

Energy Data

Gathering and Applying

Approved Document L2A

Energy Meters

4.38 *Reasonable provision for energy meters would be install energy metering systems that enable:*

- a. at least 90% of the estimated annual energy consumption of each fuel to be assigned to the various end-use categories (heating, lighting etc.). Detailed guidance on how this can be achieved is given in CIBSE TM39; and*
- b. the output of any renewable energy system to be separately monitored; and*
- c. in buildings with a total useful floor area greater than 1000m², automatic meter reading and data collection facilities.*

4.39 *The metering provisions should be designed such as to facilitate the benchmarking of energy performance as set out in TM46.*

Approved Document L2B

Energy Meters

4.33 *The aim for buildings as a whole is to enable building occupiers to assign at least 90 per cent of the estimated annual energy consumption of each fuel to the various end-use categories (heating, lighting, etc.).*

4.34 *Reasonable provision for energy meters in existing buildings would be to install energy metering systems in the building services systems provided as part of the works in accordance with the recommendations in CIBSE TM39.*

Approved Document L2B

Energy Meters *(cont'd)*

4.35 *In addition to this:*

- a. meters should be provided to enable the performance of any renewable energy system provided as part of the works to be separately monitored;*
- b. in buildings with a total useful floor area greater than 1000m², the metering system should enable automatic meter reading and data collection;*
- c. the metering provisions should be designed such as to facilitate the benchmarking of energy performance as set out in TM46.*

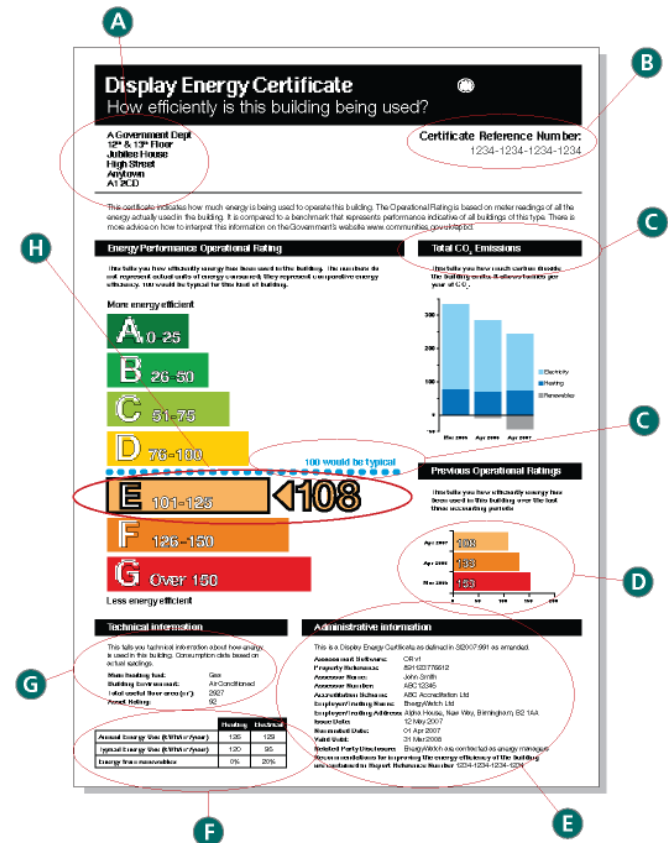
Energy Certificates

Display Energy Certificates (+Advisory Reports)

For buildings over 250m² owned
by public authorities

Energy Performance Certificates

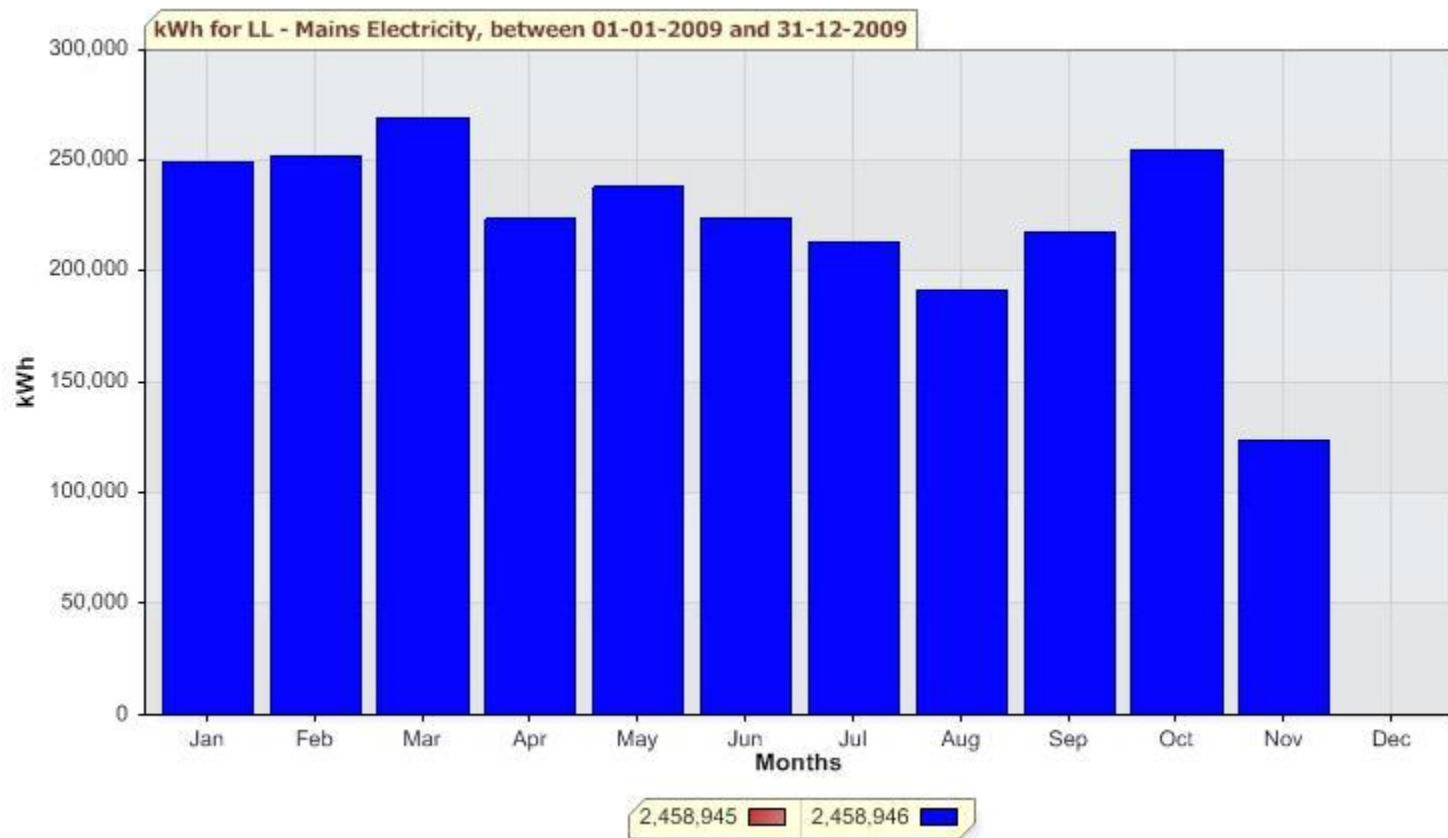
For commercial buildings over 50m²
when built, sold or rented



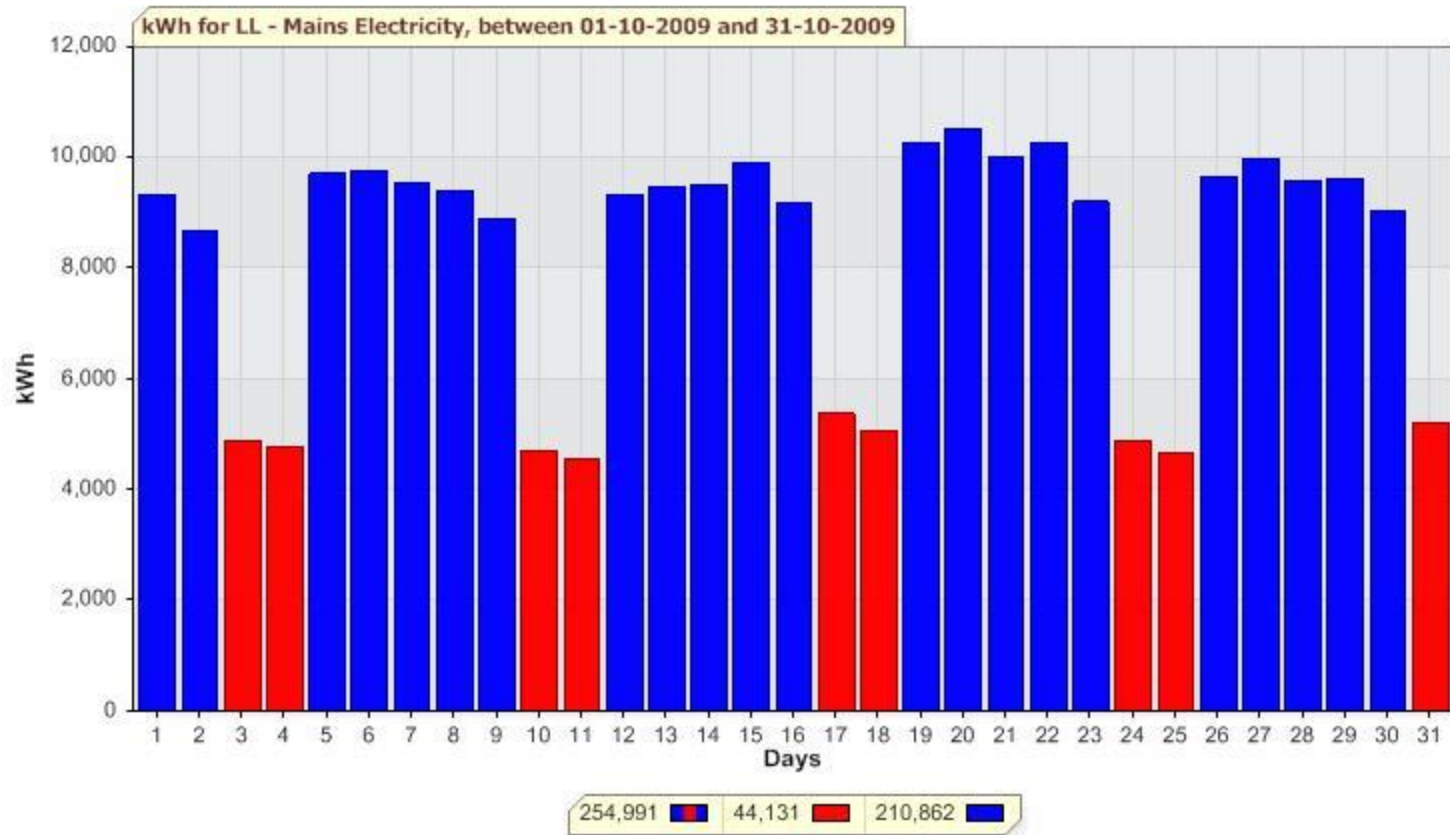
Energy “Meters”

- **Direct** – most electricity, gas, oil and water meters. Usually highly accurate but beware inferential meters e.g. those that measure pressure or velocity to “measure” volume
- **Indirect** – e.g. using a meter on a cold feed and applying a recorded temperature difference to estimate DHW cons.
- **Hours run** – only applicable for equipment that operates at a constant known load
- **By difference** – usually two direct meters used to estimate a third end use in effect creating a “virtual” meter

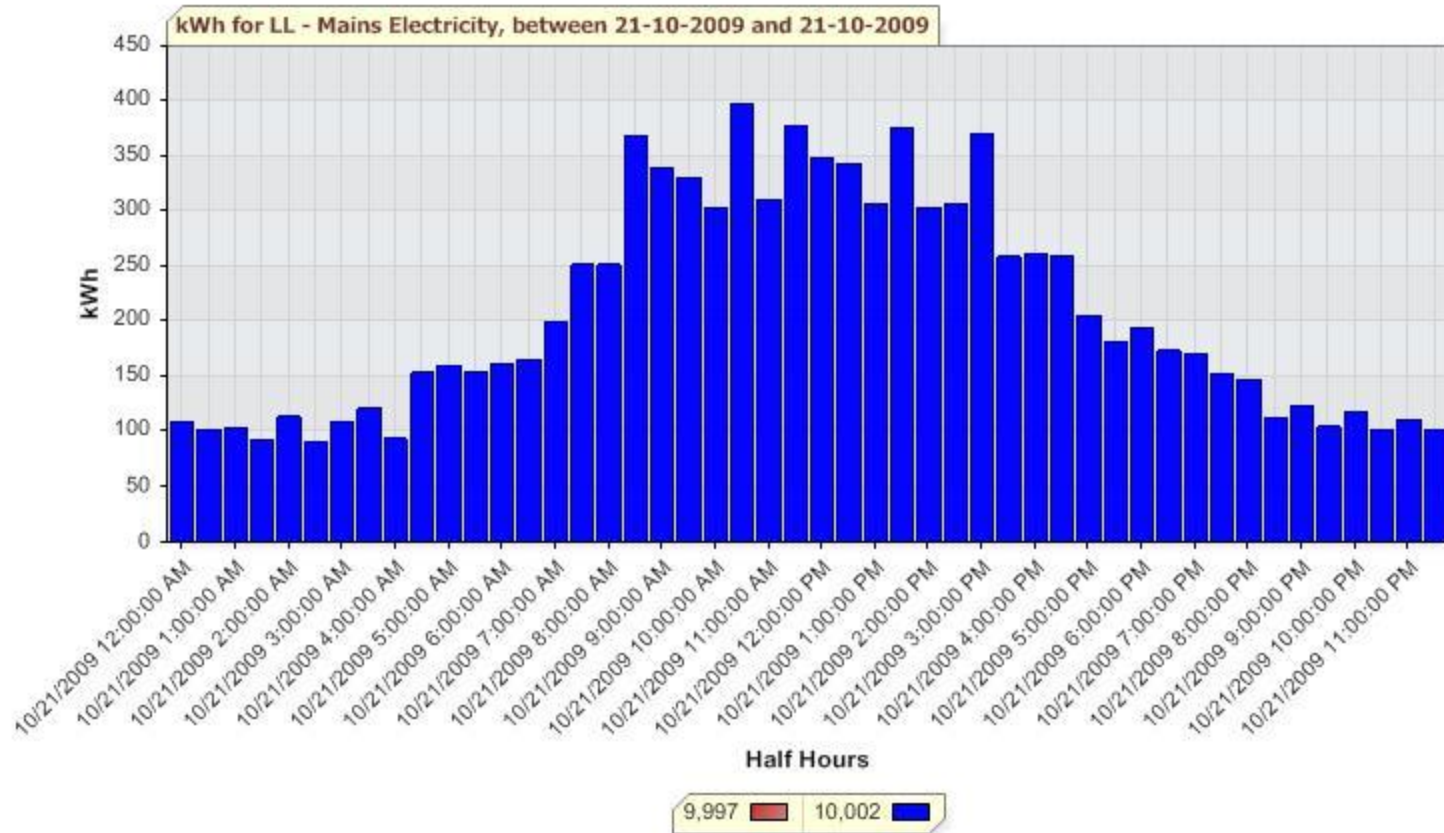
Energy consumption data – monthly profile



aM & T data – daily profile



aM & T data – half-hourly profile



Meter Schedule

STEP 7 METERING SCHEDULE WORKED EXAMPLE

SET OUT METERING SCHEDULE

The metering schedule below has been developed using Steps 1 to 6, based on the example building. The final schedule is presented in a format that can be incorporated into the building logbook.

Total estimated incoming fuel			Electricity 684,000 kWh/yr Gas 531,000 kWh/yr Other n/a		Actual consumption (to be completed by the building operator)		
Energy			Meters	Method	Meter location		Year From (date) To (date)
Incoming energy	Main end-use	Estimated end-use consumption (kWh/yr)	Meter no/ code	End-use/area/systems/ circuit or tenancy to be measured	Measurement method and calculation (where appropriate)	Estimated consumption through each meter (kWh/yr)	Location
ELECTRICITY							
Incoming	684 000	EM ₁					Electricity meter EM ₁
Lighting	180 000	EM ₂	Open plan lighting	Directly metered	157 000	Electricity meter EM ₂	Main distb. room
		EM ₃	Atrium lighting	Directly metered	8 000	Electricity meter EM ₃	Main distb. room
		EM ₄	External and car park	Directly metered	n/a	Electricity meter EM ₄	Ext. sub room
		EM ₅	External lighting	Est. by difference	6 000		
		EM ₇	Car park lighting	Directly metered	9 000	Electricity meter EM ₇	Main distb. room
Fans	162 000	EM ₈	Fans AHU 1 & 2	Indirect (hours run)	87 000	Hours run 1	Plant room 2
		EM ₉	Fans AHU 3 & 4	Indirect (hours run)	75 000	Hours run 2	Plant room 3
Pumps	27 000	EM ₆	Pumps	Directly metered	27 000	Electricity meter EM ₆	Boilerhouse
Off Eqp't	112 500	EM ₁₁	Office equipment	Estimated (CBSE)	112 500		
Cooling	90 000	EM ₁₀	Cooling (screw chillers)	Directly metered	90 000	Electricity meter EM ₁₀	Chiller room
Comp'r	76 500	EM ₁₂	Computer room	Directly metered	76 500	Electricity meter EM ₁₂	Comp. vent. room
Total electricity metered					648 000		
				% metered	648/684 = 95%		
GAS							
Incoming	531 000	GM ₁					Gas meter GM ₁
Space	427 500	GM ₂	Space heating	Directly metered	427 500	Gas meter GM ₂	Boilerhouse
DHW	67 500	GM ₃	DHW	Est. from h/w consumption	72 000	Cold water meter	Boilerhouse
Catering	22 500	GM ₄	Gas catering	Est. by difference	31 500	Gas meter GM ₄	Kitchen
Total gas metered					531 000		
				% metered	531/531 = 100%		

Source: General Information Leaflet 65

Metering energy use in new non-domestic buildings

Meter Strategy (or meter tree)

SET OUT METERING STRATEGY

STEP 8 METERING STRATEGY WORKED EXAMPLE

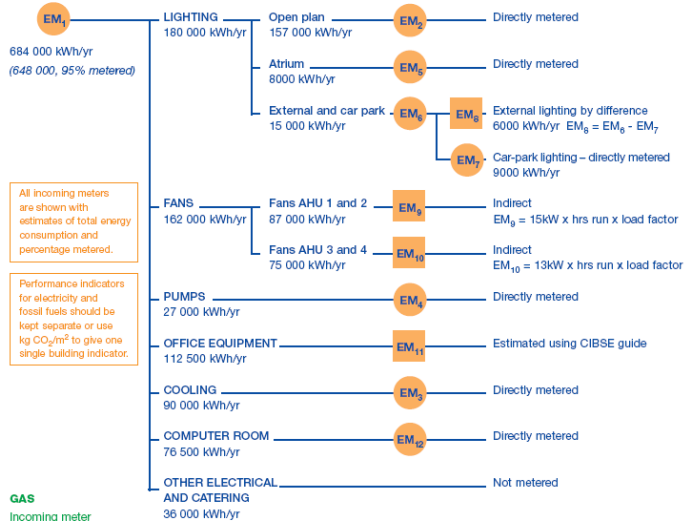
The metering strategy below is the main objective of the method and has been developed using Steps 1 to 6 based on the example building. The final strategy shows how an end use breakdown can be achieved and is presented in a format that can be incorporated into the building logbook.

KEY

- = Directly metered
- = Estimated
- EM = Electricity meter
- GM = Gas meter

ELECTRICITY

Incoming meter



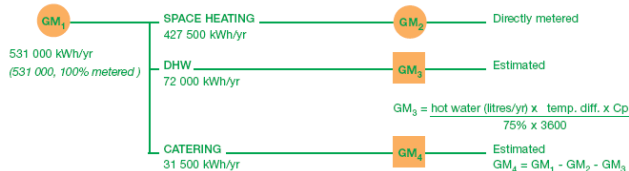
Direct metering is more accurate and reliable but may be more expensive, although metering costs have reduced significantly.

The difference between two direct meters can often give a reasonable estimate of consumption. Check accuracy, see page 12.

Using simple hours run meters is a cheap way of obtaining a reasonable consumption estimate for constant loads only, see page 12.

GAS

Incoming meter



Installing a water meter in the cold feed to the DHW provides an indirect method for estimating hot water consumption using boiler efficiency (assumed 75%). Check accuracy, see page 12, 13.

Cp = specific heat of water (4.185)

This could be achieved by difference as shown, but accuracy concerns may lead to installing a direct gas meter instead. See page 12, 13.

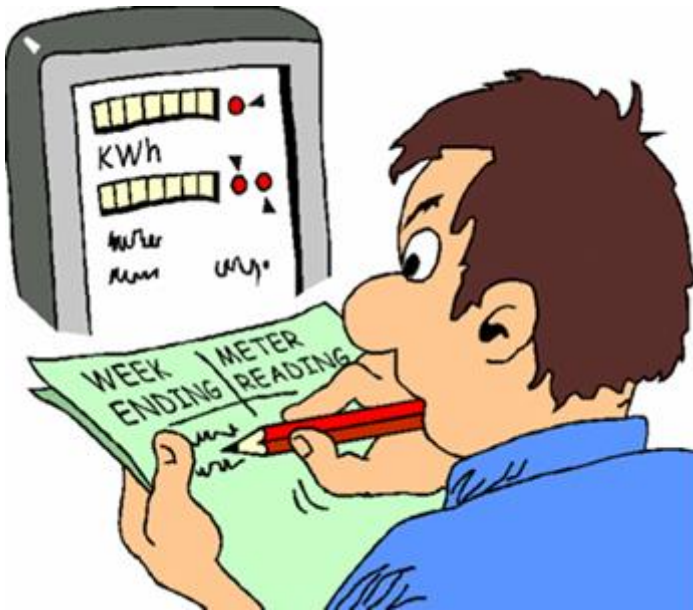
All main energy end uses are shown with estimates of consumption. These should include any special uses, eg computer rooms.

Each meter is allocated a unique code logged in the metering schedule with a label on the meter, eg Gas Meter No. 2 – Space Heating.

Source: General Information Leaflet 65

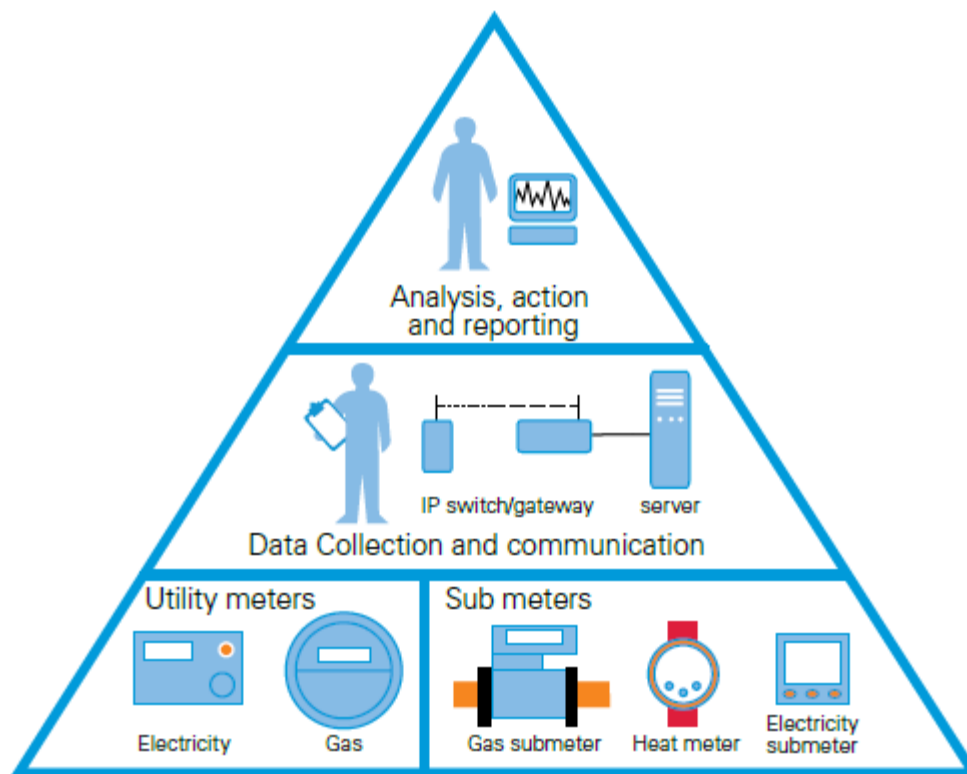
Metering energy use in new non-domestic buildings

Monitoring and Targeting



*“You can’t manage
what you can’t
measure”*

Components of a Monitoring and Targeting System



Cardiff Metropolitan University Case Study

Cardiff Metropolitan University provides education and training opportunities for more than 10,000 students over 4 campuses employing almost 1,000 staff. Through the introduction of a five-year strategic plan to reduce energy and water consumption the University is on track to achieve savings of £1m.



Metering, Monitoring & Targeting

Savings of £1m

in five years

“

The automatic monitoring and targeting system that we've installed has enabled a more holistic approach which has delivered worthwhile reductions in utility consumption across all of our buildings. Having studied our results, I cannot think of a more cost effective way of reducing our utility bills and CO₂ emissions.

”

Paul Manley, Energy Manager,
Cardiff Metropolitan University

The Business Case

With an annual utility budget rising to £2.1m in 2008, effective energy management had become a key priority for the University. That year, the University implemented a 5-year plan to reduce energy and water consumption from improved housekeeping – not only in response to rising energy costs but also to meet the Welsh Government target for public sector bodies to reduce CO₂ emissions by 3% per annum.

The 5 year strategy and implementation plan was developed in conjunction with Carbon Trust Wales to maximise the return on investment of £330k of ring-fenced funding from the Higher Education Funding Council for Wales (HEFCW) in automatic monitoring and targeting (aM&T) technology.

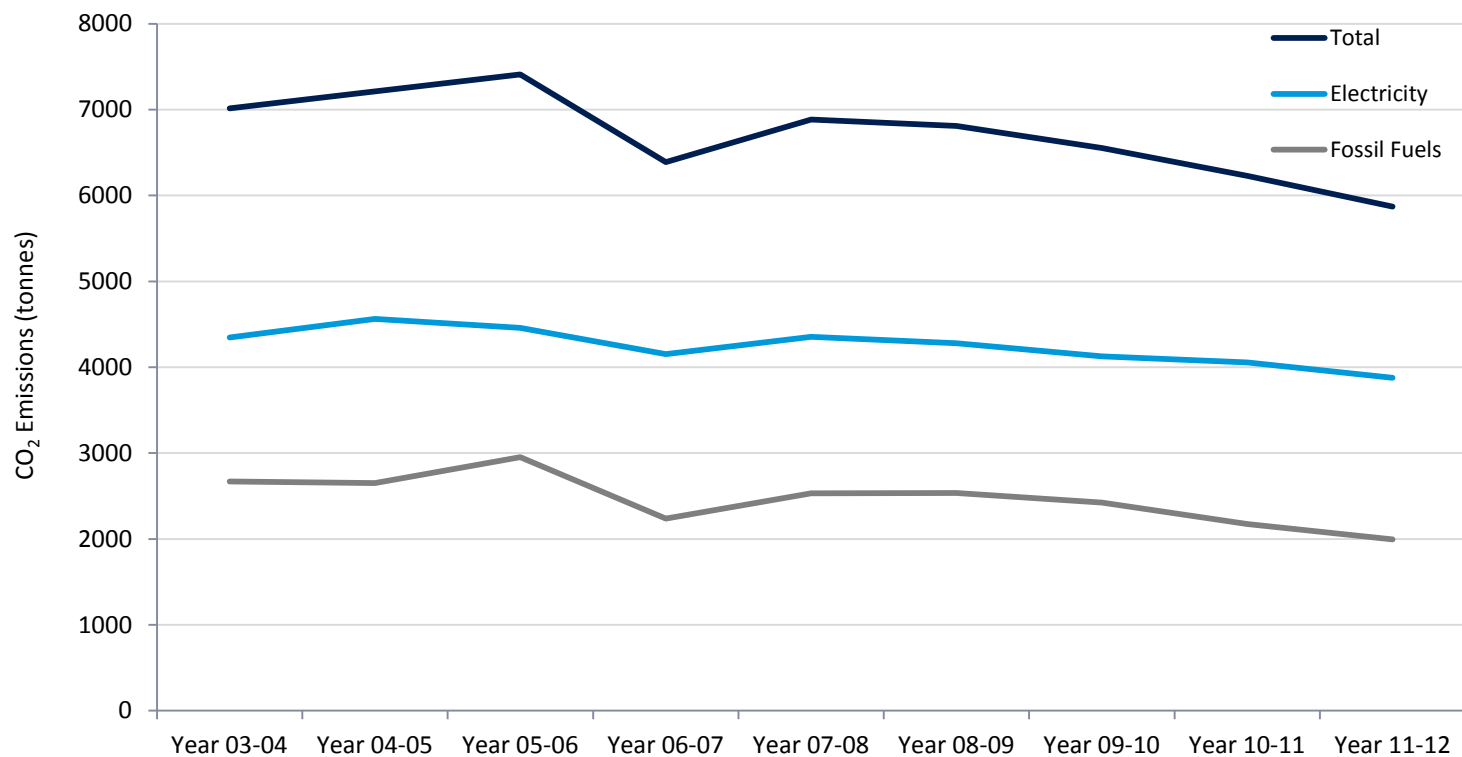
Carbon Trust Wales energy efficiency surveys confirmed that the University's approach had been successful as many buildings were identified as operating at or better than 'best practice' benchmarks.

Savings at a glance

- ▶ Savings of £1m in five years
- ▶ Simple payback in less than 4 years
- ▶ 15-20% saving across all utilities by year 4
- ▶ At the end of Year 3 the following reductions in usage have been achieved:
 - ▶ 12% Electricity
 - ▶ 5% Gas
 - ▶ 18% Water



CMU CO₂ Emissions



Source: CMU billing data , constant CO₂ conversion factors applied throughout

Carbon Management Strategic Objective

“To develop a robust management system that can engage with all stakeholders by utilising the energy monitoring & reporting infrastructure to continually improve carbon reduction performance against targets”



Visualisation

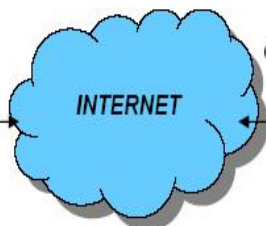
RUMM — Analysis, Reporting, Alarming.



RUMM Data Servers



GSM Link — Global System for Mobile communication



Gateway @ Site

Server VPN Gateway

ETHERNET CONVERTER—
Converts RS485 modbus hard-wired network to an Ethernet layer.

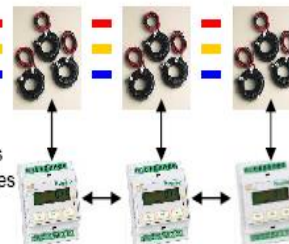
Data Acquisition

3 Phase circuit system



CT'S— Split ring CT's used for ease of installation.

SIRIO'S—Energy meters are compact and produces a pulse for every Kwh used.



Panel meter (96x96) —
Performs like a sirio meter but also has a read-out display, for mounting on electrical cabinets



Gas meter



Water meter



Portable logger— can be temporarily linked to circuits of interest for a short analysis phase. Uses GSM technology to connect to rumm server



4MOD PULSE COLLECTOR—
The collector receives a pulse from water/gas/steam meter relevant to the utility + unit type.

Radio Comm's

Transportation

5 Year Plan utilising M & T Methodology

- Year 1 - rollout period
- Years 2-5 - support to “Building Users” to help them meet their reduction targets
- Monthly Reports to “Building Users”
- Quarterly Reports to Management
- Annual Summary Report

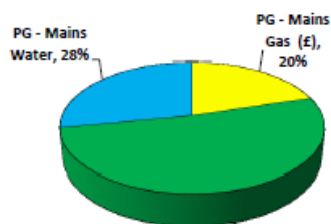
Reduction Targets

- Year 1 (2008 - 2009) – 0%
- Years 2-5 (2009 - 2013) – 3% pa

MONTHLY UTILITY REPORT
PLAS GWYN REPORTING GROUP
PREPARED FOR [REDACTED]
FOR MONTH OF JULY 2011

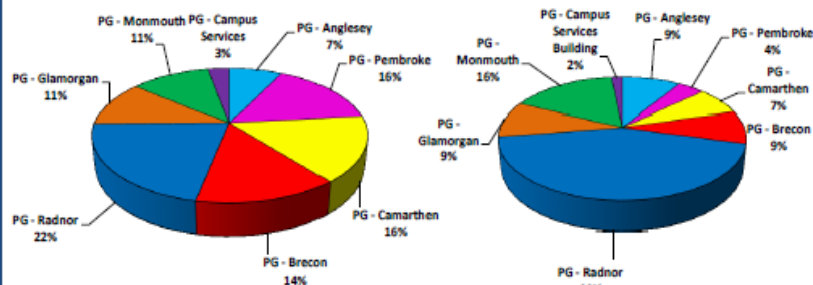
MANAGEMENT SUMMARY	
UTILITY	% AGAINST TARGET
ELECTRICITY	-13.0
GAS	-2.6
WATER	-42.0

Relative Utility Costs

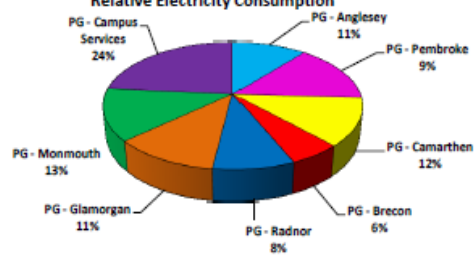


Site Costs
 % based on cost
 (all costs exclude CCL,
 Standing Charge & VAT)

Relative Gas Consumption



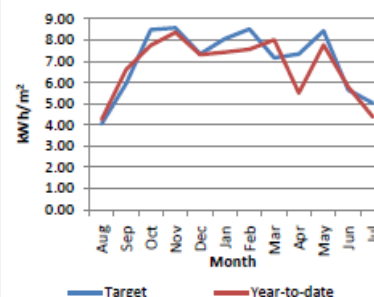
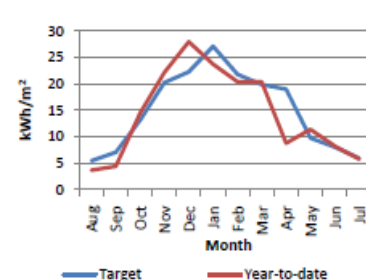
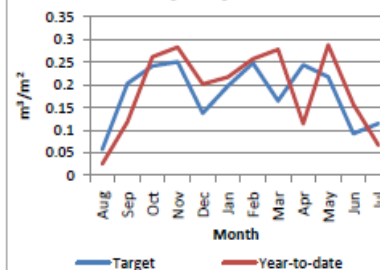
Relative Electricity Consumption



UWIC
 Cardiff Metropolitan University

In partnership with

PLMM

Electricity: kWh produced against targets normalised m²Gas: kWh produced against targets normalised m²Water: m³ used against targets normalised m²

Key to Cell Shading	
Target Met	Green
Target Not Met	Red
Zero or low consumption in report period or benchmark year	Grey

% Performance Against Targets

Building	Monthly Actual vs Target (%)	Annual Cumulative Actual vs Target (%)
PG - Campus Services	436.8	105.5
PG - Monmouth	18.4	-6.3
PG - Pembroke	-3.1	-4.2
PG - Glamorgan	-13.2	-26.1
PG - Carmarthen	-24.2	-0.7
PG - Anglesey	-40.0	3.9
PG - Radnor	-45.0	-5.6
PG - Brecon	-67.7	-29.6

% Performance Against Targets

Building	Monthly Actual vs Target (%)	Annual Cumulative Actual vs Target (%)
PG - Glamorgan	108.0	-15.1
PG - Radnor	82.0	1.2
PG - Pembroke	26.4	4.2
PG - Monmouth	0.4	6.0
PG - Campus Services	-11.4	-1.3
PG - Brecon	-18.8	-3.5
PG - Carmarthen	-28.8	-4.0
PG - Anglesey	-50.1	-7.3

% Performance Against Targets

Building	Monthly Actual vs Target (%)	Annual Cumulative Actual vs Target (%)
PG - Radnor	346.1	17.0
PG - Glamorgan	-4.1	1.0
PG - Monmouth	-36.5	16.9
PG - Campus Services	-43.5	-5.3
PG - Carmarthen	-47.0	1.8
PG - Brecon	-53.4	-4.8
PG - Pembroke	-54.2	-20.0
PG - Anglesey	-69.4	4.4

Buildings ranked by monthly performance

UWIC
 Cardiff Metropolitan University

In partnership with

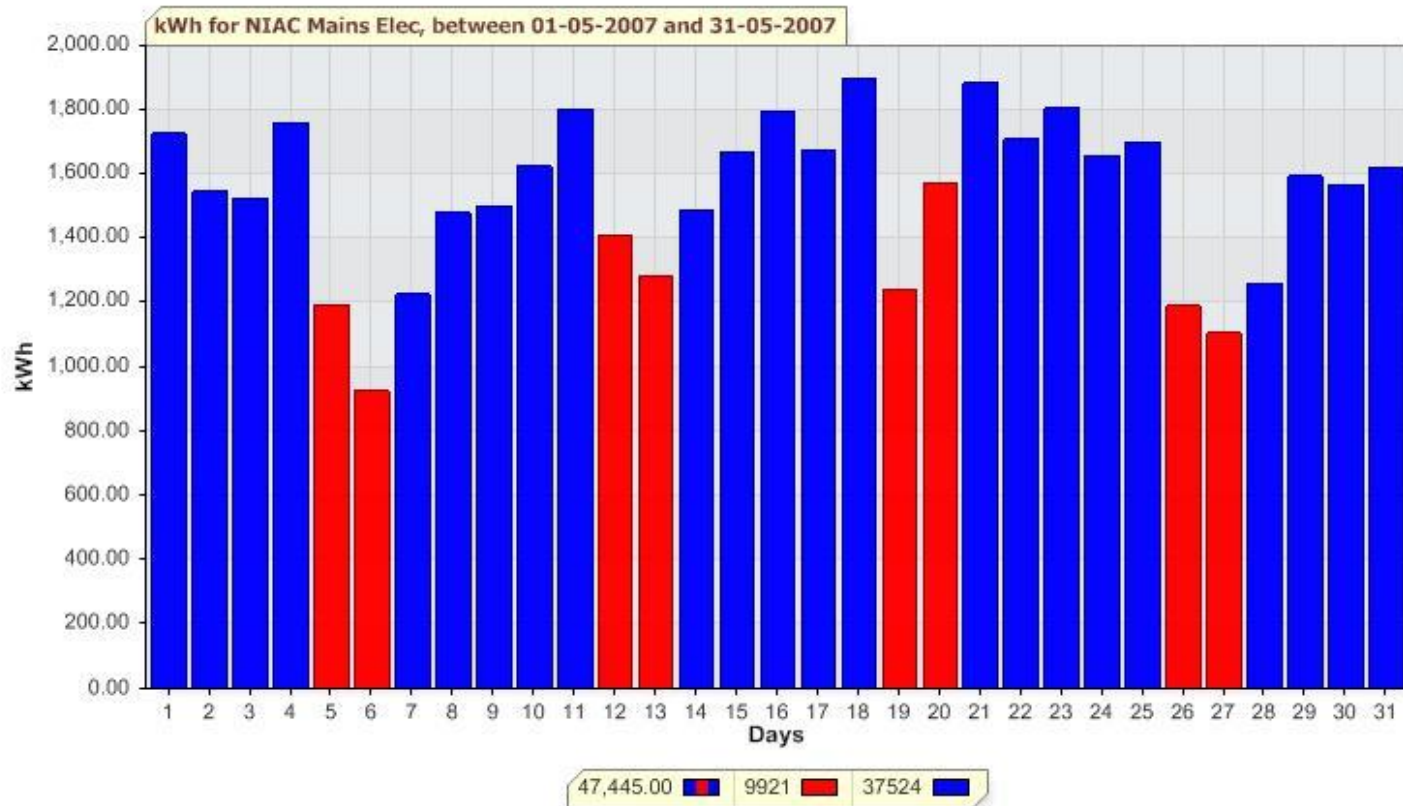
PLMM

Case Study - NIAC

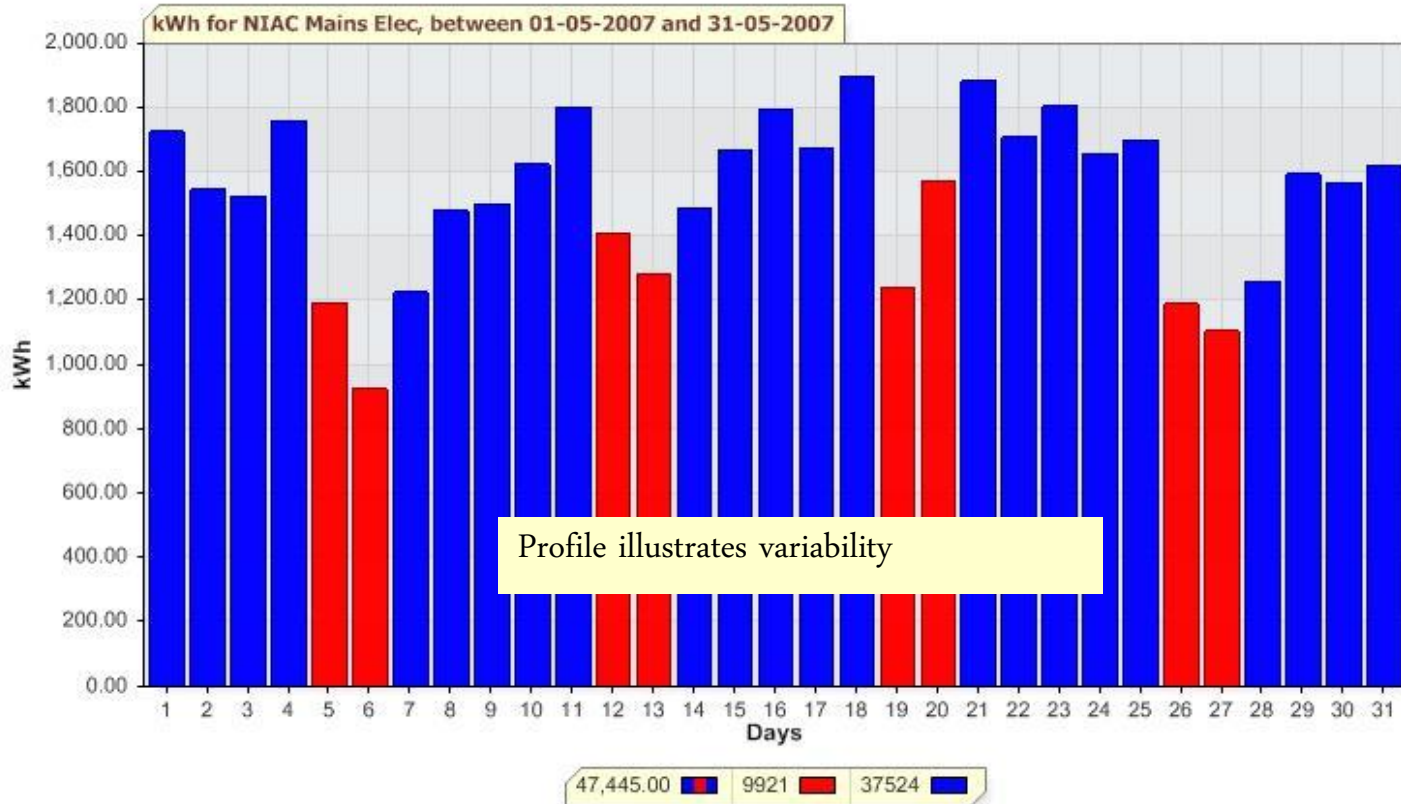


- UK Athletics Talent Development Academy
- 200m banked track, 140m straight and various field event areas
- Also has weight training, physiotherapy, massage and sports science facilities
- Seating capacity for 690 spectators

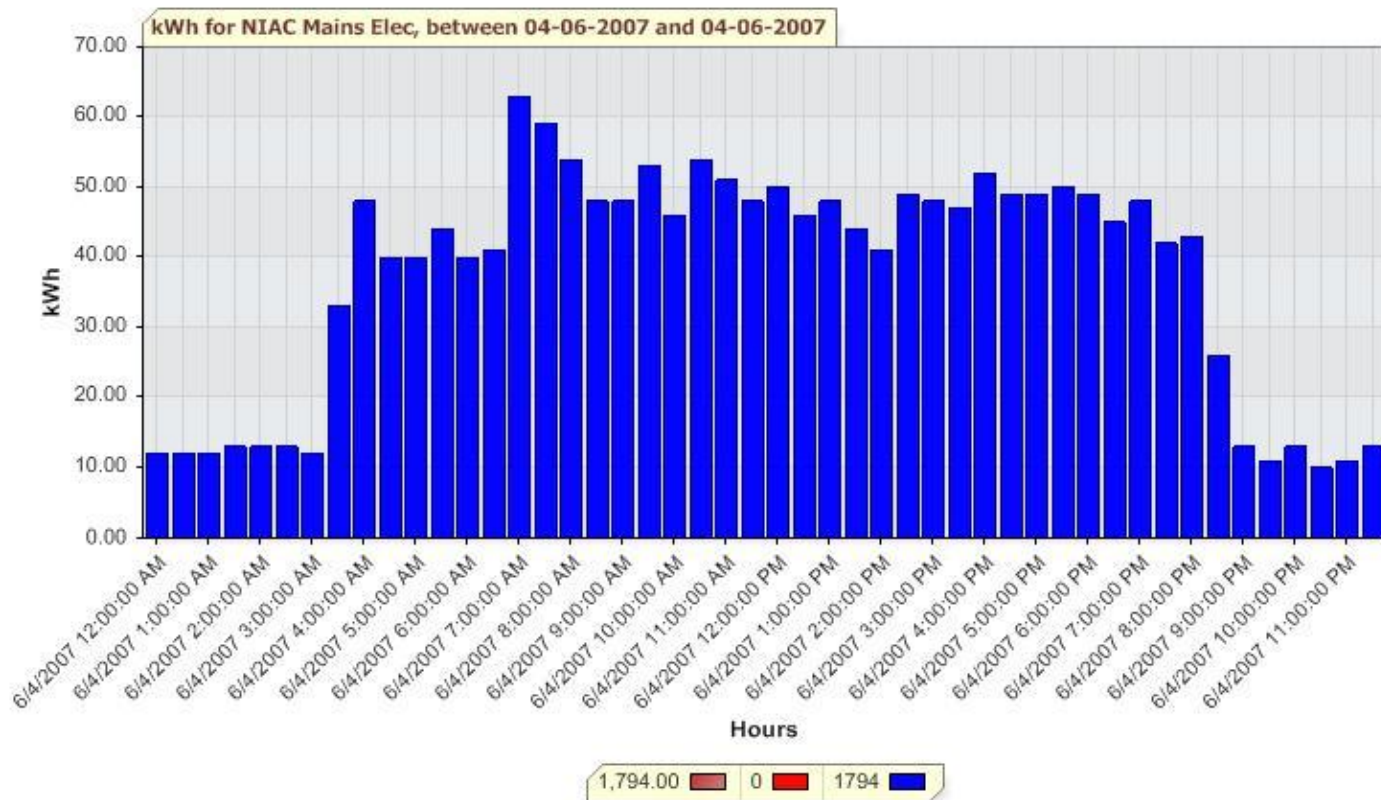
Case Study - NIAC



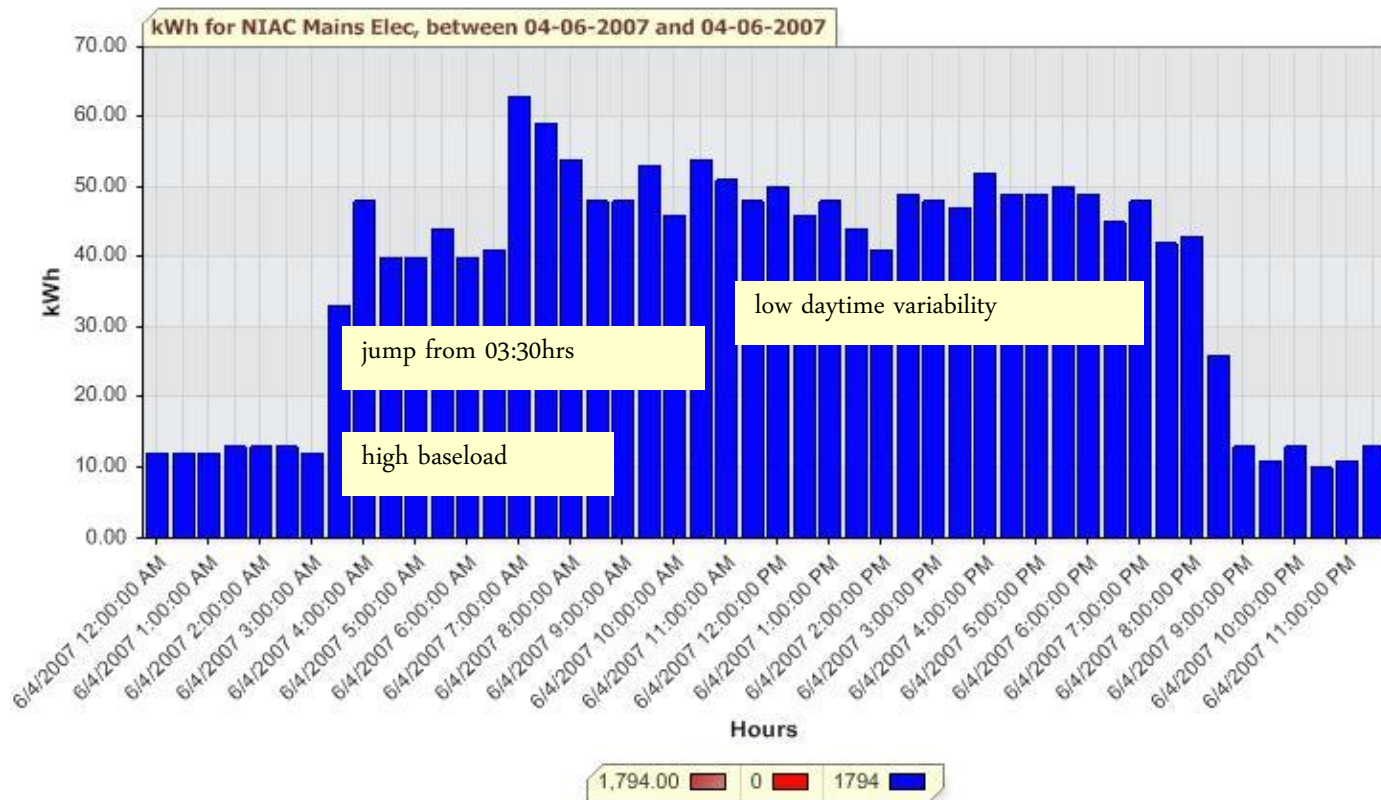
Case Study - NIAC



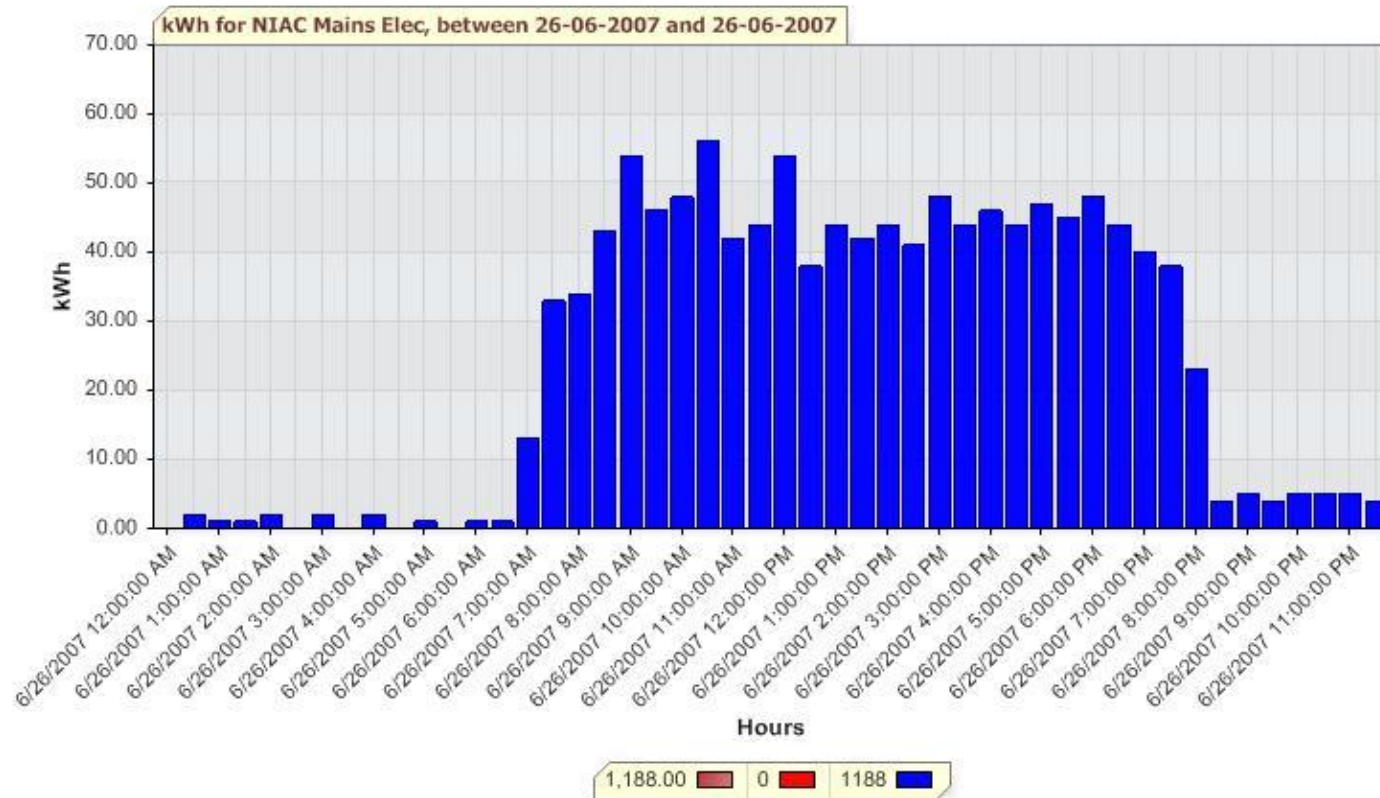
Case Study - NIAC



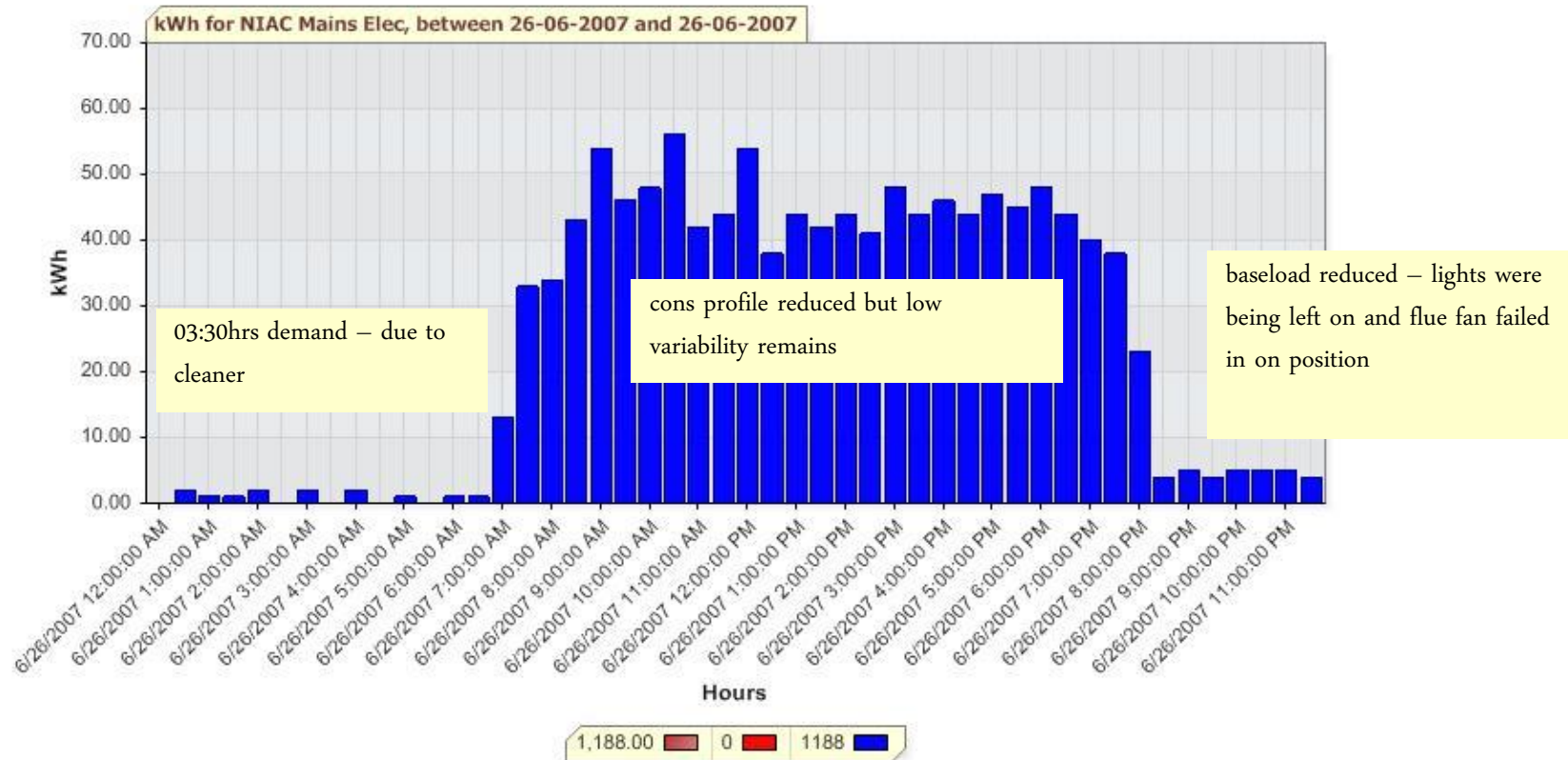
Case Study - NIAC



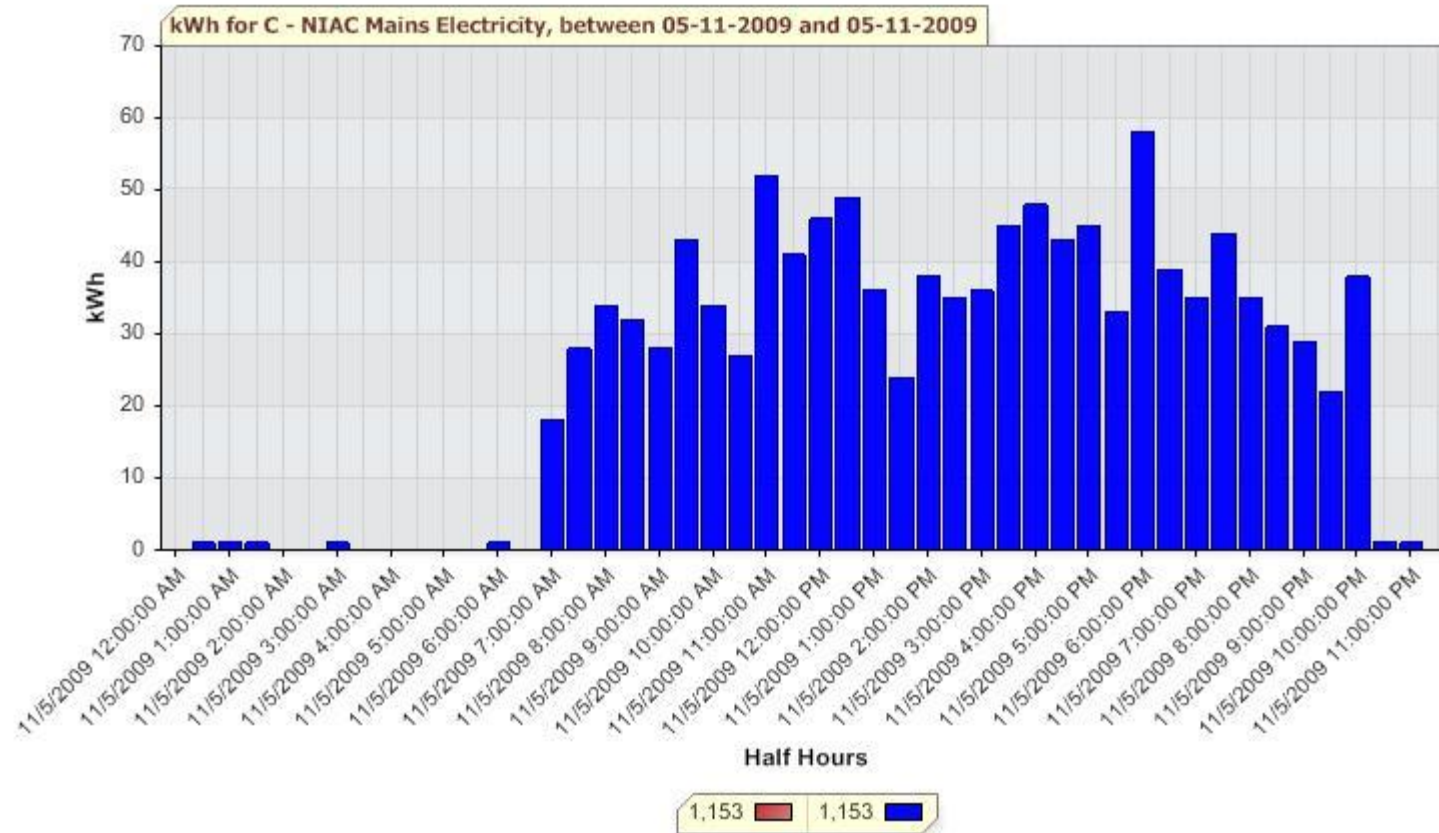
Case Study - NIAC



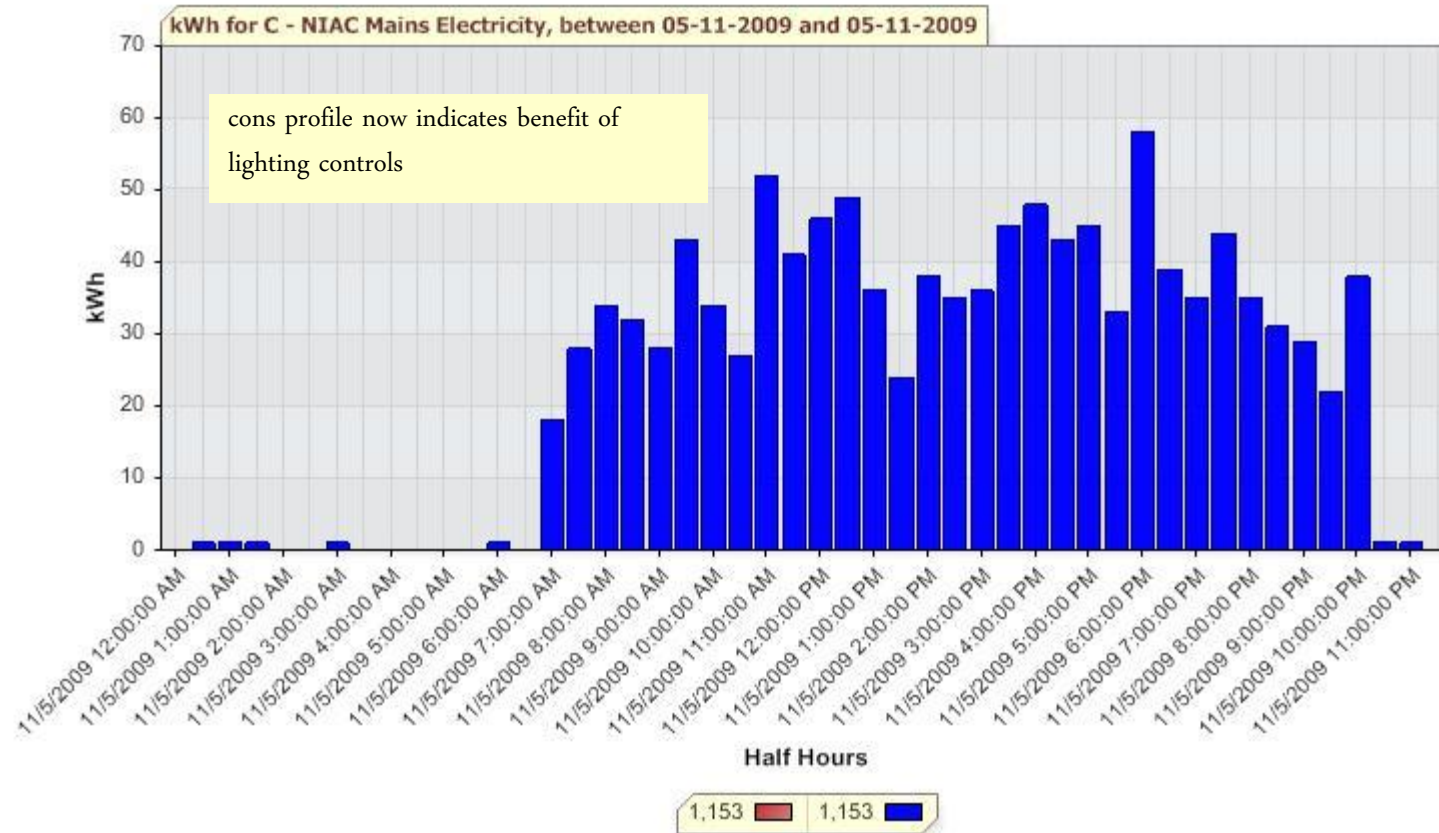
Case Study - NIAC



Case Study - NIAC

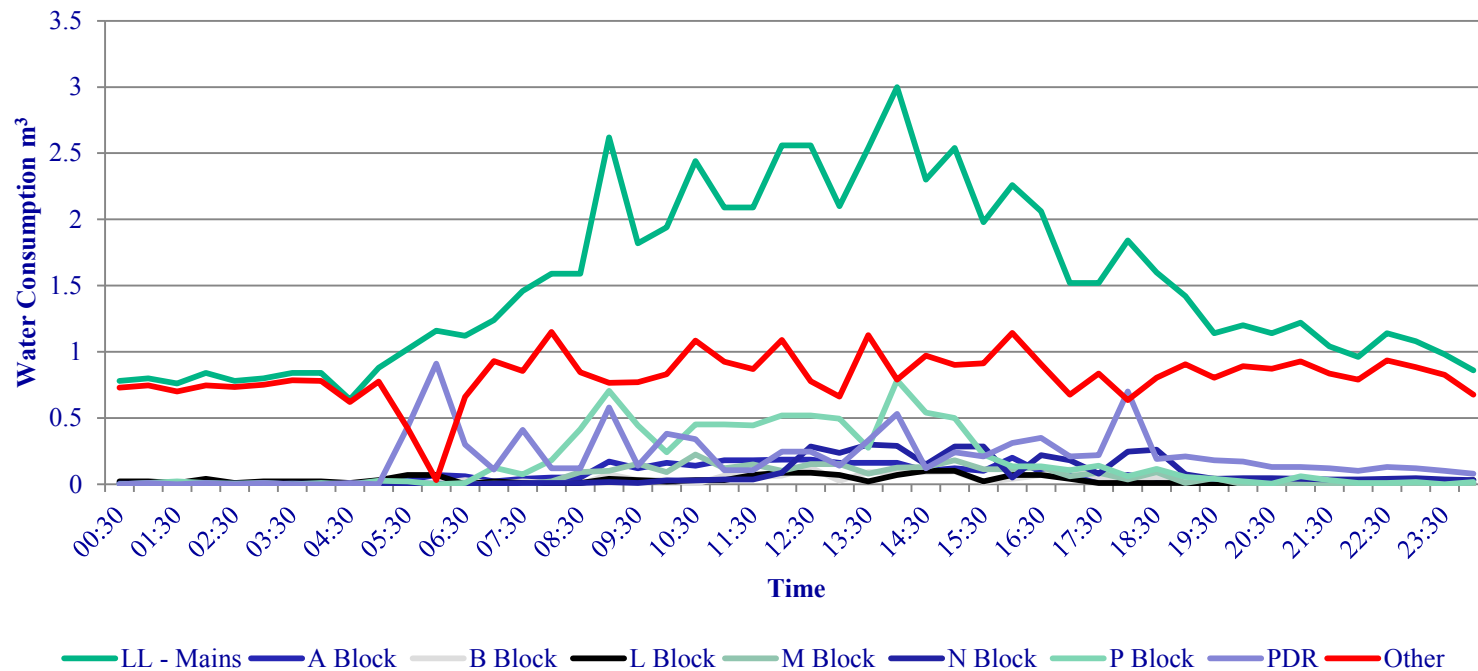


Case Study - NIAC



Case Study – Llandaff Water Leak

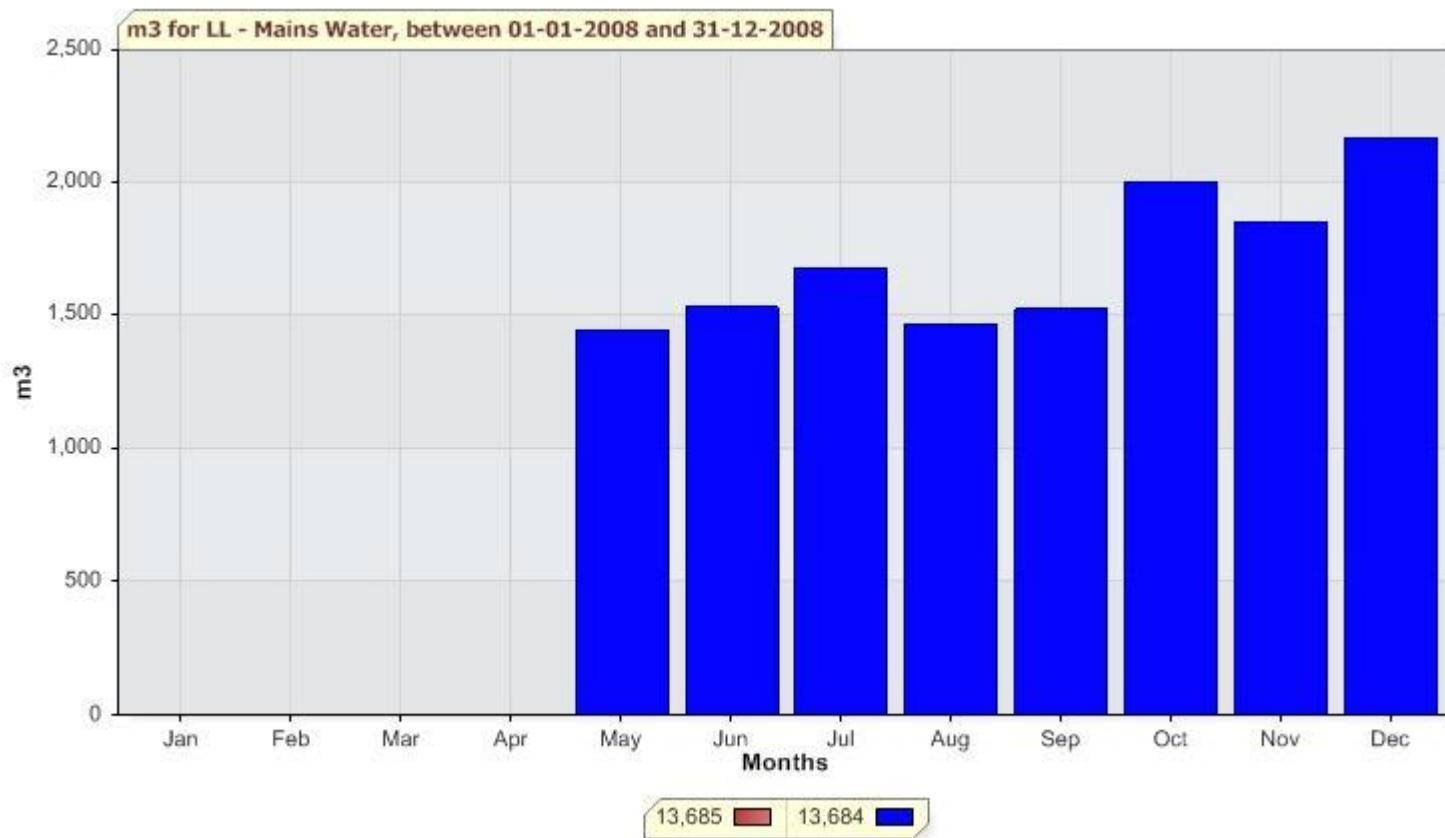
Water Consumption of the Mains and Sub-meters at Llandaff on 26/05/2009



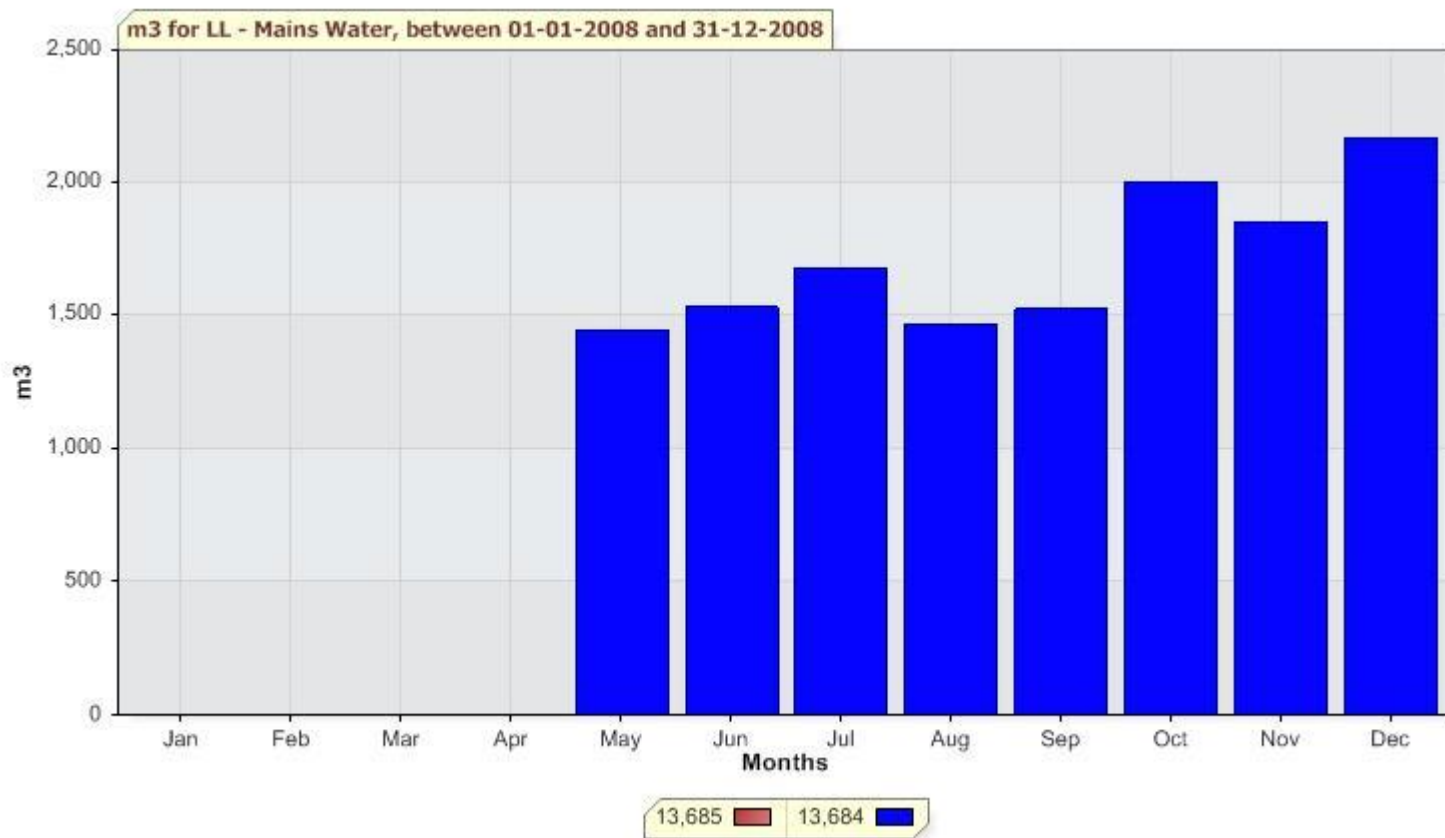
Case Study – Llandaff Water Leak



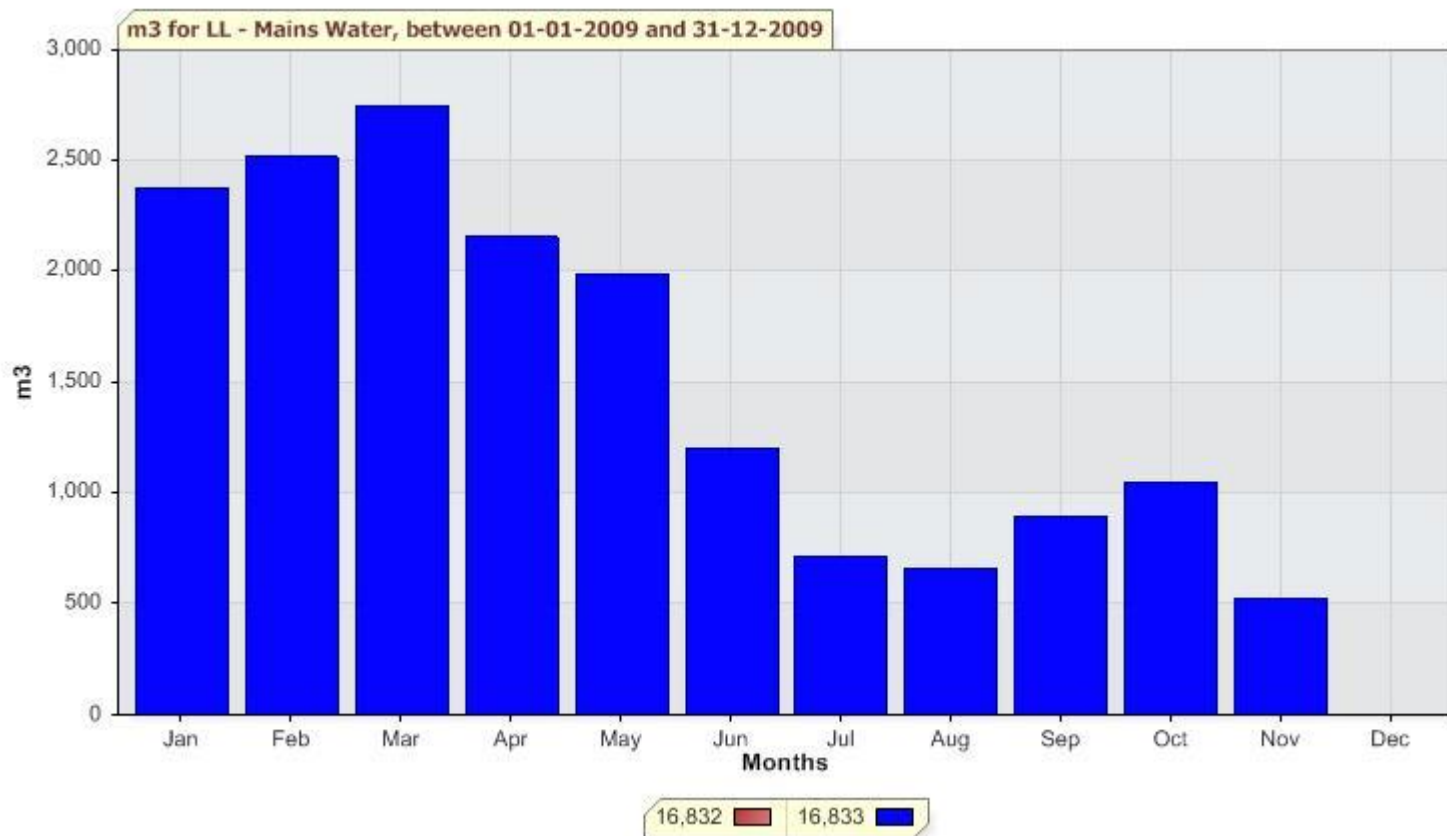
Case Study – Llandaff Water Leak



Case Study – Llandaff Water Leak

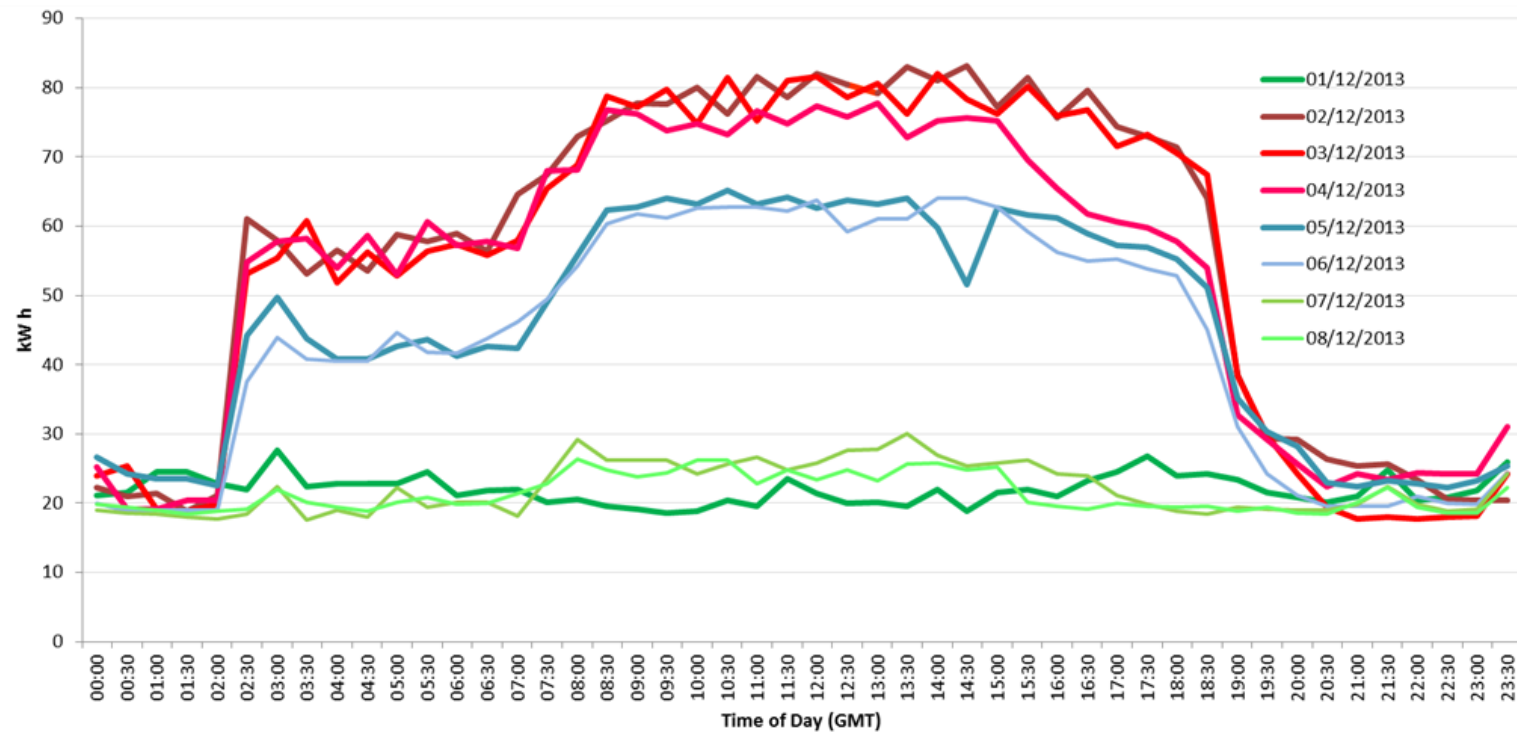


Case Study – Llandaff Water Leak



Further Case Studies

Case Study – Cardiff Bay Controls Issue



Degree Days

Normalised Performance
Indicators

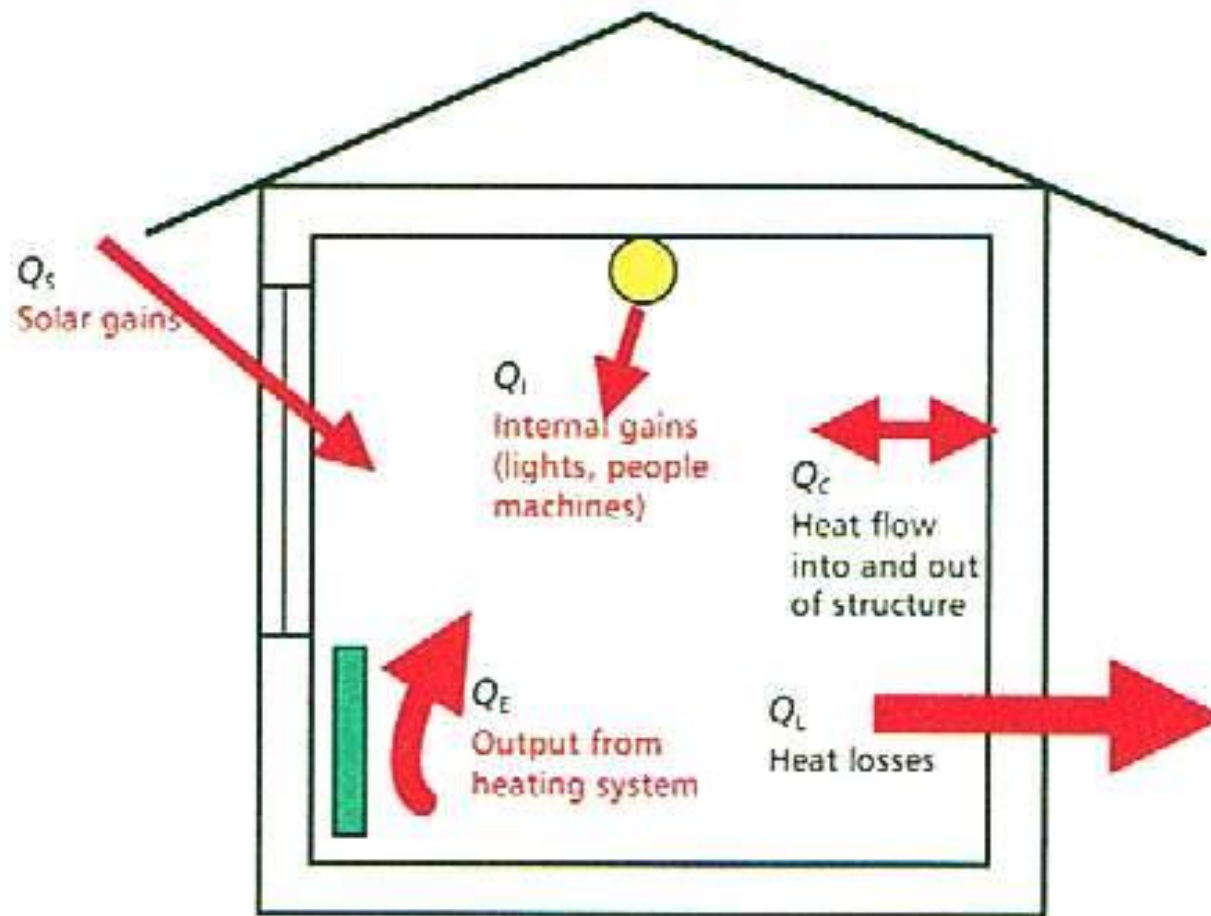


Figure 1.3 Energy balance on a heated building

Degree Days

Calculated as the difference between base temperature and the mean dry-bulb temperature for that day

$$\text{Degree days} = t_{\text{base}} - 1/2(t_{\text{max}} + t_{\text{min}})$$

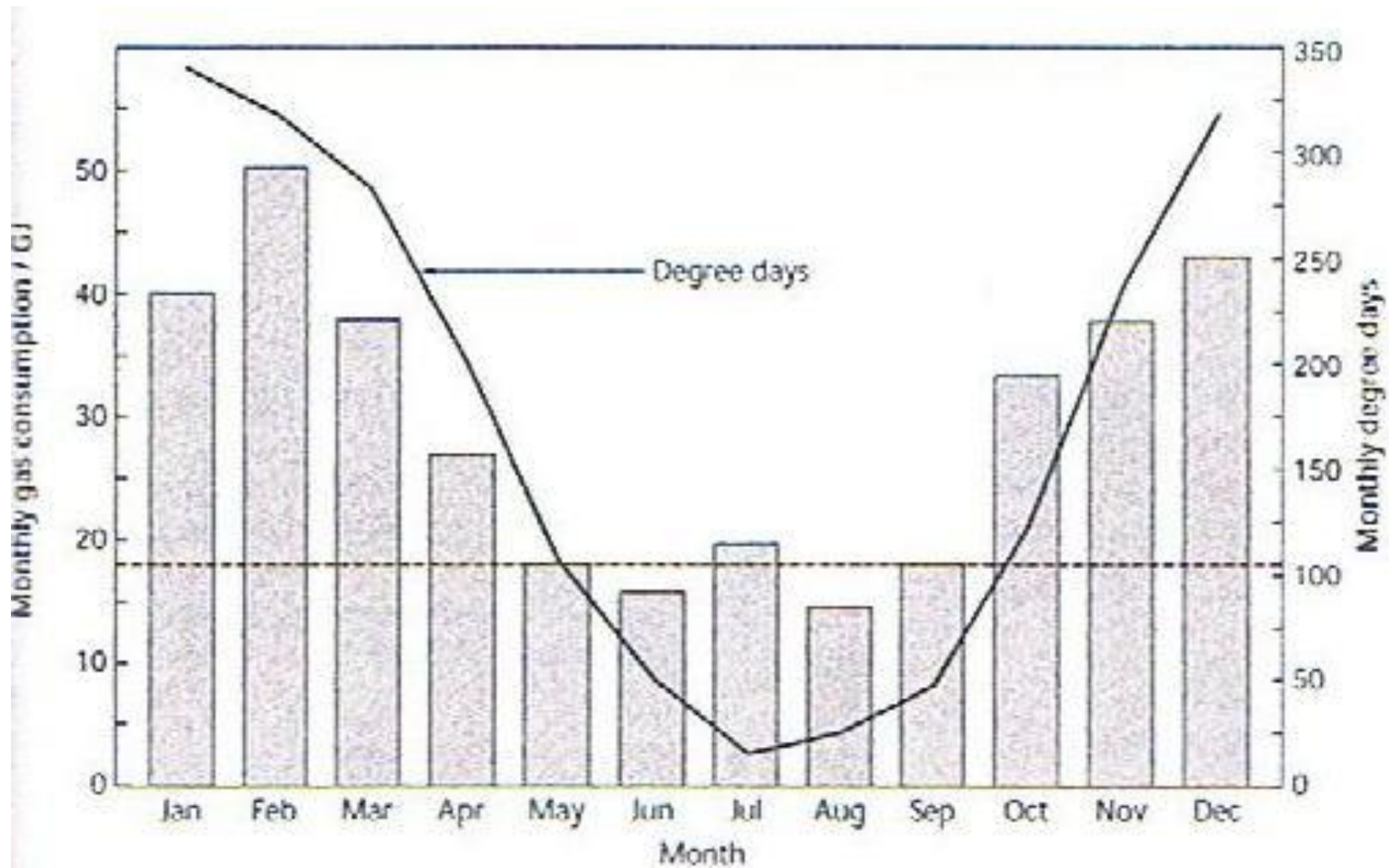
Figure 2 Degree day regions and reference sites (°)

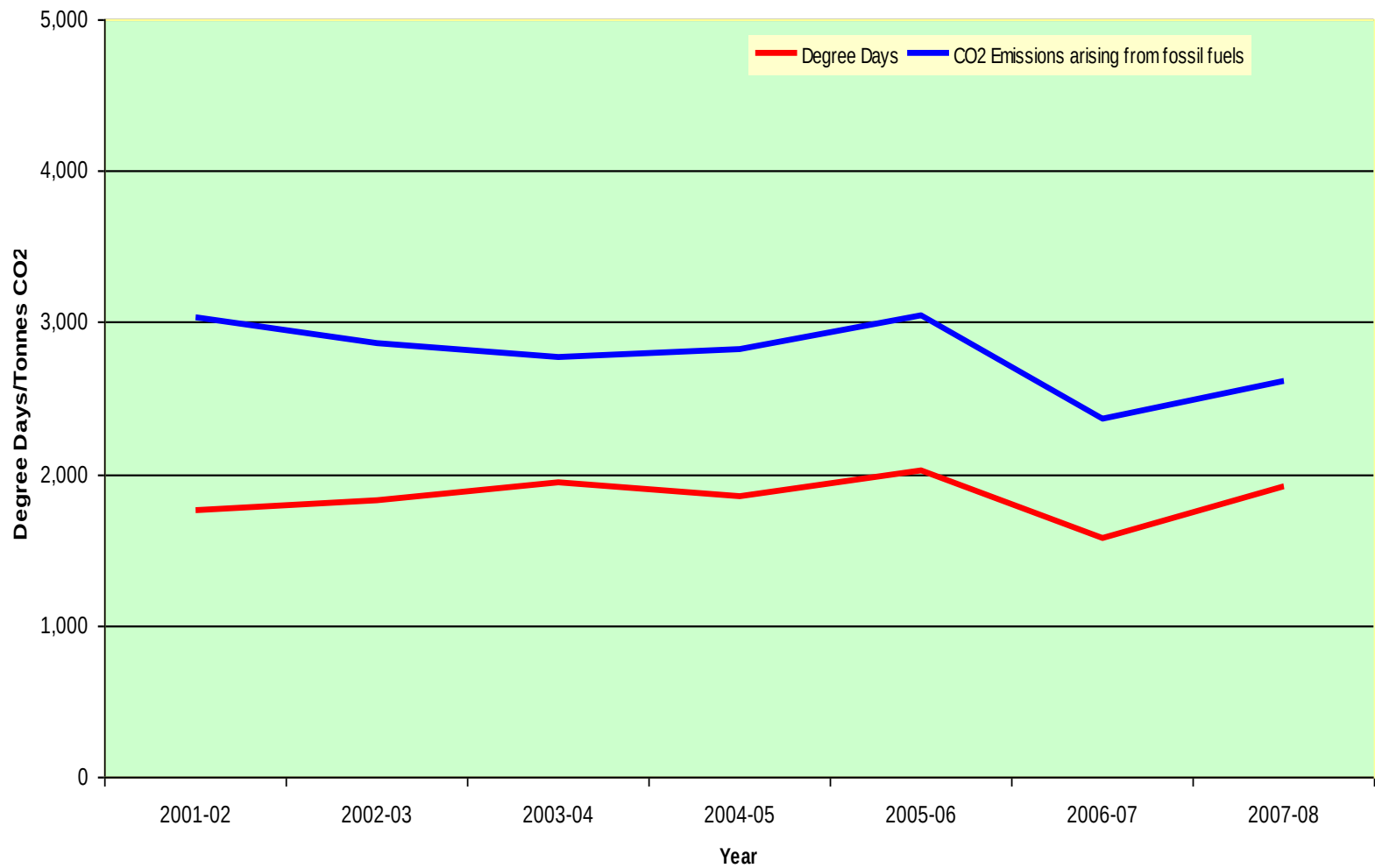


Historical UK Degree Days Data

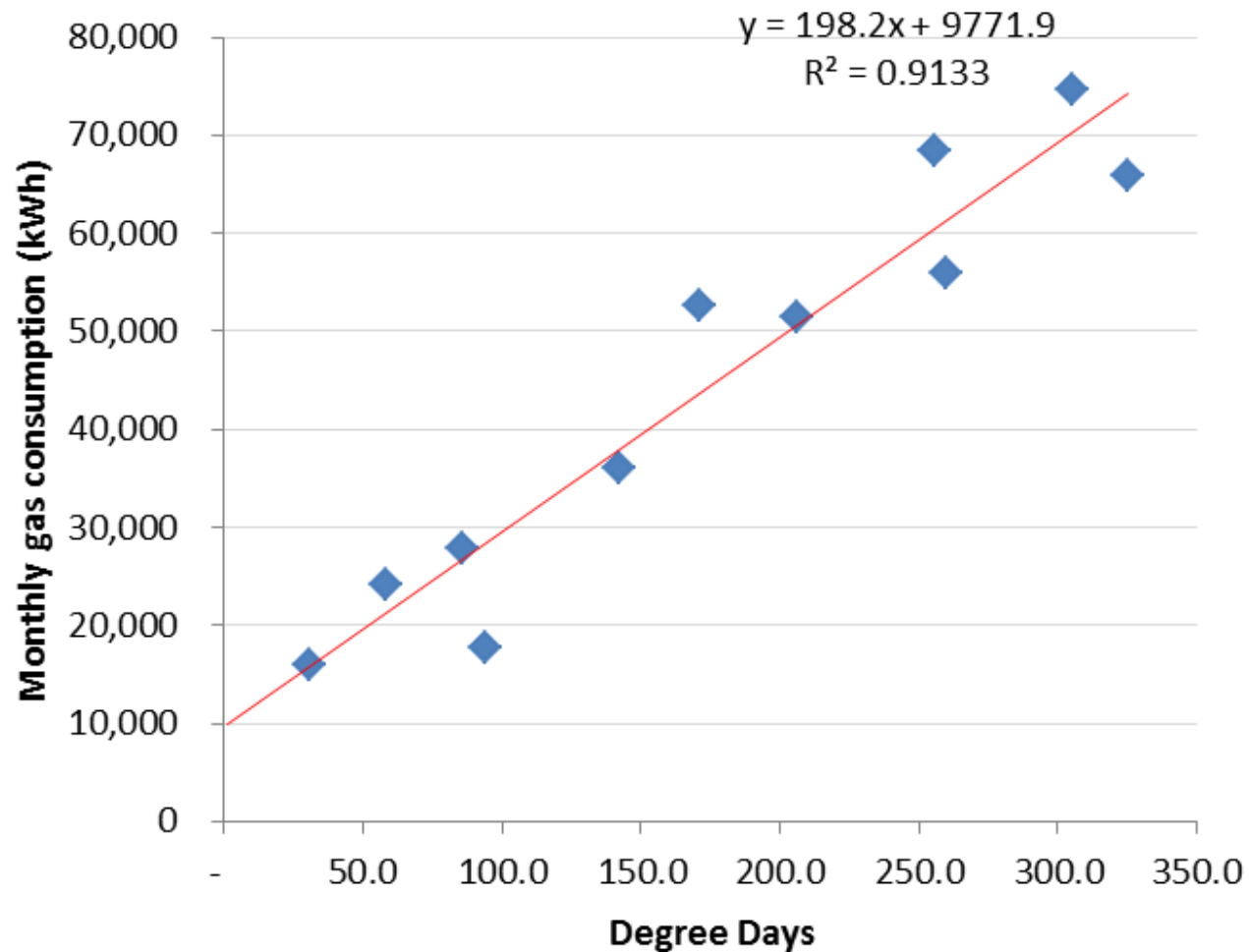
2009 (15.5 degrees centigrade base):

[illegible]





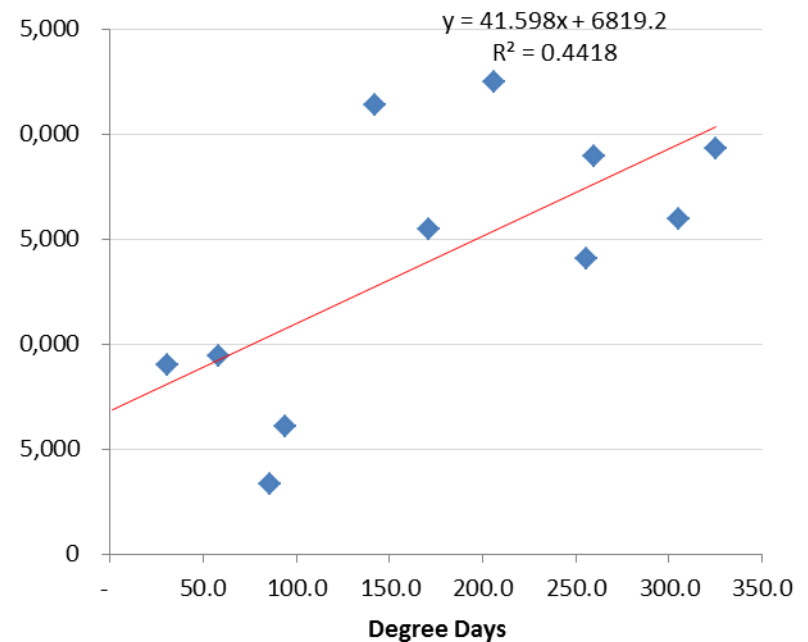
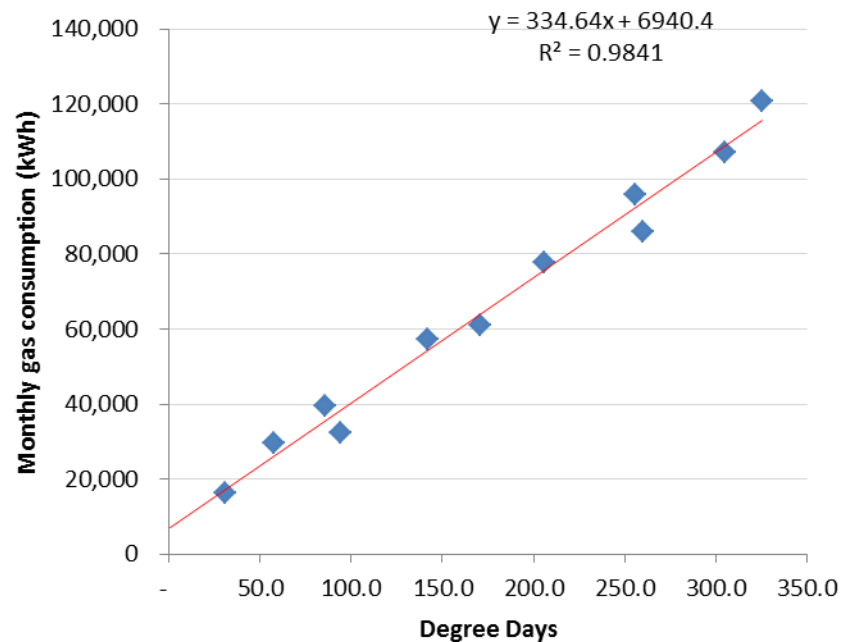
Consumption v. degree-days



Worked Example

Energy performance lines

Can be used to indicate the effectiveness of heating controls



Other examples of normalising factors

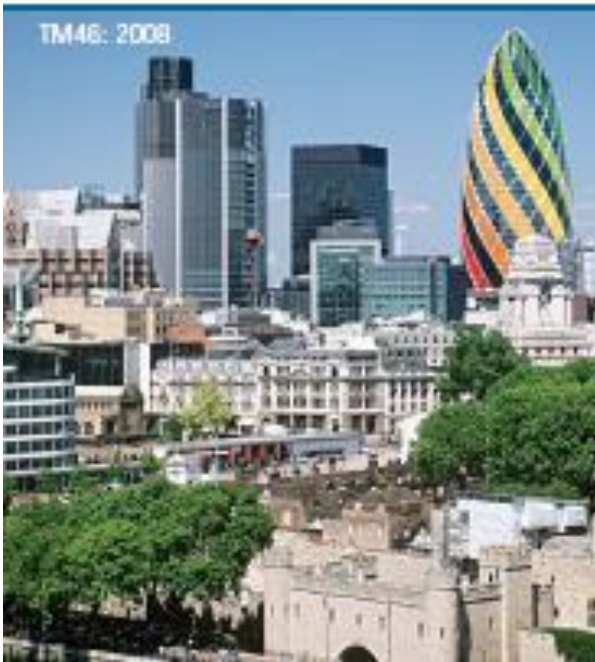
- Production output
- Floor area of a building
- Occupancy hours
- ?
- ?

Energy Benchmarking

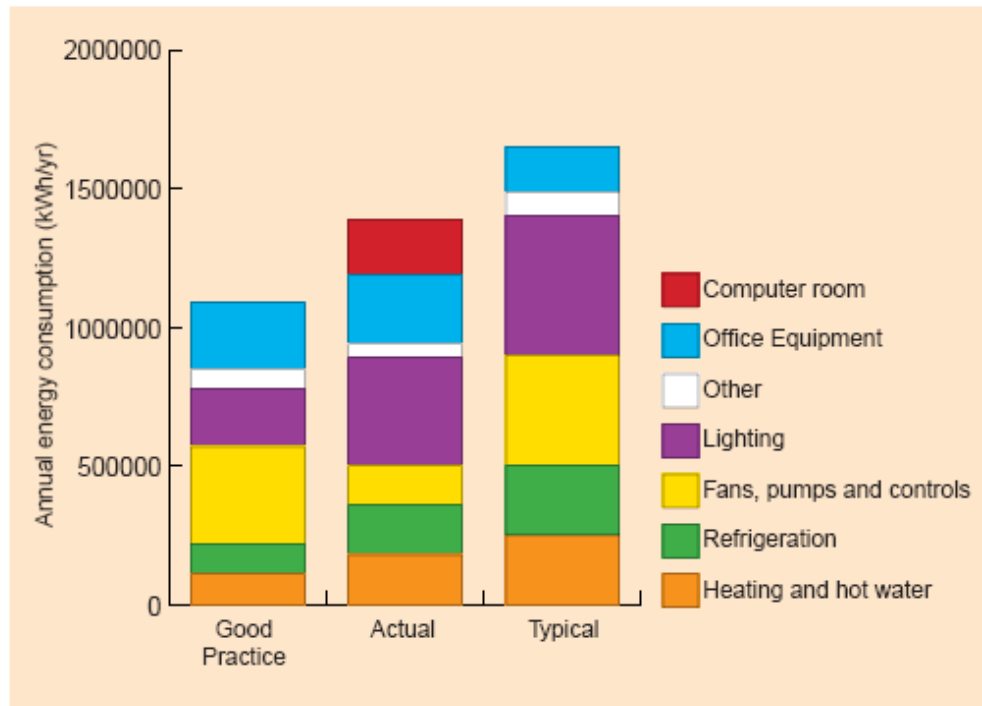
Energy benchmarks



TM46: 2008



Energy Benchmarking



Source: General Information Leaflet 65

Metering energy use in new non-domestic buildings

Figure 5 This chart shows how the building operator might use the information from the meters to compare the actual operation with published benchmarks

Useful references - Metering

- CIBSE TM39:2006
Building Energy Metering
- Energy Efficiency Best Practice Programme
General Information Leaflet 65
Metering Energy Use in New Non-domestic
Buildings

Useful references - Analysis

- CIBSE TM46:2008
Energy Benchmarks
- CIBSE TM41:2006
Degree-days: theory and application
- Carbon Trust CTG004
Degree-days for energy management – a practical introduction
- CIBSE Guide F
Energy Efficiency in Buildings