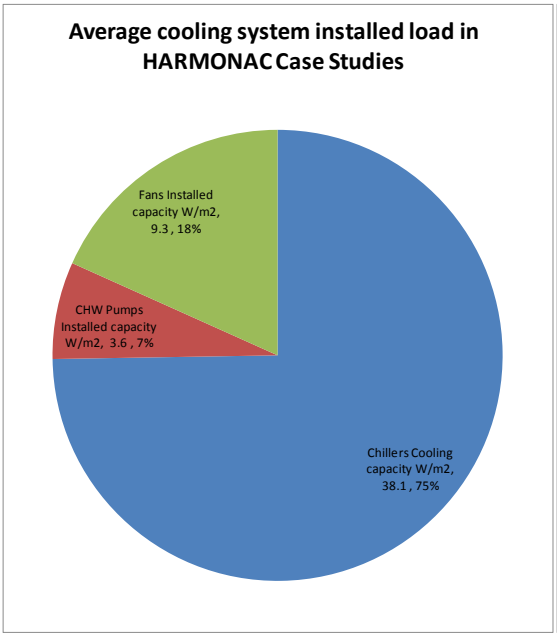
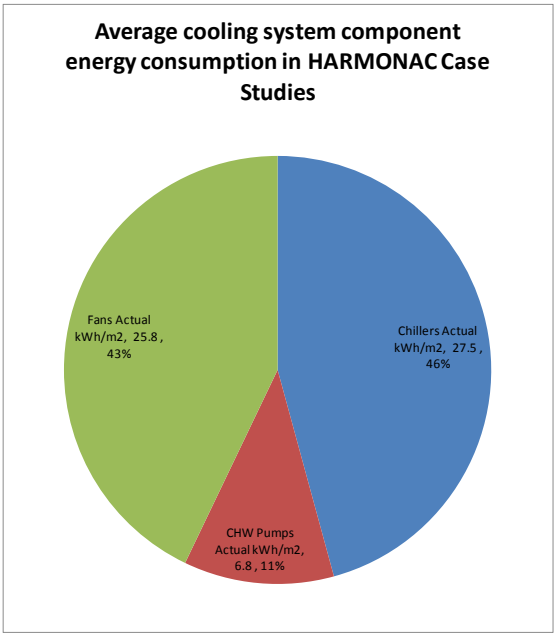
HARMONAC Short Stories on achievements – Story A

Establishing a unique body of knowledge of energy use in AC systems around Europe.

The 42 HARMONAC Case Studies on AC system energy use from around Europe have provided a unique insight into the energy consumption of all aspects of cooling delivery to buildings across Europe. This information should prove very useful to AC System Inspectors, AC System owners/operators, AC System designers and AC System component manufacturers.

From the data for the Case Studies undertaken the installed loads per m^2 and actual loads per m^2 by the cooling system components average out as shown in the pie charts below:

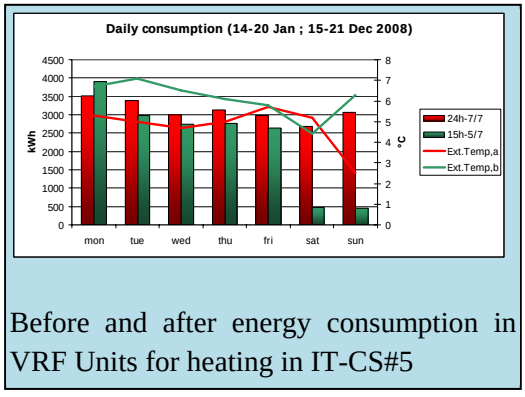




It can be clearly seen that the % breakdown of annual consumption in AC systems in buildings is not dictated by installed load, and that fans and pumps on average account for 54% of the annual energy consumption of an AC system.

By 'drilling down' into the Case Study energy consumption data in more detail we were able to identify energy consumption patterns that indicated good or poor control, and sometimes a Case Study was able to implement changes in the operation of the equipment that enabled the project to quantify an ECO or ECOs that had been found.

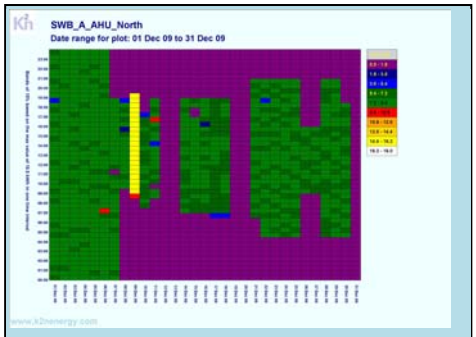
Many of the Case Study systems showed that substantial reductions in energy consumption could be achieved simply by better control of the runtimes of the systems as a whole, or their components. The graph alongside shows the saving in electricity used for heating by a VRF system over two winter weeks in IT-CS#5. This was achieved by changing the operation of the HVAC plant in an old heavyweight historic building from 24/7 operation to 15/5. As expected the Monday consumption increases due to extra heating being required to overcome the thermal inertia of the cooled building on Monday morning, but overall the energy savings are 26.7%.



Before and after energy consumption in VRF Units for heating in IT-CS#5

The detailed monitoring in the Case Study systems regularly identified energy savings of over 50% in AC system components, and achievable AC system energy savings amounting to 10% of the total building electrical energy use were also identified during this project. The Carpet Plot alongside vividly illustrates a 45% saving for one of the main AHU's in UK-CS#10.

Many of the Case Study systems could achieve substantial improvements in efficiency (50% is certainly feasible) through upgrading even fairly recent Chillers to some of the newer generation of cooling equipment available. This is one of the major elements to be investigated by any Inspector.



Before and after energy consumption in a UK-CS#10 Air Handling Unit once proper control had been imposed.

The pie chart alongside shows the breakdown of the average electrical power demands across all the Case Study buildings except the UK IT Suites. It can be seen that the AC system components account for about 28% of the overall average building energy use, with fans and chillers using about the same percentage of the overall building energy use (13% and 12% respectively) and pumps about 3%.

The overall conclusion from the Case Studies and Field Trials is that savings of 35 – 40% could be made in the current energy consumption of AC systems. If it is considered that many of the AC systems to which HARMONAC had access belonged to organisations who would be considered to be good at maintaining and operating their systems then it seems clear that in practice the potential average electrical energy savings could be larger than those found by this study.

We can look at what this information means in terms of the answers to 3 questions:

1. Where is electrical energy used in AC systems?

Answer: It seems clear that despite the Chillers having the largest installed electrical capacity, that the Balance of Plant consumes the bulk of the energy. An average split of the total annual electrical energy use in the ratio 45:55 for Chillers:Balance of Plant seems reasonable.

2. Are there obvious variations in this energy use around Europe?

Answer: This study revealed no obvious Climatic Variations in either area normalised installed cooling loads or normalised actual average power consumption, when just Offices were considered. It appears that internal activities and system design/ control still dominate the energy consumed by the AC systems. This is clearly revealed in the two UK London Offices, with almost identical use and energy consumptions being achieved despite one being designed with low energy systems and the other being over 20 years old, albeit with some recent refurbishment and control work undertaken on its HVAC systems.

3. What potential reductions could be made in this energy use?

Answer: It appears that realistically savings of around 40% can made in overall AC system primary energy use and about 10% of building primary energy use if the majority of ECOs were identified and implemented. In practice the authors believe that only 15% savings in AC system primary energy use (3.8% of building energy use) are likely to be achieved through the Inspection process.

The overriding conclusion is that much of the energy efficiency characteristics of an AC system are 'locked in' at design and installation stage. After this stage it is primarily O&M ECOs that are likely to be found by an Inspection and acted upon by an owner.

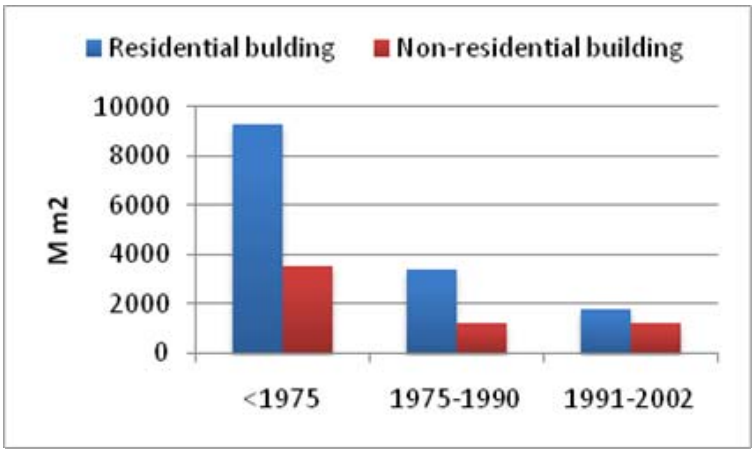
This conclusion brings into focus the lack of comparative energy performance data for different cooling approaches to the same end use. If this data were available then owners/designers/installers would be able to specify more efficient initial installations and be able to work out a cost:benefit to doing so. Just as importantly, this information would also provide a clear platform for energy efficient

systems and solutions to be able to 'prove' themselves thus enabling the market to start to value these more efficient solutions.

This should then unlock a robust improvement in HVAC system energy efficiency that would at the very least allow the missing 7% of building primary energy use savings to be obtained, and in practice could achieve much higher savings still as the impact on heating energy savings has not been dealt with in detail in this study.

Implications for European Energy Use

If we assume the findings presented here hold true for all air-conditioned European non-domestic buildings, i.e. service buildings, then we can provide a rough estimate of the likely impact of the project findings on energy use at a European level. Statistical data from Europe for 2004 notes that the Services sector (where non-residential buildings are included) totalled around 5,929 Million m^2, which represents 29% of the total building stock area[i] of 20,448 Million m^2.



European Building Stock

Of this 5,929 Mm^2 approximately 1,829 Mm^2 will be air conditioned in one form or another according to AUDITAC. If we take the UK Energy Consumption Guide 19[ii] as being a reasonable guide to energy consumption in various Office types, then air-conditioned offices typically consume 2.82 times as much primary energy per m^2 as naturally ventilated offices.

Therefore we can conclude that air conditioned offices are responsible for 56% of the Primary Energy use in this sector. The non-residential building sector is responsible for 12% of the total primary energy used in the EU-27[iii], i.e. this building sector represents 137.89 MTOE. So in total HARMONAC is addressing the 76.89 MTOE consumed by the AC part of this sector.

If the findings from HARMONAC were to be achieved in all service buildings it would be possible to save 10.4% of this figure, which would save around 8.00 MTOE.

In global numbers, this means that 93.04 TWh of primary energy would be saved and the equivalent of 18.31 Mtonnes of CO_2 emissions would be avoided if the Inspection procedures were able to find and get implemented all the ECOs potentially available.

HARMONAC expects the AC inspection process, as currently implemented, to achieve only around 37.5% of the potential savings identified. We therefore expect 3.00 MTOE (34.89 TWh or 6.87 Mtonnes of CO_2 emissions) to be saved if AC Inspection is fully implemented throughout Europe in its current form.

In terms of global savings AC system energy savings in the services sector can therefore potentially contribute a saving of around 0.7% of the total primary energy use in all European MS, but is more likely to achieve savings of around 0.26%.

The 42 Case Study reports are individually reproduced and presented by country in Appendices 2a to 2h of the HARMONAC Public Report, thus allowing them to act as a body of knowledge to all actors with interest in this area.

This information helps us to understand where energy saving efforts should generally be focussed, and is essential for underpinning the discussion about how AC System energy reductions can be achieved in practice.

References

[i] Mitigation of CO2, Emissions from the Building Stocks – ECOFYS for Eurima & EuroACE
[ii] Energy Consumption Guide 19 – Energy Use in Offices. Crown Copyright, March 2003
[iii] EU energy and transport in figures 2010, Statistical Pocketbook, European Union, 2010