Towards net-zero hospitals in the UK

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This paper reports progress toward the target of Net Zero Energy Hospitals in the UK. The UK has set ambitious targets for reducing carbon emissions and for reducing energy usage generally to move away from the use of fossil fuels and toward non-fossil or renewable' energy sources. This involves amongst other things, moving toward net zero hospitals.

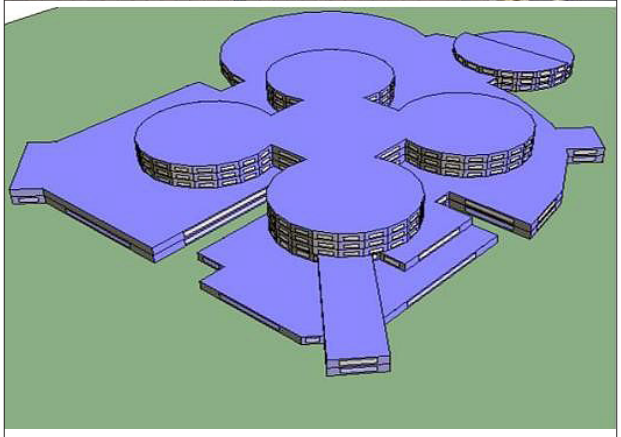
Keywords: Net zero Energy, hospital ventilation, district energy, natural ventilation.

The UK wants to achieve a 'decarbonised' electricity grid. Applying this policy to UK Hospitals, both new and existing, poses a challenge because they are amongst the highest energy consuming buildings and the trend is toward MORE rather than less energy as healthcare uses more medical equipment.

Agenda for change

Climate Change, depletion of fossil fuel reserves and rising energy costs are impacting directly on the UK and have led to the conclusion that the future will be 'zero carbon'. Continued reliance of fossil fuels is also impacting upon health and well-being and is being an economic risk.

Queens Hospital, Romford



- Energy reduced from 101 (previous hospital)- to 60 GJ/100m³/annum
- Over 50% naturally ventilated
- Daylighting with Lighting controls
- Control of glare and summer heat gains
- Heat recovery

In healthcare, the UK NHS has introduced policies for 'Sustainable Healthcare' buildings [1] and through its HTM publications (Hospital Technical Memorandums) [2] is setting new ambitious targets.

These are also in-tune with wider UK policies such as the Climate Change Act [3]and more recent city plans such as the London Plan [4] and the Manchester Climate Action Plan [5].

Future hospital energy usage

The indicators show that hospitals will need to use more energy rather than less. The population is growing – and living longer, getting older. Healthcare is also developing its scope, finding new cures, providing more and better services. Many of these new services require sophisticated medical equipment and reliable energy supplies.

The UK's energy policy can be summarised as follows

- All new buildings including hospitals should be 'Zero Carbon' from 2019.

- All existing buildings including hospitals should progress toward zero carbon as part of the commitment to reduce by 80% overall by 2050.

Action so far

Whilst there have been several exemplary projects constructed, the UK is failing to meet some of its early stage commitments. For example, the Target to build all new schools as zero carbon from 2016 onwards has not been achieved. The 'Road to Zero Carbon' report published by the Zero Carbon Task Force of the UK department for children, schools, and families, in 2010, set out strategies for achieving zero carbon schools and showed that this is a relatively easy target since schools are occupied for limited periods, during daytime hours and have limited overall energy usage. However, there are no actual zero carbon schools completed. Instead, the Building Regulations Part L target for zero carbon has been revised to 'near zero'.

The conclusions now are that the political ambitions are not being realised in practice. In healthcare, this situation is further compounded by the priorities toward the patient experience, rising demands and pressure on hospital budgets. Whilst energy reductions should lead to improved budgets the investment needed to fund energy savings is being spent on NHS Staff costs, new medical equipment – and even higher energy costs, as tariffs rise.

Hospital Boards find themselves postponing energy improvements to respond to public and political demands for more and better treatments.

The UK NHS took part in the Energy4Health research project [7] which was carried out in support of the EU Demand Side Action Plan. The aim was to develop a roadmap to influence the demand for innovative energy solutions in the healthcare sector. The vision for this initiative was to: -

1. Make the European Healthcare sector the global leader in energy efficiency and community renewable energy systems.
2. Achieving 'many' carbon and cost neutral hospitals
3. Reducing the average cost of energy to less than 1% of the healthcare budget.
4. Moving toward a target carbon footprint less than 20% of 1990 levels (in-line with the 80% reduction target in the UK Climate Change Act).

The NHS found many difficulties in establishing a realistic roadmap and noted the following: -

a) Energy benchmark data poor or not available
b) Lack of investment finance, with a general intent to direct as much funding as possible to 'front-line' services. The financial benefits of lower energy use can never be realised
c) Skills shortage in Energy Saving.

Energy4Health road map issue:

Issue identified	UK Hospitals - NZE
Energy Benchmark Data	ERIC system requires overhaul
Finance and Investment	NHS priority is patient care
Energy Knowledge and Skills	Reliance on meeting basic standards – Building Regulations
Health Impacts of Energy Choices	Lack of awareness
Strategic Direction and Incentives	NHS HTM 07 and other codes regarded as 'guidance'.
Risk Aversion to Innovative Solutions	Traditional – Business as Usual, is the norm. PFI contractor lead prefers tried and tested solutions.

UK hospitals use too much energy

The UK Energy database, commonly known as the ERIC system uses annual returns from Hospitals to provide an overview of UK Hospital energy usage. The data is configured to show usage in bands from the highest to lowest and can be used as a type of league table. However, there are usually reasons for high energy use – location, old uninsulated Victorian buildings, high equipment load, intensive usage and so forth.

What is perhaps more concerning, is a comparison of UK data with North America.

Average UK performance is 68.6 GJ/100m³/annum, the US is 45 GJ/100M³/annum.

This is a surprising fact considering that the UK has a mild, temperate climate compared to the extreme summers and winters of the US.

Table of UK hospital energy usage comparisons:

CRITERION	UK HOSPITALS
US average 45 GJ/100M³/annum	UK average 688 GJ/100M³/annum
UK Mandatory target for existing buildings is 65 GJ/100M³/annum	Only 65% of existing UK Hospitals meet the mandatory target.
UK Mandatory target for new build is 55 GJ/100M³/annum	Only 45% of new build UK Hospitals meet the mandatory target.
40 GJ/100M³/annum	Only 17% of UK Hospitals meet target
Notes: Data from NHS HTM 07	

Barriers to net zero – Fresh Air Ventilation

The UK healthcare industry still prefers full fresh air systems and there are very few recirculation systems. This is a long standing, traditional approach based on the belief that Hospital air was being contaminated by dust, dirt, particles carrying bacterial colonies, medical gases, - nitrous oxide and others – and air borne infections. Fresh air was considered 'clean', whilst extracted air was considered dirty, polluted and contagious.

The NHS Ventilation Code HTM2025 required full fresh air. However, in 2007 it was replaced by HTM03 which introduced 'Recirculation Systems' into its list of ventilation options, but appeared to limit its use to HEPA filtered clean rooms and other specialist applications. Since its introduction in 2007, HTM03 has provided designers with the option to recirculate but in practice the full fresh air option has been followed.

Natural ventilation

UK Hospitals have long favoured natural ventilation and design solutions dating back to the works carried out by Brunel in response to Florence Nightingale's appeal for better ventilation of Wards. In the publication by Robert Boyle [8], there are drawn examples of Hospital Wards and Operating Theatres using effective natural ventilation. Modern UK Hospitals still use natural ventilation. The Queen's Hospital Romford completed in 2006 has approximately 50% of its areas naturally ventilated. However, uncontrolled Natural Ventilation can use a great deal of energy and therefore the new Advanced Natural Ventilation, ANV, approach should be used. Recent research carried out by Cambridge University on behalf of UK Department of Health shows how ANV can be a significant strategy toward NZ. However, for existing Hospitals which rely on manual control of windows, it wastes heat energy.

UV air disinfection

Ultra violet light is now an established method of reducing air borne infection rates by dealing with environmental colon y spores carried in air ducts. However, despite research funded by the Dept. of Health and trial installations such as the Basingstoke and North Hampshire case [9] controlled study which showed that energy reductions could be as much as 80%, UV has had very little usage in the UK. Hospital microbiologists still view it sceptically and prefer, wherever practically possible, to use full fresh air and HEPA filtration.

Investment priorities

UK Hospitals face many pressures for funds and the priorities appear to be to focus onto the current 'front line' services, to keep the existing infrastructure operational and whenever possible improve, extend or add new, better clinical facilities. Reducing energy usage is certainly an aspiration and would in fact contribute to Hospital finances by cutting costs. However, it becomes a 'nice to have' as soon as Hospitals feel the pressures to achieve more in terms of medical performance.

There is also concern amongst Hospital Estates Staff who have the responsibility of keeping their Hospitals working - no matter what - that introducing new equipment, new strategies or even just changing existing settings will jeopardise the primary task of keeping everything in working order. This fear was evident at two recent projects where the following was noted: -

- Cancer Centre Ventilation Systems must operate 24/7 despite actual usage of 12/6. Fears that air handling plant would fail to start next day has led to a decision to operate 24/7 albeit with some energy saving by reducing fan motor speeds overnight using inverters.
- A project to replace distributed packaged chillers with a central chiller plant using three heat pump chillers incorporating heat recovery was carried out successfully and provides resilient control plant with additional capacity. The local, isolated units have been removed and a new comprehensive distribution network for cooling installed. However, the heat recovery circuit which was designed to preheat the incoming cold feed to the HWS (Hot Water System) has not been installed due to fears that it might create technical problems and could even introduce Legionella problems into the HWS circuits.

Of course, there are many successful examples of ventilation equipment that is switched off at night and on again next morning, and hot water systems that are preheated using recovered or waste heat, but in healthcare there appears to be a preference to stick to tried and tested solutions, no matter how energy intensive.

What chance NZ Hospital in the UK

The current situation appears desperate. UK Hospitals use far too much energy, in fact significantly more than other countries. Those responsible for the day to day operation of Hospitals are focused onto maintaining the status quo – 'keeping the lights on'. Those responsible for future planning and strategies are focused onto patient care, achieving performance targets based on numbers of medical procedures, patient throughput and minimising budget overspend. Energy is not a priority and may not even be on their agenda. Net Zero is certainly not. It is not really mentioned within the NHS Energy code. HTM 07 published in 2015, although it does mention the need to reduce carbon emissions.

Hospitals and communities

Hospitals are constructed to serve communities and are strategically located in places which are safe, secure, unlikely to be affected by flooding or other extreme weather events, close to transport networks and, of course, population centres.

Whilst Hospitals strive to provide 'healthcare' to people it is usually a reactive service. People are treated for illnesses and follow medical pathways to recovery. There are of course services such as maternity which are not 'illnesses' but are nevertheless reacting to a requirement for mothers and babies.

There has been a move toward proactive healthcare in which Hospitals could give advice, direction and even services around health and well-being, fitness, strength and even dietary and mental well-being. There is a strong case for doing so since it directly reduces the demand on its reactive services – people are less sick – and indirectly supports productivity and economic growth through a fitter, healthier more productive workforce.

Hospitals could extend this wider community intervention and make financial gains, by sharing its energy systems with its local community. In some ways, this would mean operating an energy business alongside its health functions, but this is already the case. All Hospitals must have resilient, reliable and affordable energy systems. They must be able to operate even if the local power supplies fail. What Hospitals do not do is share this with others – because they do not consider it to be 'their business'. It is a distraction. However, it should be their business because: -

- Supplying district heat to neighbours would allow larger electricity generation which is an increasing demand as more and more electrical medical equipment is installed.
- There is an income gain through sale of waste heat.
- Extra generation could be installed to improve stand-by cover. Basically, Hospitals move away from using expensive, never used stand-by generators to revenue earning, always running combined heat and power plant.
- Providing affordable heat (at a profit) to local communities supports health and well-being through winter months, reducing the usual 'winter rush for beds' as people struggling to heat their homes contract colds, flu and pneumonia.
- Reducing pollution from power plants by improved efficiencies. A recent paper from the Energy in Buildings and Communities Programme, EBC, May 2017, entitled 'Towards Net Zero Energy Resilient Public Communities, set out the case for community based energy systems as a route to Nett Zero Energy. In fact, community energy systems, also known as district energy systems, are not a new idea. They are commonly used around the world, especially in Scandinavian countries where they are the norm. In fact, cities like Aalborg are 100% served by district energy.
- Surprisingly it is not the case in the UK where there are only a few, local schemes. Media City UK constructed in 2010 is the most successful recent example. However, it is small scale at 2MWe, compared to Scandinavian examples. In contrast to other countries, the UK has no heat recovery from any of its national grid power plants and consequently operates an electrical grid at an average efficiency around 35 to 40%, wasting most of the input energy as heat to atmosphere.

  The UK is aware that this is a major contributor to global warming but is stuck with an established power grid with power stations releasing 3000 MW or more each, usually located a long way from communities who could use the heat, and a public dislike of the road closures which would be needed to install pipe networks.

There is a long-term solution and it involves starting small, locally and growing outward TOWARD the power stations. Hospitals provide the key to this approach as they could, and should, be at the centre of the local networks.

The low energy hospital studies

During the 1980's the UK carried out research into the next generation of healthcare building in a series of research studies and two new build hospitals – St. Mary's, Isle of Wight and Ashington, Northumberland. The research used the 'standard nucleus hospital' as its model and carried out detailed analyses using dynamic energy simulation models. They showed that energy reductions over 50% were possible and cost effective.

The two sample hospitals have been monitored post occupancy and feedback provided to assist NHS strategies.

More recently, the Dept. of Health has funded research led by Cambridge University into low energy cooling and ventilation using natural ventilation [10].

This research also showed that significant reductions in energy usage can be made if Low Energy Ventilation is employed. The project focussed onto Natural Ventilation which is still a preferred solution in the UK where possible and practical, but identified a looming problem due to Climate Change because rising summertime temperatures will cause overheating for long periods and jeopardise patient health and well-being.

The study also identified HVAC as the major energy consumer in healthcare and noted areas for improvement, in existing as well as new build.

Guidance, strategies and policies

The UK benefits from a strong technical base developed by NHS Estates in the past and from innovative research studies such as the Low Energy Hospital.

NHS Estates have a comprehensive energy reporting system and through a range of energy studies and the monitoring and reporting data from hospitals in use, have developed their EnCode information, which is essentially a Hospital energy code. EnCode has been incorporated into HTM 07-02, EnCo2de 2015– Making Energy Work in Healthcare – Environment and Sustainability [11], published in March 2015 in two parts: -

- Part A. Policy and Management
- Part B: Procurement and Energy Considerations for New and Existing Building Facilities.

These documents provide guidance and strategies for energy efficient Hospitals and in Part B, Section 3.3.3 states that the UK has set the target of zero carbon new build by 2019, creating a legal requirement for new Hospitals constructed in 2019 and beyond to be net zero carbon.

This target is implanted through the UK Building Regulations, Part L, which was last updated in 2016. The 2019 update is awaited but expected to set the Target CO_2 emission rate, TER, as zero. The UK construction industry must deliver Hospitals to meet the target. ■

References

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