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Improving Operational Performance of HVAC Equipment

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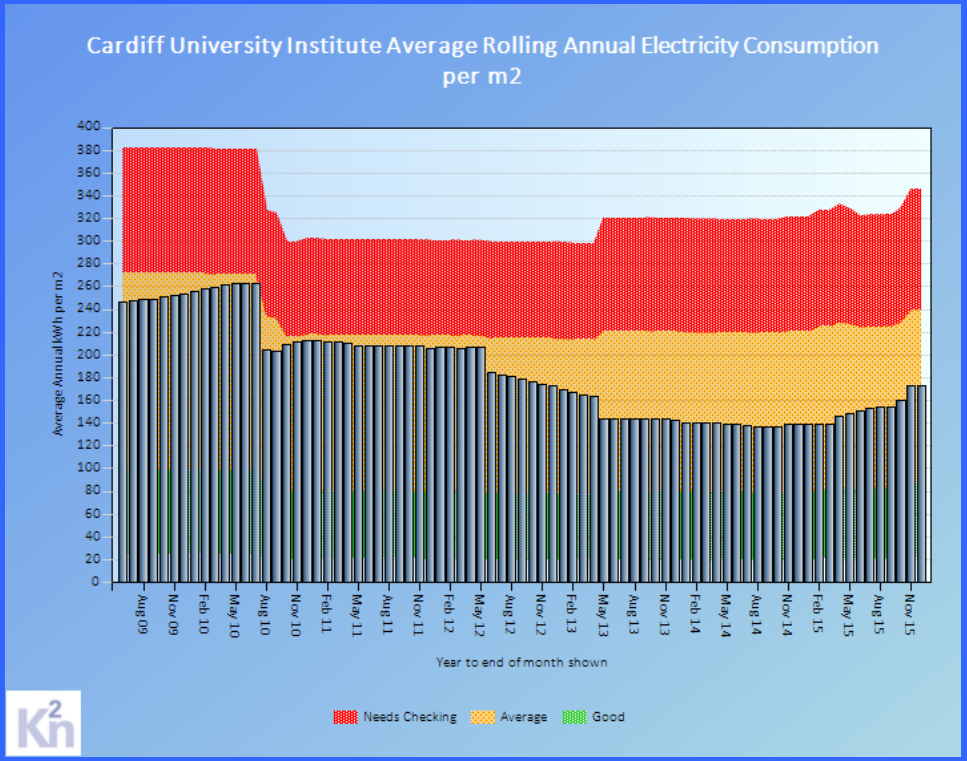

12th REHVA World Congress CLIMA 2016

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Contents

- Legislation – (10 mins/10 mins discussion)
- Framework – (10 mins/10 mins discussion)
- Implementation – (10 mins/10 mins discussion)
- Reports and impact - (10 mins/10 mins discussion)
- Summary of session

LEGISLATION

Directives, directives, directives…

Since 2002, EU Directives designed to reduce energy use tell us:

- What equipment we can buy (EcoDesign Directive – Jan 2016)
- What levels of insulation we must have in our buildings (EPBD)
- What improvements we must wrestle out of our existing buildings (EED/EPBD)
- All new buildings must be near Zero Energy by Jan 2021 (EPBD)

In reality, many of these 'improvements' exist mainly on paper not in practice – as evidenced by the 'performance gap'. To achieve energy efficiency in practice we must understand and value operation as well as much as laboratory figures and theory

How should Energy Policy change?

- To enhance the economic, social and environmental wellbeing of the people and communities of Europe, Energy Policy should address four main objectives in practice:
  - Provide affordable and reliable energy
  - Minimise environmental impact
  - Maximise energy efficiency in the activities undertaken
  - Encourage energy efficient products and services

- Operational Data helps achieve all four objectives by creating a framework in which the real-world impact of differing products, processes, services and techniques can be quantified in context.

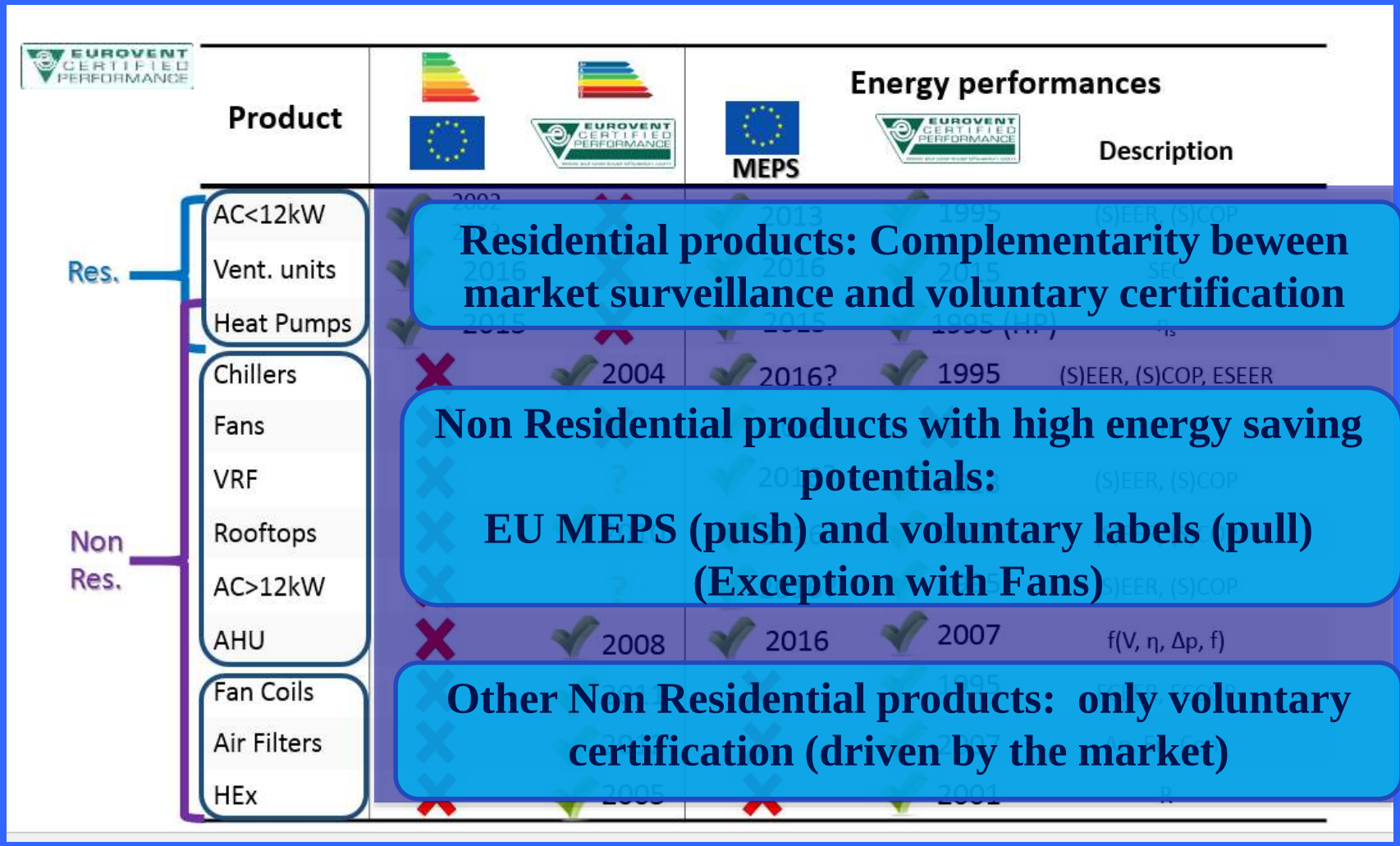
- Need to legislate for Operational Data as a route to compliance

EPBD legislation in practice

- Challenges regarding compliance and quality of the works.
- How do we get the needed result from planning through doing the work to following up the actual conditions in use?
- Energy Performance calculations, component characteristics. Legislated via ERP with reference to trusted 3rd party certification schemes?
- Implementation of the work.

- Q. How many countries control the compliance energy performance during design and then following up the results?
- Q. How are problems recorded and reported?

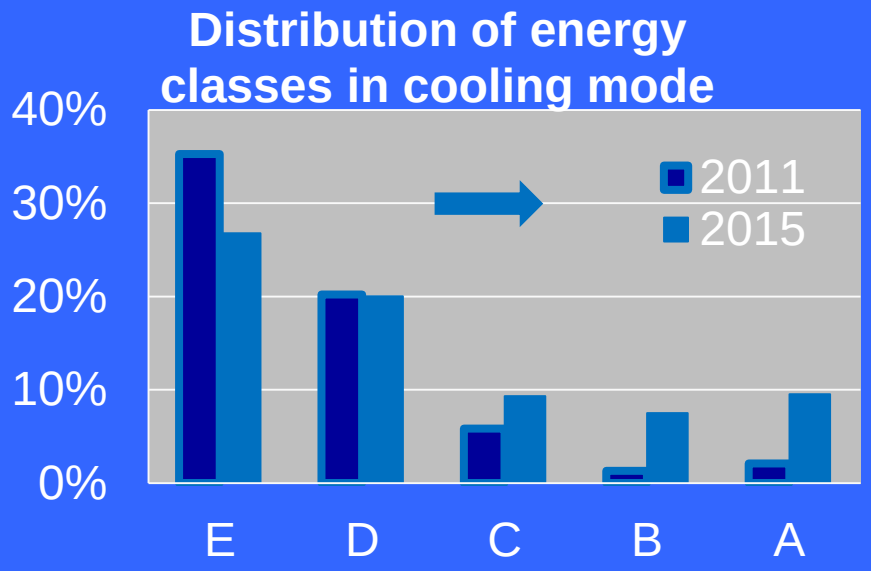
Push and pull

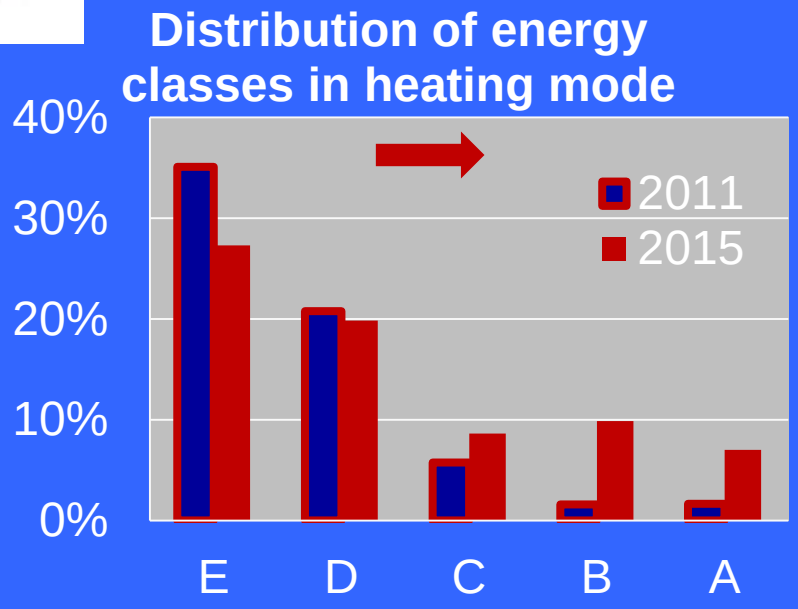


ECP energy label for certified fan coil units

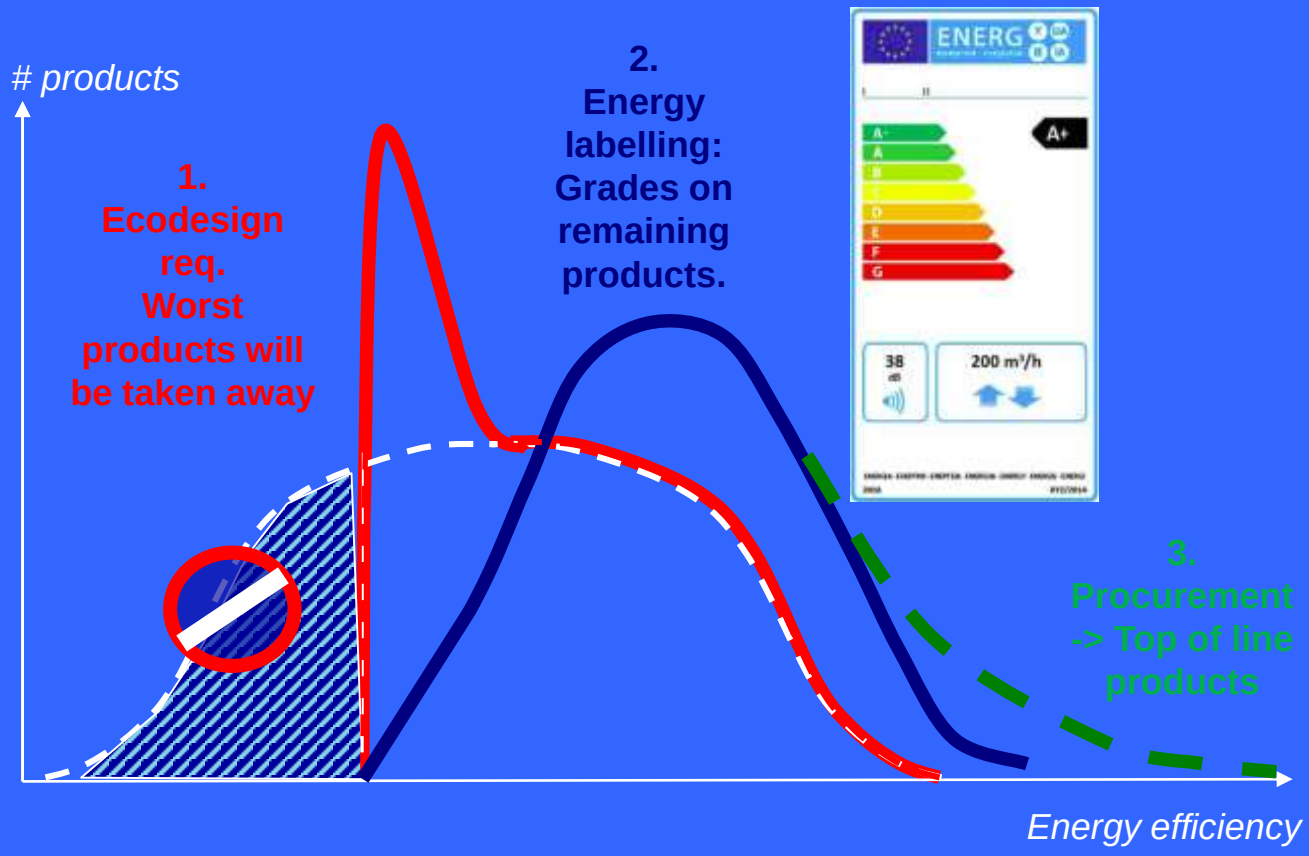
Energy efficiencies are moving from DE to ABC

Evolution after 4 years of implementation (2011 – 2015)





Politics for Promoting High Efficiency Products



Energy performance compliance

- A workable system would need:
  - Legislation (i.e. Lot 6). Is this the best way to obtain compliance data or a voluntary scheme (e.g. Eurovent)?
  - A clear procedure which is legally accountable?
  - A way to deal with non-compliance?
  - Is an EPBD approach more desirable, but a product approach more manageable?

- Challenges
  - Q. How to get MS to take compliance and quality of work seriously?
  - Q. Is EPBD the correct framework to deal with these issues or is there another way?

Summary

- The bar has been set high for energy performance of both new and renovated buildings, so the conditions need to be right to achieve a healthy, accountable building stock across Europe.

- Q. How many countries control the compliance energy performance during design and then following up the results?
- Q. How are problems recorded and reported?
- Q. How to get MS to take compliance and quality of work seriously?
- Q. Is EPBD the correct framework to deal with these issues or is there another way?

FRAMEWORK

Data and HVAC equipment

- Operational Data can inform the operation of HVAC Equipment in the following ways:
  - Shows how the delivery of a service is being achieved
  - Highlights areas for potential improvement in operation
  - Can allow comparison of achieved performance with design – enabling confidence in both initial and ongoing commissioning/maintenance
  - Enables ALL equipment to be assessed, not just a sample
  - Benchmarking of achieved performance by reference to similar
  - Identifying when it might be appropriate to replace equipment

Data and Operational Practice

Operational data provides:

- Greater certainty
- Factual information to underpin actions
- A more rapid route to dissemination of new ideas
- A means to demonstrate achievement of targets in practice

To do this it needs a framework to allow comparison

A physical-based framework

Proposed that the framework is based on physical assets and characteristics:

- Allows quantitative comparisons to be made
- Complements Standards and Legislation operation
- Allows comparative good practice to be identified
- Supports actions where needed
- Compatible with data-driven approaches

Framework discussion

Considering:

- The advent of BIM
- Easy access to data on all aspects of buildings
- The stochastic nature of human occupation of buildings
- The need to reduce absolute energy use in practice

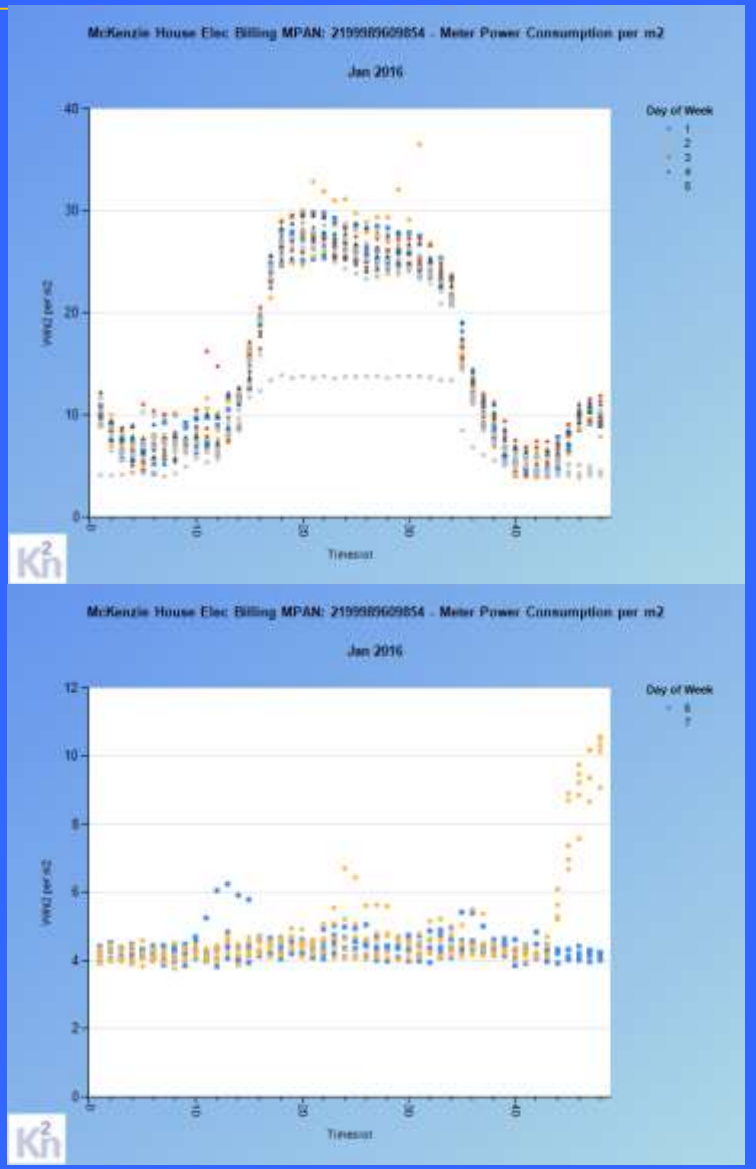
Q. Does a physically based framework provide the correct basis for helping achieve operational energy efficiency from buildings?

Q. Are there qualitative data we need to capture?

IMPLEMENTATION

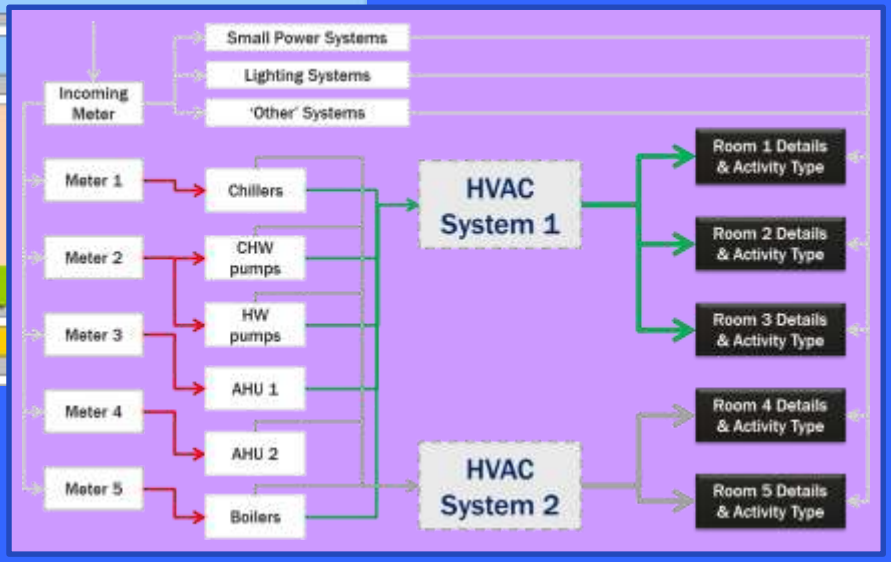
What is operational data and how does it inform HVAC Operation?

- Operational data is detailed information on consumption and conditions for spaces, activities, systems and components.
- Crucially, it is connected to the context in which it is used
- Can use this data to:
  - Compare performance against legislative and other benchmarks
  - Inform commissioning
  - Produce energy signatures
  - Inform maintenance
  - Inform upgrade/replacement timing
  - Keep benchmarks current



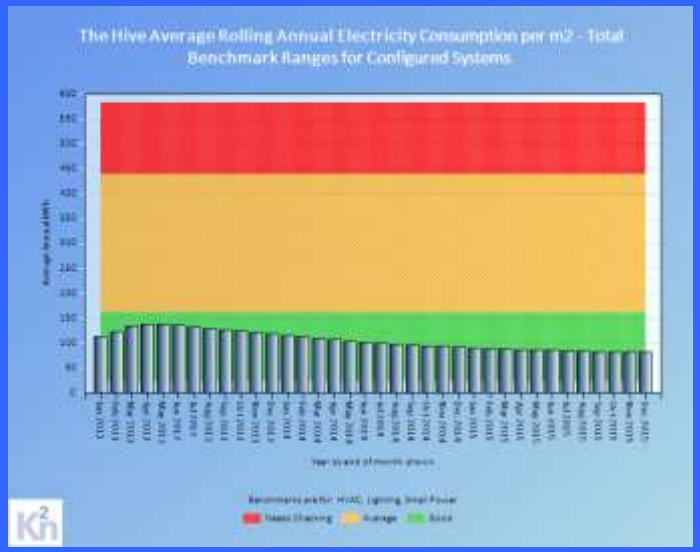
Example Implementation of Operational Data

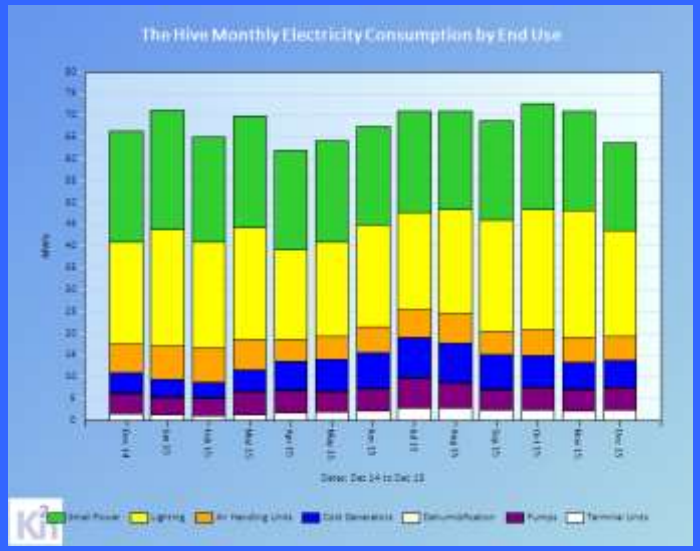
- Procedure trialled across 20 EU MS – www.iservcmb.info
- Now in commercial use – www.k2nenergy.com
- Based on the interaction of physical assets and metered use



Operational Energy Efficiency

- Achieving energy efficiency:
  - Understand whether the MAGNITUDE of power demands and energy consumptions are reasonable.
  - Understand WHY, WHEN and WHERE energy is used.
  - Understand WHEN and WHERE action should be taken, and the potential savings to be made
- Easy to say – less easy to achieve
- Benchmarks show efficiency achievable in practice

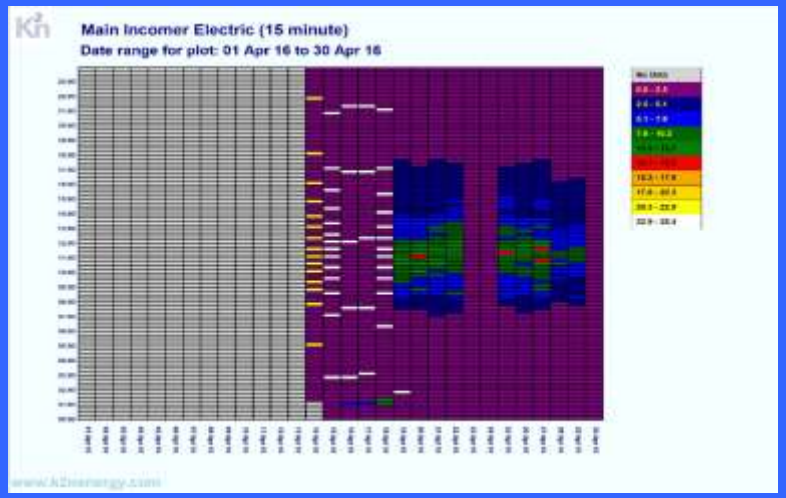




Metering, Connections and Maintenance

Lessons from implementation:

- Much data is inaccurate or missing
- Many sub-meters are not connected to the end uses assumed
- Often meter and data resolution is inappropriate
- Approach needs to fit into operational procedures to provide most impact



Implementation discussion

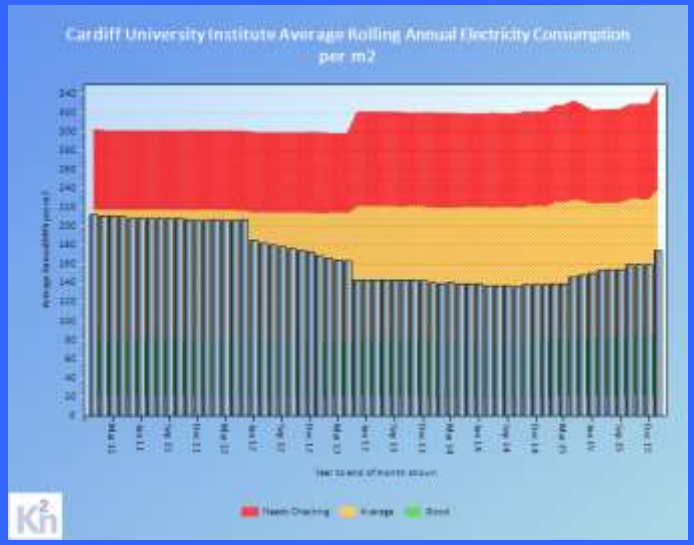
Assuming the argument for operational data is proven, then the next step is to provide operational data based procedures the MS legislators can refer to:

- Q. Can they provide a competitive advantage manufacturers can exploit?
- Q. How will this impact the design and operation of new and existing buildings and services?
- Q. Anything missing?

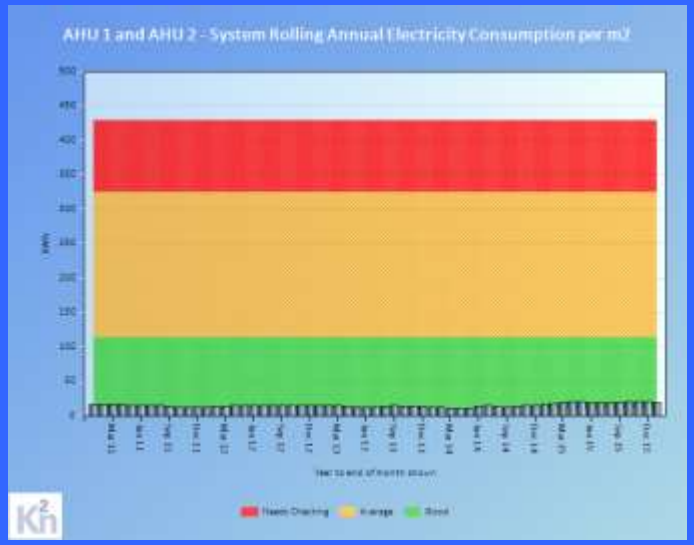
REPORTS

Data use and benchmarks

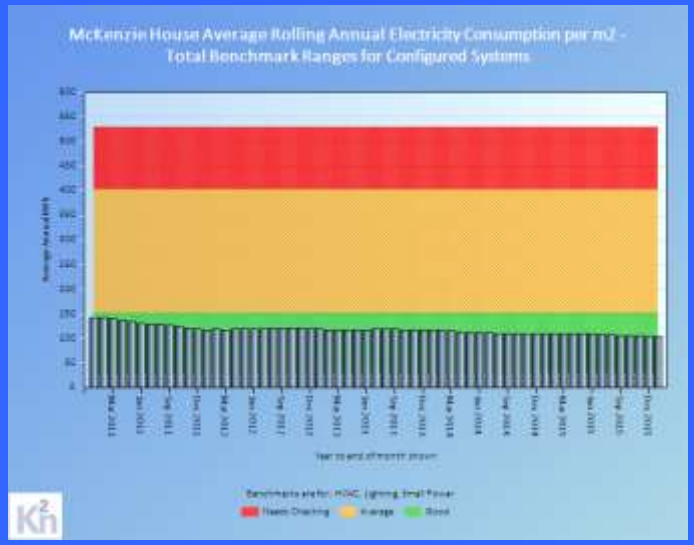
Estate



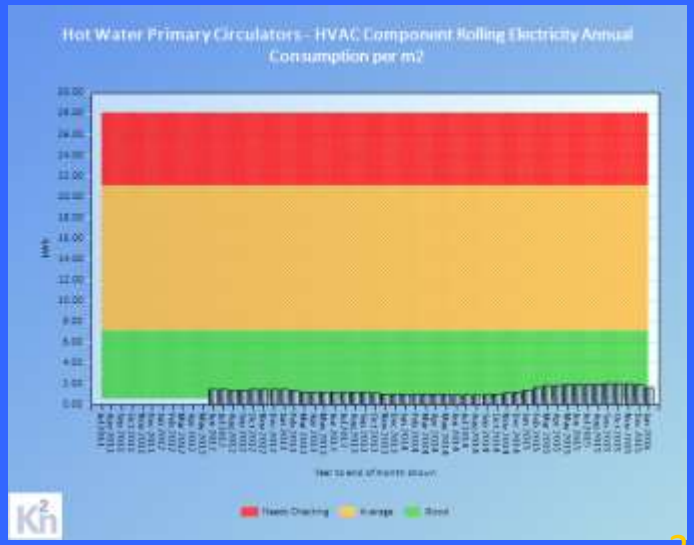
System



Building

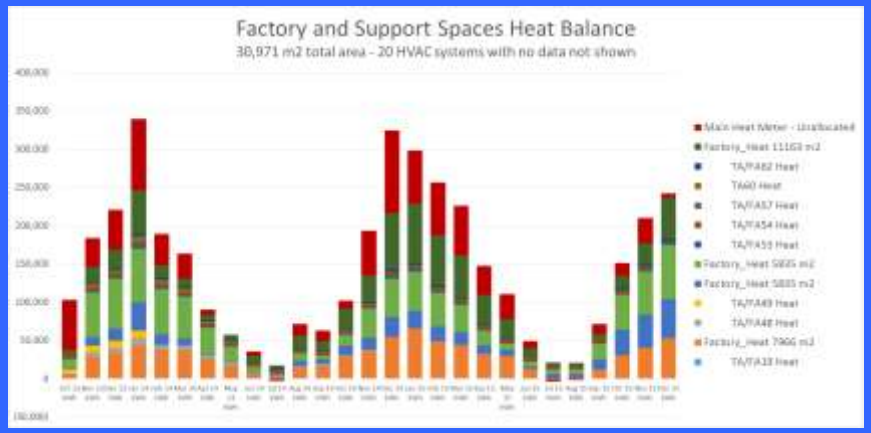


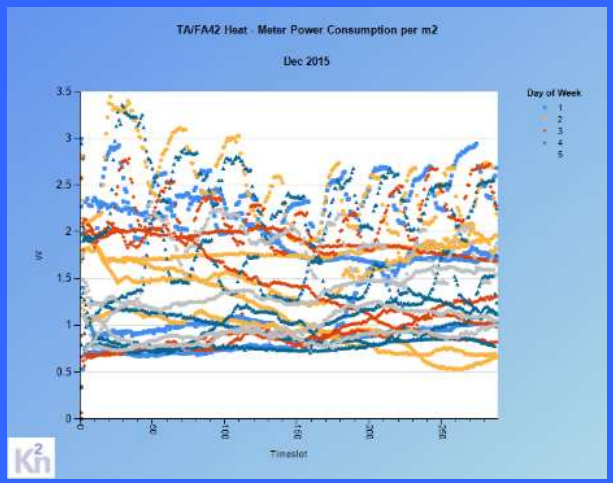
Component

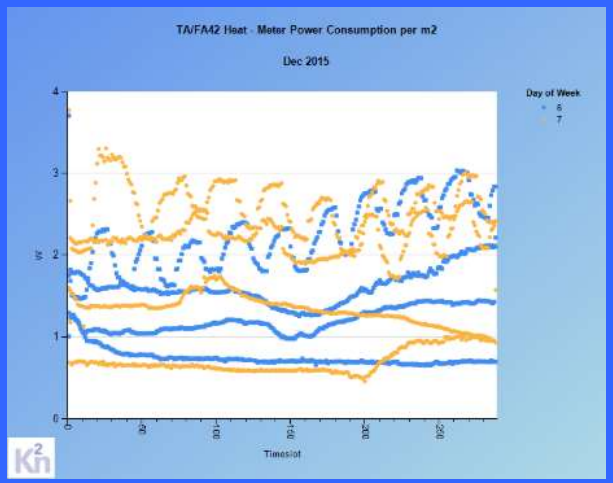


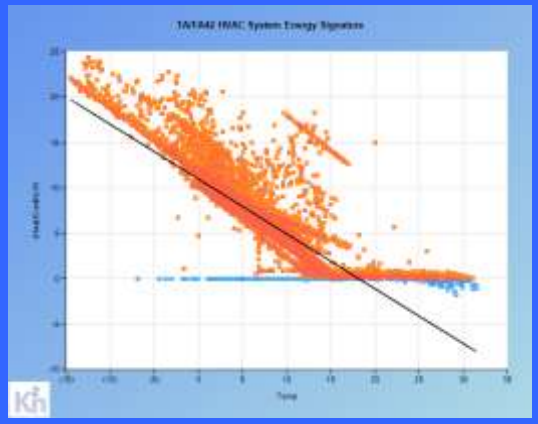
Data use in operational analysis

- Same data can be used to:
  - Understand contribution to overall energy use
  - Understand control and time of operation
  - Contribute to benchmarks
  - Produce energy signatures for spaces









Data Source and Regression Line Details		
Heat Meter	TA/FA42 Heat	
Coolth Meter	TA/FA42 Cool	
Temperature Sensor	TA/FA42_0x122F, Outside Air Temperature	
Date Range	21/10/2013 to 01/05/2016	
Regression Line	y = -0.603611x + 10.9503	
R2	R2 = 0.778165	
Activities and Spaces Served		
Activity	Space	Area m2
Industrial process area	J0.11	7966.24

Data used to achieve action

- Same data can be used with benchmarks to assess best opportunities and potential savings
- These examples rank order performance by building and show the potential for a single building compared to its benchmarks

Potential Savings Summary

The potential savings shown here are relative to the top 10% of performance (Best Practice) and top 25% of performance (Good Practice) as indicated by the benchmarks obtained from operational buildings. These levels of performance may not be possible to obtain in this building or HVAC systems as currently designed. A negative figure indicates an increased cost or energy consumption.

Whole Building		Potential Annual Savings					
		Best Practice			Good Practice		
Utility	Year To	%	Units	£	%	Units	£
Electricity	Apr 2016	69%	635,397 kWh	82,602	45%	411,616 kWh	53,510
Gas	Mar 2016	73%	921,209 kWh	46,060	35%	445,326 kWh	22,266
Water	Mar 2016	69%	2,196 m3	6,588	54%	1,731 m3	5,193

Cardiff University Yearly Building Electricity Consumption m2			Annual kWh per m2				
Status	Building Name	Year to end of	Measured	Benchmark Min	Benchmark 25%	Benchmark 75%	Benchmark Max
	38/39 Park Place	Apr 2016	**163.62**	8.42	30.98	87.34	124.49
	40/41 Park Pl (Computing Ctr) (MI)	Apr 2016	**399.70**	9.88	63.78	284.76	513.05
	49 Park Place (Gymnasium) (MI)	Apr 2016	**256.35**	15.15	30.73	63.03	79.23
	6 Museum Place (MI)	Mar 2016	**353.36**	10.95	36.30	88.41	114.85
	Cartwright Court, Block C (MI)	Mar 2016	**126.65**	10.94	36.54	99.87	139.54
	Colum Hall (MI)	Apr 2016	**162.85**	14.85	48.72	136.76	193.44
	CUBRIC Building - excluding MRI, MEG and IT Suites (MI)	Apr 2016	**409.56**	23.91	101.18	279.33	379.71
	Guest Building (MI)	Apr 2016	**27.66**	0.01	0.12	1.05	1.62
	Haydn Ellis Building	Apr 2016	**396.52**	24.62	92.39	234.22	307.90
	Henry Wellcome Building (MI)	Apr 2016	**732.77**	29.30	98.01	254.39	340.27
	LTYB, Field Hall	Apr 2016	**76.89**	17.52	26.87	70.68	90.42
	Tenovus Building (MI)	Dec 2013	**277.16**	34.57	108.39	272.42	360.60
	Tower Block 2 (MI)	Jan 2015	**118.20**	7.62	26.57	67.53	89.27
	Trevithick Building (MI)	Apr 2016	**129.24**	15.48	46.72	122.58	175.99
	University Hall, Tower & Office Block (MI)	Apr 2016	**343.27**	11.59	39.80	111.70	156.90
	154 Colum Road	Mar 2016	**66.55**	15.60	52.24	143.20	198.91
	33/35/37 Corbett Rd	Mar 2016	**41.95**	8.04	29.33	83.86	114.94
	42-45 Park Place	Mar 2016	**87.93**	9.15	34.89	95.30	127.81
	46 Park Place	Apr 2016	**52.20**	9.34	32.37	86.15	119.75
	47 Park Place	Apr 2016	**68.32**	9.96	33.36	87.38	117.11
	5/7 Corbett Road	Apr 2016	**48.31**	13.60	42.57	110.68	150.89
	52 Park Place	Mar 2016	**42.27**	11.10	36.66	92.24	126.85
	53 Park Place	Mar 2016	**30.50**	8.24	29.69	82.66	111.63
	54 Park Place	Mar 2016	**38.03**	9.84	34.55	94.70	127.42
	55 Colum Road	Mar 2016	**68.05**	15.74	51.10	139.33	193.58
	Senghennydd Court, ABEL	Apr 2016	**50.30**	13.28	45.26	126.56	177.90
	Senghennydd Court, Administration	Apr 2016	**34.01**	9.78	30.62	81.93	111.66
	Senghennydd Court, BOOLE	Apr 2016	**52.12**	13.84	46.92	131.19	184.50
	Senghennydd Court, CAYLEY	Apr 2016	**51.79**	13.71	46.63	130.45	183.52
	Senghennydd Court, DESCARTES	Apr 2016	**52.90**	14.21	48.19	133.79	187.43
	Senghennydd Court, EUCLID	Apr 2016	**52.51**	13.84	47.76	132.83	185.94
	Senghennydd Court, FERMAT	Apr 2016	**52.73**	14.16	47.76	132.99	186.70
	Senghennydd Court, GALOIS	Apr 2016	**52.71**	14.12	47.75	132.99	186.67
	Senghennydd Court, HERMITE	Apr 2016	**53.42**	14.38	48.49	134.86	189.19
	Senghennydd Court, JACOBI	Apr 2016	**52.84**	14.08	47.57	133.10	187.32
	Senghennydd Court, KLEIN	Apr 2016	**53.38**	14.33	48.37	134.68	189.02
	Senghennydd Court, LAPLACE	Apr 2016	**50.54**	13.63	44.97	125.94	177.98
	Senghennydd Court, NEWTON	Apr 2016	**51.37**	13.91	45.71	128.06	181.08
	Senghennydd Court, PASCAL	Apr 2016	**51.23**	13.86	45.64	127.76	180.56
	Cartwright Court, House 7 (MI)	Mar 2016	**27.83**	10.17	36.75	102.36	142.76
	Cartwright Court, House 9 (MI)	Mar 2016	**35.61**	12.25	42.30	117.81	165.10
	EUROS Building A (68PP) (MI)	Mar 2016	**24.55**	12.19	39.68	96.25	125.41
	EUROS Building B (67PP) (MI)	Mar 2016	**26.76**	12.17	39.84	96.74	125.95
	EUROS Building C (66PP) (MI)	Mar 2016	**22.03**	10.26	33.51	80.80	104.04
	Gordon Road Hall (MI)	Apr 2016	**46.77**	13.90	48.52	135.67	189.95
	Llanrumney Pavilion (MI)	Mar 2015	**25.05**	9.49	30.37	72.89	94.10
	LTYB, 1 Bevan Place (ARNOLD)	Apr 2016	**26.58**	14.63	48.37	136.05	192.36
	LTYB, 10 Bevan Place (ROSSETTI)	Apr 2016	**25.40**	13.81	46.19	129.99	183.61
	LTYB, 10 Trotman-Dickenson Place	Sep 2015	**36.44**	13.18	43.37	121.31	171.35
	LTYB, 11 Bevan Place (VAUGHAN)	Apr 2016	**25.08**	13.65	45.55	128.13	181.03
	LTYB, 11 Trotman-Dickenson Place	Sep 2015	**31.52**	13.16	43.27	121.00	170.92
	LTYB, 12 Bevan Place (WORDSWORTH)	Apr 2016	**24.95**	13.62	45.27	127.24	179.79
	LTYB, 12 Trotman-Dickenson Place	Sep 2015	**23.35**	13.17	43.31	121.09	171.05
	LTYB, 13 Bevan Place (YEATES)	Apr 2016	**25.29**	13.79	45.92	129.13	182.48
	LTYB, 14 Bevan Place (SHELLEY)	Apr 2016	**25.58**	13.99	46.48	130.73	184.77
	LTYB, 15 Bevan Place (THOMAS)	Apr 2016	**24.91**	13.53	45.23	127.24	179.73
	LTYB, 15 Trotman-Dickenson Place	Sep 2015	**23.32**	13.56	45.02	126.45	178.61
	LTYB, 16 Trotman-Dickenson Place	Apr 2016	**47.31**	14.50	48.19	135.70	191.78
	LTYB, 19 Trotman-Dickenson Place	Apr 2016	**47.78**	14.59	48.37	136.13	192.42
	LTYB, 2 Bevan Place (BYRON)	Apr 2016	**26.58**	14.63	48.36	136.02	192.32
	LTYB, 2 Trotman-Dickenson Place	Sep 2015	**20.25**	13.18	43.37	121.29	171.33
	LTYB, 21 Trotman-Dickenson Place	Apr 2016	**40.29**	12.65	41.73	116.71	164.80
	McKenzie House	Apr 2016	**102.71**	29.82	139.88	364.01	476.88
	Ty Dewi Sant (MI)	Apr 2016	**24.94**	14.20	44.98	110.95	148.65

Final discussion

- It is clear that operationally low energy services are a key element for achieving lower energy use in buildings.
- Q. What are the implications for all the actors in this sector of this change?

- Already we are seeing a move to building procurement with guaranteed operational performance in the contract. This potentially means choosing the best kit in the future for both new build and refurbishment.
- Q. What else might it impact?

Thank you

- Contact us if you have further questions

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