CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

CA Technical Session:

iSERV – Inspection of HVAC Systems through continuous monitoring and benchmarking

Vienna, Tuesday 13th December 2011 15:30 – 17:00

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Energy use in EU HVAC systems

Equipment	Electrical consumption as % of total EU use in 2007
Air conditioning units and chillers	0.75
Fans in ventilation systems	3.34
Pumps / circulators	1.81
Space and Hot Water Heating	5.23
TOTAL	11.13%

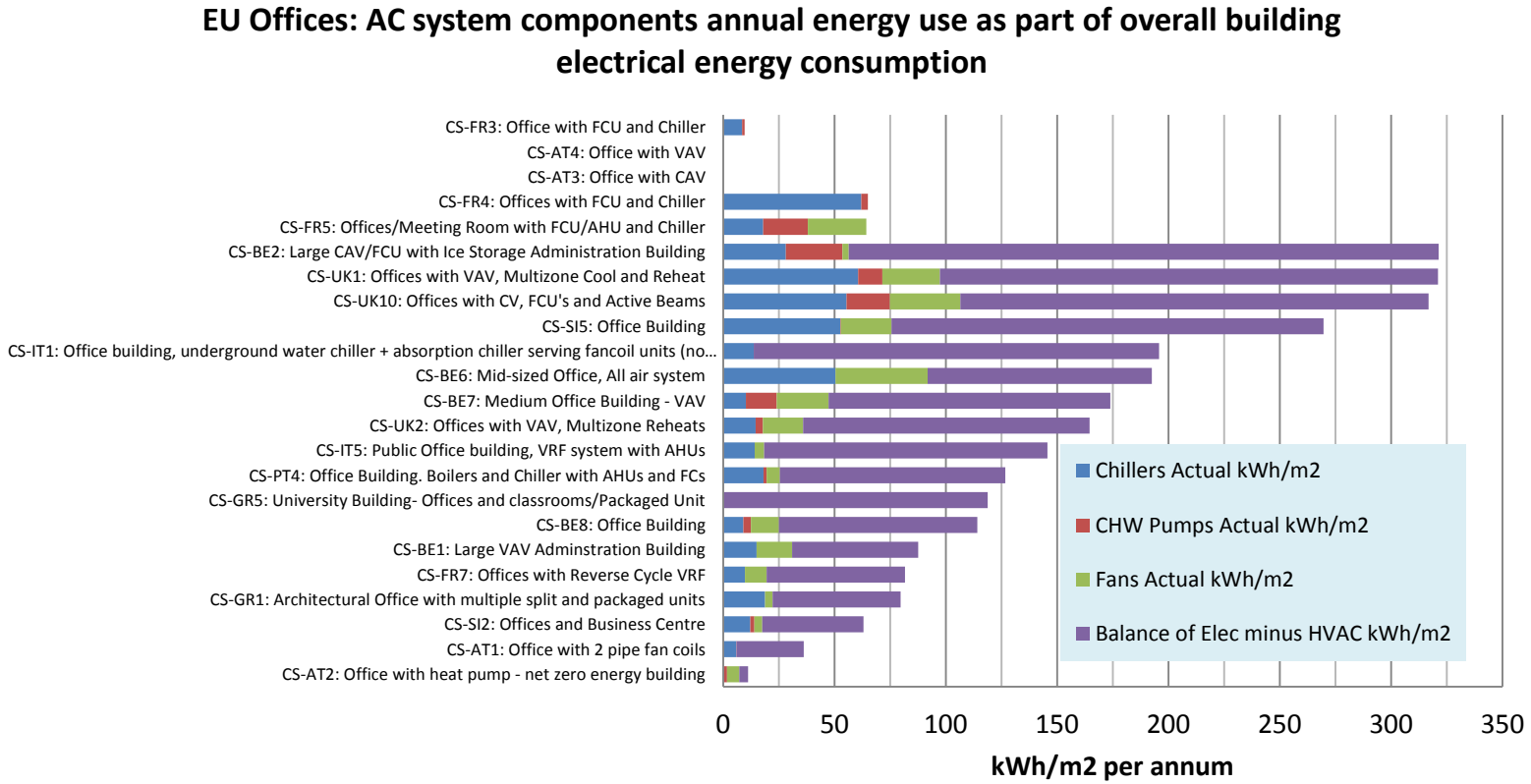
EC Joint Research Centre, Institute for Energy, 2009

In 2007, ELECTRICAL energy use in EU Building HVAC (Heating, Ventilating and Air Conditioning) systems accounted for 11.13% of the TOTAL electrical use of the EU.

Achieving a 10% reduction in this figure would be worth over €3bn at €0.1 per kWh. This does NOT include energy and cost savings from reducing fossil fuel energy use.

HVAC systems must therefore be a key contributor towards energy savings if the EU is to reach its target of reducing energy use by 20% by 2020.

HVAC system energy use in EU Offices – from HARMONAC



The data showed that neither geographical location or the age of the building were particularly useful in predicting energy use in the HVAC system. Insufficient data to draw many conclusions – **BUT…**

The crux of the issue

- The two UK HQ Office buildings were very close in terms of occupancy type and activities.
- One was new at the start of monitoring and used the very latest ‘advice’ on trying to achieve a low energy design (variable speed drives, low fresh air rates, chilled beams, low energy daylight linked lighting, etc)
- The other was old, with old plant and controls.
- They both used a nearly identical amount of HVAC energy per m^2.
- So what advice should be given on achieving energy efficiency in HVAC systems when ‘accepted wisdom’ does not seem to work in practice?
- It seems that the benefits of 'energy efficient' HVAC **components** can potentially be negated by poor design and operating decisions.
- So while initiatives such as the Eco-design Directive may help raise the inherent efficiency of the HVAC plant consuming the energy, it doesn't mean we will achieve the savings expected.
- **Poor choices are locked into system performances for decades**

Provision of advice for achieving energy efficiency in HVAC systems

- There is very little information available on what makes an HVAC installation energy efficient in practice, as the history of HVAC systems has been about providing the 'right' conditions – not reducing energy use.
- Large numbers of HVAC system types are available, some of these due to varying end use activity requirements. How to provide advice for all?
- For an HVAC system to work **efficiently** the interactions between the heating, cooling, humidification and ventilation systems are crucial, as are its interactions with the climate, building fabric and occupancy.
- HARMONAC showed that a major contributor to poor energy consumption was a lack of meaningful feedback on performance. Simple errors such as incorrect hours of operation are often missed - HARMONAC showed savings from rectifying these errors can reach 50%+
- **Therefore it is not yet possible to say "Just do this" and achieve an energy efficient HVAC system**

HARMONAC Conclusions

- "HARMONAC… …reinforced and quantified what was already considered to be 'good practice', i.e. … …**it is necessary to have good operation, maintenance and control** of an AC system, as well as **good record-keeping** and **choice of the correct type and design of system for the end use activity**."
- "The **key to increased long-term energy efficiency** in AC systems therefore **rests with making it cheaper for the owner to run their systems efficiently**… . This implies… …that there should be an alternative that rewards good energy management by allowing systems to avoid inspection if they achieve certain standards."
- "…there is **no real understanding in the market of the effect of AC system choice and design on the actual energy efficiency achieved** in practice. Without addressing this issue then more efficient solutions will not gain market share and the market for energy efficient equipment will grow more slowly than desired

Automatic monitoring – prospects for savings

- The purpose of HARMONAC was to establish, via metered EU Case Studies in installed AC systems, how many of the potential energy savings available in the systems studied were actually identified by Inspection procedures
- HARMONAC showed **Inspections identified about 37% of the energy savings shown to be present by the more detailed sub-hourly monitoring**
- The overall **average energy savings possible in the Case Study AC systems investigated were assessed as being between 35 – 40%**, or around 10% of the primary energy use of the buildings in which they were located
- Automatic monitoring has the added benefit of **continuous feedback** on performance relative to other end users addressing similar activities, thereby **not only achieving savings but also hopefully maintaining them**.

Automatic monitoring – function and principles

- Now the recast EPBD allows it, is automatic monitoring likely to provide better energy efficiency in practice? HARMONAC suggests 'Yes'
- The main advantage of automatic monitoring systems are that they reflect reality and the figures are simple to understand. They remove uncertainty.
- With sufficient data we can establish which systems consume the least energy, and therefore which approaches work in practice and with people.
- iSERV suggests the simplest automatic monitoring system needs data on energy use by the HVAC system, qualified by the activities served.
- Findings from the data should be presented to the system owner on a regular basis e.g. monthly, to enable progress and problems to be noted
- Day-to-day control and error alerts should be undertaken by the HVAC system's own control and fault alerting mechanisms
- The technology needed to establish and run such a system already exists and iSERV will demonstrate this via a fully functioning model system.

Automatic monitoring – making the right choices

- As already noted, the range of normalised energy consumptions found by HARMONAC to be possible for HVAC systems in EU Offices shows the importance of installing the correct systems at the design stage.
- Once designed and installed in a building the capital costs and disruption required to alter an HVAC system might mean it will remain for the building's working life. Certainly it is unlikely that a system change would achieve a sufficient reduction in energy costs to make it viable on these grounds alone, unless the systems were very small and easy to change
- Achieving the correct choice of system at the design stage requires establishing which system types deliver what level of energy performance in practice when servicing specified end use activities
- Independent highlighting of good energy performance by specific systems and types can also help them more rapidly achieve market share – and hence achieve more rapid energy savings overall

Automatic monitoring – informing the end user

For the full benefits of such an approach to be achieved, the data collected must have an immediate and on-going value to the end user in controlling their energy use and guiding investment in energy efficiency.

An automatic monitoring system should ideally:

- Place an HVAC system's actual energy use in context - allowing the owner/operator to evaluate with confidence the energy savings they might make from investing in better control or better hardware
- Give the end user/consumer the information they require to make energy efficiency choices that suit their particular demands.
- Be cheap to run and require little manpower

Automatic monitoring - impact

- What impacts might be expected from an automatic monitoring scheme?
- It would allow **legislation** to be written **which allows end users to join in with efforts to reduce energy use**, rather than viewing the legislation as an imposition which doesn't seem to achieve anything
- It would enable actual ranges of energy use, by activity served, to be obtained, as well as understanding of the changes occurring over time in these energy use figures.
- The data obtained would have implications for planning as well as energy saving. For example, it may prove to be demonstrably cheaper to subsidise energy saving efforts than build new generation or distribution capacity
- It would provide certainty about the savings being achieved by targeted initiatives and by energy efficient systems and designs
- It will stimulate more rapid adoption of proven technologies and techniques, as well as rapidly proving the benefits of new approaches

Automatic monitoring - costs

- For existing systems: capital costs will be incurred in installing suitable monitoring equipment but, for a initial basic system, these are now fairly low (less than €1,000 for an autonomous internet connected retrofitted energy meter)
- For new systems: many manufacturers are now building-in monitoring capabilities which can be remotely interrogated
- For initial setup for an HVAC system: Between 0.5 day to a few weeks manpower might be needed depending on the extent of the system and existing information. Much of the information SHOULD already exist from the Inspections that the systems should have had by now.
- On-going costs: a few 10's of Euros per year for a relatively simple system should be possible. For anything other than the smallest systems, these costs should be more than recouped annually in the energy savings achieved from the advice in the reports, derived from the data collected.

Automatic monitoring – relationship to Inspection

- An automatic monitoring system can be operated as an alternative to Inspection, but for best results should be a complement to Inspection
- iSERV envisages Inspection being required for systems which do not subscribe to an automatic monitoring system, or for which their monitored performance falls below a certain benchmark.
- In the context of National Regulations it seems possible to frame the requirements simply in terms of subscribing to, and meeting the terms of, an approved scheme.
- The information presented until now suggests that the worst approach for achieving actual energy savings would seem to be advice only schemes. HARMONAC showed that some of the largest recurrent savings were to do with poor control, especially of hours of operation, which cannot be simply advised against.

CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

iSERVcmb – Inspection of HVAC systems through continuous monitoring and benchmarking

www.iservcmb.info

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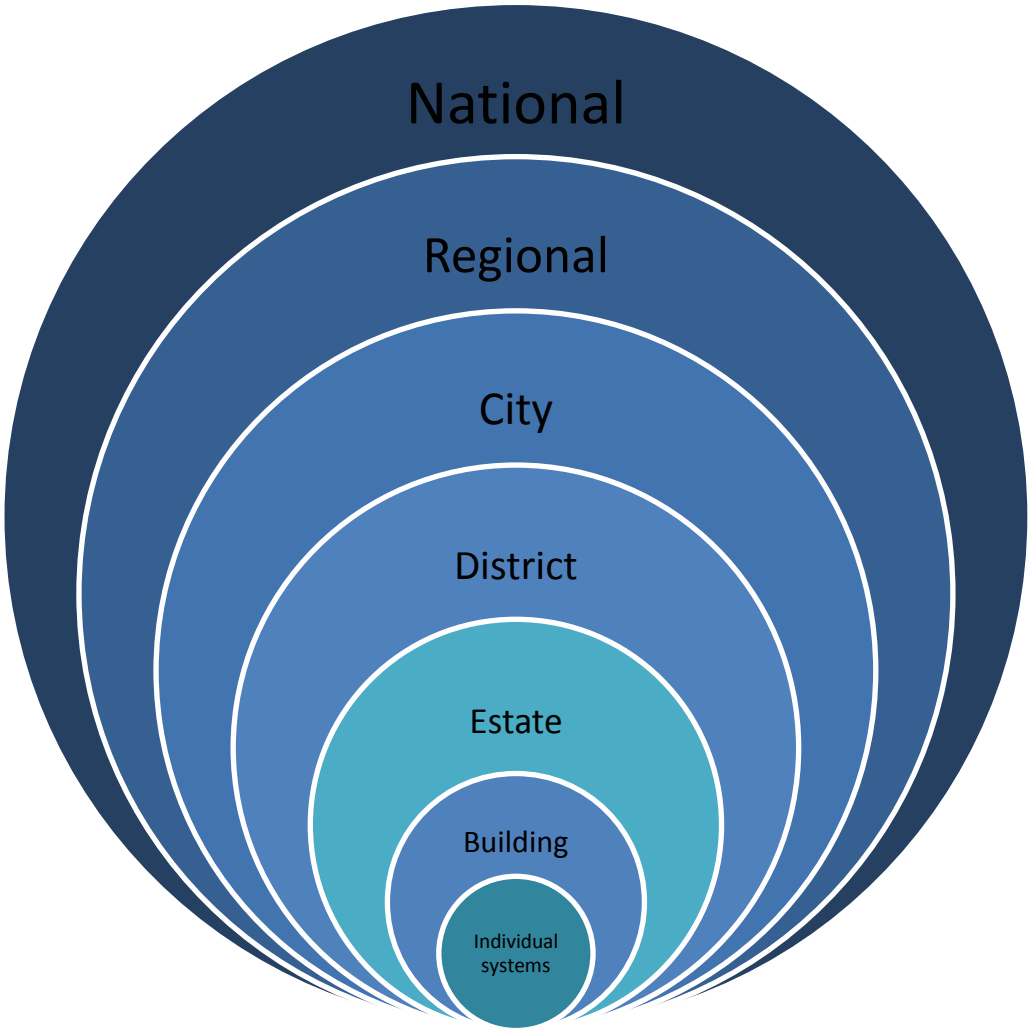
iSERV – Introduction

- The iSERV project is designed to allow around 1600 HVAC systems from around 20 EU MS to subscribe to an online monitoring system to establish whether the energy savings achieved by some HARMONAC Case Studies from detailed monitoring will be replicated in a much larger sample.
- iSERV will collate and analyse sub-hourly data from these systems, and provide energy performance feedback to the system owner/operators
- To enable benchmarks to be established for ‘good’, ‘average’ and ‘inspection required’ levels of performance of these systems, information is also required about the activities that the HVAC systems are servicing.
- iSERV will also undertake a limited (~80) number of Inspections and Indoor Air Quality tests on samples of these systems to ensure that they are as described by their owners, and that good energy efficiency is not being obtained at the expense of air quality.

Making sense of energy use



Established metering solutions exist for all levels of this figure

So **we know how much energy we are using** – but often we don't know why we are using it, or **how much we should be using**.

This is an issue with many energy monitoring systems – without benchmarks to compare the consumption with it is very difficult to start reducing consumption.

iSERV – Replicability

- iSERV intends to act as a model for other systems to follow.
- It seeks to establish a consensus amongst the major actors about how such a model might operate – it already has support from the major Professional Bodies, some major HVAC component manufacturers and a major European building developer.
- The approach is designed to be totally scalable and to exist fully online i.e. not requiring installation on, or access to, any end user computers or networks. This makes it replicable anywhere in the EU.
- The software and hardware required for such a procedure also already exists and is available from a number of sources
- The procedure will be fully documented during the iSERV project period in an effort to obtain a degree of harmonisation in this field before multiple competing solutions emerge.

iSERV – Barriers to use

There are four main hurdles to a continuous monitoring and benchmarking procedure being adopted by end users:

1. Lack of information on the HVAC systems and activities served. For many system owner/operators one of the major hurdles to such a scheme is that there is little or no existing information on, or understanding of, the design and proper operation of their HVAC equipment.
2. Installation of suitable monitoring equipment. The procedure relies on information being collected and sent to a central database. For long-term reliability this information should be collected automatically.

Neither of these hurdles are technically or financially difficult to overcome.

3. A suitable system to provide the service
4. The necessary legislation

iSERV – Barrier 1. HVAC system and activity details

- In conjunction with the Professional Bodies CIBSE and REHVA, along with its Steering Group members, iSERV has produced a spreadsheet which addresses the initial barrier of obtaining information for HVAC systems.
- This spreadsheet also acts as a means of collating information on the interactions between HVAC systems and the spaces/activities they serve.
- This information is of value regardless of whether the end user uses an iSERV type scheme, as it is essential to Inspections and for energy managers wishing to understand their systems better
- The empty iSERV spreadsheet is shown here and a completed example here

"The Excel spreadsheet developed by the iSERV project is a unique tool to structure and organise the information of HVAC systems... It aligns perfectly with the need to improve the value of HVAC system inspections by having collected and gathered pertinent information prior to the inspection…"

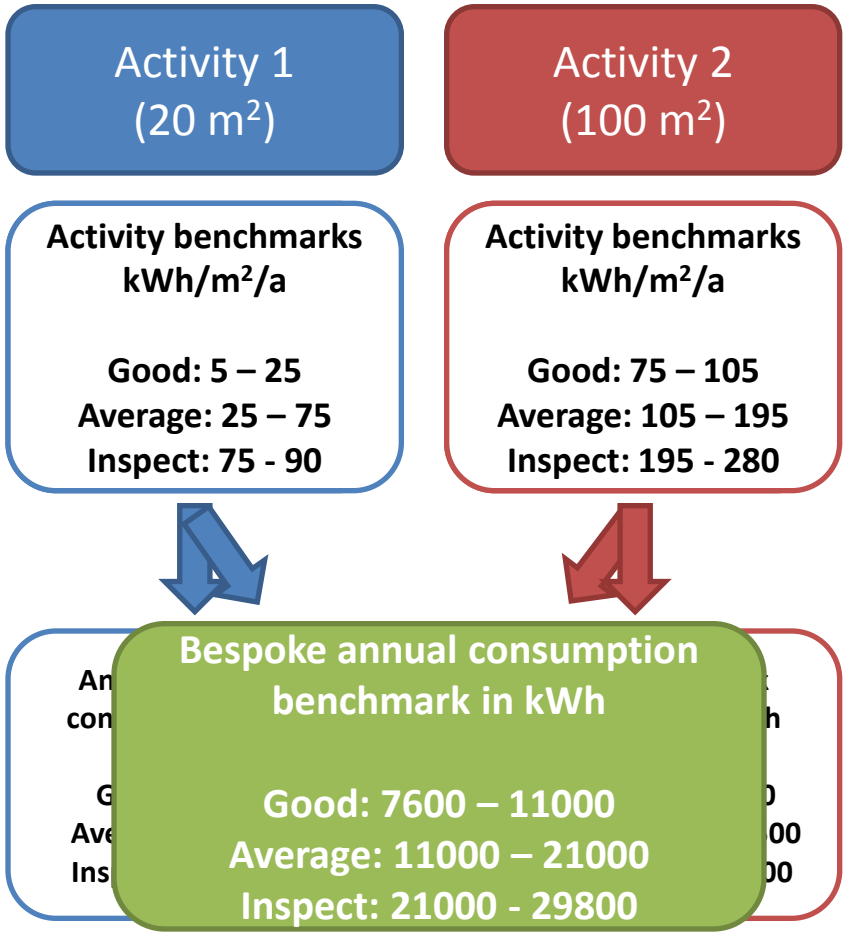
Olli Seppänen, REHVA General Secretary.

"…CIBSE is participating in iSERV as the project offers practical help to those who operate and manage HVAC systems to reduce energy consumption, carbon emissions and, most importantly to many building operators, cost. The iSERV data entry spreadsheet is an invaluable tool for gaining an overall understanding of the HVAC system described and for collating information essential for Inspections"

Hywel Davies, Technical Director, CIBSE

iSERV elements

- iSERV uses collected data to produce activity benchmarks
- The figure shows how activities, benchmarks and floor areas are combined in iSERV to give bespoke benchmark ranges for each unique HVAC system.
- Noted that iSERV calculates HVAC energy consumption benchmarks by activity mix **not** HVAC system i.e. it is neutral about system type

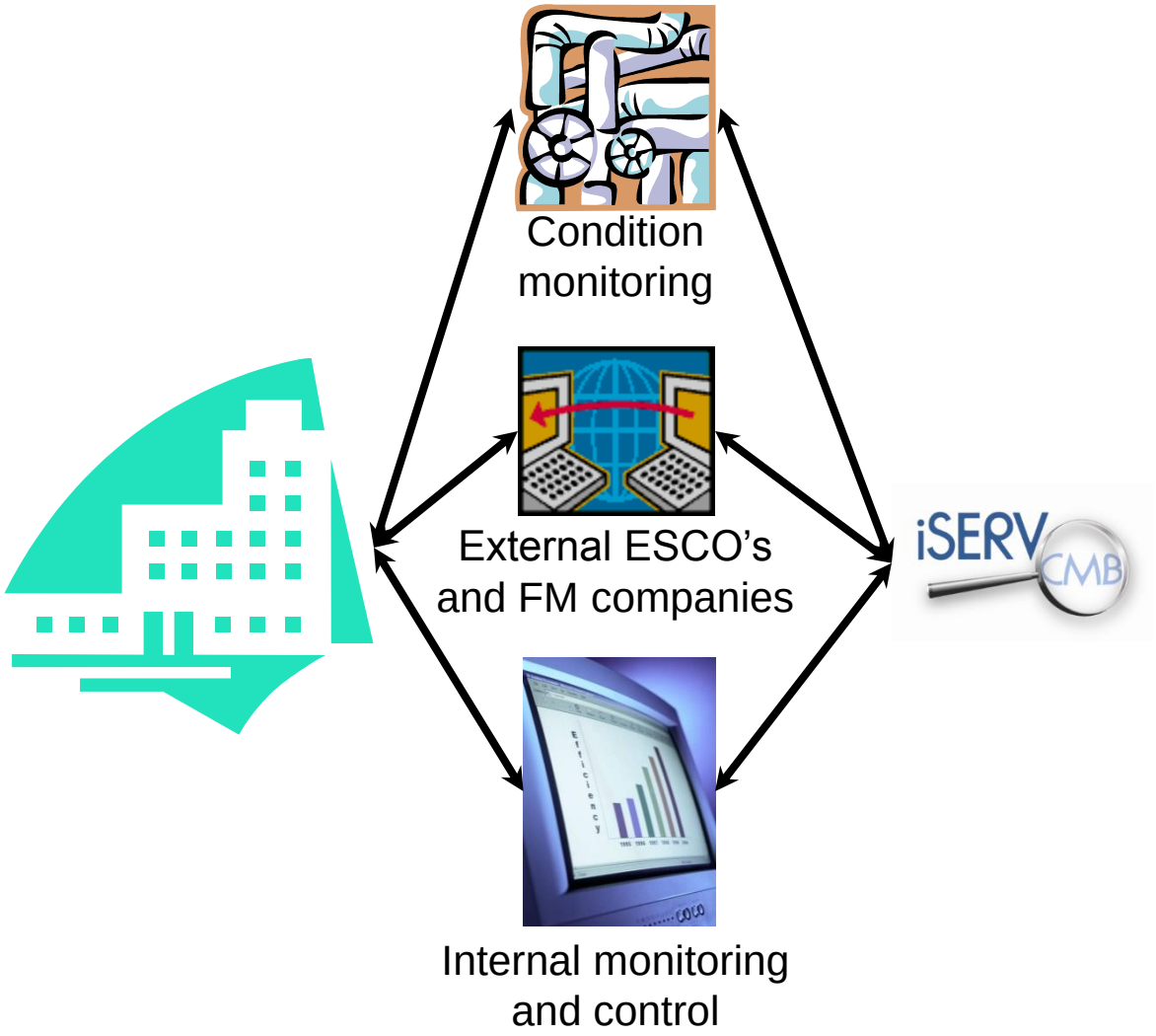


iSERV – Barrier 2. Installation of suitable monitoring equipment

- The minimum monitoring installation envisaged by iSERV in a compliance system would be metering of the Cold Generator (and Humidifier if present) electrical energy consumption in the HVAC system.
- All other equipment COULD be described in terms of their installed loads – though this would most likely lead to estimates which would put the system into the 'below average' category.
- There are numerous existing metering and monitoring solutions in the market already – all of which could provide the required data. So the means to overcome this barrier already exists in an established market.
- It is possible today to install a mainstream web-connected stand-alone energy monitoring system for all the major elements of an HVAC system for less than €5000. Newer entrants are cheaper.
- HVAC component manufacturers are now starting to build this capability into their equipment so costs of participation for end users should continue to fall rapidly

Relationship with existing monitoring systems

- Can collect data from the wide variety of data monitoring systems that already exist
- Can provide feedback to any authorised recipient



iSERV – Barriers 3 and 4. A suitable system and legislation

- iSERV is currently a big IEE project with a limited life. However it is intended to act as a model for commercial services to follow.
- The funding from the IEE programme is very specific in wanting the project to stimulate major savings through introducing a procedure which should have long-term appeal to the market in this area
- For automatic monitoring and feedback systems to succeed, the market needs strong signals from the EU legislators that they are preparing to support such approaches in the EU Member States.
- Initially these signals could be as simple as attributable quotes in support of the iSERV project aims and procedures
- Even should the project last only for its funded period, the information to be derived should prove invaluable to Member States for all aspects of meeting the requirements of the EPBD. Providing support is therefore in everyone's best interests.

Interaction with legislation

- For the iSERV approach to be adopted and achieve the impact it wants, it needs MS to enable legislation that allows the approach to be used alongside Inspection
- It needs the relationship to Inspection to be determined and to be clear for each MS

iSERV summary - why bother?

- Potential reduction in **total** EU **electrical** energy use of 0.5 to 2.0%.
- Fossil fuel savings not quantified but are significant.
- Substantial cost savings can be achieved for low or no cost
- Low barriers to entry. All technology already exists.
- Backed by Professional Bodies, HVAC Manufacturers and a major Developer.
- **Allows the end users to participate in saving energy**
- IEE project to help MS implement the recast EPBD as well as improve the quality of HVAC Inspections.
- iSERV – May 2011 to May 2014

Summary - what are the questions iSERV addresses?

- The ranges of energy use we should expect a specific HVAC system to consume, based on the mix of activities served
- Obtaining regular HVAC system specific guidance on reducing energy consumption
- The best energy performance being achieved by HVAC systems to meet a given end-use activity
- How to provide support for a rapid development of a market for efficient HVAC products
- How to provide confidence to end users about investing in more efficient systems

Summary - unique iSERV features

- Can aggregate collected data into reports back to the HVAC owner showing comparison with **bespoke targets derived from ACTIVITY-based benchmarks**
- Can provide guidance to possible ECOs specific to the HVAC system
- Independent – crucial to providing confidence to the end user that the reports provided are not biased
- Based on real data from real systems using existing data collection technologies
- Easy to understand by end users re. decision making
- Provides HVAC system specific info to owners/ operators – again allowing easier decision making

Insert example report here from iSERV showing first simple profile and then fading in the background target ranges

Show HARMONAC CS breakdowns of consumption by HVAC relative to whole building, and OWS breakdown within a building

Summary - Support for Building Professionals

- The professions responsible for designing and operating Building Services in practice will gain from CIBSE and REHVA publications and guidance using iSERV material. Both are full Partners in iSERV.
- This guidance is already starting to be seen in a forthcoming Air Conditioning Inspection Guidebook from REHVA, which is using the findings and outputs from HARMONAC as its basis

Summary - Support for HVAC Manufacturers

- The HVAC Industry struggles to sell its more energy efficient solutions in the market as they generally come with a premium and customers are unclear that they will really achieve the energy savings claimed.
- As an independent procedure iSERV can demonstrate which HVAC system types are currently most efficient for which end use activities. It is anticipated that both end users and HVAC manufacturers will want to be associated with these 'good' systems and will therefore wish to disclose who they are and the equipment they are using.
- iSERV also allows HVAC manufacturers on-board diagnostic capabilities to have added value, as they can now be used to indicate overall performance via iSERV. These capabilities further allow HVAC manufacturers to highlight good performance and engage with end users to rectify poor performance.

Summary - Legislation and implementation

- For the iSERV approach to be available in the market, legislators need to enact legislation enabling this type of approach as an option to meeting the requirements of the EPBD in their MS
- iSERV can discuss implementation with interested MS. A perhaps unrealistic preference would be for a coordinated approach in the EU, to allow lessons to be learnt across MS
- How and who to implement? MS can implement their own iSERV type approach or the iSERV project team could help setup an iSERV type system for countries that would prefer not to run their own. This latter option would also allow long-term understanding to be obtained of how to improve HVAC energy efficiency.
- iSERV principles and procedures will be published as project progresses

iSERV and CA3 interaction

- Help from CA3 – quotes and other high profile support for the approach from MS legislators would be very helpful in recruiting HVAC systems in the MS countries.
- In return, MS legislators will get up-to-date data about HVAC use in their country and how any energy savings are being made – plus iSERV does the hard work in analysing it for you

What I'd like:

"iSERV is the best project ever and we will enact legislation allowing this approach to be used to show compliance with EPBD legislation in <EU MS>"

Signed by all MS legislators

I'd settle for:

"Approved monitoring schemes will be an acceptable alternative/complement to Inspection in <EU MS>"

Attributable to a MS legislator for each EU MS wishing to adopt this approach

Conclusions

- Automatic monitoring and feedback systems provide a unique opportunity for MS to establish an effective and harmonised approach to substantially and sustainably reducing HVAC systems energy use in practice
- MS engaging with iSERV **now** will enable iSERV to produce the maximum amount of information on energy use in HVAC systems for that MS

Final thought

- The extent of iSERV's final impact will, to some extent, be dependent on the level of support it achieves from the main actors who are involved with it.
- We are asking end users to invest their own time, money and effort to participate. They are far more likely to do so if they think the effort will have a long-term benefit to them.
- This means that visible support from MS legislators for such an approach will be important to getting participating HVAC systems from their countries.
- I hope you feel able to support this initiative.

CONCERTED ACTION EPBD

HOW ENERGY EFFICIENT ARE YOU REALLY?

THE iSERV CMB PROJECT

www.ISERVCMB.INFO

INSPECTION OF HVAC SYSTEMS THROUGH CONTINUOUS MONITORING AND BENCHMARKING

Thank you for your attention

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www.iservcmb.info