Inspection of HVAC systems through continuous monitoring and benchmarking

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The HVAC sector, legislation and the market

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Presentation to EPEE,

May 2012

Supported by INTELLIGENT ENERGY EUROPE

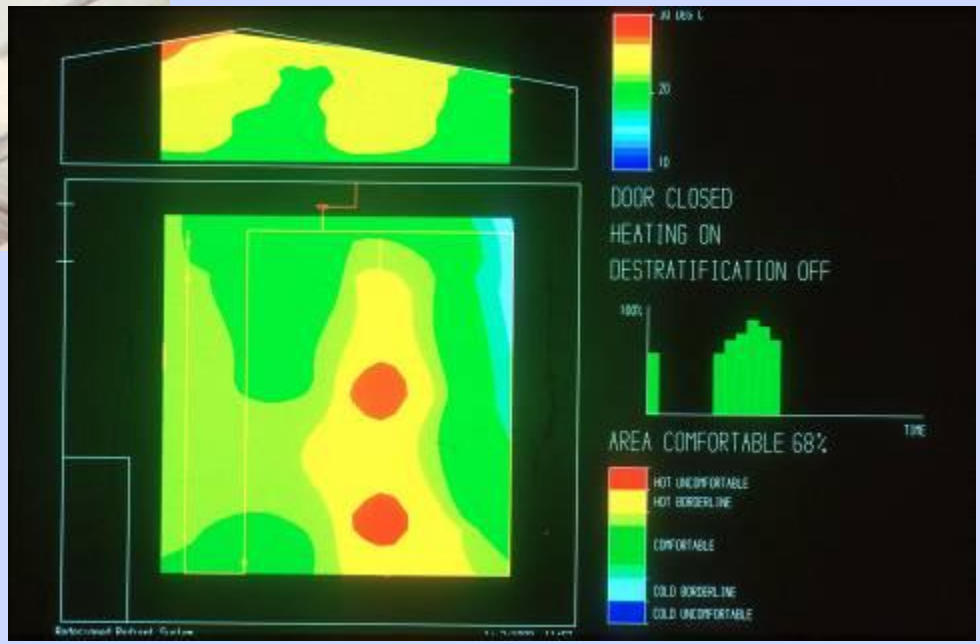
Context

- ➔ Need to improve energy security in Europe
- ➔ European Legislation – EPBD
- ➔ Near Zero Carbon Buildings by start 2019
- ➔ Reactive or proactive HVAC sector?
- ➔ Route to legislators via iSERV
- ➔ iSERV end goal – HVAC sector and end users to take responsibility for reducing HVAC energy use long-term, hence reducing legislation and rewarding good behaviour
- ➔ Emerging market for **proven** low energy HVAC components

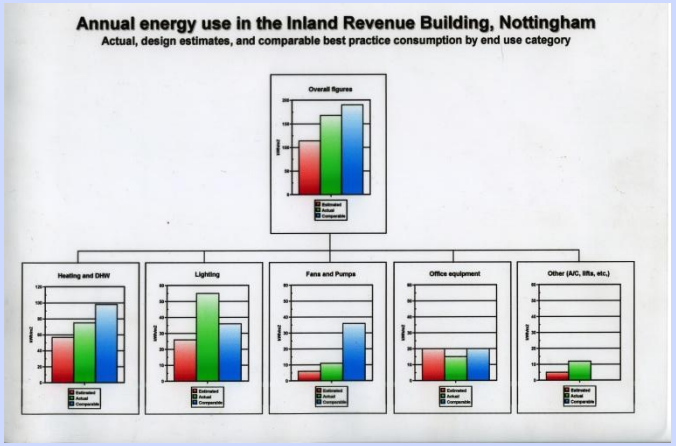
Background – Ian Knight

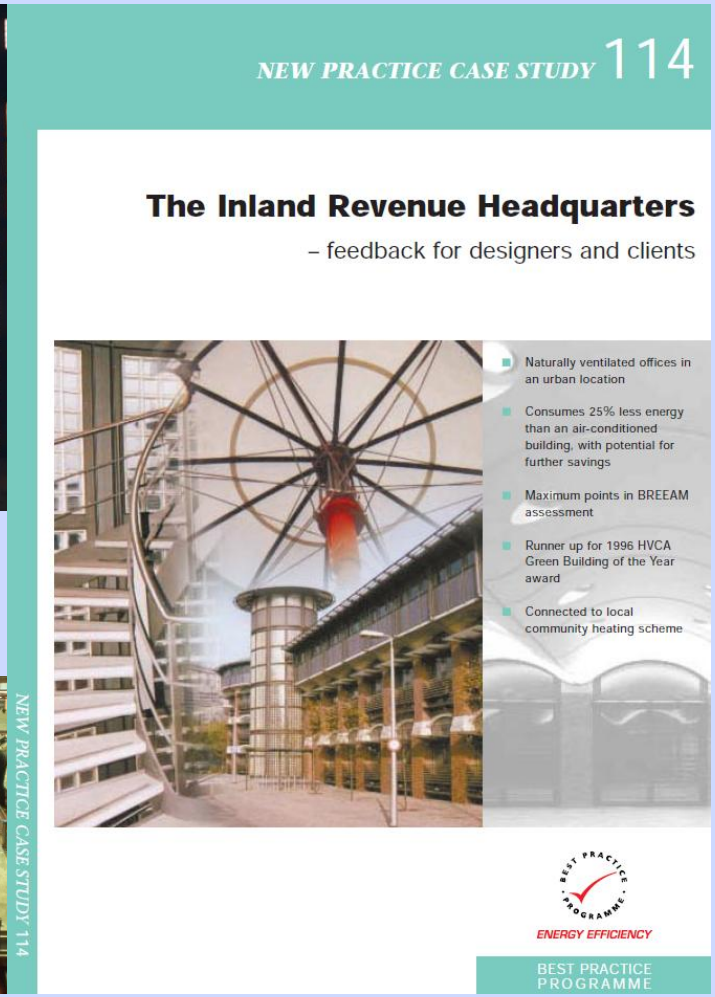
- ➔ Engineering/Physics Degrees – followed by 25 years studying the energy use of buildings and services
- ➔ IEE HARMONAC Project Coordinator 2008 to 2010 – HARMONAC led to changes between Article 9 in EPBD to Articles 15 and 16 in recast EPBD i.e. allowing alternatives to physical Inspection based on measurement
- ➔ HARMONAC also showed the savings achievable from using detailed data on HVAC components compared to mandatory EPBD Inspection
- ➔ HARMONAC and iSERV are the two largest projects ever funded under IEE. They carry a great deal of weight.

Assessing buildings – factories and comfort – 1980's

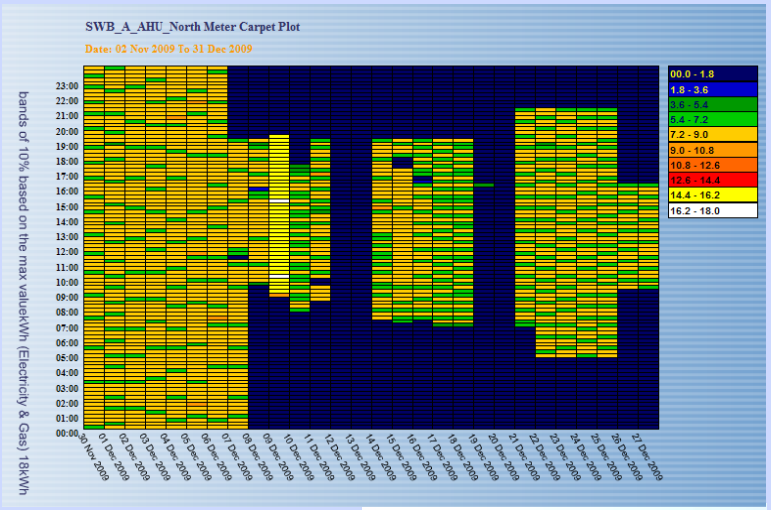


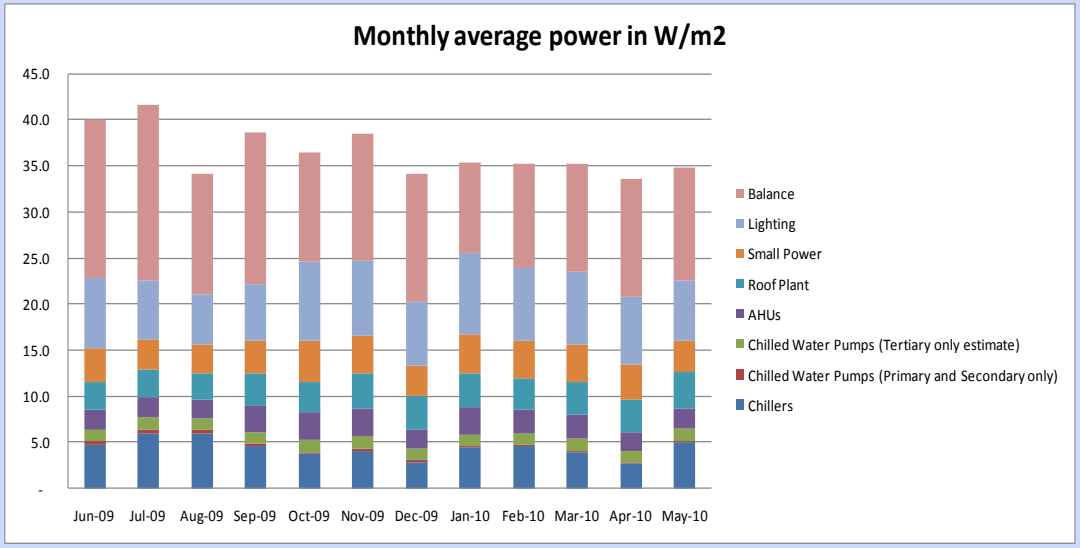
Assessing buildings – low energy designs – 1990's





Assessing buildings – end use and services in detail – 2000's





iSERV basics

- ➔Involving the end user along with the design of HVAC systems and choice of components are key elements in reducing HVAC energy use in buildings
- ➔HARMONAC showed end users will act if given information focussed on their systems
- ➔**iSERV benchmarks HVAC components against the activities they serve**
- ➔Building design and alterations are part of the potential iSERV ECOs to improve HVAC performance

What are the problems to solve?

- To date the market has not provided the energy efficiency improvements needed in buildings – hence we have the EPBD and other legislation.
- Owners want HVAC energy efficiency, but the market lacks the **independent proof** of likely performance to be achieved from investment.
- Need to demonstrate applicability of low energy solutions **to specific situations**
- Need to demonstrate clearly to the legislators where nZEB will not be possible
- How to create a common sector wide approach to demonstrating energy efficiencies available from HVAC components and systems serving specific end uses

How does iSERV help?

We all know how to get consumptions and gather data for HVAC systems. The question that iSERV tries to answer is:

Is the energy being consumed by an HVAC system reasonable for the activities it serves?

iSERV's approach will provide independent verification of current energy use possible at **HVAC component** level when serving given activities

How does iSERV propose to do this?

➔iSERV collates information in a way which is rarely (if ever) done for HVAC systems:

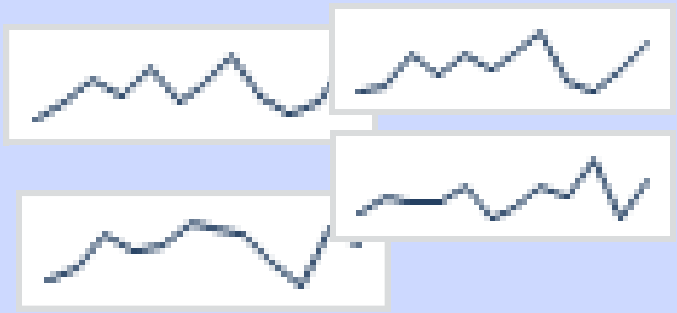
- It catalogues the HVAC components, meters and sensors
- It describes the spaces, areas and activities served by the HVAC systems
- It then links all these elements together to describe the HVAC system components in terms of areas and activities served

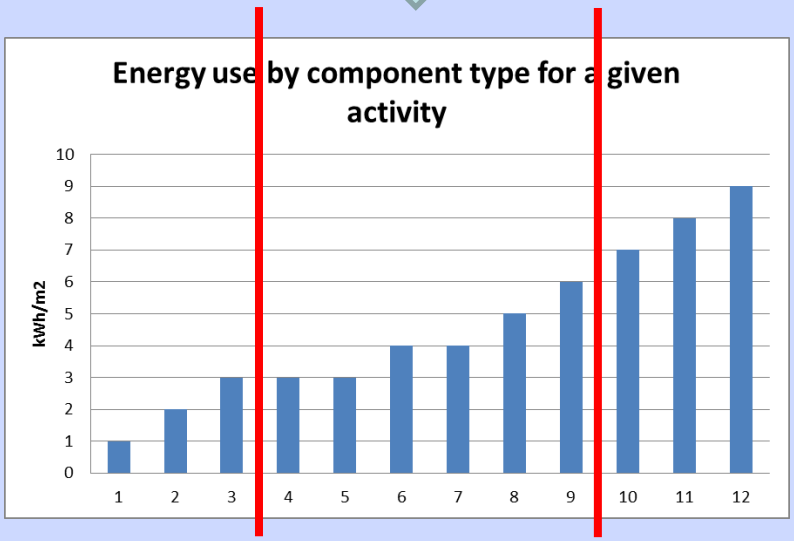
Too much effort?

- ➔We need to understand what an HVAC system comprises, and what it is meant to be doing, in order to improve its energy efficiency.
- ➔iSERV provides tools and guidance to collect and collate the initial data needed. This usually need only be done once and is then available for Inspections and future system improvements.
- ➔Approach is endorsed by CIBSE and REHVA and will be promoted heavily over next 2 years

Where do the benchmarks come from?

- By collecting energy use data from HVAC component types serving the same end use activity in different areas
- iSERV will provide ranges of measured energy use by component type for the same activity served
- These will be the first data on energy use ranges for an HVAC **component** for a given activity served





What about a complete system?

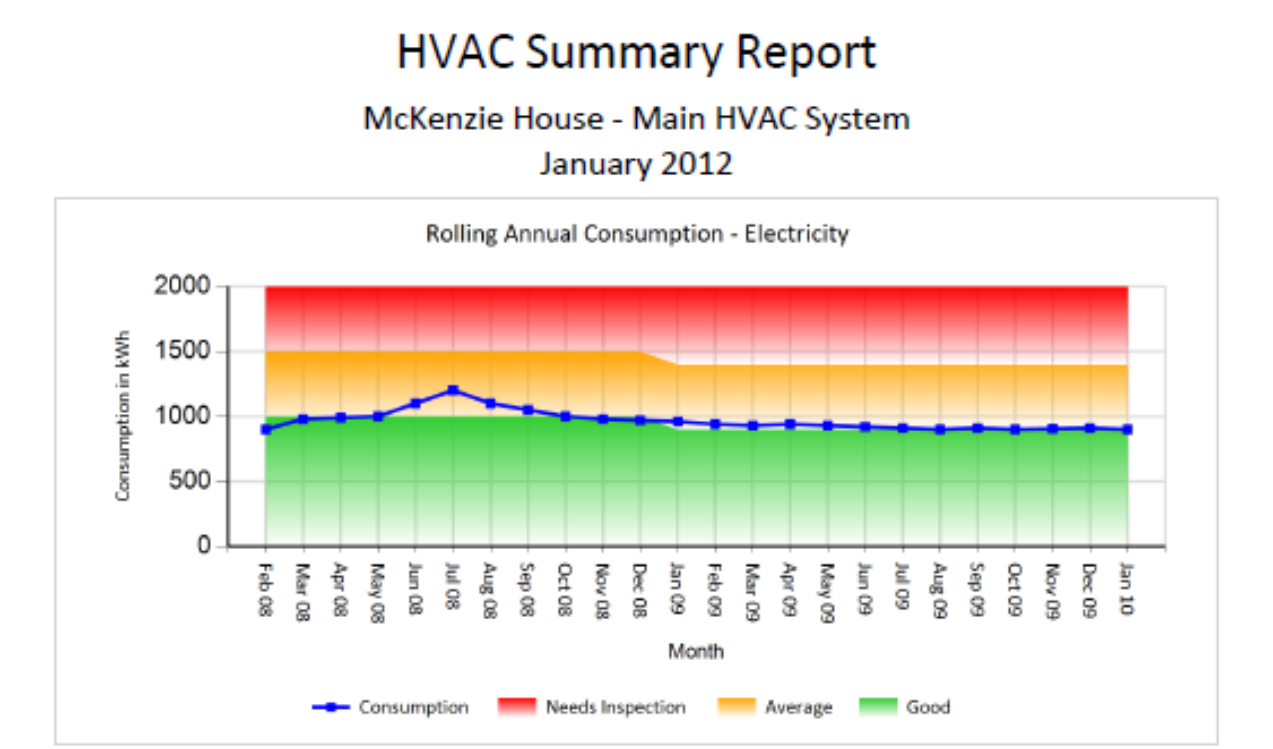
- ➔iSERV will produce bespoke ranges of consumption for any combination of HVAC components used in a real system
- ➔To do this it need only know the end use activities served, along with (usually) the total floor area each activity type occupies.
- ➔The exact methodology used for the predicted ranges of consumption and ‘sanity checks’ will be derived during the project, but will include assemblage of component benchmarks in some form

Benchmarks

- ➔To cover annual and monthly energy use per m^2 as well as power per m^2
- ➔These 3 different benchmarks cover all possibilities for assessing energy use
- ➔The annual energy use is likely to be the benchmark for legislation
- ➔Monthly energy use and power are the most useful for diagnosing Energy Conservation Opportunities (ECOs)

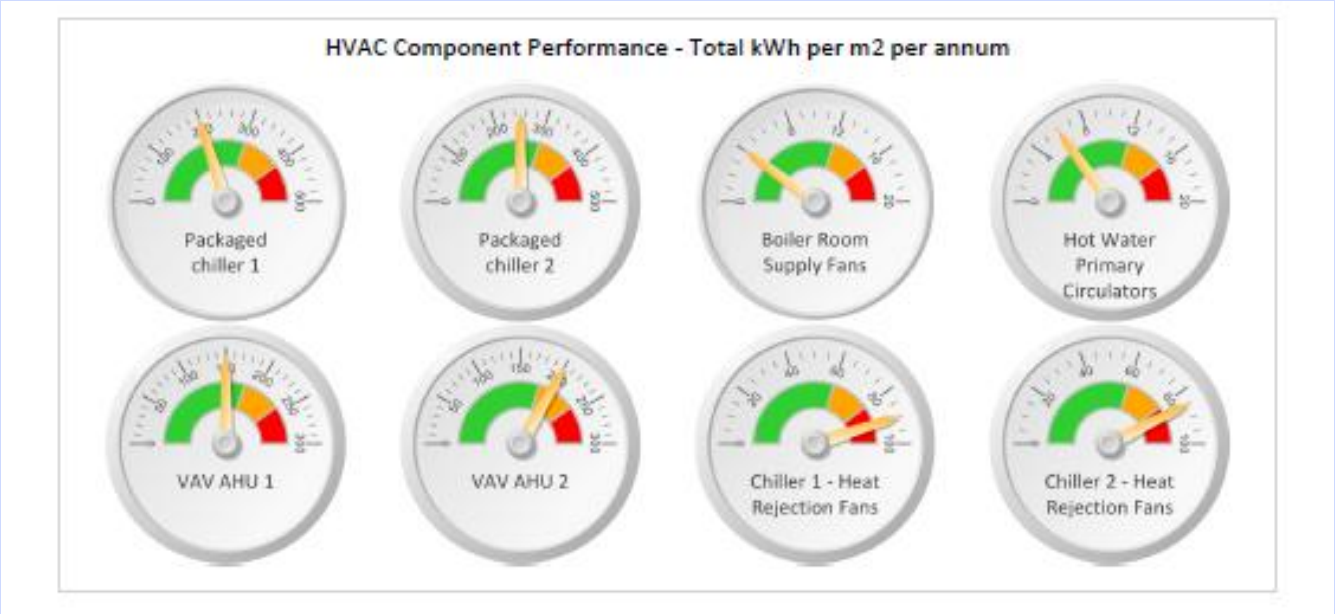
HVAC System Report

➔Overview of whole HVAC system performance against bespoke ranges predicted for mix of activities served



HVAC Component Reports

➔Overview of individual HVAC component performance against ranges predicted for mix of activities served

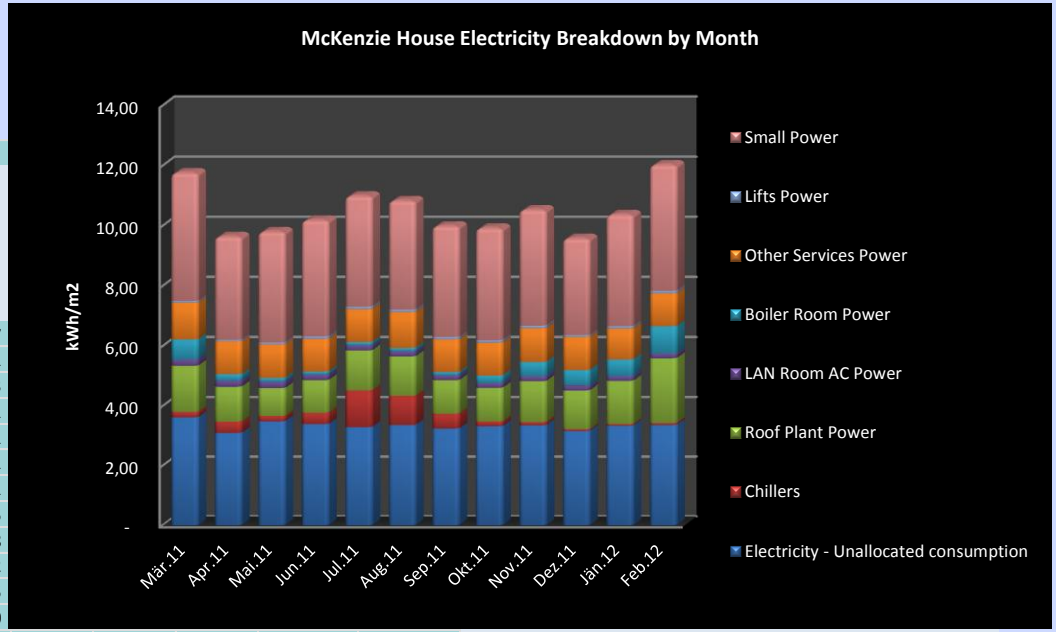


Energy Conservation Opportunity (ECO) Reports

- ➔Another unique feature of iSERV is its ability to take the measured data for the HVAC components and automatically suggest potential ECOs that could reduce the energy use of the HVAC system
- ➔iSERV will provide an indication of the likely energy and costs savings to be achieved for each ECO.
- ➔ECOs maximise the value of submeters, and reduce the analysis time needed by the energy manager to understand his HVAC system's performance

Example outputs from iSERV data – monthly data

McKenzie House Conditioned Floor Area/m2 =			8434.93		
All Figures in kWh/m2					
Month	Electricity - Unallocated consumption	Chillers	Roof Plant Power	LAN Room AC Power	Boiler Room Power
Mar-11	3.62	0.18	1.54	0.21	0.67
Apr-11	3.10	0.38	1.17	0.21	0.21
May-11	3.49	0.18	0.93	0.21	0.13
Jun-11	3.39	0.39	1.09	0.18	0.11
Jul-11	3.29	1.24	1.33	0.17	0.11
Aug-11	3.36	0.98	1.32	0.17	0.11
Sep-11	3.25	0.50	1.12	0.16	0.11
Oct-11	3.33	0.15	1.13	0.17	0.25
Nov-11	3.36	0.11	1.37	0.16	0.48
Dec-11	3.17	0.06	1.30	0.17	0.52
Jan-12	3.34	0.05	1.45	0.16	0.55
Feb-12	3.37	0.07	2.16	0.16	0.90

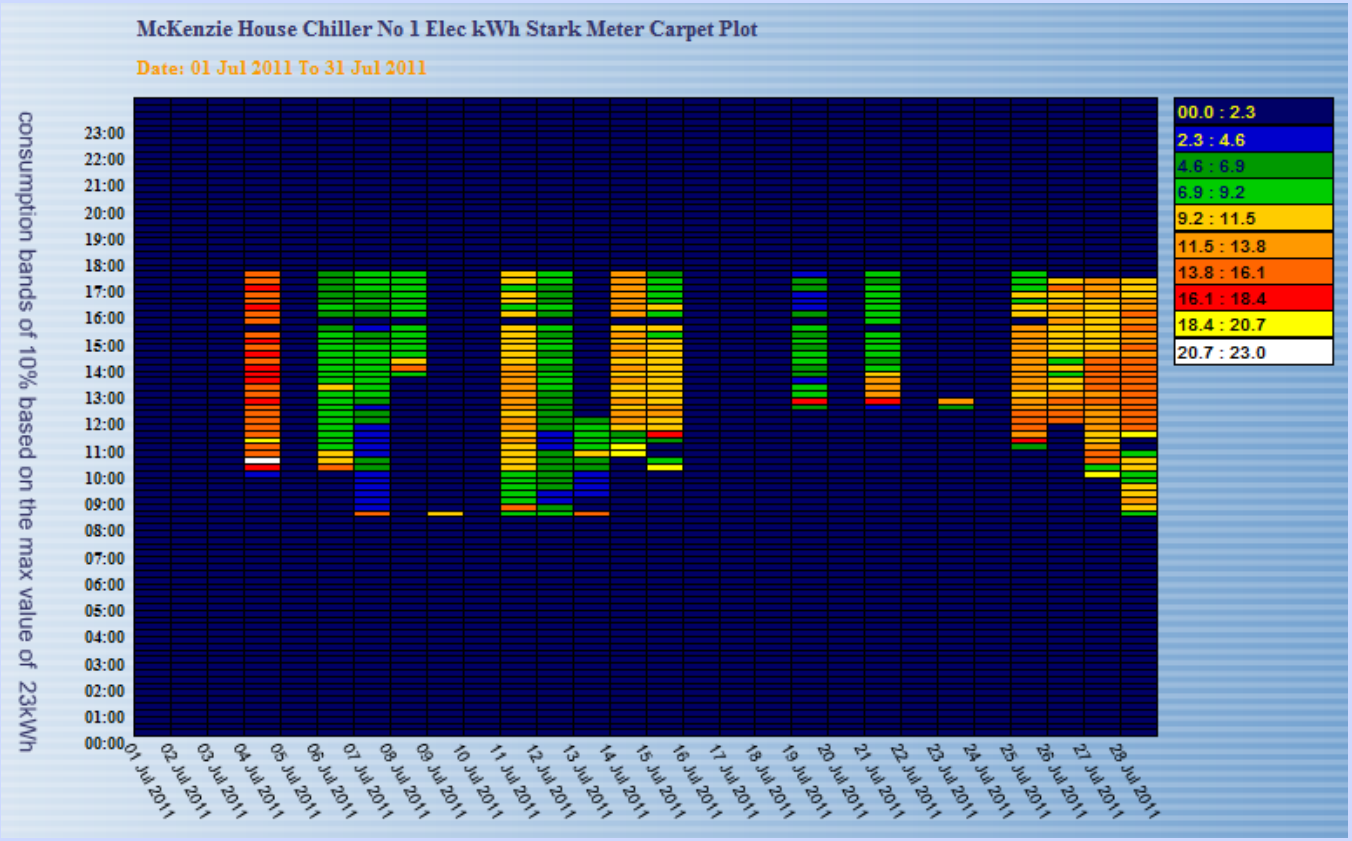


Sum of Std_Month_ Consumption	C	L										
Total Mar-11 to Feb-12			40.1	4.3	15.9	2.1	4.1	13.3	0.8	45.0	125.7	257.0

Month	Blr 1 Cumulative	Blr 2 Cumulative	Blr 3 Cumulative	Chiller 1 cum power	Chiller 2 cum power	Clean Supply DB cum power	DB Floor 2 cum power	DB Floors 1&3 cum power	DB Ground cum power	Fire Panel cum power	Lan Room AC cum power	Landlords DB cum power	Lift 1 cum power	Lifts 2&3 cum power	Main Incomer CP	MCP 4th Plant cum power	MCP Boiler Plant cum power	MCP Central services	MCP Dining cum power
Mar-11	5,956.81	316,373.75	9,614.31	986	561	37	-	10,993	-	1	1,792	-	206	253	99,253	207	5,623	567	622
Apr-11	2,919.58	18,340.97	3,903.47	1,846	1,374	47	-	9,154	-	1	1,734	-	1	412	81,365	177	1,772	534	628
May-11	791.39	3,443.61	1,058.75	1,042	464	49	-	9,661	-	1	1,792	-	24	490	82,732	188	1,062	561	859
Jun-11	-	-	-	1,868	1,382	12	-	9,904	-	1	1,543	-	249	416	85,947	176	907	574	559
Jul-11	-	-	-	5,326	5,092	22	-	9,299	-	2	1,400	-	276	388	92,747	185	930	537	488
Aug-11	-	-	-	4,555	3,730	1	-	9,455	-	-	1,401	-	259	371	91,448	182	961	560	548
Sep-11	224.58	224.58	-	2,561	1,651	13	-	9,341	-	2	1,356	-	270	382	84,318	177	935	542	529
Oct-11	2,481.11	246,988.19	3,443.61	806	498	17	-	9,422	-	1	1,403	-	272	378	83,722	185	2,079	536	514
Nov-11	4,320.56	73,631.25	6,523.61	561	354	10	-	10,019	-	1	1,358	-	282	403	88,882	179	4,018	541	523
Dec-11	242,218.47	294,749.58	12,533.89	288	189	110	-	7,816	-	2	1,402	-	217	305	80,854	198	4,373	522	556
Jan-12	71,075.28	266,901.25	10.69	261	190	145	-	8,854	-	1	1,359	-	252	364	87,521	215	4,628	498	515
Feb-12	277,756.11	76,197.92	225,684.86	316	234	109	-	10,176	-	2	1,362	-	277	407	101,491	248	7,620	510	534
Mar-12	19,378.33	20,982.50	19,378.33	93	58	46	-	3,337	-	-	454	-	89	133	30,778	63	2,577	165	175
Grand Total	627,122.22	1,317,833.61	282,151.53	20,509	15,777	618	-	117,431	-	15	18,356	-	2,674	4,702	1,091,058	2,380	37,485	6,647	7,050

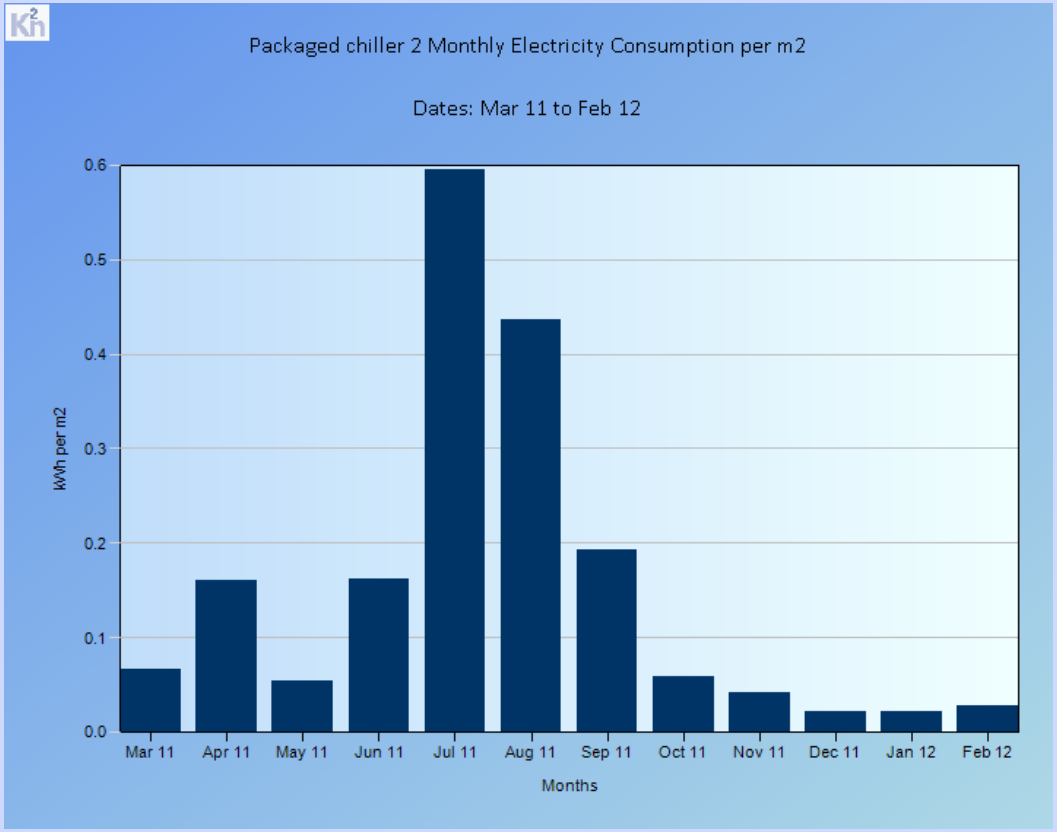
Example outputs from iSERV data – subhourly data

➔Example for Chiller 1 for July 2011 showing good control both inside and out of occupancy hours



Energy use by component

➔ iSERV will also calculate/estimate the consumption of individual HVAC components PER UNIT AREA SERVED and PER ACTIVITY where their supply meter is recorded.



iSERV project outputs and impacts

- ➔ Establish approach as a complement to Inspection
- ➔ Allow end users to access ECOs specific to their HVAC systems
- ➔ Rewards good system design and operation
- ➔ Energy savings of 5 – 60% per system anticipated
- ➔ Expecting 5 – 15% electricity savings on average
- ➔ Savings expected to be maintained vs Inspection reductions
- ➔ Establish that end users and manufacturers can help meet energy reduction goals with the correct support framework
- ➔ Reduce cost of doing business in Europe
- ➔ CIBSE and REHVA will be using this information to produce professional guidance.

How accurate will iSERV be?

- ➔Until we have collected the data it is too soon to make any claims for accuracy – but we will produce information on HVAC component energy use that has never been publicly documented before.
- ➔Initial HVAC benchmarks will be established during iSERV but these will clearly improve with more data over time

Getting onto the iSERV database

- ➔Register on the iSERV website
- ➔Notify the relevant iSERV Partner for your country that you wish to participate, so that they may give you the latest information and tips
- ➔Download the iSERV spreadsheet and complete it for your HVAC system.
- ➔Validate the spreadsheet and send to the iSERV Partner for checking and entering to iSERV database
- ➔Check and validate your data collection with iSERV
- ➔Start using iSERV to help manage your HVAC system

Summary

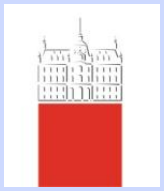
- ➔iSERV's approach was trialled in HARMONAC. This showed there were significant savings to be made
- ➔iSERV's approach is free to use during the project
- ➔'Blind' to manufacturer and other potential bias
- ➔Allows rapid verification of novel HVAC approaches in real buildings
- ➔iSERV will produce 'benchmark' figures at HVAC component and activity level for the professions
- ➔iSERV is the only large-scale 'open' approach in this area at present in Europe

Already convinced and participating in iSERV…

The following organisations have already agreed to participate in iSERV and to associate themselves with iSERV:

Already convinced and participating in iSERV…

As are these:



Futures

- ➔ iSERV completes, publishes benchmarks and the approach is continued by K^2n. Some HVAC manufacturer buy-in, including data collection support. May not have sufficient data to be statistically robust but will be used by professional bodies. May not get EU-MS recognition.
- ➔ As above but gets sufficient end users to make scheme robust and gains EU-MS recognition.
- ➔ Project evolves with HVAC manufacturer backing which the EU-MS accept as an alternative to inspection and regulation.
- ➔ All approaches provide a major impetus to energy efficient HVAC components through original and replacement orders.

Involvement of HVAC sector

- ➔ SWEGON and Camfil already participating in iSERV
- ➔ Opportunity for HVAC sector to establish a voice in setting benchmarks for HVAC components.
- ➔ Project WILL produce professional guidance
- ➔ Potential for further funding to support uptake of the approach by the HVAC sector if iSERV works well
- ➔ Why wouldn't an HVAC manufacturer want to participate? Anonymity unless requested otherwise, unique marketing opportunity across EU-27, access to early results, low cost of involvement, etc.
- ➔ iSERV is happening – we'd like you involved

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Thank you for your attention

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