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Step to the active smart building with continuous monitoring

RCEPB, Bucharest, 5 June, 2014

Active smart building REHVA nZEB technical definition and system boundaries for nearly zero energy buildings zation organization CI **ON SITE RENEWABLE RE** generators **ENERGY W/O FUELS** Heating en Cooling en Electricity DELIVERED REHVA ENERGY **REPORT NO 4 ON SITE** Electricity **ENERGY District heat** USE Solar gains/ **ENERGY NEED District cooling** loads BUILDING BUILDING Heating energy **NEEDS** Fuels TECHNICAL Heating (renewable and Heat Cooling energy **SYSTEMS** non-renewable) Cooling transmission Ventilation Electricity for **EXPORTED** Energy use DHW ENERGY and production lighting Lighting ON SITE Electricity for Internal heat Appliances Electricity System losses gains/loads appliances and conversions Heating en. Energy need SB Cooling en. Energy use SB

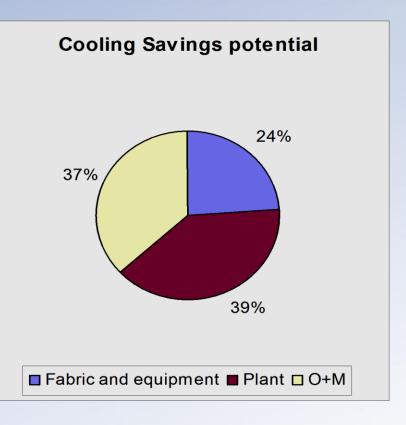
Building site boundary = system boundary of delivered and exported energy on site

Context: Potential Energy Saving

Potential for savings through:

- Load reduction (24%)
- Improved efficiency (39%)Better operation (37%)

Source: HarmonAC project results. http://www.harmonac.info/





- Energy Performance of Building Directive EPBD 2002/91/EC
- Ecodesign of Energy Using Products Directive 2009/125/EC
- Energy Labelling Directive 2010/30/EU
- > EPBD "recast" 2010/31/EU
- Energy Efficiency Directive EED 2012/27/EC

Acknowledgements

iSERV

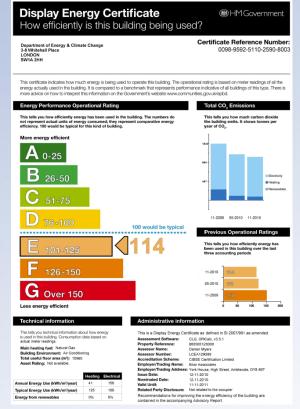
Inspection of HVAC systems through continuous monitoring and benchmarking <u>www.iservcmb.info</u> Co-ordinator: Prof. Ian Knight Cardiff University, UK 2012 - 2014





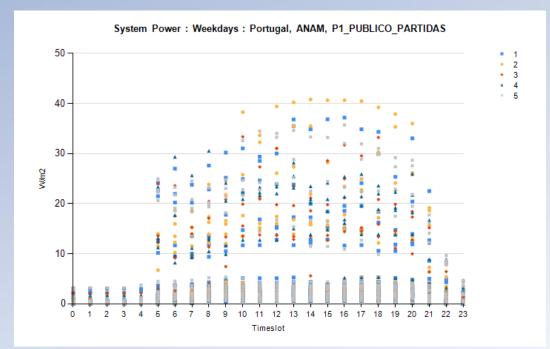
A 20th Century approach to a 21st Century problem

- Most EU MS Legislation aimed at reducing energy use looks at whole buildings and annual energy use due to the availability of billing meters for most buildings.
- So we know WHAT we are using, but not WHY we are using it.
- Current processes do not show what is possible to achieve with our actual existing building and activity mixes.
- Most organisations JUST comply with legislation, i.e. they spend time and money on compliance exercises but not improving their energy use in a robust manner.



A 21st Century approach to a 21st Century problem

- New data sources now allow us detailed insights into how energy is used at sub-hourly intervals and by end uses.
- This level of detail is sufficient to provide confidence in what needs to be done to reduce energy use.



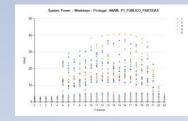
 iSERV utilises these new data sources to show how such a new approach might work - from defining the buildings through to how it might work with legislation.

The iSERV recipe

A Spreadsheet



Sub-hourly data



+ A database

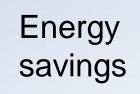


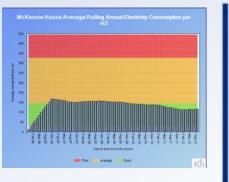
Component benchmarks



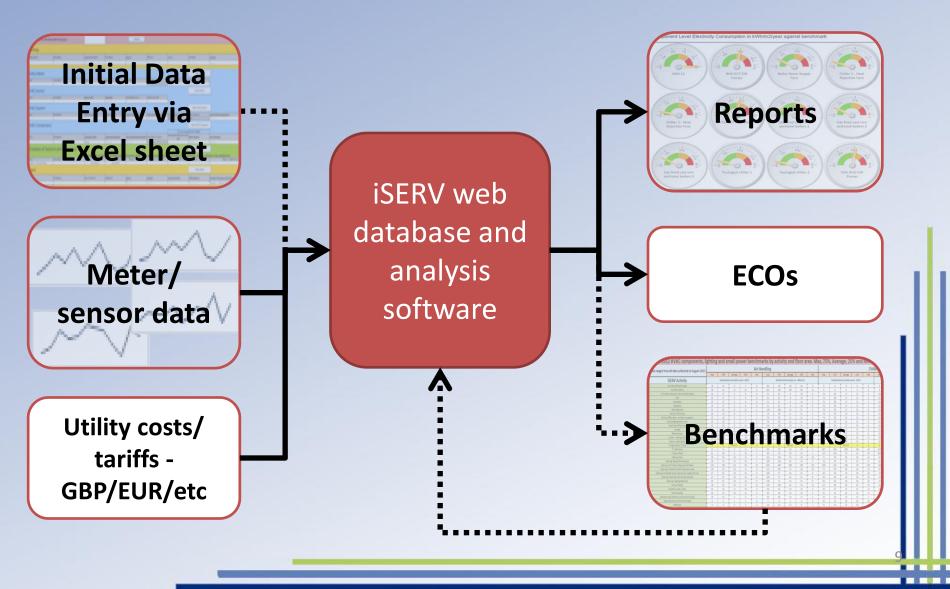
+ Targeted reports

www.iservcmb.eu		Energy Conser	vation Opportuni
Cooling Equipment / Fi	ee Cooling : Replace or Up	grade cooling equipment an	Theat pumps
	oad efficiency. This is verified	ton of the chilled water pumps. I by examining the equipment's i	
	Annual KWh Savinas	Annual Energy Savings	Annual CO2 Savy





Overview of basic process



Collate information on the building

- iSERV has set up a spreadsheet to act as a data collection focus for the building, meters and services physical elements
- The spreadsheet also acts as a means of connecting all the elements together

Data applies from this date	(dd/mm/yyyy):			Validate	Show Instructions	FAQ	Import from CSV					
Building												
Building Name*	Description	Organisation Name"	Site Name"	Sector	Address"	Town	Postcode*	Country.	Control of HVAC Temperature	Construct Month	Property Reference Code	GPS - Lat
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HVAC System						'	Add a HVAC System	1				
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Other System							Add a System					
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Schedules of Setpoi	nt and Occupation						Add a Schedule					
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Name" Schedule 1 - Whole Building	Description	01/01	Range 1 - Applies To 31/12	F	Range 2 - Applies To	From	Range 3 - Applies To	Erre	Range 4 - Applies To			
ocnequie I - whole Building		1 0801	5⊮I2		1			1	1			
Space							Add a Space					
Name'	Description	Floor Area (m2)*	Height (m)	Sector	Activity"	Served By HVAC(s)	Small Power System(s)	Lighting System(<)	Other System(s)	Schedule of Setpoints	Sensor Name(s)	Control of HV
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Database

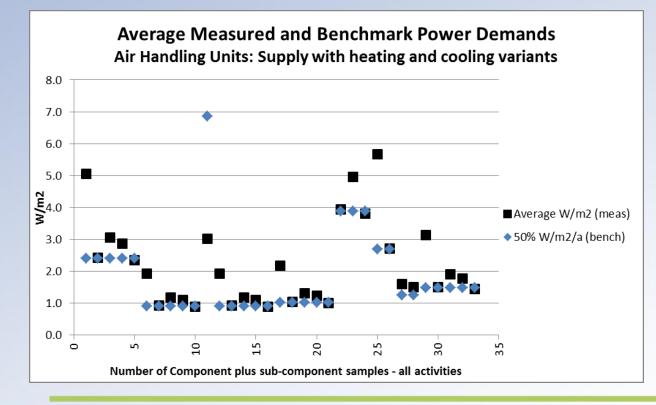
- A bespoke database has been written for the project
- Based on a commercial product
- Acts as the focus for the iSERV project elements:
 - Data collection
 - Benchmark use
 - Benchmark
 - generation
 - Reports
 - Energy
 Conservation
 Opportunity
 algorithms

leport Navigator	McKenzie House	
-AA - Residences - University Hall		Description
-AB - Academic - Glamorgan and Bute	Report Type Consumption •	
AC - Residences - Cartwright Court	Date Range * Monthly Rolling Annual Consumption •	Shows monthly rolling annual consumption per m2 for a Building over a configurable date range. The values are calculated by taking the Building's monthly rolling annual consumption and dividing it by the
AD - Academic - Colum Road and Humanities Site Buildings		Building area. Rolling Annual Consumption is the sum of the previous 12 months consumption. It allow
AD - Residences - Colum Road and Humanities Site Buildings	Report By Area * Per m2 *	users to more easily examine trends in consumption by smoothing out annual temperature variances.
AE - Residences - Gordon Road and East Grove	Reports Monthly Rolling Annual Consumption per m2	
AF - Residences - Hodge Hall	Output Type Column -	
-AG - Residences - Llandaff Boathouse	Utility Electricity -	
-AH - Residences - Llanrumney Pavilion and Workshops	* From January - 2002 -	
-Al - Academic - 3 Llwyn-y-grant place -Al - Residences - Tal-y-bont Court	*To December • 2012 •	
-AJ - Residences - Tal-y-bont Court -AJ - Residences - Tal-y-bont North	December • 2012 •	Run
AU - Residences - Tal-y-bont North		
-AJ - Residences - Tal-y-bont Sports and Social	14 4 1 of 1	M A XML file with report data
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Benchmarks

Three types of benchmark being produced and explored:

- Annual energy/m² kWh/m².a
- Monthly energy/m² kWh/m².month
- Power demands/m² W/m²

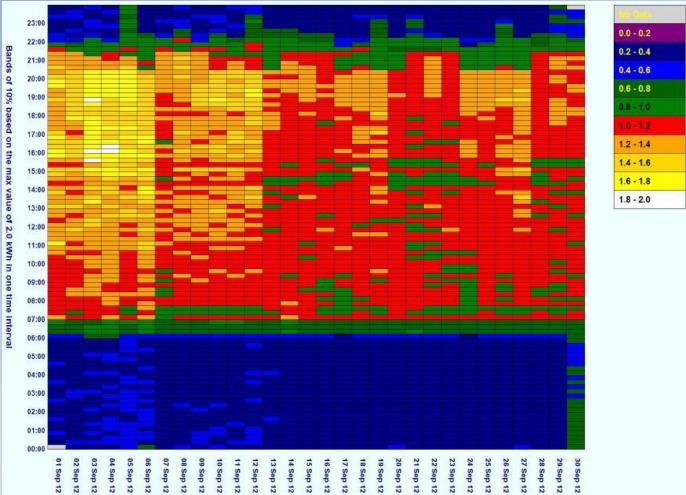


Three ways to save energy – regularly show performance

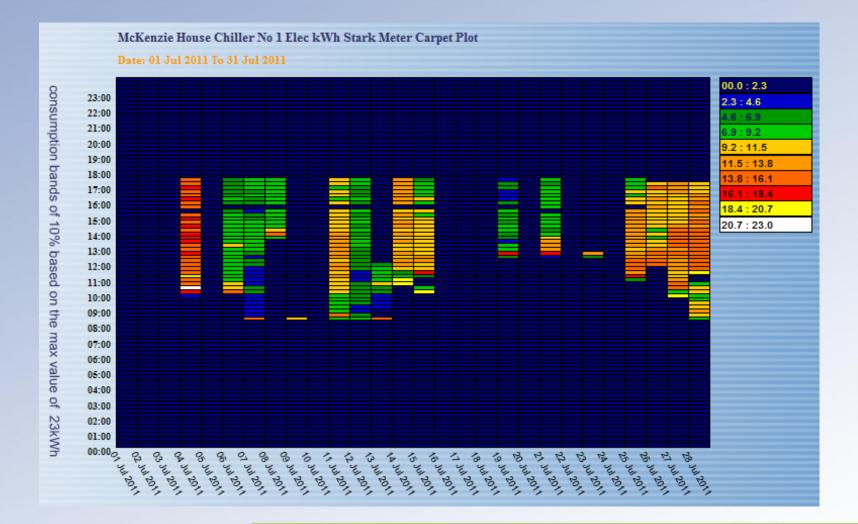
- Regularly show performance against benchmarks derived from the spreadsheet description of the building and services
- Benchmarks will evolve over time as the buildings / components providing data change their performance – so benchmarks always reflect current practice



Identification of Energy Conversation Opportunities (ECOs)

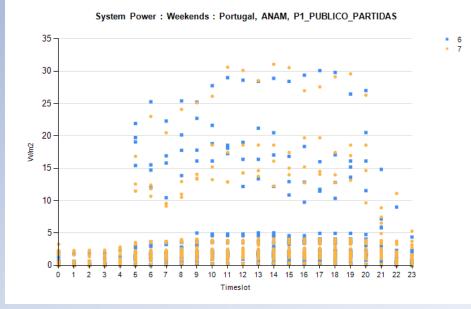


Identification of Energy Conversation Opportunities (ECOs)



Three ways to save energy – better control of existing plant

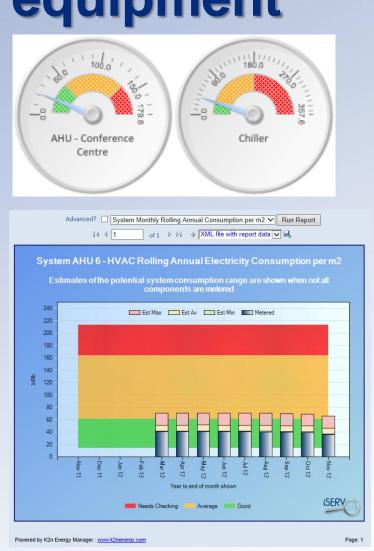
 Better control of what you already have e.g. use of ECO algorithms or scatter graphs/carpet plots to identify when systems and components are running outside of expected hours



- Clearly shows what could be controlled better
- Can use the data directly to calculate potential savings

Three ways to save energy – install more efficient equipment

- Install more efficient equipment. Even if equipment is well controlled it may well require more power when in use than more modern equipment
- Benchmarks based on power demands when in use can help show this difference and when equipment might benefit from being upgraded





- The key is to not just present meter data but to interpret it with respect to the situation in the real building
- A number of report sets are being trialled to see which provide the information in the best form to allow

	how energy efficient are you really?	ISERYCOD	Insection of HVAC System	how energy efficient are you really?	ISERV			energy efficient are you really?	
McKenzie House	Cardiff University	www.iservcmb.eu	Performa	nce Ananlysis	www.iservcmb.eu	Energy	Conservation	Opportunities	
Cardiff University Estate			olling Annual Consumption - Electricity		BEMS and controls / Miscelland	POUS			
	Cardiff, United Kingdom Weather Analysis November Monthly average .	2000	anny annual consumption - checkholy	6,000 E	Reduce power consumption of a checks the following: It's happening	auxiliary equipment : Descripti ng that HVAC components like fa	on To reduce energy consumption ins and pumps work outside the sch redule, thereby preventing energy	edule of building. This ECO algo-	
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google map picture bird view bing map picture	map joture bid view big map joture bid vie				Conside equipment, retectioning Consider cold storage applications (chilled water, water ice and other phase changing material): Description To reduce energy consumption of pumps and fins the algorithm checks the following it is happening that HAC components like fins and pumps work outside the schedule of building. This ECO algorithm checks if pumps and fars work accounting to the building schedule.				
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Monthly kWh Consumption Monthly kWh Comparison Month	nly CO ₂ Emissions Cost Analysis				£560,00	3500 kWh	5.2%	800 tons	
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CORACE 2012 TRACE THE 2012			\smile		£560,00	3500 kWh	5.2%	800 tons	
Comparison with peer systems around Europe	farmer a mart	Component	Total kWh per Average W per	%FLE Performance					
McKenzie House uses XX% more energy than an efficient peer system	Compared to 100 new systems in a oth		m2 per annum m2		Consellation				
Potential Energy Savings : 3000 kWh / year	Compared to 100 peer systems in Europe, for the period 1° October to 1° November 2012, McKende House ranks.	Packaged chiller 1		46.0% Good	General HVAC system				
Potential Cost Savings : £5000 / year	efficient	Packaged chiller 2 Boiler Room Supply Fans		57.0% Good 23.0% Good	Shut off A/C equipment when it the following: It's happening that	not needed: Description To rec HVAC components like fans and	luce energy consumption of pump I pumps work outside the schedule	is and fans the algorithm checks	
McKerzie House	xxxxkWh/year	Boiler Room Supply Fans Hot Water Primary Circulators		23.0% Good 34.0% Good	checks if pumps and fans work ac	cording to the building schedule	, thereby preventing energy over-	onsumption.	
	xxxx£/yesir	VAV AHU 1		57.0% Good	Annual COD Could	Annual LAND Card	Annual Frances Conde	Annual CO2 Environ	
Below Average Peer	soooxikWhykear soooxi£/wear	VAV AHU 2		76.0% Average	Annual GBP Savings	Annual kWh Savings	Annual Energy Savings	Annual CO2 Savings	
	xxxx Lykar	Chiller 1 - Heat Rejection Fans		86.0% Needs Inspection	£560,00	3500 kWh	5.2%	800 tons	
Mast Efficient Peer	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	Chiller 2 - Heat Rejection Fans		81.0% Needs inspection					
The sole responsibility for the content of this email lies with the authors. It does not nec- analy reflect the opinion of the European Union. Neither the EACI nor the European Corm sion are responsible for any use that may be made of the information contained therein.	Supported by Supported by EUROPE	The sole responsibility for the content of this email lies v sarily reflect the opinion of the European Union. Neither th sion are responsible for any use that may be made of the	e EACI nor the European Commis-	Supported by INTELLIGENT ENERGY EUROPE	The sole responsibility for the content of sarily reflect the opinion of the European sion are responsible for any use that ma	Union. Neither the EACI nor the Eur	opean Commis- 🚬 🛛 N T E	Iby LLIGENT ENERGY OPE	

Monitoring savings: Case Studies

- Building electrical savings of between 19% to 33% p.a.
- Building electrical savings/m² between 61 to 100 kWh/m²/a
- In economic terms:
 - Measured recurrent savings of 9 to 14 EUR/m²/a
 - Recorded 'one-off' setup costs between 0.1 to 2 EUR/m²
 - Estimated 0.1 3 EUR/m²/a to maintain.
 - Net returns between 7 13 EUR/m²/a
- Success in reducing HVAC energy use is providing the confidence and finance (from savings) to tackle other electrical use as well

Monitoring - Conclusions

- Monitoring brings:
 - Clarity and Certainty;
 - Proven energy and cost savings to the end user and MS;
 - End user engagement and ability to contribute to 2020 targets;
 - Proof of impact achieved;
 - Increased use of energy efficient products;
 - Ability to use Smart Metering data which is coming.
- As a commercial prospect monitoring makes sense already.
- Monitoring is a step to nZEB, zero energy buildings and active buildings.

Thank you your attention!

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