figure had risen to over 50%. By 2030 it will be more likely 80%[4]. Globally there are 468 cities of over one million[5] people, and 19 of those are 'megacities' with over 10 million inhabitants. Over and above this, many more –most of us - live in towns and big villages, or in other words, in dense communities.

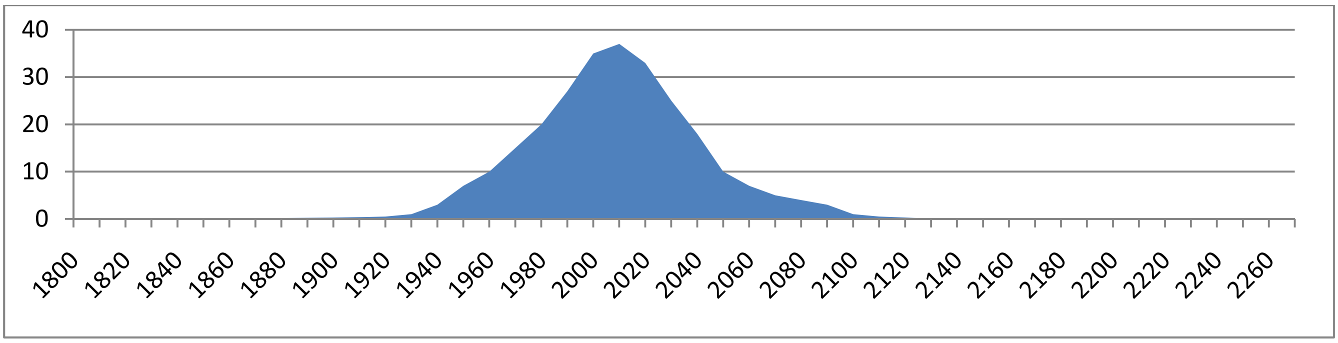
Covering only 3% of the land area of the globe and yet generating most of the world's income from goods and services (85% GNP in high income countries)[6] the urban environment gives great opportunities for advancement in numerous fields from technology and science to arts and culture. Education, health care and other social services cost less in cities per capita than in rural areas. High density living and the combination of residences, commerce, leisure and industry has the potential for sustainable communities – energy efficient with a good spread of energy demand from a variety of users.

The challenge is to find a way to maintain cities, to make them functional, sustainable, enjoyable places to live. Cities will always rely on input from outlying areas in terms of food and fuel but must as far as possible learn to close the circle of consumption and waste.

Urban areas are typically more affluent than rural areas and therefore better able to find local financing for major projects. With a reliance on imported energy, food, fuel and water cities are highly vulnerable to the impacts of climate change but they also have a great potential to instigate innovative solutions to its impacts.

The Move to a Low Energy Lifestyle

Global energy use is rising as population figures and consumption levels increase. Predictions for remaining oil, gas and coal vary but all agree that they are running out with many studies indicating that oil at least has already peaked. In years to come the sudden availability, and subsequent loss of widely available fossil fuels will be visible as a brief spike.



[4,5] State of the World Population 2007, George Martine, published by UNFPA available online at www.unfpa.org:80/swp/2007/english/introduction.html
[6] British Council 2008 www.britishcouncil.org/spain_society_cityofthefuture_english.pdf

World oil production in 10 billion barrels per year (based on Hubberts curve[7])

As we descend into a post peak world remaining reserves will become more precious. Developed countries, with their dwindling indigenous reserves, will be increasingly dependent on energy imports plunging people into fuel poverty.

The only logical conclusion has to be that we must move away from fossil fuels. A low carbon future is not only the best way forward, but indeed the only way. For decades the development of many cities has been reactive – responding to cheap energy and rapid growth with sprawling suburbs. But a more proactive approach which combines high density living with open spaces accessible to all, rapid and affordable public-transit systems, local food production and waste treatment is being recognised as the route to successful urban development.

Local (Urban) Energy Strategies

Energy affects every aspect of our lives and the energy we use in our buildings accounts for over half of all we use. Despite this we have created a culture where most of us are unaware of where our energy comes from and do not exercise much care in the use of it. As our reserves of cheaply available fossil fuels reduce and energy prices rise accordingly we will need to become smarter both in our generation and use of energy. In the UK, with large remote power stations, almost half of the energy generated is lost as heat to the atmosphere or wasted in transmission. By making our energy choices at a local level we not only reduce transmission waste but we also raise awareness regarding our energy usage and thereby promote energy efficiency.

The primary focus of this study was the energy choices made by or on the behalf of communities, either by local government or by community groups, especially those that have made unusual and forward thinking decisions. By the nature of this all of the locations studied had a strong local energy strategy whether it had come about as the result of a conscious decision or had been built up to by a series of events with various drivers.

Peak Everything

As our access to cheap energy runs out every area of our lives will be affected from mobility to food. Furthermore - as we eat through the available resources of fossil fuels we are also consuming other natural resources critical to our current mode of living[8] from minerals such as iron ore, copper and uranium (all of which have already, according to some studies, passed peak production) to the natural ecosystems of the planet with 36% of species currently threatened with extinction[9]. Ultimately most of the choices we make can be viewed as a matter of resource use and conservation; from fossil fuels to water, from land to the ecosystems that inhabit it. So energy usage cannot be viewed in isolation. As buildings are only part of the energy story, so energy is only one facet of sustainability. Of the places visited on this trip many of them have also found innovative ways to address the associated issues. What follows is a précis of some of the main concerns.

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[7] Information available from the oil drum www.oildrum.com
[8] Andre Diederen, www.theoildrum.com/files/20090627_TODASPOSummit_Diederen_Elements%20of%20hope.pdf
[9] International Union for Conservation of Nature and Natural Resources (IUCN) Red list http://www.iucnredlist.org/

The Bigger Picture - Transport

The urban environment has great potential for energy saving in the field of transportation both by reducing the distances between home and workplace and in the viability of providing public transport and effective walking and cycling networks. In high density Hong Kong only 5% of earnings are typically used for travel costs as opposed to sprawling Houston where they account for 20%[10]. Cycling and walking do not only reduce energy use and save time and money, they reduce pollution and improve public health through reduction in traffic accidents and improved fitness (a study of 60,000 people in Copenhagen showed a 39% reduction in death by any cause for regular cyclists[11]). But to promote cycling as a viable option the dangers – both real and perceived – the number one reason people cite for not cycling[12], must be addressed. The only guaranteed way to reduce cyclist accidents is to increase the number of cyclists[13] – for every doubling of cyclists numbers accidents have been recorded as dropping to one third. To reverse the catch 22 situation where lack of cycling infrastructure deters cyclists making it more dangerous to cycle, city-wide infrastructure which allows people to safely access all parts of the city must be created. This will attract cyclists, leading in turn lead to safer cycling, and more cyclists.

This trip included numbers 1 and 3 of the top ten cities in the world for cycling – Amsterdam and Copenhagen[14]. In both of these, and also in Malmo and Stockholm cycling has been prioritised by local councils with the introduction of many kilometres of cycling routes, secure cycle parking, government funded bike hire schemes, and legislation which places the burden of guilt on drivers in collisions with cyclists, known as 'strict liability'. These tactics have reversed a decline in cycling numbers, in Copenhagen to the point where 55% of all journeys within the city centre are by bike.

Left: Rush hour in Copenhagen – cyclists have priority at crossings, traffic light timings on the main arterial routes into the city mean that during rush hour cyclists travelling at 20kmh can 'ride the green wave', without stopping, to the centre. Right: Multi-storey 9000 place bike-park at Amsterdam Central train station

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[10] http://www.guardian.co.uk/world/2011/jan/14/population-explosion-seven-billion
[11] Andersen, L., Schnohr, P., Schroll, M. and Hein, H. (2000) All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work, Archives of Internal Medicine, 160, pp. 1621-1628.
[12] A qualitative assessment of attitudes to cycling MAYES M, Accent Marketing and Research, HALLIDAY M, Transport Research Laboratory and HATCH 0, European Cyclists Federation, available to download at http://www.etcproceedings.org/paper/a-qualitative-assessment-of-attitudes-to-cycling
[13] http://www.ctc.org.uk
[14] Full list available at www.virgin-vacations.com/11-most-bike-friendly-cities.aspx

The Bigger Picture - Water

Another natural resource which comes under pressure with increased population density and is therefore a critical component of urban development is water. In the first instance the safeguarding of potable water supplies using water efficiency, rainwater harvesting and water re-use strategies are required.

But the water issue extends far beyond these considerations. The potential for future sea level rises and more extreme water conditions (1:1000 year storm events and droughts) need to be accounted for in designs. Where development replaces previously permeable surfaces with hard standing and buildings so landscaping must allow for the removal of storm water run-off. In Augustenborg, in Malmo the basements were frequently flooded and so new green spaces were created between blocks of flats with attenuation ponds and rain gulleys with cobbles to encourage the flow of water away from the buildings. Combined with green roofs and re-greening previously paved areas this has addressed the flooding issues and also created beautiful spaces.

Stormwater control, Augustenborg Left to Right: Attenuation pond, gulley, swale and green roof

In some places visited during the study little concern was demonstrated regarding future sea level rises even in relatively low lying regions but in the Netherlands the Water Board, the oldest democratic society in Europe, holds a position of power that allows it to shut down any construction project with immediate effect if it suspects that the security of the national system of dykes may be impaired. Despite reluctance to invest in renewable energy the Dutch government has committed one billion Euros of funding per year for the next two decades to research into sea level rises and sea defences. Rotterdam has established itself as a world expert in delta city water management. With hundreds of years of experience in the field the Dutch do not fear sea level rises, but neither do they ignore them and they are now turning this potential threat into an opportunity.

The Bigger Picture - Waste

The provision of food and the removal of waste are a problem that is many ways made more complicated by dense living. Greater access to urban gardens, vertical farming and local composting, and waste to energy facilities are some of the solutions employed to address these issues.

Waste chutes in Hammarby Sjostad, Stockholm – waste is collected by suction at the edges of the development to reduce traffic. The green (compost) chutes are locked and the householders provided with keys following problems with insertion of non-organic waste.

In Malmo, Sweden waste from the town is fed into an energy-from-waste (EfW) CHP plant that provides heat for the whole of Western Harbour. Within the development grinders besides kitchen sinks feeding waste chutes are provided within people's homes and the resultant sludge is used for biogas generation. The first does contradict the development's sustainability in that it relies on waste from a much larger populace but it goes some way to dealing with waste locally and changing a problem into a solution. In a severely resource constricted future where the vast majority of our waste is biodegradable we may move away from incineration towards anaerobic digestion plants which will provide, heat, electricity and compost.

The Bigger Picture - Food

The elephant in the living room for many environmentalists and barely recognised as an issue by planners or developers the provision of food for a growing population, especially to city dwellers who are generally far removed from the source could ultimately prove our biggest threat to social stability. Little progress has been made in this area in any of the places visited as part of this trip.

Garden in the sky – Olive trees on the top floor of the Ministry of Justice, the Hague

On a grassroots level community kitchens have been set up in a number of cities with a view to reducing food waste and providing nutritious food to those in need. One such organisation was visited in Sweden where every Monday evening a banquet of food is provided free of charge or for a donation to those who can afford it in a large community hall. Food gathered for the meal but not used in the cooking was left for anyone to take away. Back home in the UK Food Cycle[15] has set up a model for a similar operation, repeated throughout the UK along the lines of the longstanding 'Food not bombs'[16] groups. These organisations not only reduce waste and provide food to those in need, but also promote social cohesion and offer personal development opportunities to a team of volunteers. They also stress a need to move away from meat due to the practises of factory farming and the land use and carbon emissions associated with a meat based diet.

It is interesting to note that food production is covered in Greenstar , the Australian version of BREEAM, whose draft Communities scheme includes a 'local food' credit. This sets a target of 50m² of land for food production per person to provide 'food security' but recognises the following as making a valuable contribution

- 12m² of land for food production per dwelling
- Access to a local farmer's market
- Funding and space for as local food co-op
- Community supported agriculture fund for farmers within a 200km radius of the development.

To put this level of land requirement into perspective 50m^2 per person in Manchester would result in a requirement of some 23 million m^2 of growing space, around 20% of the land cover of the city and metropolitan borough area. An increased level of local agriculture would lead to a greater awareness of food issues, improved public health (due to both the physical exercise involved in growing the food and the benefits of fresh produce) and properly managed would enhance biodiversity and ecology and create green corridors linking wildlife habitats outside cities.

[15] http://www.foodcycle.org.uk/
[16] http://www.foodnotbombs.net/

The Bigger Picture - Placemaking

Whilst energy, water use and transport can be subject to a technical design process the creation of sustainable communities ultimately rests with the communities themselves, in other words the people. For this reason placemaking – or placeshaping in the case of existing communities – is another key element. By creating a high quality public realm and spaces where people are happy to spend time we promote happiness and social cohesion but we can also save energy. Clever use of passive design, ensuring that areas where we expect people to gather are sheltered appropriately to the climate makes the most of ambient energy.

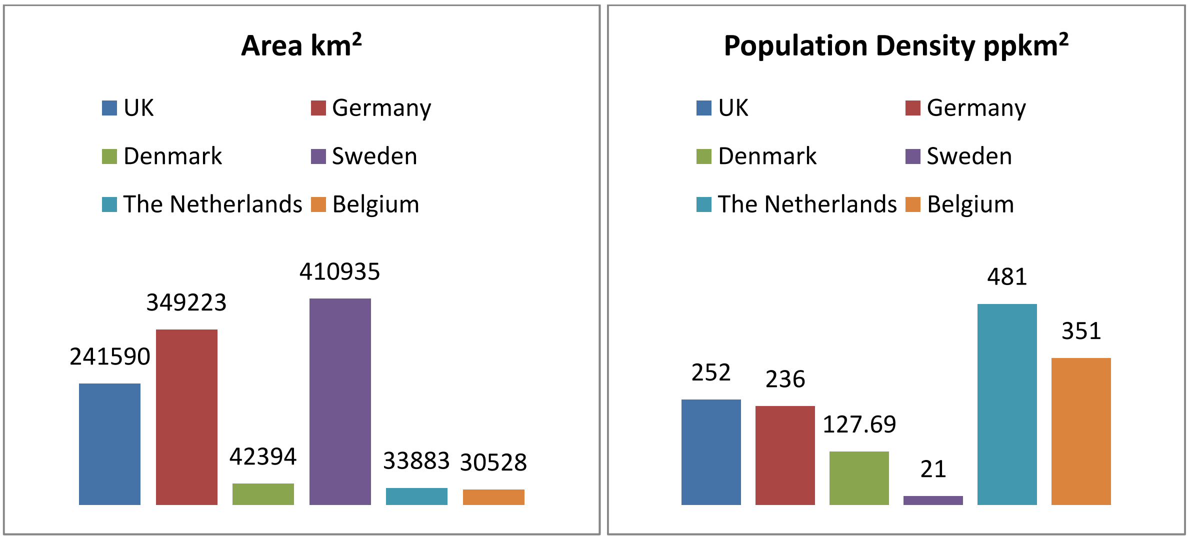
Great Placemaking: Left: Pocket Park, Western harbour, Malmo, Centre: MediaCityUK, Salford, Right: Waterfront at Hammarby Sjostad, Stockholm

By massing buildings and planning planting correctly we can reduce heat islanding, allow cooling breezes and yet prevent howling gales and create spaces that provide suntraps and sheltered spots. Where we deliberately create outdoor spaces without awareness of these issues we invite the use of additional energy to make them suited to the use that people put them.

For example - in the centre of Malmo, one of the greenest cities in the world, a whole square of restaurants and bars lights up hundreds of gas fired patio heaters every evening to protect their diners. This is mirrored in hundreds of thousands of public houses across the UK who have followed suite since the introduction of the smoking ban, heating up the night and, quite literally, throwing energy away.

Country Comparisons[17]

The countries visited on this trip enjoy a similar climate, culture and political landscape and yet there are marked differences in size and population density. These could, at first glance, account for variations in the percentage of renewable energy uptake and yet would seem to have depressingly little effect on carbon emissions per head of population.

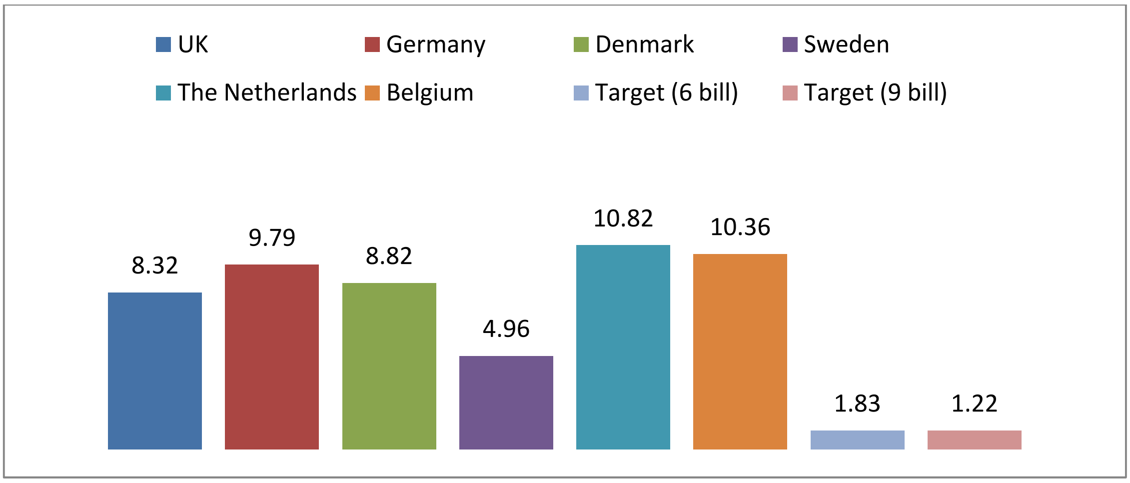


Comparisons of size and relative population density

This study was initially intended as a series of comparisons between countries and how national policies and attitudes had affected the adoption and interpretation of sustainable development. Wherever I travelled, though, I found strong regional or local drivers, frequently at the level of individuals, which did not necessarily relate directly to national policy. For this reason I have chosen to focus on a number of key lessons and illustrate each with relevant projects, regardless of country. It is hoped that this approach will result in a more informative, useful and fair report rather than a comparison between countries. Before my trip I attempted direct comparison of the countries I would be visiting, considering carbon emissions - both per capita and per household. I looked at fuel imports and uptake of renewable energy and reduction in carbon emissions. Whilst it could be concluded that larger size and low population density make for lower emissions the correlation is certainly not directly proportional. From the above we can see that Sweden is the largest but only by a small proportion. It has by far the lowest population density, less than a fifth that of Denmark, the next least densly populated. The Netherlands on the other hand is very nearly the smallest, less than a tenth the size of Sweden and by far the most densely populated. So what impacts do these facts have on carbon emissions?

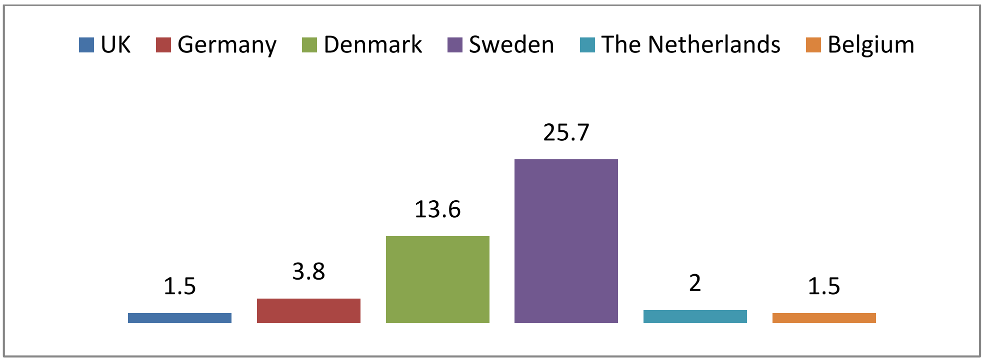
From the above we can see that Sweden is the largest but only by a small proportion. It has by far the lowest population density, less than a fifth that of Denmark, the next least densly populated. The Netherlands on the other hand is very nearly the smallest, less than a tenth the size of Sweden and by far the most densely populated. So what impacts do these facts have on carbon emissions?

[17] Data from European Commission epp.eurostat.ec.europa.eu/portal/page/portal/sdi/indicators and international energy agency www.iea.org



CO_2 Emissions per Capita (tonnes per annum)

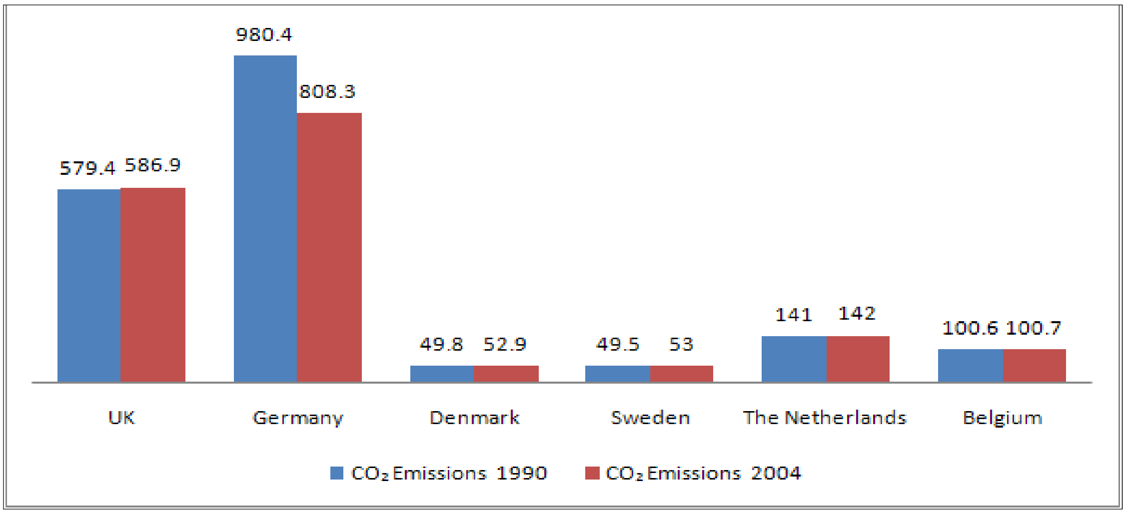
The above shows that the densley populated Netherlands has the highest per capita carbon emissions, but by no means proportional to their population density. Sweden, the largest and least densely populated has a relatively high renewable energy provision (26%), the bulk of this being due to well established large-scale hydro. But they also have a heavy reliance on nuclear power (37%) resulting in a low carbon grid intensity. This is despite a referendum in the 80's when people voted firmly against nuclear which meant that no new nuclear was built. Now, however, with reactors coming to the end of their lives, the possibility of new nuclear is back on the cards and increasingly being accepted as a necessary evil. Sweden have also had very tight building regulations for decades with a variation on the Passivhaus standard currently being required in new build domestic.



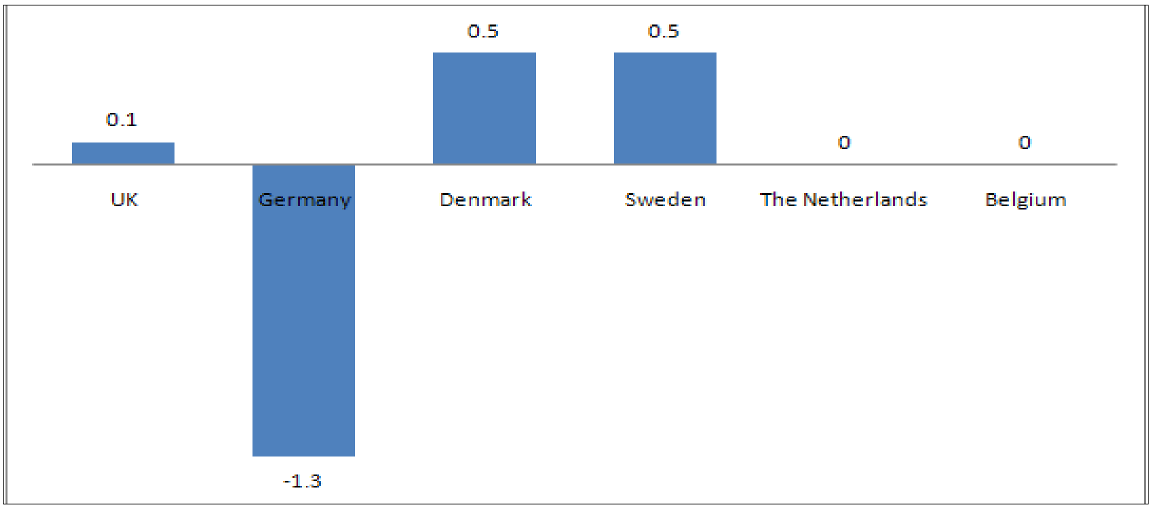
Renewable Energy as a percentage of Primary energy consumption

This combination of factors gives Sweden relatively low carbon emissions (less than half of the others) and an annual per capita emission of 4.96 tCO_2. To put this in context, however, an equitable target for carbon emissions would be 1.83 tCO_2 per annum per person, based on humanity needing to reduce its emissions to half of 1990 levels, at current population levels. When population peaks at a predicted 9 billion then this figure drops to 1.22 tCO_2 per annum.

An alternative way to view it would be to compare levels of improvement in carbon emission reduction. This paints an even more depressing picture with Germany (just) in the lead[18], being the only country in the study with any overall reduction in carbon emissions between 1990 and 2004



Changes in CO_2 Emissions between 1990 and 2004 in Million Tonnes of CO_2



Changes in CO_2 emissions 1990-2004 by annual percentage

Ultimately comparisons between countries are unhelpful, if not impossible and given the urgency of the problem at hand there will be no winners if we do not address the need for low carbon living and learn from the best practises both in our home countries and in others.

Despite similarities between countries and cultures there would appear to be many more differences than similarities and it would not be possible to carbon copy a countries approach in another. Even if this approach were possible, none of the existing approaches are demonstrably successful enough to make it desirable to do so.

[18] From World Fact book http://www.allcountries.org/ranks/carbon_footprints_emmissions_of_countries_1990-2004.html

In conclusion then, we must take the best practices from each country, region and project and adapt and implement these where possible.

The following key lessons were identified as crucial to successful low carbon projects:

1. Governmental policies
2. Integrated design teams
3. Monitoring and feedback
4. Stakeholder engagement
5. Focus

These are explained in more depth in the following pages and illustrated with case studies of projects where they have been successfully implemented.

Key Lesson One: Governmental Policies

Policies can be either a 'carrot', such as a feed-in tariff, or a 'stick', such as the Carbon Reduction Commitment (CRC) and can come from any level of Government. Some examples are:

- European Performance of Buildings Directive (EPBD) which comes from a European Parliament level, although the implementation is up to individual country governments and requires buildings to measure energy performance both at design and during operation, set targets and (in publicly funded) display the results of this.
- Feed in tariffs, generally set by central Government to provide a guaranteed income for energy generated by renewable means, discussed in greater detail below.
- 'Merton-Rule' type policies set by local Government where new developments over a certain size are required to have a minimum percentage of renewable energy generation on-site.

Not all policies that affect carbon emissions are designed with that in mind and not all policies which are aimed at emission reductions have the desired effect. Overall, though, Government policies at every level can have powerful results. Three examples are discussed in more detail below – the German Feed in tariff, the energy taxation in Denmark and a council engineering department led initiative in Skive, again in Denmark.

Germany - Feed in tariffs

A feed in tariff guarantees a price for renewable energy for a fixed term. Combined with a legal requirement for electricity network operators to allow people to feed in this provides a secure climate for investors and stimulates markets for equipment suppliers and installers. Studies have identified the following factors as being critical to the success of a Feed in tariff[19].

- Grid operators must be legally required to allow connection to electricity producers.
- Utilities must be legally bound to purchase electricity fed into the grid.
- Price paid and the timeframe over which they are paid must be mandated.
- The price should be technology specific, long term and sufficient to ensure a reasonable profit.
- An annual digression rate for tariffs should cause them to reduce each year to promote technology development and cost cutting.

Germany first considered a feed in tariff in 1979 and introduced the first legislation in 1990 which guaranteed a price of 65-90% of the price to the consumer for electricity generated by small hydro and wind installations. In 1998 the deregulation of the electricity markets reduced the cost to consumers which in turn reduced the prices paid to producers. In response to this the Act on

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[19] http://www.e-parl.net/eparlimages/general/pdf/080603%20FIT%20toolkit.pdf Success story: Feed-In Tariffs Support renewable energy in Germany from climate parliament website http://www.climateparl.net/home.do an e-group of legislators from around the world working together to promote and develop cross party networks to tackle climate change

Granting Priority to Renewable Energy Sources (2000)[20] introduced fixed rates, a 20 year timeframe and profit-based, technology specific prices for a wider range of technologies (with a premium for photovoltaic systems). The feed in tariff is financed by a cost sharing mechanism by which the impact is passed onto end users. At a typical cost of €1.50 per household per month it is sufficiently low to be accepted and this mechanism decouples the scheme from the national budget making it resistant to changes in political power.

Results of the German feed in tariff Left: Solar and wind farm, Centre: Biogas Installation, Right: Rooftop Solar PV array - on a solarium

Over the next four years renewable electricity in Germany from wind power and biomass doubled and that from PV increased nine times. The renewable industry in Germany increased its turnover by €5.2 billion – over 30% between 2005 and 2006 and is expected to employ 500,000 people by 2020

Case Study: Schleswig-Holstein

Schleswig Holstein is the most Northern of the sixteen states that make up Germany. It lies between Denmark and Hamburg and between the Baltic and North Seas, with over half of Germany's total coastline.

Key Facts:

- Area: 15,763 km^2
- Population density: 179.6 $ppkm^2$ (lower than the national average but higher than Denmark)

In 2010 Local government achieved their target of half of their power coming from renewable energy. To reach this required installation of the following technology:

- 2600 turbines (providing a third of the power and covering 1% of the land area)
- 10,000 solar thermal installations
- 1,300 PV facilities
- 80+ biogas plants.

The majority of the biogas plants are pig farmers who use the gas generated for heat but an increasing number are electricity provides (see below). RE Power, producer of the world's largest wind turbine are based here and over 5000 people are employed locally wind energy. Many of these

[20] http://www.solarpaces.org/Library/Legislation/docs/EEG%20English.pdf English version of the Act on Granting Priority to Renewable Energy Sources 2000

are in 'repowering' -where existing turbines are replaced with larger, more efficient models before the end of the life of the turbine and the old ones refurbished and used in developing countries. Wind farms can double or even treble output with this approach without increasing their land take.

Although some schemes, especially the off shore arrays, are corporate concerns many have brought energy production into the hands of small groups and individuals. This in turn has helped to raise local awareness of energy issues to the point where recently public backlash against plans to put a CCS CO_2 storage facility in the region has driven the company involved to look elsewhere.

Case Study - Schweslig-Holstein Biogas installations

20 years ago farmers in the northern region of Germany were struggling to survive by traditional means but the feed in tariff has given them a lifeline. Most have incorporated wind turbines or wind farms run by co-operatives into their operations and, more recently PV arrays. As a higher feed in tariff is available for roof top arrays it is usual to construct additional buildings for mounting PV rather than have stand alone arrays. In the last couple of years there has been a sudden move towards biogas installations which was not anticipated by the politicians and so has not been properly regulated. The feed-in tariff pays for electricity produced by biogas with a premium for 're-growing' feed stock (which includes harvested crops such as maize but rules out cow manure). This has resulted in manure being avoided as a feedstock and meant that land which could otherwise have been used for food crops is being turned over to fuel production. As these commercial plants are set up principally for electricity production heat is frequently wasted and although gas can be fed into the gas mains there is some resistance to this and insufficient financial incentive to make it attractive.

The proximity to the border highlights a problem with the disparity in the laws between Denmark and Germany. In Denmark it is illegal to feed electricity produced with biomass which can be classed as a food stuff (for example rape seed and maize) into the mains. It's not illegal in Germany and so these crops are trucked across the border and sold to the German biogas plants. This transportation increases carbon emissions associated with the production of the maize and in many cases is likely to negate the benefits – but because it is financially profitable it still happens.

Denmark - Energy Taxation and Competitions

Despite their disparities with the Germans over electricity produced with biomass the Danes have found their own successful driver for energy efficiency and renewable energy in the form of high energy taxation. Denmark introduced it's first energy tax in 1917 on petrol[21] and in 2006 received 6% of GDP in the form of environmental taxes – by far the highest in the EU[22]. Danish energy taxes comprise three parts – energy use (introduced in the late 1970s), CO_2 emissions (being one of the first countries in the world to do this) [23] and on SO_2 emissions (introduced in 1996). Raises in 1998 resulted in approximately 30% rise on a typical heating and power bill. The Danish Environmental

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[21] http://www.iea.org/textbase/pm/?mode=pm&id=1573&action=detail

[22] http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/economic_analysis/tax_structures/Country_tables/DK.pdf

[23] Economic Instruments – Charges and Taxes – Energy Taxation Denmark www.economicinstruments.com/index.php/climate-change/article/120-

Protection Agency calculates that 13.5 million tonnes of CO2 equivalent have been avoided between 1990 and 2001 due to taxes. Impact on industry has been mitigated by at first exempting VAT registered companies and, more recently, exempting the power used for heavy industrial purposes. The burden on householders has being reduced by reducing income tax but made people much more aware of their energy use and prepared to invest in energy savings measures in their homes. The majority of people spoken to in Denmark during my visit commented on their high heating bills and said it was a major part of their household expenditure. A feed in tariff has finally been introduced in June 2010 but given its low rate (equivalent only to the price paid for electricity) it's unlikely to be a driver for installations.

Secondary glazing on an old building in the centre of Viborg – historic Capital of Denmark. Triple glazing is not uncommon on new builds.

Case Study - Skive Council

In Skive municipality the council's team of four engineers have overseen, over the past 20 years, the installation of renewable energy on almost all of the council's buildings, about 400 in total including 50 schools.

In the basement of the town hall are three biodiesel CHPs (25kW elec, 40kW thermal) which, combined with 273m² of solar thermal collectors on the roof, does all of the heating and most of the electricity for the 5000m² building. Due to the laws regarding feedstock of biomass boilers none of the electricity is fed into the grid. An absorption cooler serves the server rooms and the politicians chambers (to combat the hot air produced in there one presumes). A heat pump is used to create an 800m² ice rink outside the post office between December and March. They have a 32,000 litre underground storage tank for rainwater which is used for toilet flushing, laundry and cleaning. This provides for more than half their water consumption. The 1kW vertical axis wind turbine on the roof is the third one they have tried and is producing well below its rated output, despite being on one of the tallest roofs in the town. The building is naturally ventilated (as are most new non-domestic buildings in Denmark) with the central corridors leading to an atrium on timers and the offices controlled by CO_2 sensors. The roof also sports a small PV array. The new town hall site a few hundred metres away will boast a ground source heat loop and they have been testing an ORC (Organic Rankine Cycle) engine to generate electricity from waste heat (currently they have a two dry coolers and an evaporative cooler to dissipate this). Using the town hall as a test bed for various technologies and gathering data from all of the installations has allowed them to justify increasingly larger spends on renewable energy.

Left to right: Gravity filtration of biodiesel at Breum school, pellet production, Skive town Hall roof

The municipality is home to Skivehus School, with the largest PV array in Denmark and Breum School where in addition to solar thermal they manufacture their own biodiesel from rapeseed and biomass pellets from the waste. The pellets are burnt in the school boiler during term time and in the holidays bagged up and sold. The equipment is maintained by the council engineers, not school maintenance staff, who replace equipment before the end of its service life, as technology improves, and manufacture a lot ancillary equipment themselves in their own workshops. The excess heat from the solar thermal arrays on the schools is dissipated in summer by turning the heating to full and opening the windows. Back up gas boilers are provided but they are not used.

Skive is great example of how a small group of dedicated people can make a difference and how rigourous monitoring and reporting are necessary to demonstrate energy savings and achieve buy in.

Sweden – Building regulations[24]

Sweden's building regulations have required minimum U values and double glazing in dwelling since 1960. This was driven by comfort rather than energy efficiency which first became an issue following the oil shocks of the early 1970s. In 1975 U values and air tightness requirements were set which would not be mandatory in the UK for another 35 years.

Element	Sweden 1975	UK 2006	UK 2010
Wall	0.3	0.35	0.2
Roof	0.2	0.25	0.13
Floor	0.3	0.25	0.2
Windows	2	2.2	1.5

Comparison of U values in Building Regulations Sweden – UK

In addition heat recovery was required on mechanically ventilated dwellings.

[24] Energy Aspects in Swedish Building Legislation of the 20th Century Concerning Dwellings http://www.byfy.lth.se/Publikationer/semuppg2004/JSmeds.pdf

These, combined with a national energy strategy which drove large uptakes in Nuclear have resulted in very low national carbon emissions. In 1988 however the U values were changed to an averaged figure which has resulted in some confusion with planners not always able to understand the calculations submitted by contractors. Also a move to allow the removal of heat recovery where heating is by renewable means has led to an increase in energy use. There is no mandatory requirement to meter individual properties for heat and hot water and a seemingly national disinclination to do so. In Hammarby Sjostad I was informed that this would be seen as ‘unfair’ in blocks of flats where the corner flat or those at the top might experience greater heat losses and so have higher heating bills than those centrally located. Of course, where people are not responsible for their individual energy use then they have no incentive to reduce it.

Energy Policies – Conclusions

Energy policies are key to reducing carbon emissions. To be effective they must enforce building standards and fuel use efficiency, promote installation of renewable energy generation and govern national energy strategy. These three aspects must work hand in hand and must line up with those of neighbouring countries. A combination of punitive (taxation) measures for energy wastage and rewards (feed in tariffs) for energy generation are most likely to be successful. Legislation must be updated regularly to take account of developments in technology and made as simple to understand and follow as possible.

Key Lesson Two: Integrated Design

Initially developed in the second world war to streamline weapons development, integrated design was widely adopted by the manufacturing industry in the 1980's and eventually found its way, in a recognisable form, into construction in the 1990's.

Integrated design includes all members of the design team from the beginning of the design process and typically has a greater degree of involvement from the client end. Architects become guides to the process rather than the lead designer. Design philosophy is established by consensus at the start of the process and targets and strategies are clearly communicated to all team members at every stage. Budgets are not separated between systems – reflecting the fact that a greater spend on Building fabric or HVAC equipment may save money elsewhere in e.g. on capital cost of cooling systems or operating costs. An energy specialist is a part of the design team and provides energy simulation to guide the design. The key difference is that rather than a linear process integrated design is iterative. Ideally the operators and occupants of the buildings should be included and the process should extend beyond practical completion to include operation and monitoring.

Combined with modern software tools such as BIM, integrated design has the capability to reduce design time, provide greater accountability, produce buildings closer to the client's requirements and take into account the needs of all stakeholders. 'Ownership' of the design is felt by all team members who learn through the process and develop a greater understanding of the roles of each other. This means that team members who may have traditionally been involved towards the back end of the process need to be involved at early stages and building service engineers especially, with their knowledge of energy use and generation need to be involved right at the start.

Despite the benefits of integrated design it's use is still to be widely adopted within construction. Barriers to achieving the integrated design process have been identified by the University of Salford as follows[25]

1. A lack of understanding by the client of their role in the process
2. A lack of incentives for design professionals to change their traditional patterns of working
3. The adversarial nature of traditional procurement on a design-bid-build process
4. A lack of knowledge and a code of practise for integrated working.

Some move towards integrated teams has been forced by a change in the way the UK government procure for example education and health projects where teams are expected to form to bid together for projects and demonstrate their design capabilities at tender stage. However these integrated design teams are, more strictly speaking, coalitions comprising a number of different companies with different organisational structures and working cultures, maybe just a temporary

[25] The Influence of a Collaborative Procurement Approach Using Integrated Design in Construction on Project Team Performance, Forgues D, Koskela L, University of Salford www.usir.salford.ac.uk/9358/

arrangement rather than true integration. They also do not usually include the operational team and so the process breaks down at handover.

Case Study – Viverion Social Housing Association, Lochem

Although increasingly tight building regulations and the EPBD are drivers for improvements in buildings in Holland social housing organisations have chosen to target higher levels of energy efficiency and renewable energy generation partly in anticipation of future legislation but also for reasons of social responsibility. They have formed a 'gentleman's agreement' to all meet certain targets by 2020 – zero carbon in new build and 25% reductions in existing stock.
As part of this Viverion, a social housing provider in Lochem, are replacing all of a development of 500 houses between 2006 and 2016. One part of this, a collection of 57 houses is to be a test site for different technologies. From an initial list of 15 solutions they have trimmed it down to 5 which will be implemented. Energy improvements have been calculated for each and will be monitored for accuracy. The impact of resident's behaviour on the results will also be scrutinised. The entire cost of the additional items will total 750 thousand euros, a bill that, with no grant funding, the association will have to foot. Legally they cannot charge more rent for low energy housing – there was some discussions around this in the government early 2010 but with the recent election results there is no confidence that it will be back on the agenda any time soon. The five levels of measures are as follows:

1. Demand flow ventilation – Carbon dioxide sensors in each room and humidity sensors in the bathroom provide 'intelligent' ventilation that responds to the location of the occupants.	Cost uplift: €3K per house SAP rating 0.66 (current EPC requirement 0.8)
2. Mechanical vent with heat recovery and low temperature underfloor heating,	Cost Uplift €7.5K per house SAP rating 0.55
3. Increased insulation, mechanical vent with heat recovery, low temperature underfloor heating, ground source heat pump, heat recovery from shower water, some solar PV and solar shading.	Cost Uplift €30K SAP rating 0.29 (Passivhaus would typically achieve 0.3)
4. Passivhaus construction (extreme insulation and air tightness) Warm air heating via ventilation, solar thermal, solar shading and shower water heat recovery.	Cost Uplift €36K SAP rating 0.27 (an additional €6K for a reduction of 0.02)
5. As for scenario 4 but with additional PV	Cost Uplift €40K SAP rating 0

The project team was established in the early stages and included suppliers of equipment who, in return for their input, will not be value engineered out at tender. Representatives of the residents association are also included. The whole team started with a common goal and aim in mind and worked together to create the whole concept, before they split off into their traditional roles and financial responsibilities.

The project was conceived five years ago, it took three years to come up with the 'long list' of 15 solutions and another year to whittle it down to five, which is where they are now. Construction has just started and they will complete in October 2011. How they will monitor such aspects as resident satisfaction and behaviour has yet to be defined. An initial monitoring period of two years is planned. This results in a decade from project inception before useful results will be available.

Case Study - MediaCityUK

Media City from across the Manchester Ship canal and view over the public plaza from the apartments

As the flagship project on which the new BREEAM Communities scheme was developed, MediaCityUK demonstrates some of the potential of integrated design. Peel Holdings, the developer, is also the facilities manager and owner post occupancy and so has a keen interest in the operation and ongoing energy costs. The anchor tenant, the BBC, was identified at an early stage and their requirements have guided the majority of the design. Salford Council has ensured that the development meets the needs of the neighbouring communities by providing additional facilities and a new public realm. The Media department of the University of Salford occupies one of the buildings fronting onto this. The result is a mixed use community including residential, retail, businesses, leisure and a drop-in health centre linked to Manchester by an extended tram line and existing road networks. The development is car-free with parking in a multi storey car park which also houses the new energy centre.

Left: District heat and chilled water mains being installed (sized to meet future requirements) and right the Energy Centre on ground floor of the car park building

The development does not incorporate all of the factors of integrated design and the individual buildings have progressed very much in a traditional manner. An energy specialist was not introduced until late on in the game but as a result of this the separate building energy plants were replaced with an energy centre feeding a district heating and cooling mains, saving costs and increasing lettable building space. The existing car park was re-designed to incorporate a ground floor energy centre, required structural improvements. The heat main is run from a CHP and canal water is used to provide free cooling. Gas was chosen as the fuel of choice but sufficient plant space has been provided to allow for a future move to another, more bulky, fuel such as biomass if future technology improvements and fuel costs dictate. The energy plant is designed to be modular with the initial installation sized to meet the demands of the first phase. Peel has moved forward with this model and energy and sustainability strategies based on the BREEAM Communities criteria are being used to guide the master plans for the company's next developments Wirral Waters and Liverpool Waters.

Integrated Design – Conclusions

As regulations become tighter and more coherent and as end users become more aware of the imperative to reduce energy use integrated design offers an opportunity for greater involvement of all the team players and improved results i.e. better buildings with happier, more informed, occupants. If we can develop the models currently being used to incorporate the facilities management staff and occupants then feedback from the operational stage can be used to inform future building design. An early stage energy strategy is crucial and where district energy systems can be incorporated there are both cost benefits and the opportunity to future proof developments against an uncertain future.

Key Lesson Three: Monitoring and Feedback

Monitoring of performance of buildings and energy systems has been inconsistent at best over the past few decades. In 1963 RIBA stage M – Feedback – was introduced, only to be withdrawn less than a decade later in 1972. The oil shocks of the early 70's saw a renewed interest in the subject, only for it to be dropped when prices stabilised.

It is a well recognised fact, if reluctantly acknowledged, that actual performance of buildings is generally poorer than design. The CIBSE PROBE[26] series of building surveys looked at hard (technical data) and soft (occupant satisfaction) issues and found that buildings frequently failed to meet their design targets. The carbon buzz initiative between CIBSE and the RIBA shows that across nine building sectors the five for which most case studies have been done (Education, Offices, Residential, Retail and Health) are consistently and significantly performing worse than their design standards[27]

The drive for monitoring is gaining ground again with the low carbon agenda and requirements from various standards and legislation[28] [29] that performance be, at least, predicted and monitoring systems put in place, even if there is seldom the motivation to continue monitoring after handover.

A successful monitoring strategy should address the following:

1) Design predictions for new build or an audit of existing energy use, in existing buildings.
2) Appropriate method of data collection giving consideration to complexity of the scheme, availability of resources (people) and cost. Data collection may be from invoices, either half hourly for large installations or monthly or from meter readings. The latter may be hand read or smart metered via a BMS system. A BMS reduces errors but increases cost but where it is being installed anyway may be the best solution with an appropriate interface.
3) Energy targets. Initial goals may be based on either the design standards or typical from benchmarks[30] but should then aim to reduce and should be regularly appraised.
4) Reporting will depend on the size of the organisation and could be monthly or weekly. To prevent information overload 'reporting by exception' can be adopted whereby manager's only get a report in the event of exceptionally high or low energy use.
5) Communication. Results should be published within the organisation, to client and design team, and to industry.

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[26] Post-Occupancy Review of Buildings and their Engineering, reports available from the Useable Buildings Trust at www.usablebuildings.co.uk
[27] Carbon Buzz website www.carbonbuzz.org
[28] Building Regulations Part L conservation of fuel and power, 2010 available online at www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/approved
[29] Energy Performance of Buildings Directive
[30] Available for many building types from the carbon trust at www.carbontrust.co.uk/Publications

Case Study - Itho ventilation, Schiedam, the Netherlands

Gas as a fuel for domestic heating has never been widely accepted in Holland. At one point the government even promoted the idea of selling gas cheaply as the advent of nuclear was expected to make it completely redundant. This fact, combined with disinclination by homeowners towards shared systems, has resulted in individual heat pumps becoming the method of choice for new build. Key to this fact is a lower night time electricity tariff – vital as specific financial support from the government for low carbon technology is even more sporadic and unreliable than the UK. Targeting the SAP rating of 0.4 which will be required by the 2015 revision of the EPBD regulations in the Netherlands Itho ventilation have joined forces with social housing providers (who have a long term responsibility for, and therefore interest in, running costs) in monitoring programs across their portfolio of properties which record and transmit data at two hourly intervals.

As a result of this the company were able to demonstrate the performance of their closed loop inter-seasonal heat storage designs. Calculations had been initially based on a worst case scenario where the ground operated permanently at 12°C – i.e. with all energy dissipated and no thermal storage. Data gathered provided information which would have been impossible to predict without extensive geological surveys which in turn allows more accurate predictions of payback for future systems.

In another study of 54 heat pump installations they identified that despite a target design temperature of 20°C, the majority of the occupants set their thermostats to 21 or 22°C. This led to one heat pump operating in cooling mode in winter (immediate neighbours in this case had theirs set at 24°C). This was initially thought to be an error with the pump (the original reasoning behind the monitoring – to identify faults before they were reported and so provide a more responsive repair service) but led to a conclusion that thermal insulation was required between flats in addition to acoustic in future developments.

Case Study – Western harbour Bo01

100 years ago Western harbour didn't exist. Created with 'fill masses' in the sea, the last of which was put in place in 1987, the area was falling into disrepair as it was built and was predominantly derelict by the 1980's. Following decisions to reverse their economic decline and a firm commitment to sustainability design on Bo01 started 2001. More people now work there in technology and knowledge than in the heyday of the industrial. New transport links include green walkways from the city centre, 8km cycle lanes within the development and a high frequency bus services which is given traffic light priority, features elevated platforms, runs on a combination of electricity and hydrogen. The developments extensive public parks and pocket parks feature bird and bat boxes and buttefly planting.

Electricty is provided predominantly by one large wind turbine on the next promontory. This is not private wire but produces more than the development requires, averaged over a year. This is supplemented by 120m^2 of solar PV and some electricity from the energy from waste plant. The latter provides the majority of heat for the development, supplemented by two water source heat pumps and a 1400m^2 solar thermal array. All of the energy systems are owned and operated by E-on who have identified through comprehensive monitoring that one heat pump is badly underperforming and that the evacuated tubes of the solar thermal array – mounted on the face of a building at the entrance to the development were overshadowing each other in midsummer, reducing output. This identified a software glitch that based modelling on a more southerly location with lower sun.

Additional monitoring projects have identified that building energy use is much higher than predicted by as much as 300kWh/m² in one instance. Some of this has been identified as issues with the occupants but more work is being undertaken to investigate it.

Left: Solar PV array offers some shading to the top flats of this building, Centre and Right: The 'Turning Torso', 50 storey landmark of the Western Harbour development

Monitoring – Conclusions

Without monitoring and honest reporting of performance we cannot progress our knowledge of successful designs. Where end-users frustrate the original design intent then we need to understand the reasoning behind this and account for it in future designs. Monitoring can provide additional benefits – such as the responsive repair service highlighted in the example of Itho above and if necessary should be sold on this basis. Monitoring can also have unexpected benefits from raising the general awareness of energy use amongst building users to unexpected lessons.

Key Lesson Four: Stakeholder Engagement

Stakeholder engagement is almost universally acknowledged as beneficial but frequently side-stepped or half-heartedly utilised and, on occasion, completely ignored. Problems arise due to the sheer volumes of stakeholders in construction projects, their varying levels of involvement and understanding and their conflicting needs and desires. Some project teams view stakeholders as only those who are footing the bill or occupying the eventual development but many more groups are affected. Fear exists that opening up a consultation process too widely will allow plans to become sidetracked and that allowing the quietest of stakeholders a voice will provide a platform for the more vociferous members of the community who may have a particular axe to grind or be focussed on a single issue and blind to the relative benefits of a project – as in the case of NIMBY objectors to wind farm developments. Even where engagement is embarked upon wholeheartedly it is often viewed with suspicion by those involved who do not believe that their input will be heeded, or the victim of apathy where people do not have any interest in the subject.

Sometime full stakeholder is not always desirable or possible. In Malmo for example there was no community to consult for the western harbour development. The existing community within the city complained that it would become a gated community, accessible only to the rich who lived there. The council ensured that this could not happen and now the public realm there is enjoyed by thousands of locals throughout the year – ironically to the complaints of the new residents.

Case Study – Nordby and Marup District heating System, Samsoe

Following on from the success of the offshore wind array which provides electricity for the island and the promotion of biomass as an alternative heating fuel a group of villagers in Nordby decided to pursue a district heating network. Following initial feasibility studies it was identified that the scheme would be too small for economically viability unless it could be expanded to include the neighbouring village of Marup. And so the villagers ran public meetings and literally went door to door explaining the benefits and gaining buy-in from the local community. This was no mean feat when it meant people stumping up money for connection to the new system.

Nordby and Marup District Heating Left: Solar Farm, Boiler House and Buffer Vessel, Centre: Woodchip Boiler, Right: Automated movement of woodchip to feed hopper.

Eventually and with some provision of funds from the island government they succeeded and now a solar thermal field (sufficient for the network’s summer base load heat demand) and woodchip boiler sits midway between the two villages. The scheme was aided by the fact that the entire island has been given a degree of ownership in the existing energy systems with the government funding the offshore wind array to the tune of €4,000 per resident. Talking with people there, even those with little interest in other aspects of sustainability, it is clear that they have a deep routed pride in their special status as 'energy island'.

Stakeholder Engagement - Conclusions

Finding a way through the maze of engagement requires time, patience and frequently the involvement of inspirational leaders. Much could be learnt from the process of concensus decision making which is a well established practise long used by non-hierarchical groups such as the Quakers, feminists and anarchists[31]. In order to be successful it is important that all stakeholders are recognised, at a sufficiently early stage (i.e. project inception) and are given some ownership of the process – even if it is just the use of public areas in a development and a sense of association with the scheme. Effective engagement can lead to grass root spin off projects and where communities achieve real ownership of projects then engagement becomes inherent in them.

[31] http://www.seedsforchange.org.uk/free/consens

Key Lesson Five: Focus

Focus – targeting one particular goal and pursuing it to completion - is too nebulous a concept to demonstrate the benefits of without resorting to anecdotal evidence and so the following case studies are intended to illustrate its benefits. These are not intended to be prescriptive – the characteristics of each project and the motivations of each set of stakeholders will result in a different set of the targets. To achieve a genuine reduction in carbon emissions however it is vital that this is made a target, with figures attached. Although a reluctance exists to tie a project into specific goals (with their associated costs and restrictions) at an early stage this must be overcome if targets are to be recognised.

Case Study – Samsoe

In 1997 the Danish government held a competition in which four islands and a peninsula made submissions. The challenge was for a region to become 100% powered by renewable energy with community involvement key to achieving this. Samsoe won and was awarded a small bursary for some early stage feasibility studies. They have achieved some European funding since this but the large majority of the financial input has come from the island either from the local council or from people investing in the wind turbines. Their target was to be 100% powered by renewable energy for all building and transport, an aim they have achieved within six years through a combination of large scale off shore wind for electricity and locally grown wood fired district heating or individual house boilers for more remote properties. An undersea cable connects to the mainland so the island can feed into the national grid. The transportation, however, is still mainly based on fossil fuel with the ferries consuming about 50%.

They made the decision early on to only base the studies on tried and tested technology. The exception to this was transport where anticipated developments in electric vehicles have failed to materialise and so the carbon emissions from vehicle use are effectively offset by the wind turbines.

District heating plants are sited at either end of the island, three in the South and one in the North serving the villages of Nordby and Marup. A variety of ownership models have been adopted with one (Ballen-Brundby) being community owned, two (Tranebjerg and Nordby-Maarup) being owned by NRGi, the energy provider and the last (Onsbjerg) by a private company.

The offshore wind turbines are operated by a special company, that sells the electricity to NRGi.



Samsoe Left:Energy academy, Centre:Offshore wind farm, Right: Nordby and Marup biomass and solar thermal district heating plant

The island has had a declining population which is more than doubled during the summer months with tourists. With no higher education establishments on the island they have been experiencing a brain drain to the mainland for years with few returning to work. Mechanisation of agriculture has improved yields whilst reducing employment opportunities and the development of more holiday homes and old age villages the trend looks set to continue.

The benefits from the offshore wind array, however are beginning to be felt with the construction of the Energy Academy, an education and demonstration centre which provides office facilities for the Samsoe energy agency and acts as a meeting place for local groups with an interest in energy. The building was constructed with predominantly local labour (an unusual choice – generally construction workers are shipped out from the mainland) and hopes to attract out of season study tourism.

Case Study - Sheffield Renewables[32]

Formed by a group of volunteers in late 2007 Sheffield Renewables aims to 'improve Sheffield's environmental sustainability'. The specific focus of the group is to establish renewable energy schemes which will provide benefits to the local community both in their construction, through using local labour and in their operation by generating funds for further projects. Following initial set up as a volunteer only organisation they are now able to support a number of part time staff, supported by volunteers.

They operate as a business but any surplus earnings are re-invested to support new work as well as benefitting people and communities in Sheffield. They are legally incorporated as an Industrial and Provident Society for the Benefit of the Community (IPS BenCom) which enables them to finance work by selling shares, primarily to people and businesses within Sheffield.

Kelham Island Hydro Site (Photo by Richard Keenan)

They have initially focussed on hydro and more recently wind, both technologies being tried and tested and hydro being relatively uncontroversial as being typically located on existing sites. The principal benefit they recognise of being a community group is communication. They are able to honestly share both their successful and negative experiences in a more open way than is possible for the commercial sector. Relatively unstructured communication to the general public through social networking has been key in gaining acceptance and funding for schemes.

[32] www.sheffieldrenewables.org.uk

They identify their greatest challenges to date as overcoming misconceptions both from the community that there must be a mercenary aspect to any income generating developments and from the business community that as unpaid volunteers they couldn't be relied upon to be professional. Further - with limited funding and a steep learning curve the time taken to develop projects has been frustrating.

Focus - Conclusions

Without a clear idea of where we need to be we cannot achieve our destination. Although targets may change as projects progress a clear statement of intent is required throughout. If carbon emission reductions are the key then specific targets are required which can be measured and compared with post-occupancy measurements. A project may have a number of stated targets for different aspects but in general a clear focus on one or two related areas will bring more reliable results.

Over all Conclusions – A Vision for the Future

We are now fully aware that 'business-as-usual' is no longer a viable option. As we try to find a way forward to a sustainable future every development, every building, every project is experimental to some degree or another. As new ways of working and improvements in technology offer new opportunities and regulations tighten and energy costs increase then energy in all guises will become more critical and central to every decision we make.

Governmental policies – regional, national and international - must work seamlessly across borders and be regularly updated to reflect changes in circumstances. Teams must not only work together from project inception but must extend to include all stakeholders to the process not just those with a financial involvement. Projects must be used as vehicles of engagement of the wider community as this drives grass roots projects and acceptance of large schemes – without which carbon emission reductions cannot be realised.

Tried and tested technology is available to meet our needs at a district level and the expertise exists to design, install and operate it. Projects should still be encouraged, however, to allow for the inclusion of experimental technology. Everything that is installed must be monitored and lessons learnt and shared. We do not have the luxury of time or the abundance of resources to waste learning the same lessons over and again.

Projects Visited

Artefact Power Park, Glucksberg, Germany

A non profit making organisation Artefact is an infotainment park, conference centre and guest house, attracting thousands of visitors per year. With a wide range of interactive displays it provides education on energy efficient building techniques and renewable energy, in conjunction with sufficient energy for its own needs with surplus electricity to export to the grid. Whilst being firmly rooted in the local community, with links to many projects in the region, Artefact enjoys many international links and draws on experience abroad, especially in developing countries to promote many solutions applicable to a wide range of climates and economic situations.

Key success factors: Adaptation of technology to suit situations and stakeholders, participatory apraisal, project management and private-public partnership.

Kraftwerk, Flensburg, Germany

One of the biggest in Germany, Flensburg district heating networks stretches to over 600km of pipework and has an impressive 98% uptake amongst residents. It stretches all the way to Glucksberg, some 12km to the North West and over the Danish border. It's run from one central power station, a coal-fired fluidised-bed CHP. They also have four oil fired engines at dispersed locations to provide back up in the event of failure. At the moment they co-fire with around 10% RDF (refuse derived fuel). Under German law they can go up to 25% but above this the plant would be classified as a waste disposal plant rather than a power station. Even at the current levels they experience problems with high chlorine content which combines with the sulfur at high temperatures to become very caustic, eating its way through the machinery. Installation of the network began in 1969 to replace gas mains (run on town gas). Industrial users are provided with heat from the (high pressure, high temperature) primary mains and domestic users are provided from secondary mains.

Left: Flensburg power station with its 180m high flue, Right: old photo of original heat mains - ten different ages of heat main now make up the system

The central plant gives them high efficiencies and the harbour location means coal can be delivered by sea. Combined with the lack of natural gas as competition this makes the scheme economically feasible. Over the next five years they plan to change over entirely to wood, also shipped in and bought from the Baltic states.

Klimapakt, Flensburg, Germany

In 2008 a representative of a local housing co-operative attended a workshop on energy efficiency. Impressed at the content he asked if he could bring some more people to the next one. The organizer agreed, expecting a couple of other housing association people, but was taken aback when he brought nine others back with him including representatives of a hospital, the local transport operator, the Sparkasse bank, the University and local manufacturers. From this group the Klimapakt (Climate pact) was formed with an ambition of achieving carbon neutrality for Flensburg by 2050. In December 2008 each partner contributed €5,000, most of which has gone research. They now have a clear picture of the source and scale of current emissions, based principally on data from the utility companies. Transport has been the subject of a benchmarking exercise but they are on the verge of carrying out a detailed survey to get a clearer picture. They are focussed only on carbon emissions from energy and transport and have designated a boundary around the town. So although they hope to influence people's travel patterns outside of Flensburg those miles will not be included in the 2050 target, nor will travel to or within the town by visitors from outside. Through it's original partners Klimapakt has forged links across academia, industry, commerce and finance and sees this as its key strength. When multiple stakeholders feel ownership of a scheme then they are more likely to buy into, and support, it.

Linau Biogas Plant, Schleswig Holstein, Germany

The biogas plant at Linau annually produces 1.1MWe and 1.2MWth from 20,000 tons of maize. The maize feeds from a hopper which is filled once a day through three fermentation vessels running at increasingly lower temperatures. The resulting biogas is burnt in two of the three 370kW gas engines (the third is back up) producing electricity which is fed into the grid and heat which feeds a district heat main that serves the village. Two dry coolers are also provided to deal with excess heat. The initial six houses which connected to the heat main when it was first constructed pay a flat rate for heat and the rest of the 90 properties have a heat meter. A few new properties which ahave been built to passivhaus standard as have refused to connect to the main as their heat requirements are so low. Connection to the main is subsidised by a local government initiative. The plant is 50% owned by a company set up by the initial investors who were all local farmers with wind turbines, the other half being split between 9 local investors, also mostly farmers. The plant is reckoned to save 12,000 litres of heating oil per year. They are still trying to find ways to use the excess heat and are currently investigating using it to dry the maize out before use. The plant took one year from inception to completion of commissioning. They encountered problems with laying the heat pipes but recent developments in technology mean that a mole type digger can now lay the pipes without digging through the surface which would have reduced costs. Future plans include running a gas main to more distant properties – they work on a distance of 2km maximum for the heat mains but say up to 12km would be economically viable for gas. Another possibility is 'washing' the gas and feeding into the gas main which runs nearby (but does not supply the village). The deliveries of maize in trucks have meant that the local roads have needed to be strengthened.

Nissen Biogas Plant, Schleswig Holstein, Germany

The Nissen Biogas site was constructed in 2006 by second generation energy farmers, Bernd and Dirk Nissen and follows wind (first installed in 1995) and PV. Currently they have 4 x 600kW and 2 x 1.5MW wind turbines shared with 3 other investors and 125kW of roof mounted PV.

The biogas scheme has an electrical output of 715kWe split between three engines running on a combination of maize (12,000 tonnes/annum) grass (2,000 tonnes/annum) and cow dung (6000 tonnes/annum). The engines run 24 hours a day and have an expected lifespan of 4 years but the tanks can last for decades if properly maintained. The waste heat provides heat for the only three farms in the vicinity (approx ½ km apart) and drying straw and hay. This isolation has been identified as a benefit to obtaining planning permission as there was no opposition but also means that, being remote from other buildings, there is no further market for the heat.

Nissen Biogas plant Left: one of a number of feed stores, Right: First and second fermentation vessels and controls house

As with other biogas farms in the region they identify access to sufficient feedstock as their prime problem. In addition they expressed concern regarding investment timelines. They are running research programs in conjunction with Berlin University to investigate the effect of the use of fertilisers, weather conditions, and the moisture content of the feed crops on calorific output.

To address issues with waste heat they are developing plans to run a gas main to the nearest town to a satellite engine to provide heat. By not feeding into the gas mains (which would be technically feasible) they feel they are able to demonstrate that this is a viable alternative to the big energy companies.

Shafflund Farming Advisory, Schleswig Holstein, Germany

Shafflund is a small town of approx 2,200 inhabitants and the farm advisory based there provides consultancy services to farmers across the north of Schleswig Holstein. They were first approached for information on biogas in 2005 and now it is the mainstay of their business with well over 100 farm biogas installations and many more in planning. They identify the following barriers to biogas:

- Financing – this is the primary concern of all farmers who contact the advisory.
- Feedstock availability – this is the primary concern of the banks.
- Planning – above 1MW planning permission is required but below this threshold it is designated a 'privileged' construction, provided certain minimum distances from dwellings are observed and federal laws on noise and odour emissions.
- Roads – these are requiring upgrading to support the increased duty of traffic in delivering feedstock.
- The lack of detail in feed in tariff bands. These were described as being 'not clever enough'. One development which consisted of ten sub 1MW units is currently undergoing legal action for applying for the higher rate.

To a small degree there have been some companies and farms which grew too fast and collapsed and a very few issues with poor levels of technical expertise (but as biogas installation has been ongoing (albeit at a smaller scale) for over a decade in the region there is a good supply of knowledge and experience.

The big problem is the rapid growth and uptake of the technology and the slow development of legislation to take account of it. Wind power in the region has been strategically planned and now the 1.5% targeted land use has been reached effort is going into re-powering sites instead of adding to them, but there is no such strategic plan or controls for biogas plant development. Big investors from Hamburg have made inquiries but thus far there is resistance to them. This is both due to the perception that external investors will reduce the social capital of the plants and also a reluctance to lose local control of the process.

Ultimately it seems that availability of feedstock or growing capacity (with a premium on maize farmers are growing the same crop repeatedly without rotation and an estimated 15,000ha worth of maize is being imported annually from Denmark) will be the limit to growth.

The farm advisory see a future of collaboration between biogas farms transporting the gas to co-generation plants which will then feed district heat mains and have co-ordinated such a scheme in Shafflund. This would reduce the heat loss and allow farmers to deal with a small number of larger customers rather than a large number of domestic ones.

Denmark – Skive Council

See details under Policies

Denmark – Samso – Energy Academy

See details under Focus

Denmark – Samso – Nordby and Marup District Heating Network

See information in stakeholder engagement

Denmark – Samso – Hardware Store and Renewable Energy Information Centre

Having seen a local need for information and equipment driven by locals rising awareness of the opportunities of renewable power the store has responded by becoming an information and education centre for the renewable and low carbon technologies which they sell. It is a great example of local businesses benefitting from and assisting in driving awareness of the low carbon agenda.

Denmark – Samso – Tranebjerg Housing Development

Tranebjerg Housing Development - Michael Kristensen and his family's low energy house

Tranebjerg housing development lies on the outskirts of the capital of the Danish island of Samsoe. A newbuild development on Greenfield land of speculative building plots, permission was granted on the basis that every house constructed here would be exemplary in construction and energy use.

Danish building regulations recognise the following four classes of house:

Standard (building regulations compliant)
Low energy I (maximum 38kWh/m^2/annum, 1.5l/s/m^2 air tightness)
Low energy II (maximum 58kWh/m^2/annum, 1.5l/s/m^2 air tightness)
Passivhaus (1 l/s/m^2 air tightness)

Classes I and II are total energy usage and the Passivhaus is a variation on the Austrian standard but modified for Denmark with its low angled sun in Spring and Autumn (so requiring additional solar shading to prevent overheating during these seasons). The air tightness testing is carried out under both
The house shown above, belonging to Michael Kristensen, has high levels of insulation (400mm, roof, 215 walls and 220 floor) and an air tightness of 0.8 l/s/m^2. It's fitted with a wood burning stove but for purely aesthetic reasons. It is connected to the local district heating main but uses only half of the annual heating as predicted by the EPC.

Denmark – Copenhagen - Cycling City

See information in Introduction

Sweden - Malmo - Augustenborg

Augustenborg Left: External cladding, new balconies and play spaces, Centre: Public Art and Right: Water attenuation creating pleasant spaces and biodiversity.

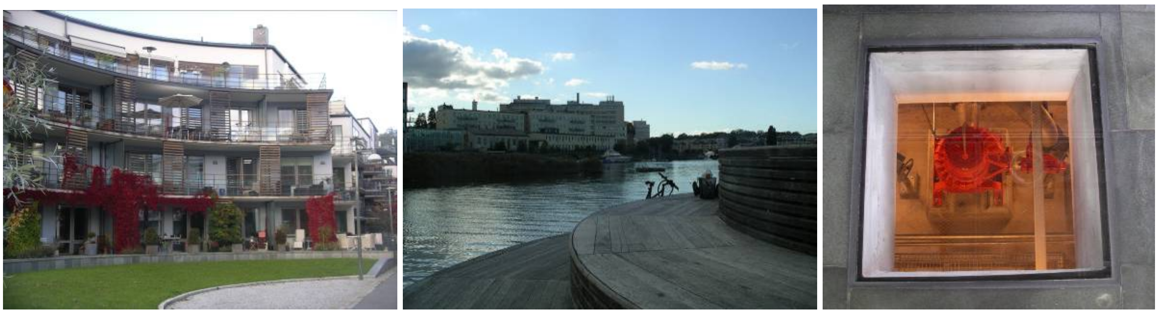
See details in Placemaking

Sweden – Malmo - Western harbour

See details in Monitoring

Sweden – Stockholm - Hammarby Sjostad

See details in Placemaking



Hammarby Sjostad – left to right: Balconies on all flats, watrerfront promenades and a view down into the engine room through the floor of the 'Glasshouse', the information centre and visitor centre at the entrance to the development

Holland – Itho Ventilation

See details in Monitoring

Holland – Viverion

See details in integrated teams

Holland – Rotterdam Climate Initiative

Future impression of Rotterdam Ports

Rotterdam Climate Initiative was founded in the wake of a visit to the city by Bill Clinton promoting the Clinton Initiative. Although Rotterdam do not fall into the C40 category of largest cities in the world in terms of geographical area, with their status as an international port they do in emissions terms and so, following discussions between Clinton, the then Prime Minister and the Mayor they agreed to join. The target of a 50% reduction in CO_2 emissions seems to have been fairly arbitrarily chosen as a significant and satisfactorily large target rather than being based on an assessment of current status.

The project has a four yearly scope to tie in with political terms and responsibilities. The first of these has just come to a close and has seen integration with the Rotterdam Climate Adaptation Strategy. The actual level of emissions has been assessed and the following opportunities for reductions identified as follows:

- 20MT – large scale CCS
- 4MT Biomass
- 4MT Energy Efficiency

These are the technically feasible reductions, only 4-6MT of these are currently deemed economically feasible.

The biggest problems to date have been engagement of the port companies without whose buy-in the council were reluctant to commit funding to feasibility studies. Initially reluctant and fearing the loss of a level playing field, the companies, especially those who have headquarters based in the Netherlands, have now bought into the scheme as they see opportunities for business development as world leaders in sustainable port development and cost savings to be made in the areas of energy efficiency. As the scheme moves beyond planning stages they predict problems with translating the targets into reality, the ongoing support of (a new, less environmental, more right-wing) government and the policing of voluntary commitments. Initial ‘hype’ on climate change in 2007 is identified as having helped the scheme get off the ground in the first place but recent groundswell against this has lead to the climate adaptation aspects of the scheme being downplayed and the benefits in terms of long term cost saving and energy security coming to the fore.

The scheme has seen the working together of companies who may be competitors in other fields and industry working hand in hand with, and now leading, government to achieve environmental aims.

Belgium – Bosteon

Bosteon, an architectural and construction firm, have been building houses for 35 years. Since 2010 they have made the decision to only build to the Passivhaus standard and have undergone a rigorous design process to ensure affordability. There designs are either for 'Zero-Energy' which uses PV driven heat pump to cover all heating loads or 'Zero-carbon' which provides additional PV to provide hot water and cover all secondary energy use also. Payback times for this second addition are currently calculated at 25 years but with an upfront cost uplift of €26K it's not always feasible for people to afford it. A central government subsidy introduced in the last three years which gives an annual income tax rebate for 10 years for the owners of zero carbon houses and in Flanders a regional subsidy of a 20-40% reduction in house tax for low energy buildings combine to provide around €1400 per annum 'bonus'. Bosteon is now working with banks to develop a finance model that would take into account the tax rebates to provide upfront funding for the zero carbon model. They are also looking at entire developments and addressing site wide issues such as travel and ecology with car free zones, links to regional cycle ways and green corridors.

Bosteon place a great deal of emphasis on quality of life and realise that to successfully market a sustainable building it has to be promoted as offering benefits above and beyond energy saving. To this end they avoid the mention of 'air-tightness' preferring the term 'draught-free' and have developed the following list of 10 'key qualities' that they will incorporate into their housing developments.

1. Living in nature – inclusion of green spaces.
2. South facing – natural daylight in living spaces for minimum 5 hours a day for 9 months of the year
3. Provision for different sizes of houses for different family sizes
4. Passivhaus
5. Privacy
6. Car-free areas
7. Play spaces
8. Tailored housing – the layout and fit out of the interior of the houses is not developed until a buyer has been found
9. Provision of a car sharing scheme with aspirations to move to 'green' motors, either biodiesel or electrical, in future
10. A central information point where residents can report any issues

Bosteon are also working on a 'Bosteon standard' through which they could validate the work of other firms to spread the message and are keen to work with other construction professionals, in Belgium and further afield, to share the experience they have gained in the last few years.

UK – Media City

See details in Integrated Teams

UK – Sheffield Renewables

See details in Focus

END OF THE REPORT


Left: The future of city transport? Cargo bicycles at Christiana, Copenhagen
Centre: The future of energy? Solar cooker and Solar PV at Artefact, Germany
Right: Rotterdam central library - what happens when ventilation engineers design buildings?

Blog: www.kendale2010.blogspot.com

Contact: rxwarren@globalskm.com or becca@bikerider.com