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How Can Change Be Achieved?—Energy Saving in Cambridge

*Jeremy K. M. Sanders**

Jeremy K. M. Sanders
Pro-Vice-Chancellor and Professor of Chemistry, University of Cambridge

The history of Cambridge is our strength and our problem. The University of Cambridge has huge intellectual energy; it also consumes massive amounts of electrical energy, our annual electricity cost being over £11 million (€13 million, $16 million). How can we use our intellect to reduce our energy bill? Here I outline the complex physical and human landscape in which we are trying to bring about change, and describe our first steps in tackling the reduction of energy consumption.

Every reader will be working in an environment that is different from that of Cambridge, but many of the problems, and some of the solutions we are exploring, will be relevant everywhere. And the challenges I describe here in bringing about long-term change in a free-thinking university reflect in microcosm the challenges of democratic governments everywhere.

I am responsible for both the University's 9500 staff and its environmental and energy strategy, so my role is to focus some of our intellectual energy, and manage all our staff and buildings, in a way that reduces our carbon footprint and energy costs, improves our sustainability, and provides leadership for other institutions. The pressures to move in this direction are both political and financial, and they are growing. UK universities are independent—their staff are not civil servants—although much of their funding comes from the Government with strings attached.

Human Context

You might think that because Cambridge is home to so many talented and open-minded people, energy use would be a simple problem to fix. However, our strength is also a challenge. Our unique scientific history, being associated with over 80 Nobel Prizes from Lord Rayleigh in 1904 to John Gurdon in 2012, surely derives from the University's tradition of individualism, creativity, and intellectual challenge. However, people who can overturn decades or centuries of conventional thinking through a new experiment or insight do not fit comfortably into a neat top–down, rule-based management system; they are also surprisingly resistant to change. Cambridge is a democratic place in which 3500 people have the right to vote on every important decision being proposed; Heads of Departments are, in effect, elected by their staff and they tend not to take instruction from the central administration. Departments mostly have their own devolved budgets, and their own building managers, and they defend both fiercely, so how can the University leadership bring about change that it believes is necessary but is seen as uncomfortable or intrusive?

How can necessary but uncomfortable change be brought about?

In energy use, there is a gulf between researcher and operational estate. We are amongst world leaders of research in organic and solid-state LEDs, photovoltaics, new lightweight battery materials, and new methods of efficient manufacturing and recycling. This is brilliant science and engineering, but it is years or decades away from transforming the life of a building manager who is fully stretched keeping the sinks unblocked and the computer cooling operational.

Physical Context

The University operates over 300 buildings with a total floor area of over 600000 m^2: the earliest buildings are over 600 years old, and preservation orders limit our ability to make them more energy-efficient; the science buildings we are creating are elegant and energy-efficient, but are full of heavy-duty equipment; and many of our major buildings are from the great 20th Century expansion when energy saving was not in the front of architects' minds. The Chemistry building is a perfect example: opened in 1958, it has been upgraded, extended, and modified many times over the years, so its heating and cooling systems are now complex, suboptimal, and poorly documented. It is home to 500 staff and graduate students, sees a flow of 800 undergraduates a week through its labs and lecture theatres, and it costs well over £1 million a year in electricity and gas.

Most of the University's energy use is associated with research, mostly in science, medicine, and engineering. A rapidly growing dimension is cooling for IT: we use as much electricity for air

[*] Prof. J. K. M. Sanders
University of Cambridge, The Old Schools
Trinity Lane, Cambridge CB2 1TN (UK)
E-mail: jkms@admin.cam.ac.uk

conditioning in computer rooms as we do for running servers. The University discourages the use of air conditioning for labs and offices, but our mice and other research animals are more comfortable because legislation demands that they must live in a closely controlled environment: we cool and dehumidify ambient air before carefully warming and rehumidifying it. Our medieval books and ancient artifacts in libraries and museums demand even more stringent environmental control of temperature and humidity, while our plant growth facilities attempt to create a tropical climate in cold Cambridge by using multiple banks of energy-hungry fluorescent tubes.

Towards a Solution

With ever-rising energy consumption and prices, costs for the coming decades looked unaffordable and out of control. In response the University set up the Energy and Carbon Reduction Project (ECRP) in 2011, with a budget to be invested in measures that quickly led to a financial return. ECRP started with five pilot projects to identify the most effective measures. Details of the projects, and of the evolving carbon management plan can be found at http://www.admin.cam.ac.uk/carbon/projects/.

Two years into this project, our most important conclusions are that 1) behavioral change will be crucial for success, and 2) retrofitting an engineering solution to a building is easy, while motivating people to change their behavior is difficult. And we need behavior change at every level: we need individuals in labs to turn off unnecessary lights, ovens, and computers, and to wear warmer clothes in cold weather; we need building managers to optimize the performance of their heating and cooling systems; we need heads of department to realize that if they can persuade their staff and students to save on electricity bills, then this money can be used more productively; we need our planning of new buildings to take more account of lifetime running costs, even if that means higher initial capital expenditure; and we need through procurement processes to persuade all our suppliers of goods and services that we are serious about energy savings.

> ***Change will come about only when all people feel it is in their own best interests***

For behavior change to work, individuals need to see the fruits of their efforts, and they often need an incentive. So, we are installing meters at every practical location in our pilot sites and making the data available on public screens and personal computers through "energy dashboards". This allows local units to assess their own performance and compete with each other. Time switches on drying ovens, and motion sensors connected to light switches, when coupled with local metering, are remarkably effective not only in terms of rapid financial payback but also in raising awareness. One department stimulated competition with a monthly bottle of wine for the best-performing lab; it was a short-term success, but it depended on enthusiastic individuals, and as with many addictive drugs, withdrawal of the stimulation can lead to rapid worsening of performance.

Building managers are vital agents in optimizing energy performance in their buildings, but many do not have the knowledge, time, or resources to identify and implement simple energy-saving measures such as optimizing flow rates for hot water or air conditioning. Providing help in the form of roving energy managers is very effective in driving down cost and energy usage, especially if the department can keep the financial benefit through an electricity incentivization scheme.

As well as the ECRP, we have schemes at every scale, from a Living Laboratory Project sponsored by Santander, in which undergraduates carry out small-scale studies of real buildings as part of their studies, and suggest practical solutions, through to a possible district heating scheme that we are exploring in a joint venture with the City Council. We have a travel plan to further reduce single-occupancy car journeys—over 40% of staff already travel by bicycle, bus, or on foot, but if we were to encourage car-sharing and charge for parking we might do even better. The centralization of servers into large, well-designed, and naturally cooled rooms or buildings is effective in saving electricity and releasing valuable space for other activities, but is not popular with colleagues who like to keep "their" equipment in "their" space under their own control.

The academic community at large has yet to come to grips with the carbon footprint of international air travel for conferences, and indeed for students who study on distant continents. This is something that Cambridge cannot tackle on its own, but it will surely rise up the political agenda at some point.

The effect of the various approaches described here is that the University's electricity consumption has stopped rising, despite an ever-increasing volume of research activity; we expect real decreases in years to come, but major reductions will be a huge challenge, and they will not be achieved because I, or anyone else, has decreed that it must be so: change will come about only when staff and students feel it is in their own best interests.