

Monitoring and Targeting for Energy Management

Professor Tony Day

01908 690018

tday@teamenergy.com

www.teamenergy.com

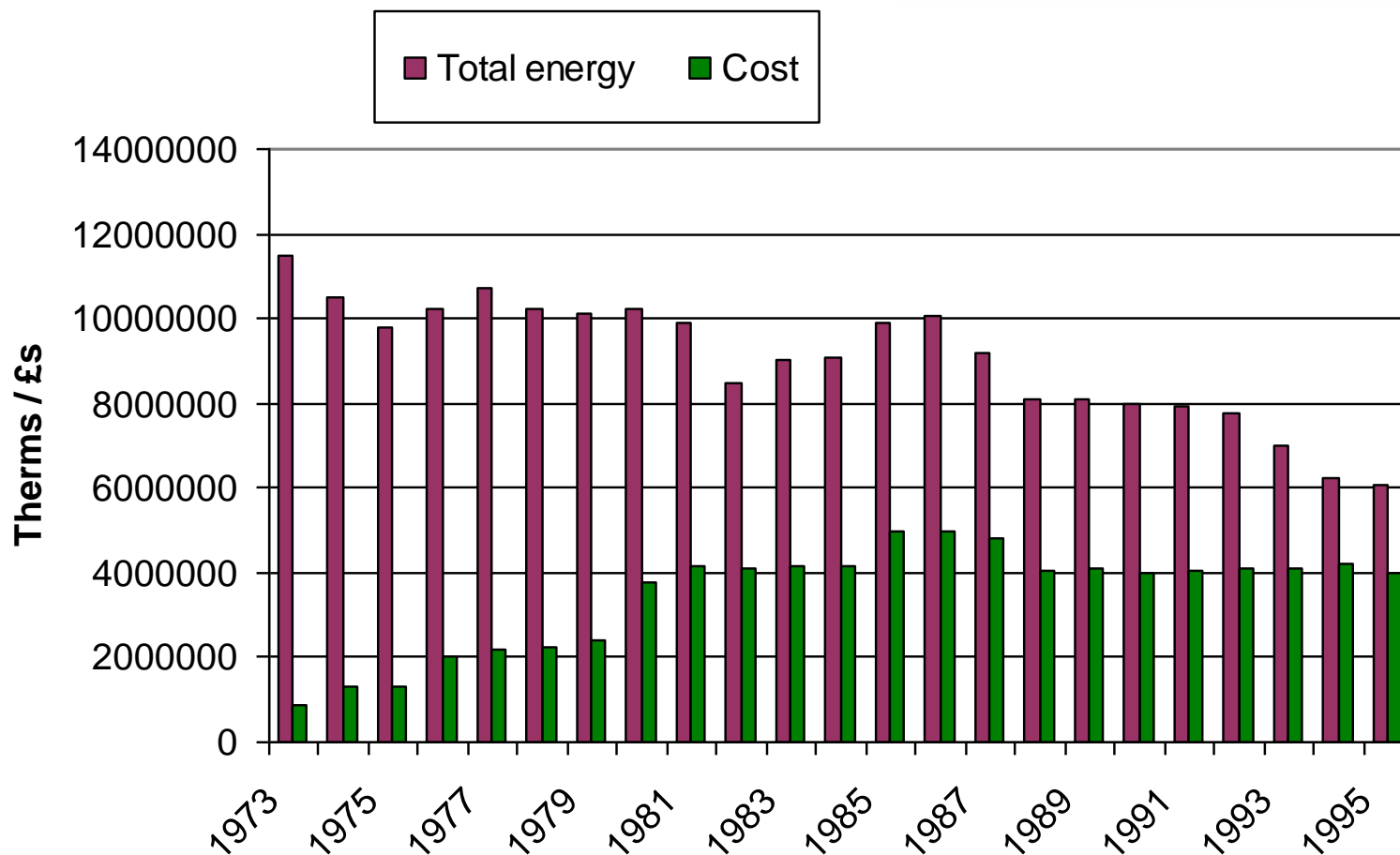
The importance of the Energy Manager

- Would an organisation lay off a successful production/process/project manager?

NO!

- So why does the successful energy management function get cut?

Industrial energy profile

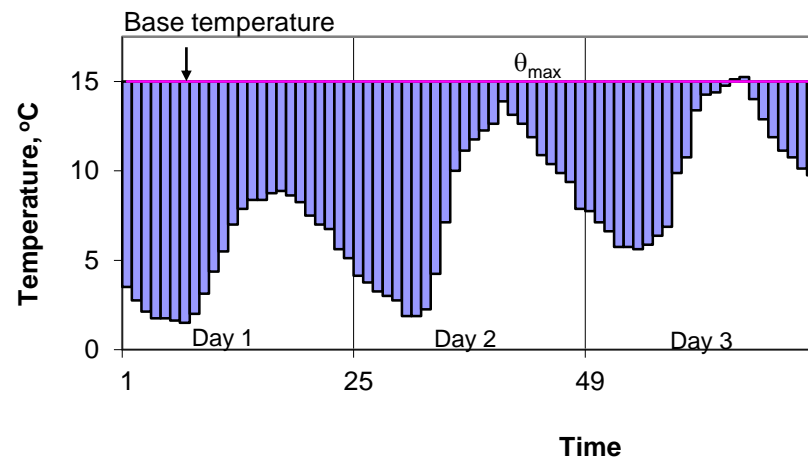
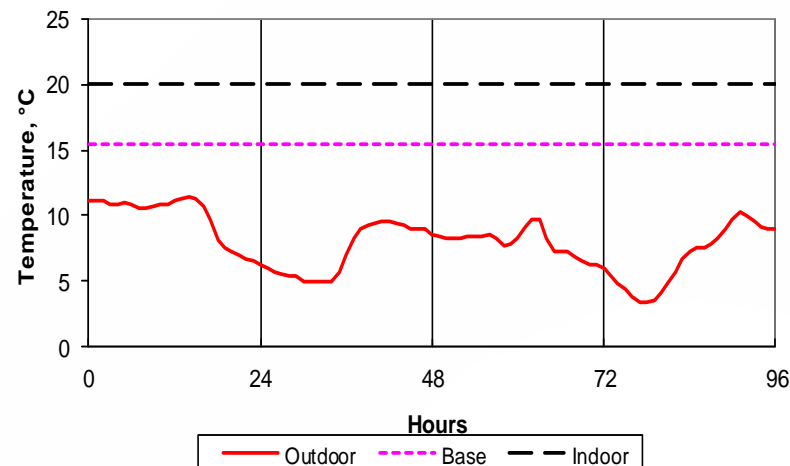


Finding the incentive

- Energy use is difficult to relate against productivity and activity
- A need for robust analysis and reporting methods
- Room for innovation to make energy visible

Degree-days and energy consumption

- Heating energy use is directly related to changes in outdoor temperature
- Degree-days are the difference between a base temperature and the outdoor temperature over time
- Base temperature accounts for useful heat gains – solar, people, lights etc
- Calculated daily and summed to give weekly, monthly and annual values
- Degree-day values published monthly by UK region to a base



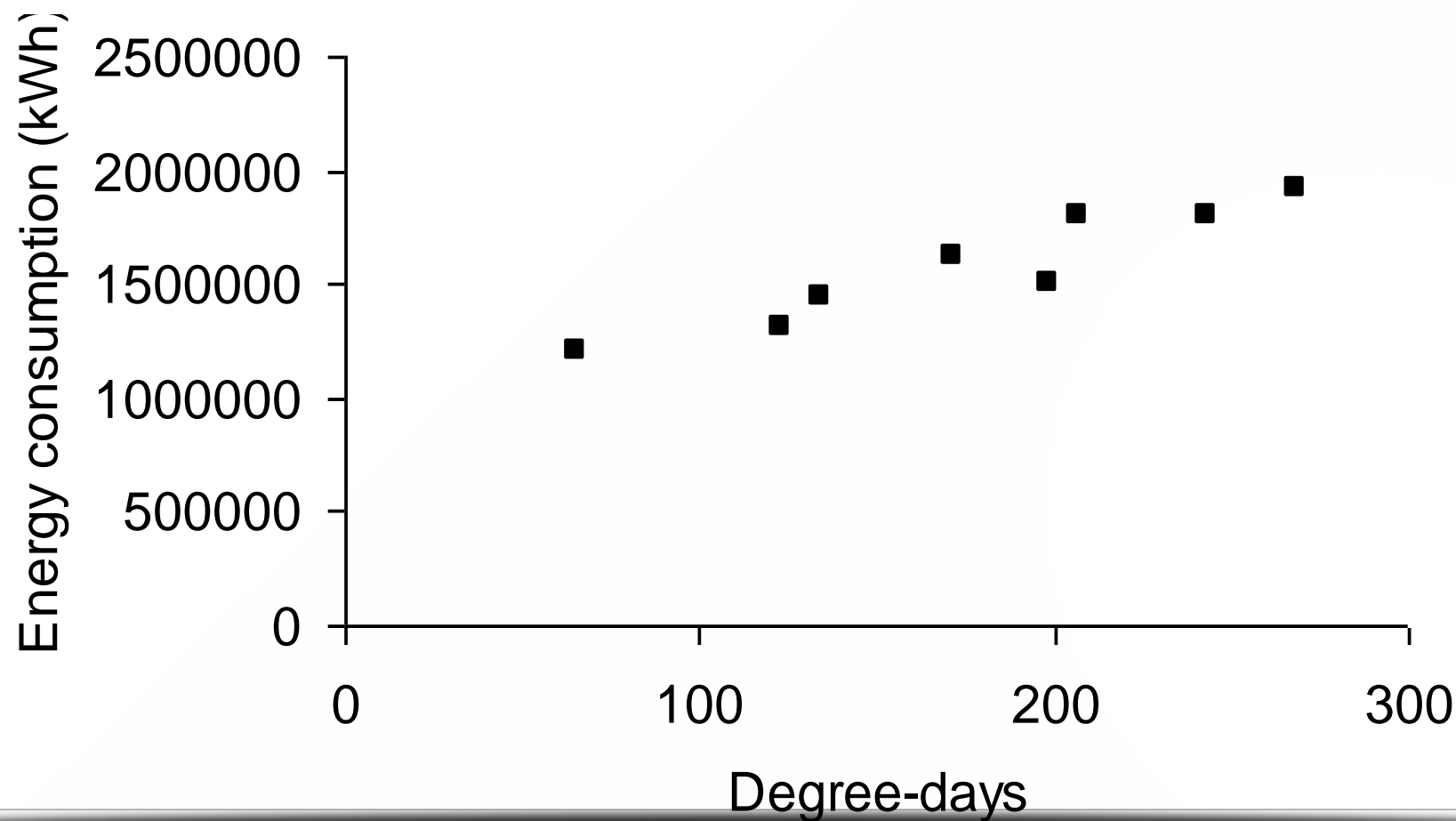
Monitoring

Monthly energy analysis (heating)

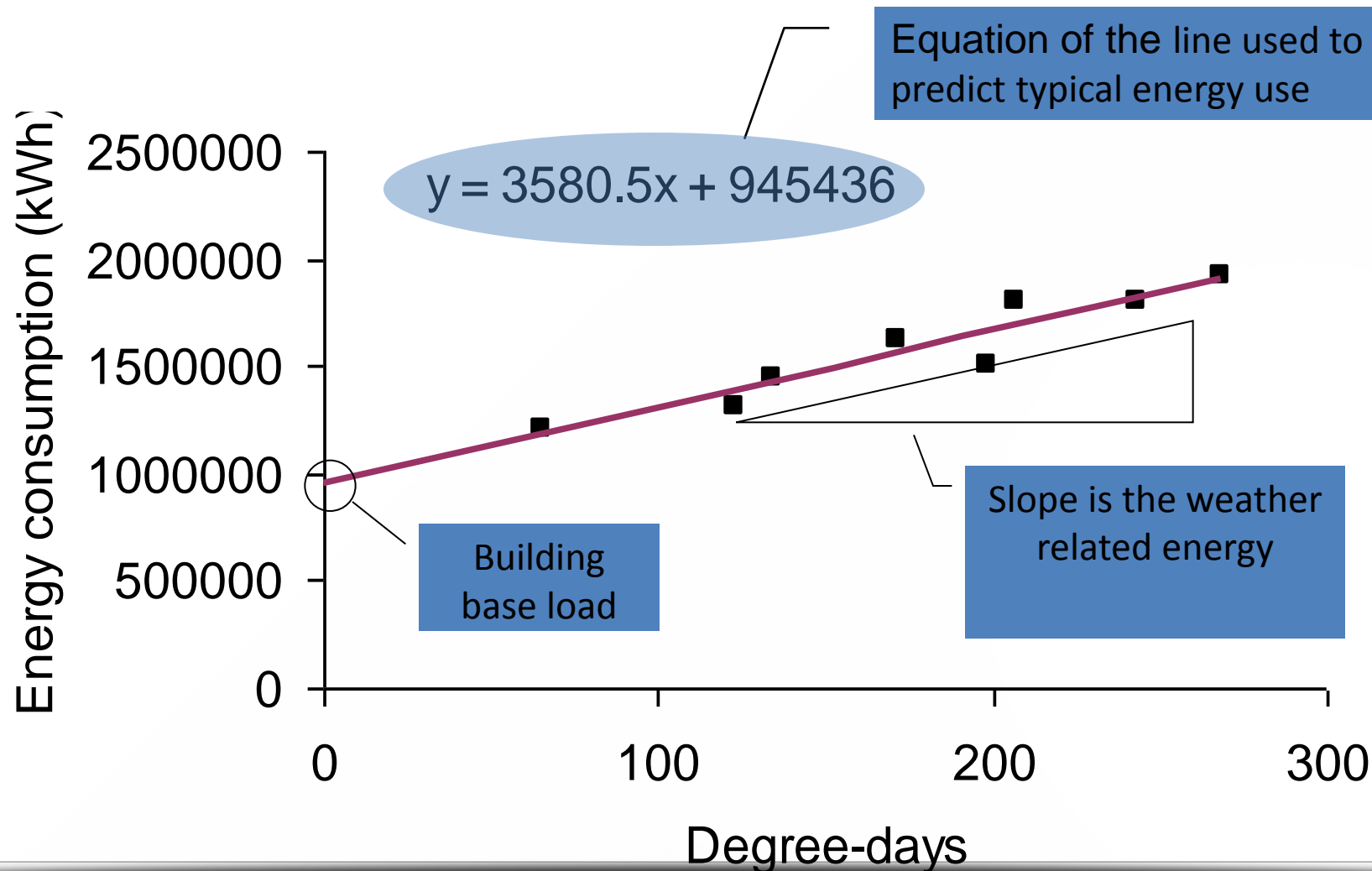
- Collect monthly energy data
- This needs to be weather normalised using degree-days
- Used to construct a performance line for the building
- Can compare future use against historic consumption

	Degree-days	Monthly consumption kWh
Oct-05	123	1306915
Nov-05	134	1443453
Dec-05	243	1800038
Jan-06	268	1915600
Feb-06	198	1507208
Mar-06	207	1798807
Apr-06	171	1629026
May-06	65	1207358
Jun-06	69	1128322
Jul-06	44	1006266
Aug-06	36	995705
Sep-06	43	1002490
Oct-06	151	1408449
Nov-06	235	1662201
Dec-06	284	1856632
Jan-07	285	1880107
Feb-07	261	1847220
Mar-07	228	1834833

Performance line



Performance line

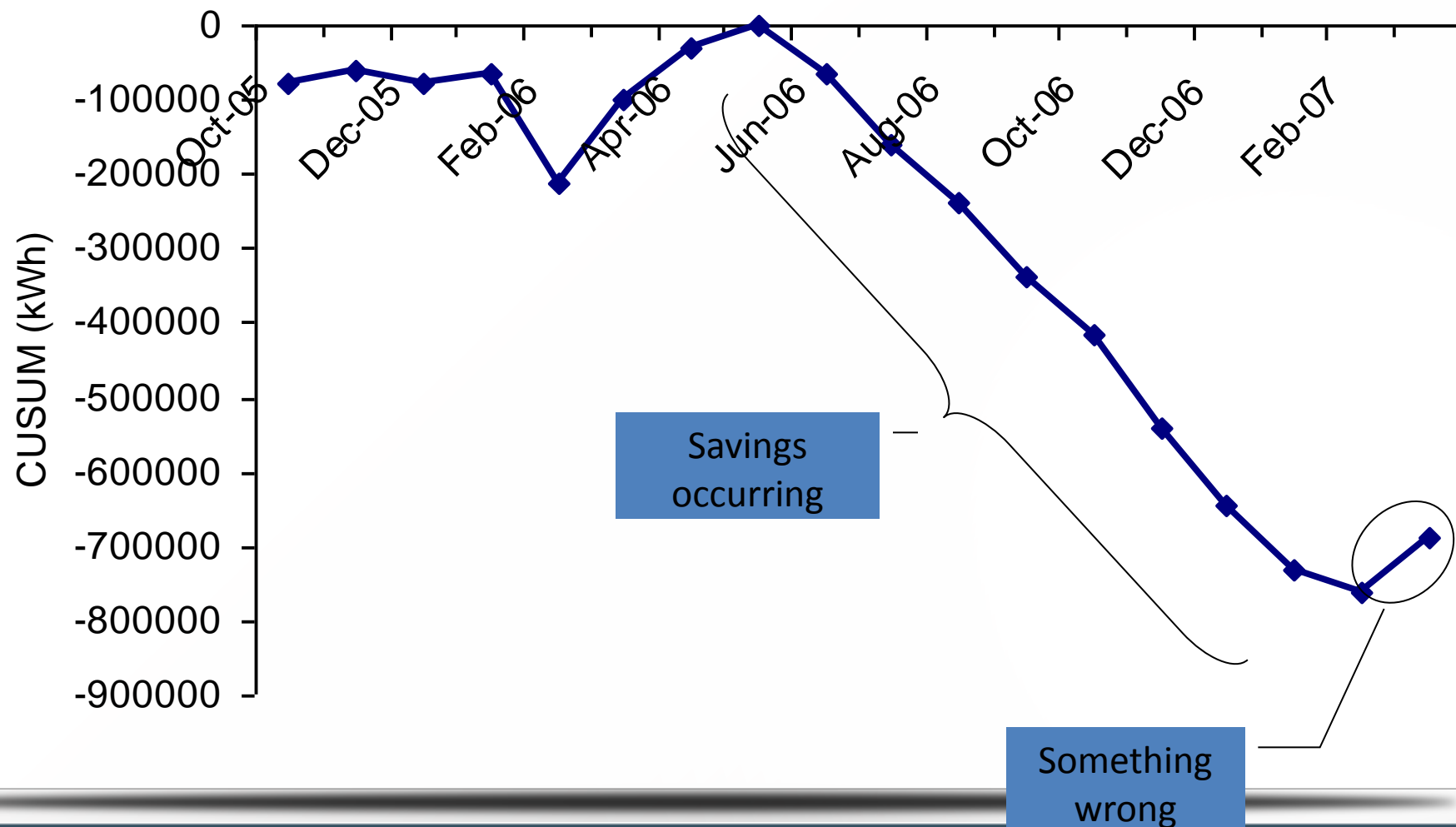


CUSUM Plots

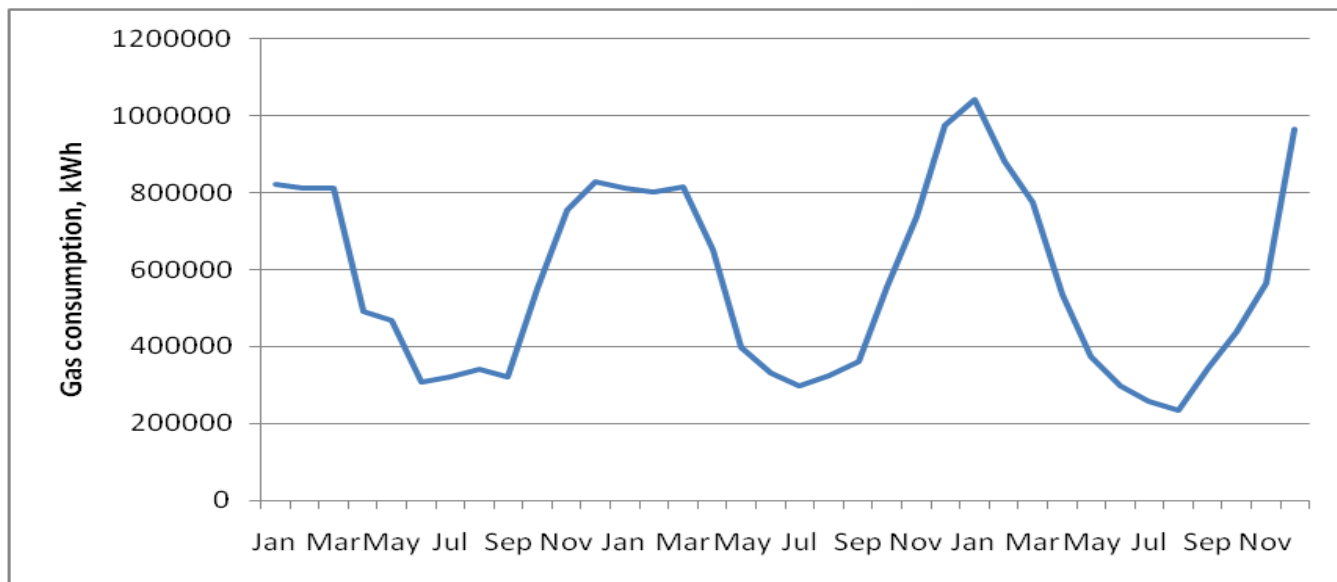
- Cumulative Sum Difference
- Shows trends in savings and wastage
- A very powerful tool

	Degree-days	Monthly consumption kWh	Predicted consumption kWh	Difference kWh	Cusum kWh
			3580.5 945436	Equation of the performance line	
Oct-05	123	1306915	1385837	-78922	-78922
Nov-05	134	1443453	1425222	18231	-60691
Dec-05	243	1800038	1815496	-15458	-76149
Jan-06	268	1915600	1905009	10591	-65558
Feb-06	198	1507208	1654374	-147166	-212724
Mar-06	207	1798807	1686598	112209	-100515
Apr-06	171	1629026	1557701	71325	-29190
May-06	65	1207358	1178168	29190	0
Jun-06	69	1128322	1192490	-64168	-64168
Jul-06	44	1006266	1102978	-96712	-160880
Aug-06	36	995705	1074334	-78629	-239509
Sep-06	43	1002490	1099397	-96907	-336416
Oct-06	151	1408449	1486091	-77642	-414058
Nov-06	235	1662201	1786852	-124651	-538709
Dec-06	284	1856632	1962296	-105664	-644373
Jan-07	285	1880107	1965877	-85770	-730143
Feb-07	261	1847220	1879945	-32725	-762869
Mar-07	228	1834833	1761789	73044	-689824

CUSUM graph



Example of the impact of weather

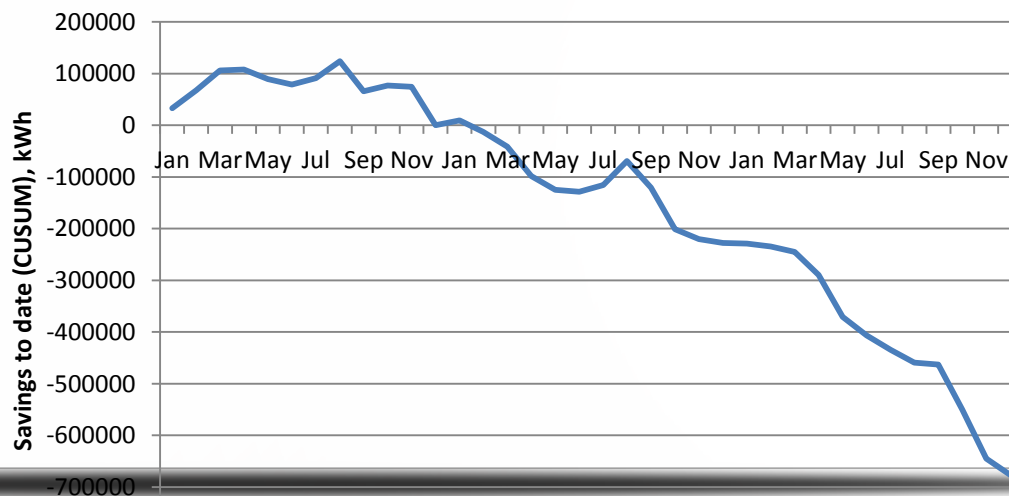
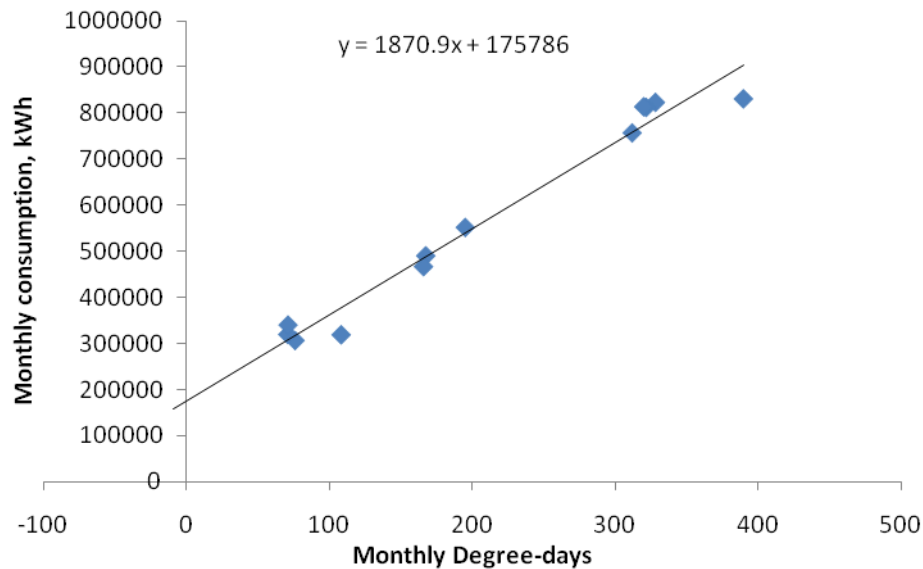


- Plot of energy consumption over 3 years
- Consumption looks to be increasing

Simple comparison with base year

Year	Actual energy kWh	Apparent comparison against base year		
2007	6,830,307			
2008	7,066,501	+235,764	+3.5%	
2009	6,713,669	-117,138	-1.7%	

Performance line and CUSUM

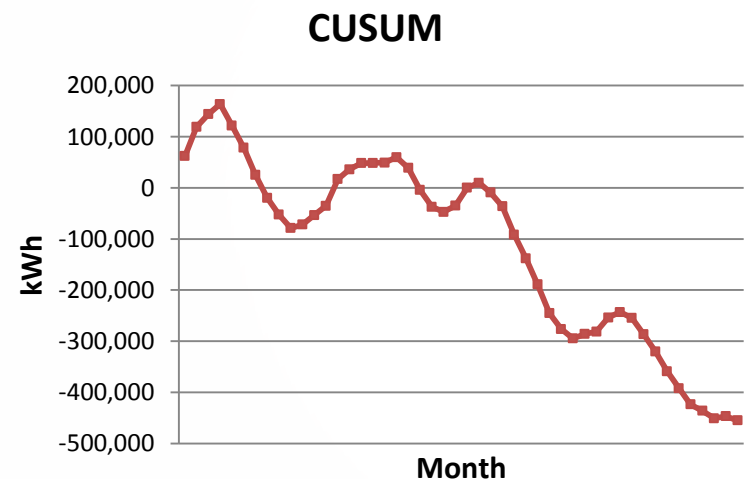
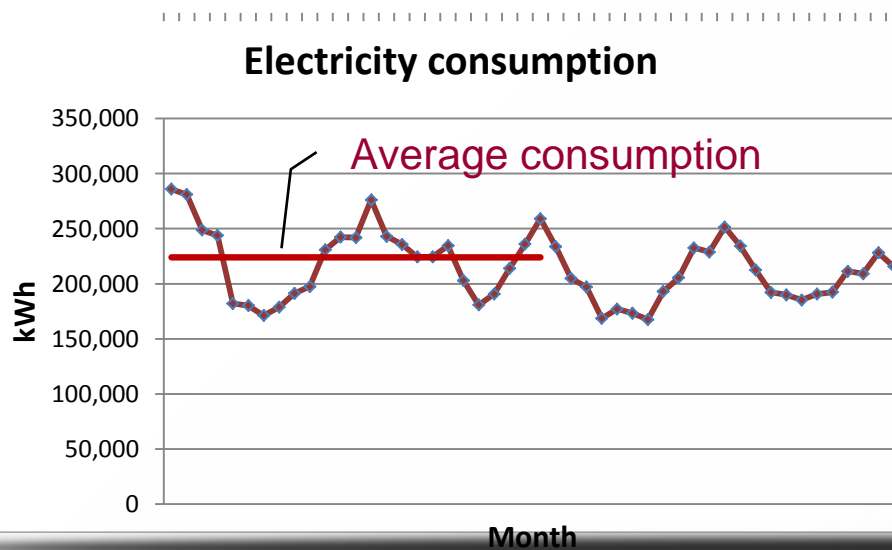


Weather normalised comparison

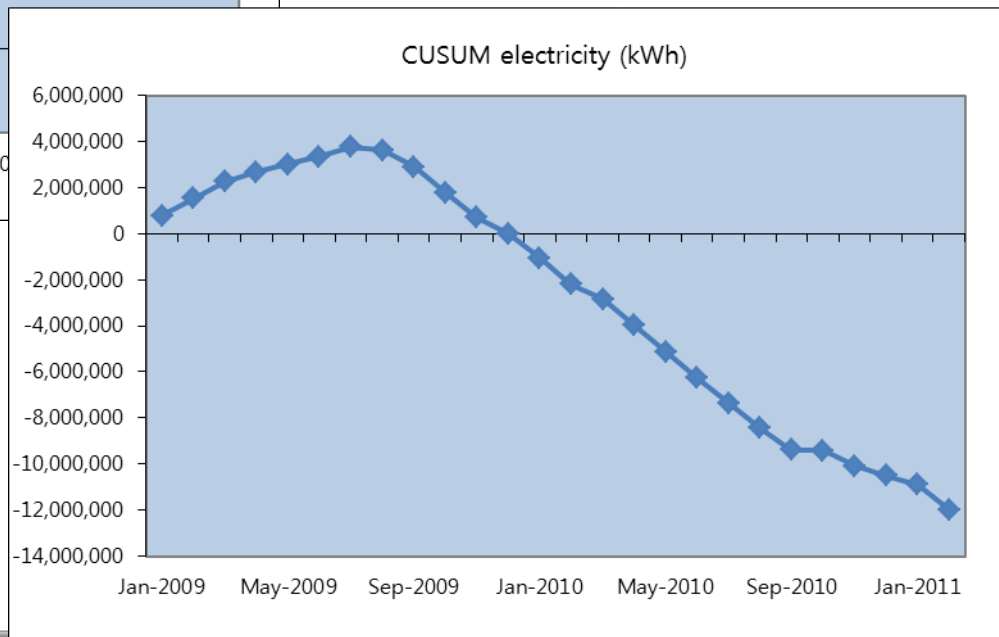
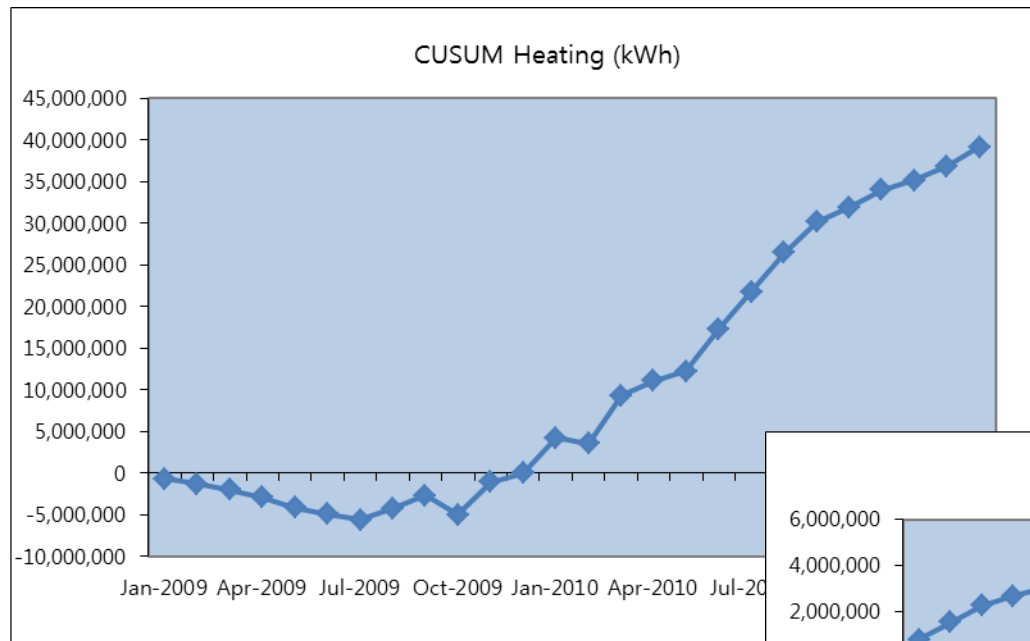
Year	Actual energy kWh	Apparent comparison against base year	Predicted performance as usual	Savings	% saving against base year
2007	6,830,307		6,830,307		
2008	7,066,501	+235,764	7,294,060	-227,489	3.3%
2009	6,713,669	-117,138	7,163,079	-449,410	6.4%

Electricity where no cooling

- Can still apply the CUSUM method to non-weather related loads
- E.g. electricity use in buildings with no cooling
- In this case the predicted consumption is just based on average monthly energy use

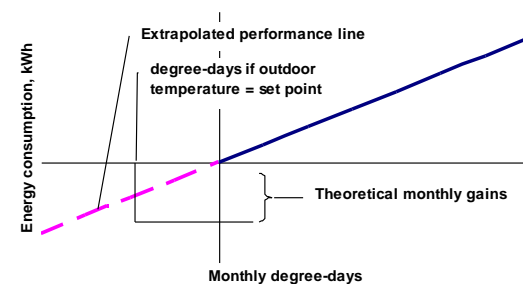
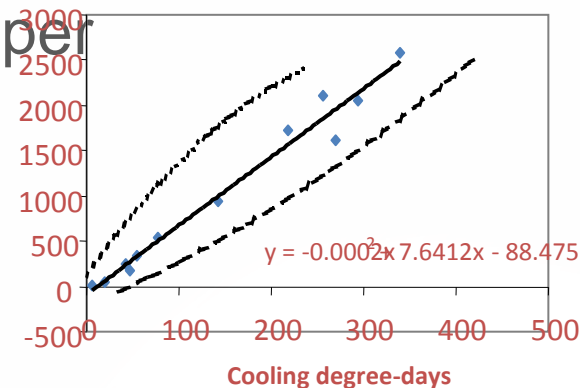


Hospital CHP engine switched on

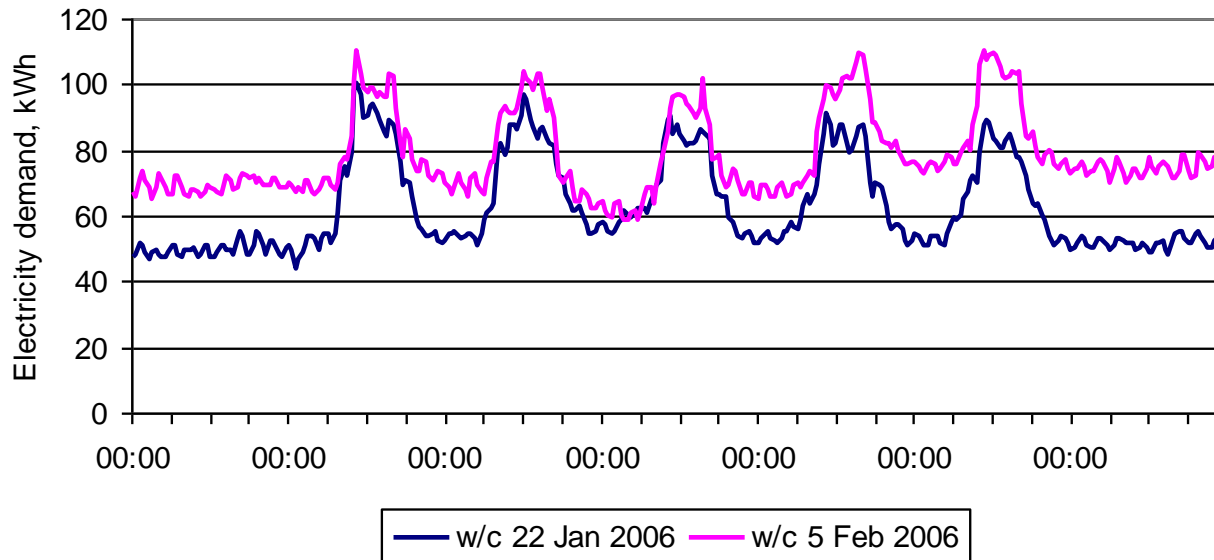


Advanced energy analysis

- Performance lines can be used for deeper analysis of energy use
- Establish the base (or balance point) temperature for heating and cooling
 - For heating and cooling – can be used for control set point checks
- Assess infiltration rates and other thermal properties of the building
- Determine the casual gains into the space
- New websites exist that supply appropriate weather data

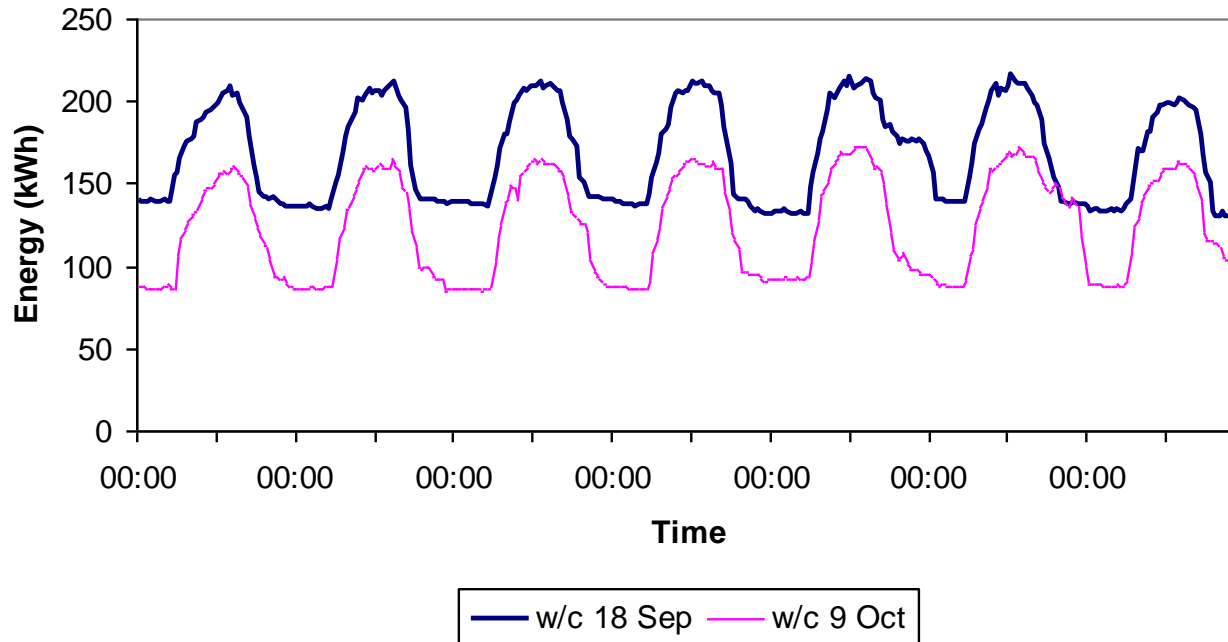


Use of half hourly data



- University building
- Base load jumps 40 kW at the start of term – stayed there until April
- Subsequent survey showed heating system inadequate on one floor with local electric heaters in use

Use of half hourly data

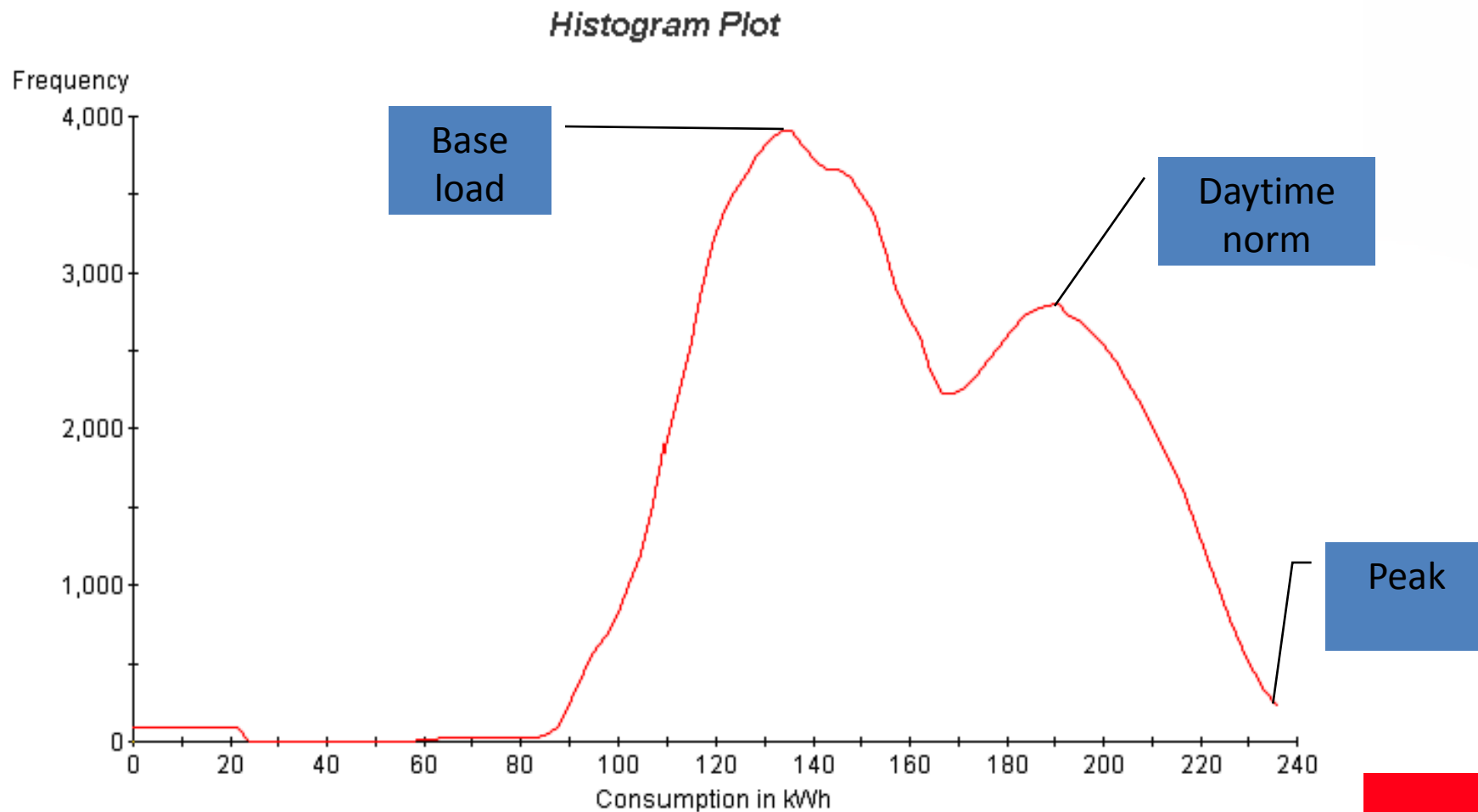


- Museum building
- Very tight control limits temperature and humidity
- The later week shows energy consumption with these limits relaxed
- This evidence used to encourage other curators to relax the operating conditions

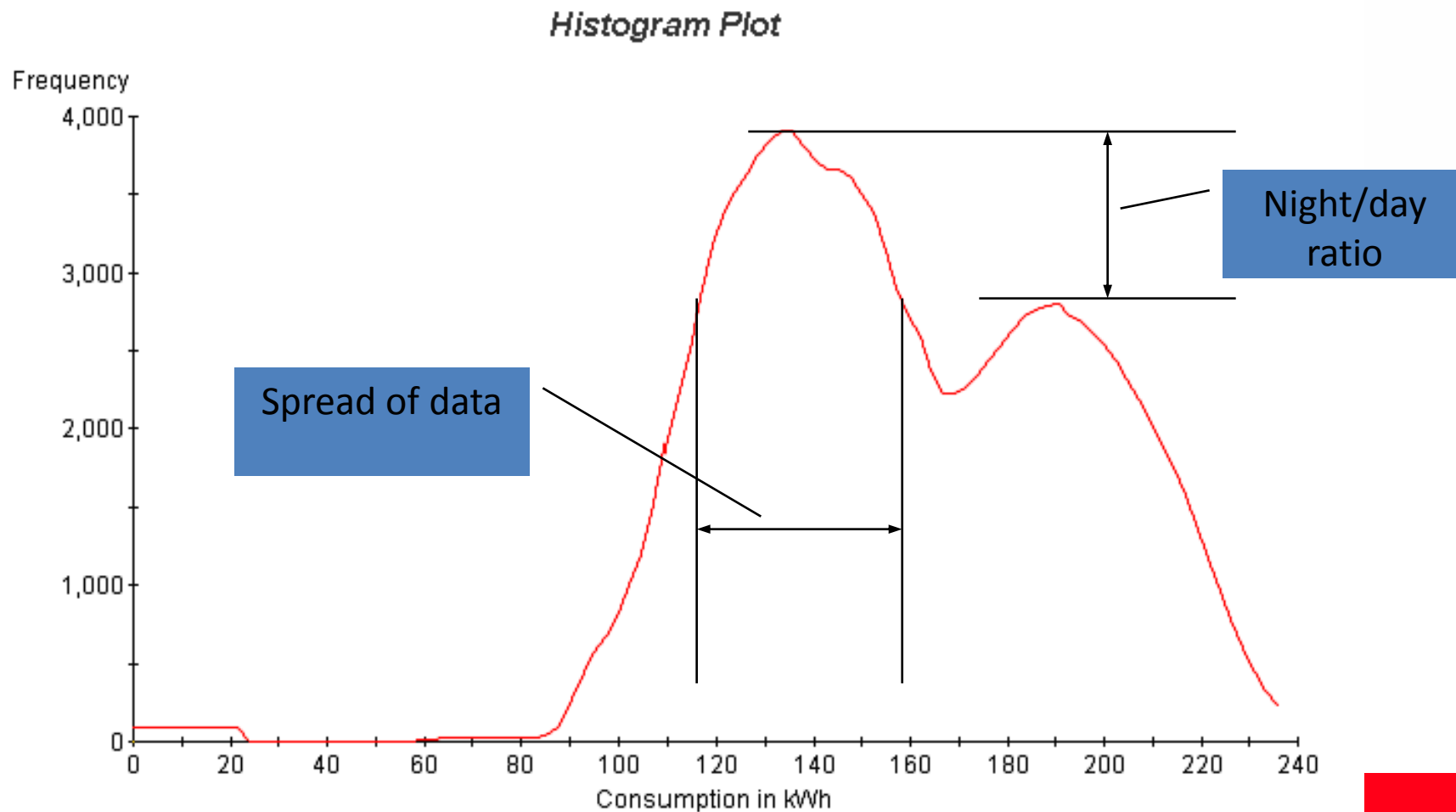
Half hourly analysis

- Danger of data overload!
- Half hourly data can be used to track and analyse
 - base loads
 - Peaks
 - Peak to base ratios
 - Spikes
 - Timings of anomalies
- Two base load techniques investigated by LSBU and TEAM
 - Using statistical analysis (standard deviation) to track load variations
 - Frequency analysis
 - The latter also provides a new type of building signature

Frequency plot of half hourly data



Frequency – as a new signature?

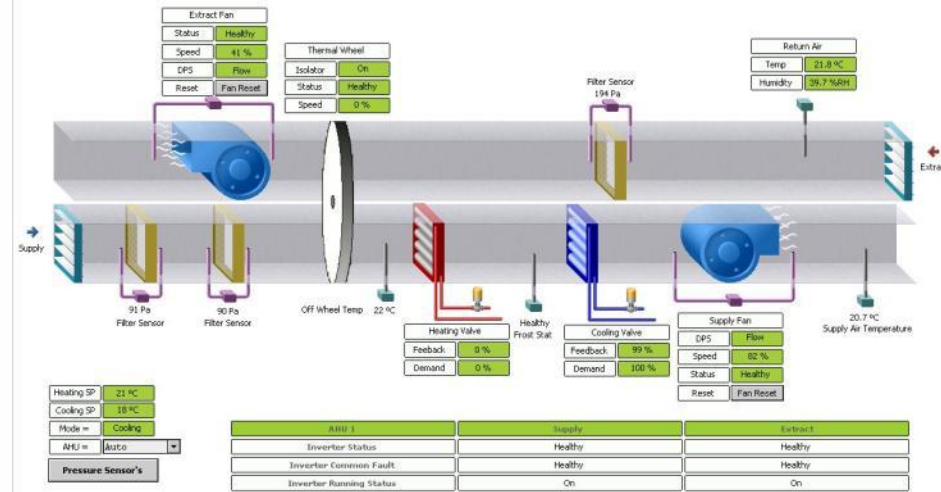


However...

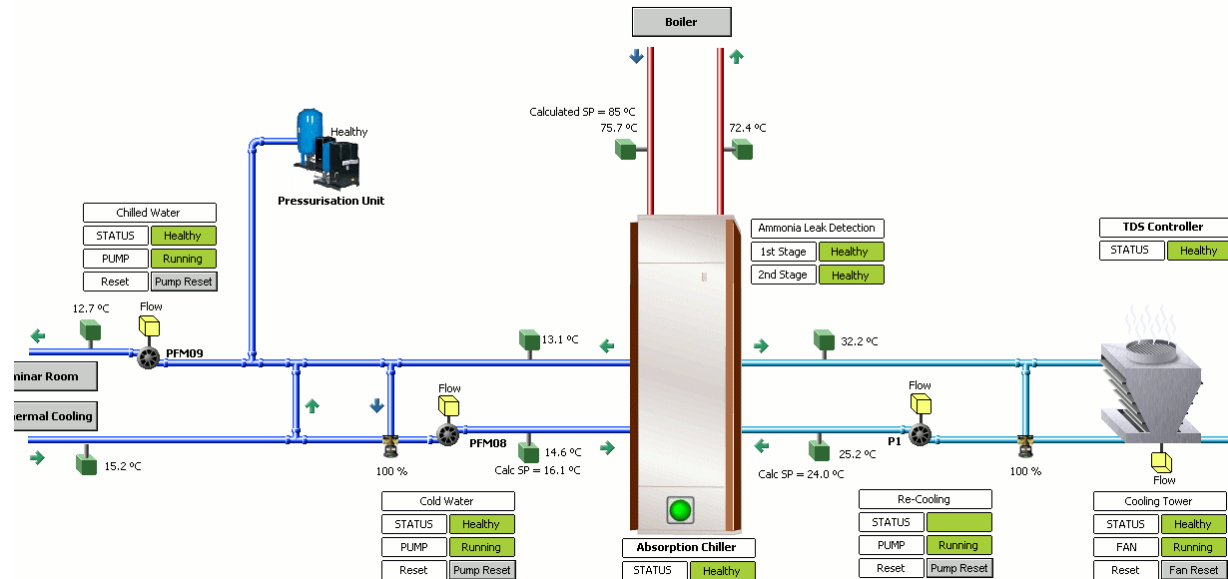
There is a need to include the building user

Building Management Systems

- BMS provides extensive information on the operation of systems
- Provides real time status
- Data can be stored for analysis of performance



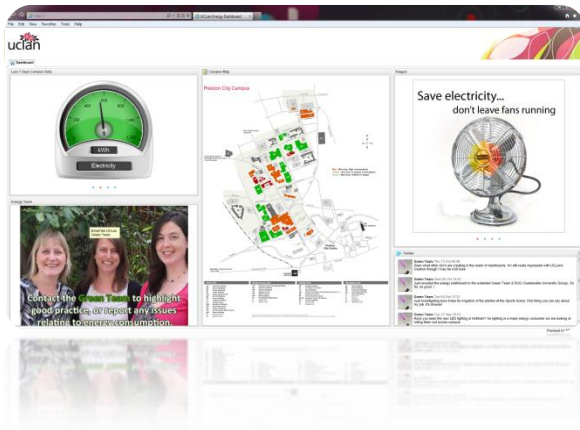
But it is highly complex...



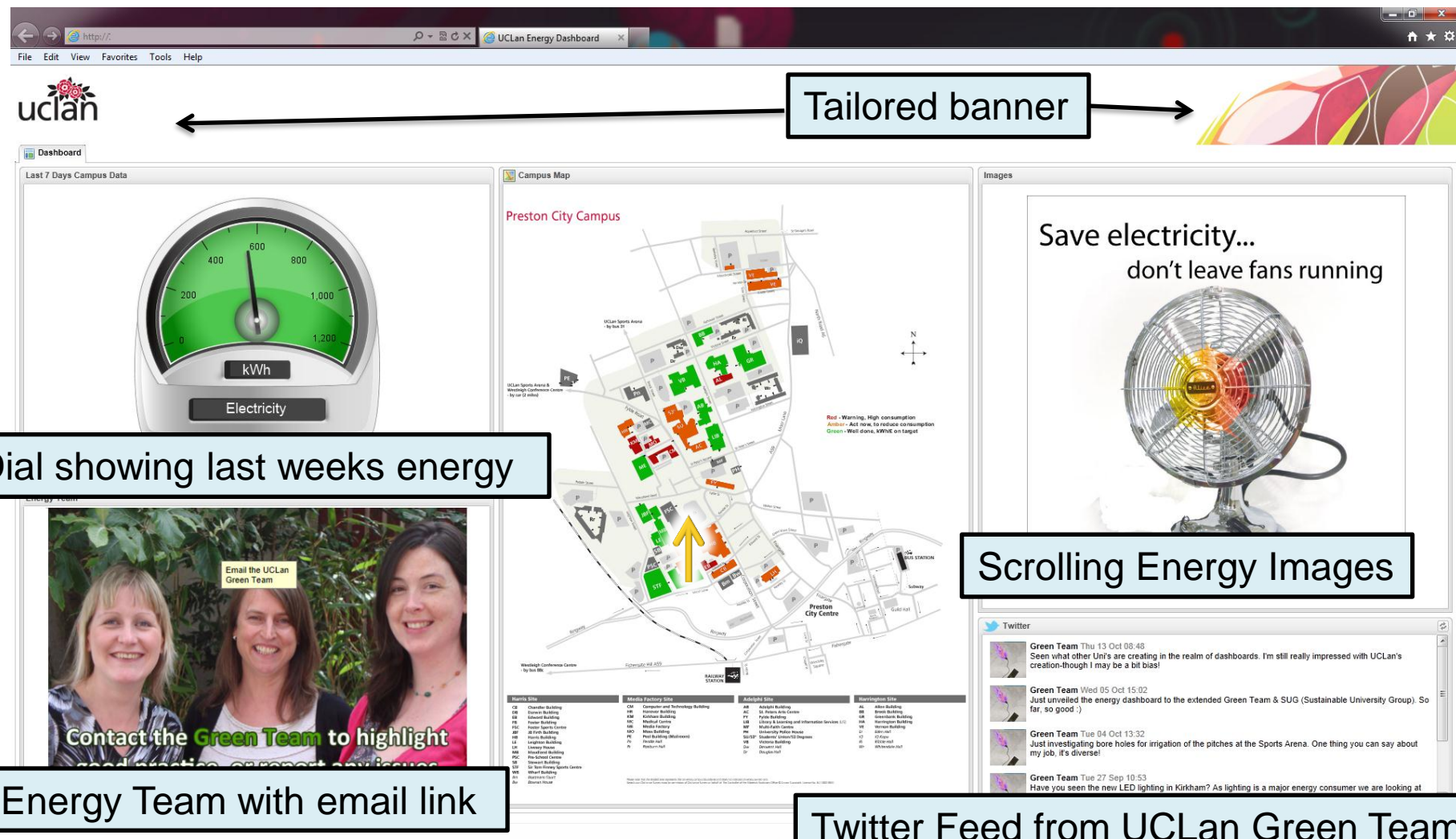
- A danger of too much information
- Alarms switched off
- The system becomes ignored
- And of no use to the general building user

TEAM Dashboard Solutions

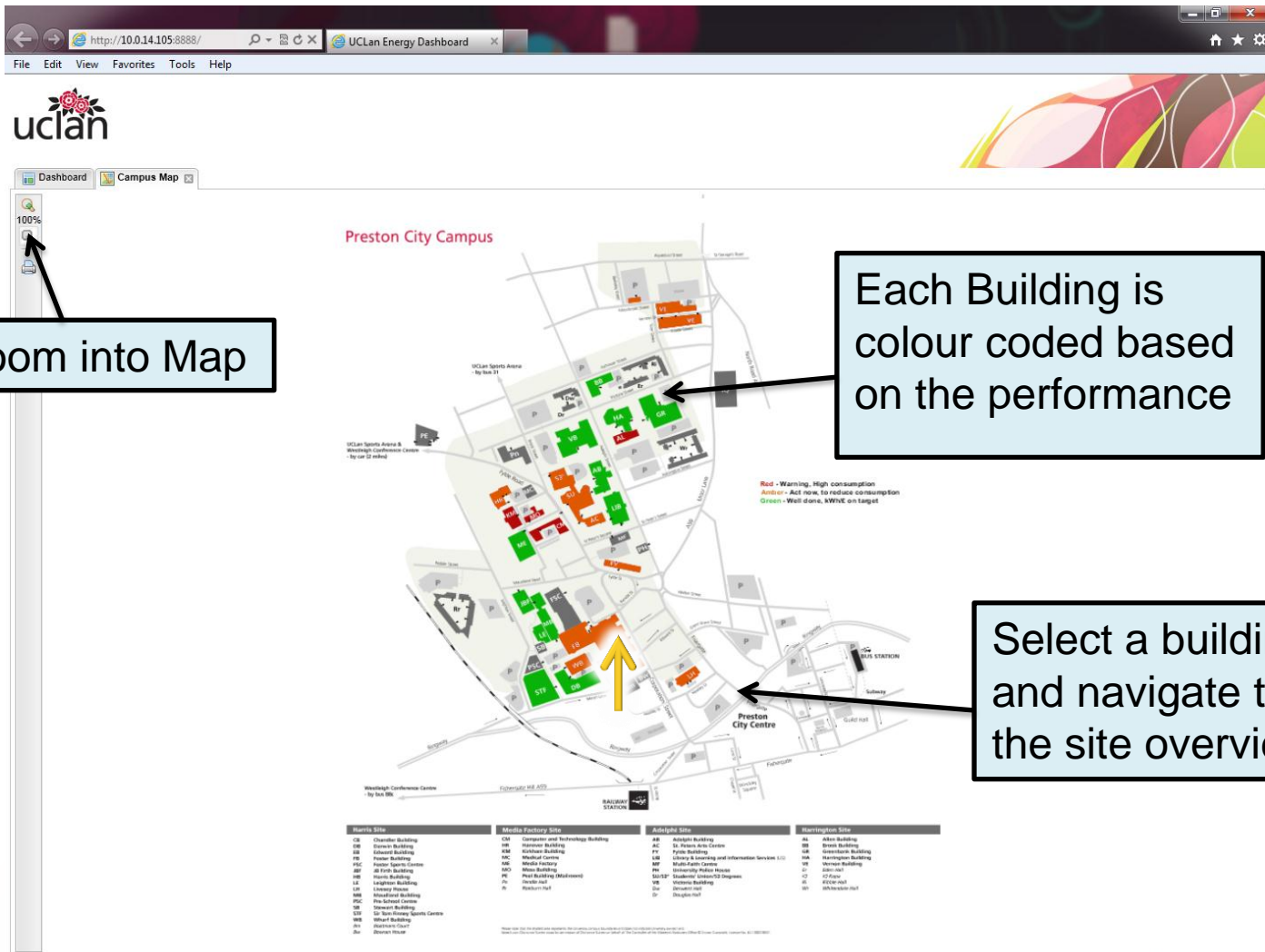
- **Energy Web Dashboards** - an interactive tool for sharing energy performance via the intranet or corporate website.
- **Desktop Gadget** - show real time consumption on the desktop every time occupants log on to their PCs.
- **Digital Signage Solutions** - share energy information with staff and visitors by using digital displays in reception areas or other high traffic areas.



UCLan Web Dashboard - Homepage

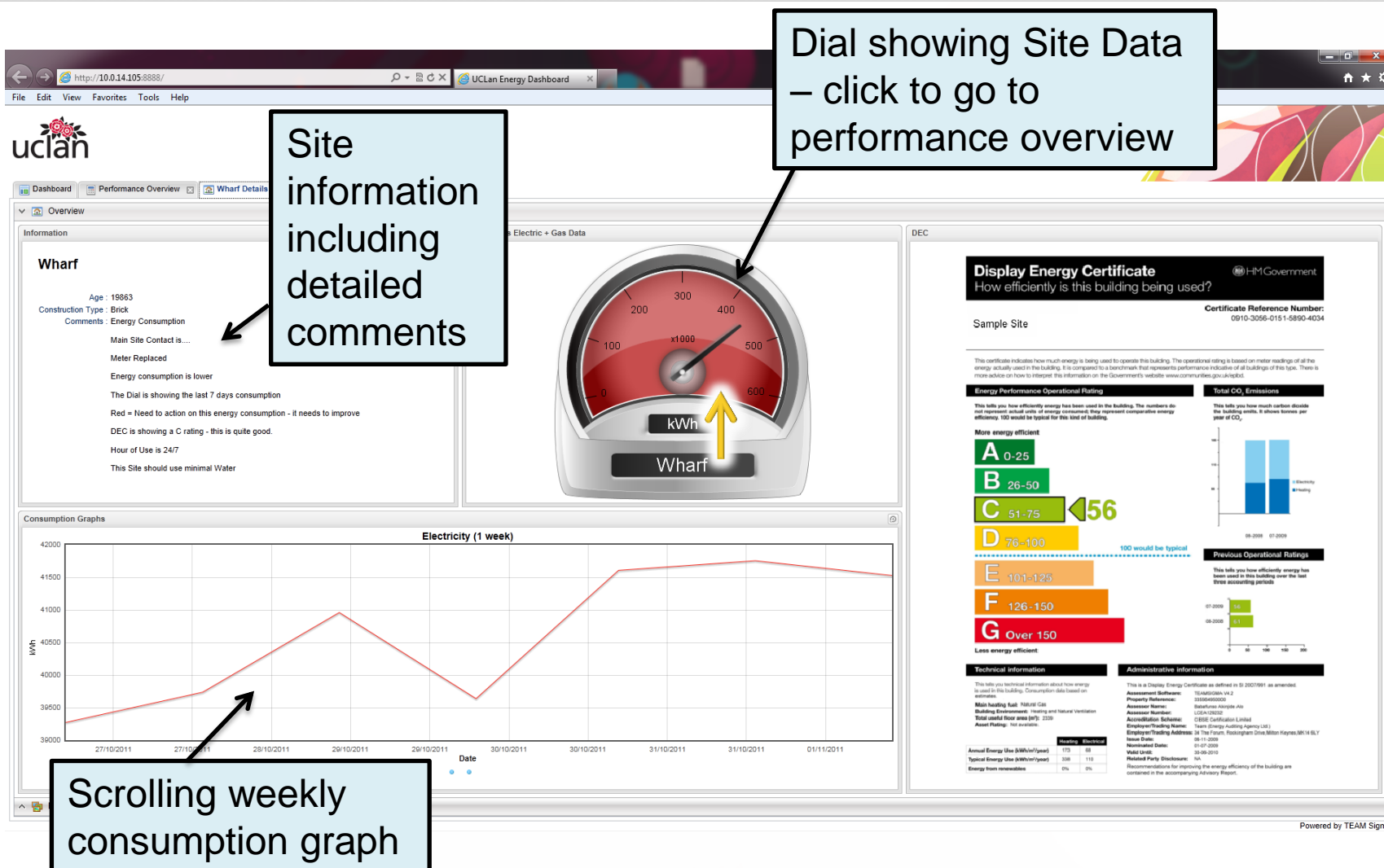


UCLan Web Dashboard - Map



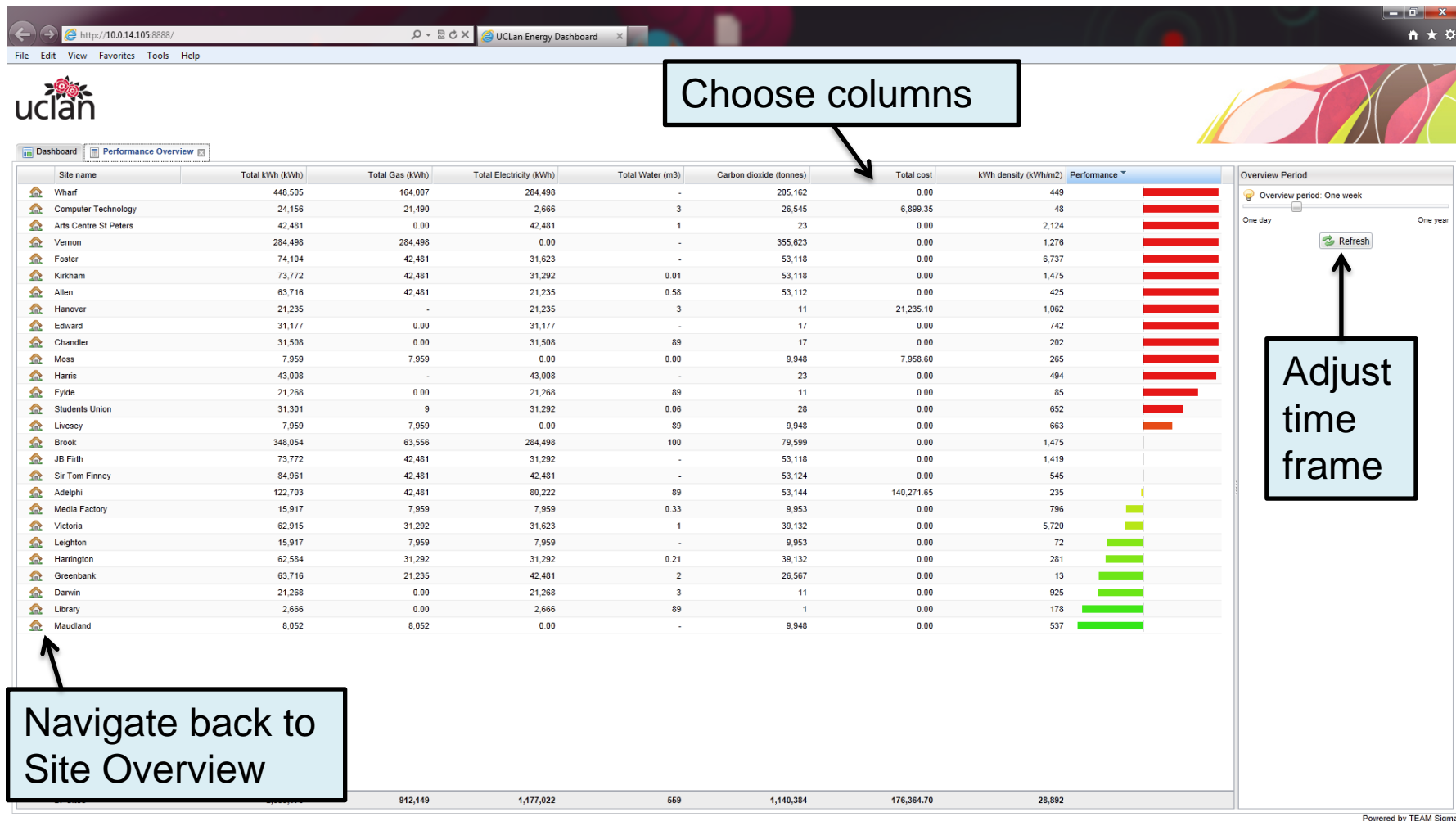
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UCLan Web Dashboard – Site Overview

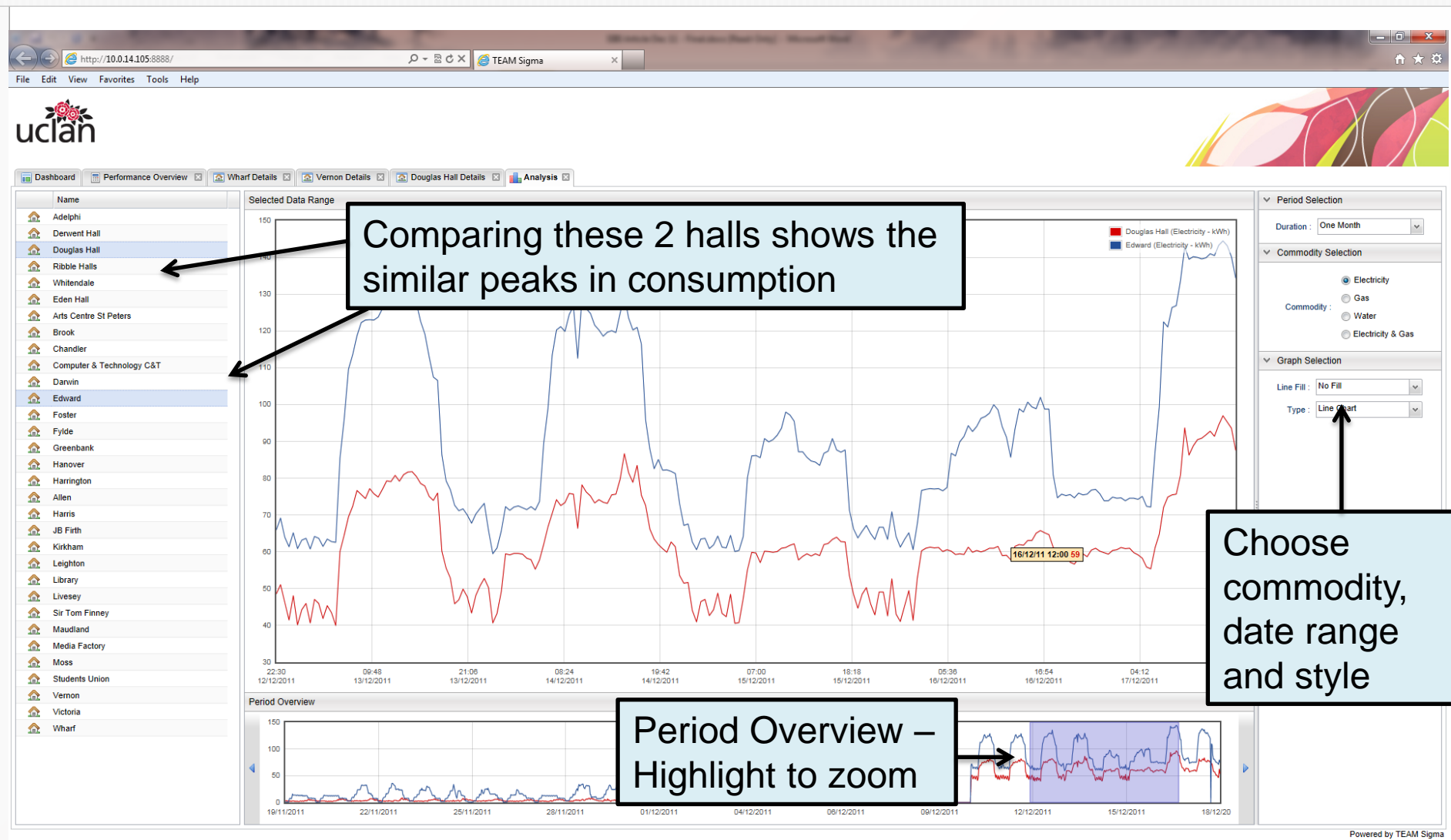


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UCLan Web Dashboard – Performance



UCLan Web Dashboard - Analysis



UCLan Desktop Gadget

- Setup on all computers across the UCLan network
- Each computer displays its current performance based on location
- Clicking on the Desktop Gadget takes you directly to the Web Dashboard

Ruth explains: “The gadget provides a quick overview of the campus energy and water consumption so students and staff can see if we are meeting our targets. This is the first time they have had this information at their fingertips and we are hoping it will see a positive change in behaviour.”



Conclusions

- Need to actively manage energy in buildings
- Correct reporting is essential
- Engaging the occupiers is increasingly important
- > 30% savings are regularly seen to be possible at low cost