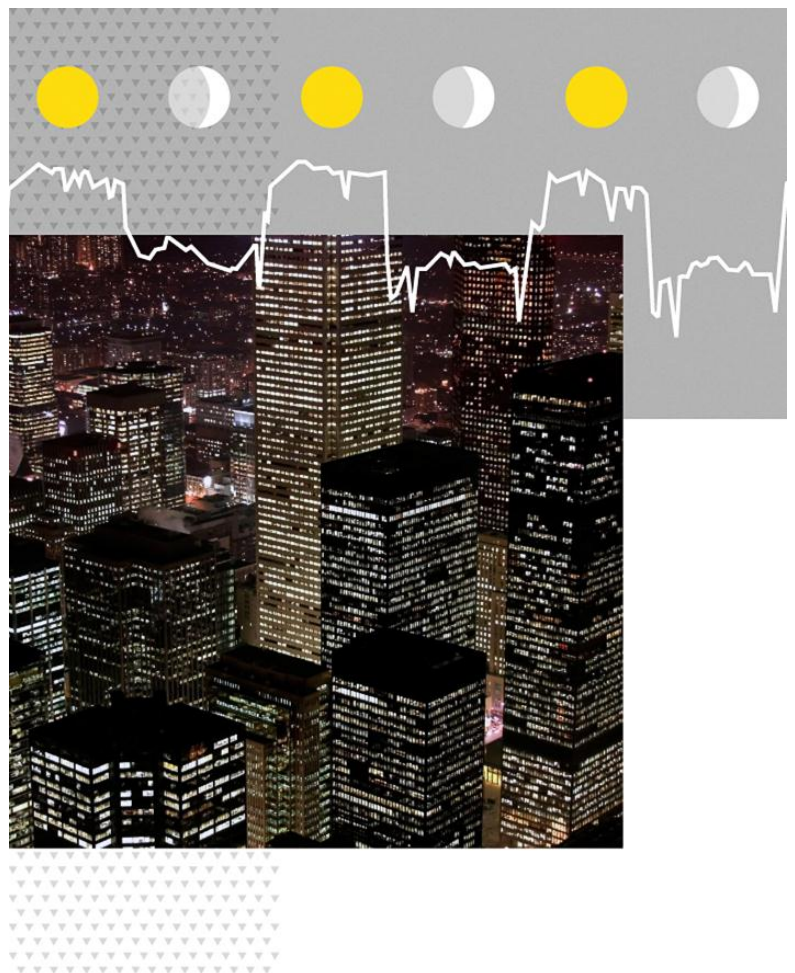


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## LER Phase 2: Case studies

A contribution to the development of a Landlord's Energy Rating for the Better Buildings Partnership

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## 1. Introduction

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This report presents the findings of four case studies undertaken by Verco and William Bordass Associates as part of the development of the Landlord's Energy Rating (LER) on behalf of the Better Buildings Partnership (BBP).

Following an initial pilot of the LER tool involving BBP members in self-assessment and data collection from their own buildings, issues became apparent. Errors occurred in the interpretation of the scope of the energy data required for the rating, and in the application or understanding of the extent, resolution and reliability of sub-metering available in order to calculate an accurate score.

To obtain further insight into the challenges faced, build an evidence base for the estimation of tenant supplements and begin to develop examples for case law, four buildings were selected for a closer review. Two of these had already been the subject of prior detailed, but unrelated, investigations by Verco (201 Bishopsgate, City of London – British Land, and Palestra, Southwark, London – TfL). The other two were selected from the pool of buildings which had responded to the earlier data collection exercise (Livingstone House, Leeds – GE Capital Real Estate, and 99 Gresham Street, City of London – Legal & General Property).

## 2. Case study 1 - British Land: 201 Bishopsgate

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### 2.1 Background and energy efficiency context

201 Bishopsgate in the City of London is a large prestige office development owned by British Land and managed by Broadgate Estates. The building was the subject of a detailed study over the past two years by Verco in collaboration with the building's managers and occupiers, as part of the Technology Strategy Board's Building Performance Evaluation (BPE) programme.

A GIA (57,067m<sup>2</sup>) was stated in the LER pilot return. This seems unrealistically high relative to the NLA (37,768m<sup>2</sup>). In past commissions a significantly lower GIA has been used (47,213m<sup>2</sup>). This lower value has been adopted for the whole building performance benchmarking. The building is primarily let for office use but also includes four retail units.



From the perspective of an LER assessment, the prestige nature of the building (e.g. extensive double height reception area, generous floor-to-ceiling heights on all floors, some floors being used for trading, etc.) and the high level of servicing (full air conditioning to tenants) would be expected to impact negatively on the score. It is worth highlighting that whilst an allowance in the assessment is provided for long operational hours (greater than 40 hours a week) no similar adjustment is made for the type of servicing provided by the landlord i.e. mechanical ventilation versus natural ventilation.

### 2.2 Data availability

Previous and ongoing studies have invested extensive time in resolving data discrepancies in sub-metered systems. Although some issues still remain unresolved, this LER case study was able to take advantage of this significant investment, and it can be stated that the data availability in this building is now reasonable. This is a qualitative observation based on the assessor's experience of benchmarking similar sites across the UK.

In spite of extensive metering, energy data cannot be wholly apportioned to end uses. The BPE study had to spend a long time identifying which loads were being measured by each of the large number of sub-meters (and this was never fully resolved). Furthermore, about 8% of the building's total electricity use is not sub-metered and cannot be confidently assigned to specific end uses. For the purpose of the LER assessment this was deemed within the LER scope. This is arguably an acceptably small portion of 'residual' energy, but in such a large building it is still a significant absolute amount (>1,000,000 kWh/year).

One specific area where data was lacking was for the tenant cafeteria on the floor with a cellular layout. In accordance with LER scope, metered energy used for small power/cooking within this space is deducted, being treated as tenant use. However, the metering arrangement does not permit the

deduction of any additional HVAC services installed for the kitchen over and above the building's normal provision.

**Wider operational data was readily available. This includes hours of use and floor area data for each individual tenant. Figure 2-1: Data availability matrix: 201 Bishopsgate**

			201 Bishopsgate	
Availability of data required for LER	Key parameters needed for LER assessment	Units	Coverage	Accuracy
	Area of tenanted space	m2 NLA		
	Area of individual tenant spaces	m2 NLA		
	Services provided in common parts eg HVAC, lifts, other	Text		
	Services provided to tenants eg HVAC, other	Text		
	Operational hours for landlord services	hrs/wk		Not confirmed
	Hours of use for each tenant	hrs/wk		against documents
	Electricity use by landlord and each tenant	kWh/m2/year		
	Gas use by landlord and each tenant	kWh/m2/year		Some estimation
	Other fuel use by landlord and each tenant	kWh/m2/year	N/A	N/A
	Sub metering of tenant supplements	kWh/m2/year	(Local DHW)	(Local DHW)
Sub-metering of exceptional uses	kWh/m2/year	Heat/cool	Partial	

Key:

	Coverage	Accuracy
	Full information provided or can be calculated	All information from robust documentation or metering
	All critical information provided or can be calculated	All critical information from robust documentation or metering
	Critical information is unavailable	Critical information/metering estimated for the purpose of the exercise

### 2.3 Energy efficiency comments

A detailed assessment of the building's energy efficiency was carried out as part of the BPE study. The charts below display the energy consumption of the whole building when compared to benchmarks taken from CIBSE TM46 "Energy Benchmarks" (as used for DEC's) and adjusted for the building's extended hours of use (3,315 hours per year).



Figure 2-2: 201 Bishopsgate whole building energy performance

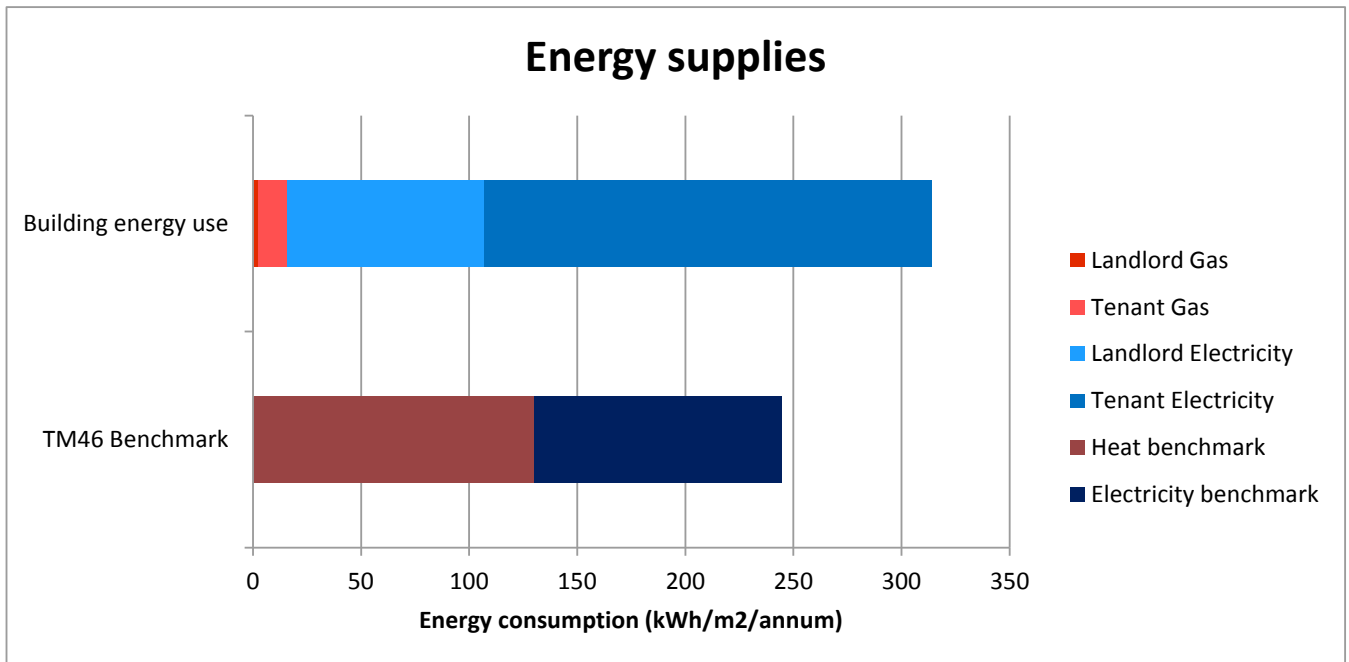
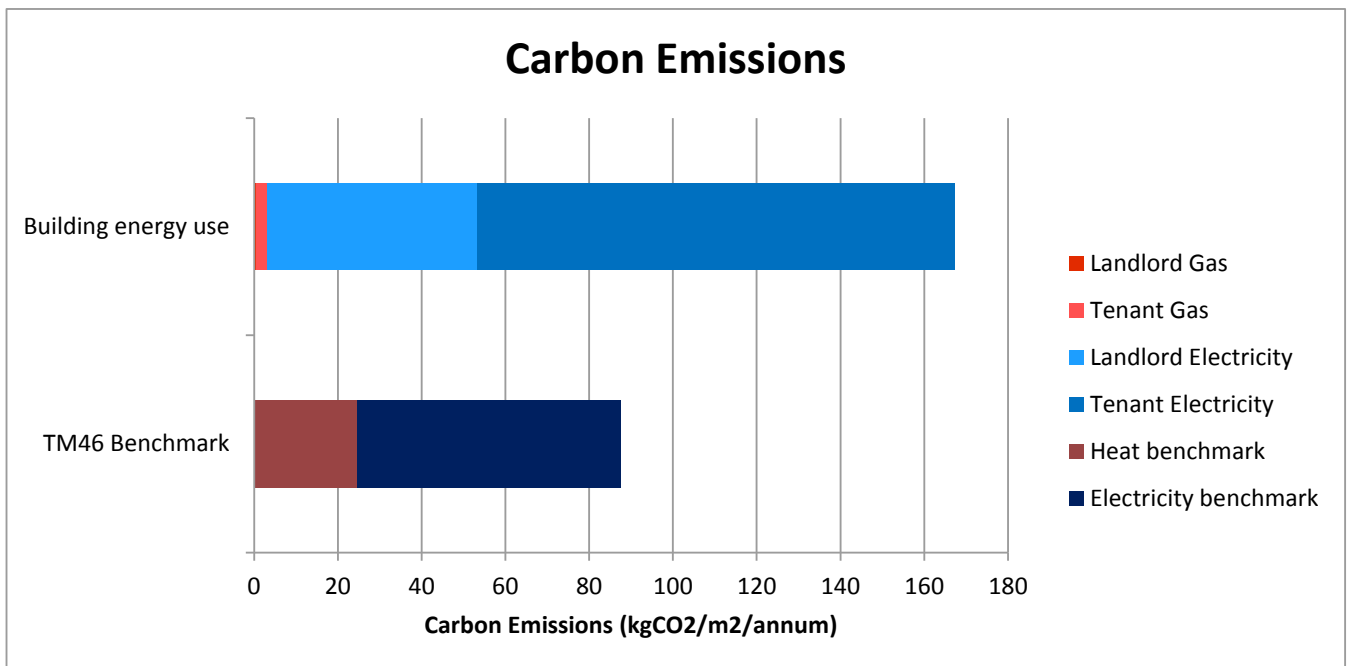


Figure 2-3: 201 Bishopsgate whole building carbon emissions



The whole building’s energy use and carbon emissions are substantially higher than the TM46 office benchmarks adjusted for the building’s extended hours of use – by 91% for carbon emissions. This is not surprising given the building’s prestige nature, but it should be noted that the near all-electric nature of the building contributes to the high carbon emissions.



## 2.4 LER assessment

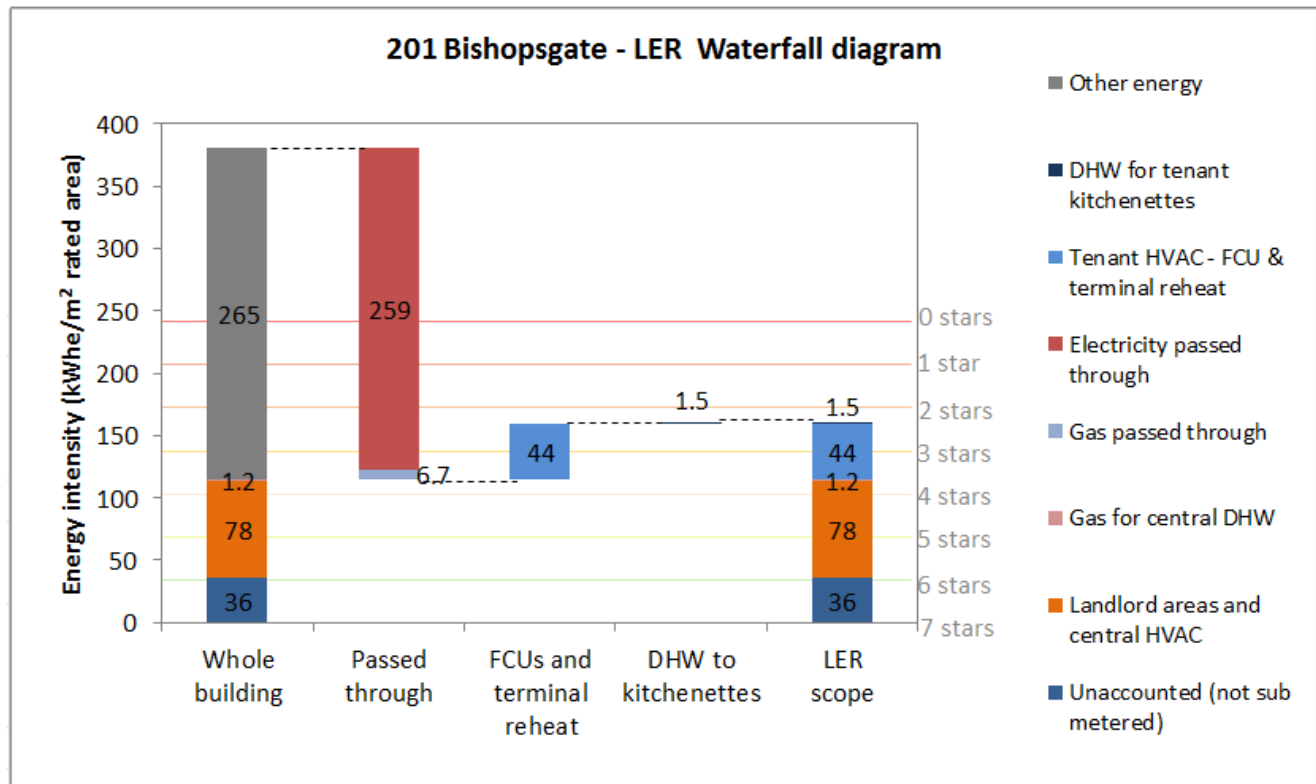
A review of the building's services provision and metering was carried out by the Verco team, and the managing agent (Broadgate Estates). This identified that sufficient metering was installed to calculate a near investment-grade LER. It also highlighted misinterpretations in the LER scope for the original LER assessment submitted by the Broadgate Estates team. This has a substantial impact on the building's rating, with the original score being 5.9 stars and the revised score 2.4 stars – still a commendable result for a prestige office.

The energy performance of the building is presented in the table and graphic below.

**Table 2-1: Key values used in the LER assessment**

Quantity	KWh	kWhe/m <sup>2</sup> rated area	Data	Effect on star rating
Electricity consumption	14,080,275	373	Actual	-
Gas Consumption	748,312	7.9	Actual	-
Electricity passed through	9,769,312	259	Actual	+7.45
Gas passed through	636,053	6.7	Actual	+0.19
Tenant HVAC - FCU & terminal reheat	1,656,490	44	Estimated	-1.27
DHW for tenant kitchenettes	56,652	1.5	Estimated	-0.04
<b>LER Scope</b>	<b>5,967,453</b>	<b>161</b>	<b>Rating</b>	<b>2.4</b>

**Figure 2-4: 201 Bishopsgate LER waterfall diagram**





The following observations are made on the calculation of the LER for this building:

1. The landlord purchases all energy for the building and it is sub-metered comprehensively.
2. 69% of the building's energy consumption is passed through to tenants.
3. Of the passed-through energy, 17% is in-scope and the majority of this is sufficiently metered to be accurately assessed.
4. For this building, the fan coil units with terminal reheat use 44 kWh/m<sup>2</sup> NLA – equivalent to 1.25 stars adjustment of the LER score. This is based on metered data for the whole building, taken from the sub-meters on the mechanical risers.
5. DHW to kitchenettes was estimated by the Verco team at 1.5 kWh/m<sup>2</sup> based on existing benchmark information – this is approx. 1/20<sup>th</sup> of a star score and could be viewed as a de minimis quantity.
6. Hot water for central services (WC's, showers, etc.) contributed 1.2 kWh/m<sup>2</sup> to the LER total. This is based on metered data for the whole building.
7. There may be some additional HVAC use (over and above base build spec) for the tenant catering which is fed from central services; this is not metered separately in this case and would likely be complex to measure independently. Whether any deductions could be made for this is a point for discussion.

## 3. Case study 2 – Transport for London: Palestra

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### 3.1 Background and energy efficiency context

Palestra is a large prestige office development owned by Deka and managed by DTZ. Transport for London (TfL) fully occupy the building and are effectively the day to day building managers in terms of energy efficiency and services operation. The building has recently been the subject of a study by Verco investigating the possible causes for high energy use in the building, and optimisation of the on-site CHP.

The building covers a stated GIA of 36,352m<sup>2</sup> over 13 floors (DEC TUFA 37,476 m<sup>2</sup>), of which 27,000m<sup>2</sup> is let out as office space.

The building has a number of unusual features which are of relevance to the LER and the wider energy efficiency of the building:



- The building features a CHP unit as well as a fuel cell, both of which run on natural gas.
- The building has two floors which operate 24/7: the seventh floor, which has only recently switched from normal hours of occupancy following refurbishment; and the second floor, which is TfL's control room and houses a server facility. This latter activity can be treated as a separable energy use due to its high equipment and server loads. However, the building servicing is not set up to enable conditions on the different floors to be efficiently controlled in a fully independent manner, according to their hours of use.

From the perspective of an LER assessment, the prestige nature of the building and the high level of servicing (full air conditioning to tenants) would be expected to impact negatively on the score. It is worth highlighting that whilst an allowance in the assessment is provided for long operational hours (greater than 40 hours a week) in any 'functional space', no similar adjustment is made for the type of servicing provided by the landlord i.e. mechanical ventilation versus natural ventilation.

### 3.2 Data availability

Data availability is good, with floor area data for each individual tenant; and electricity and gas sub-metering that separates landlord and tenant as well as HVAC and non-HVAC uses. The metering arrangement is relatively complex (as would be expected for a building of this size) and required some time to be spent in familiarisation.

Data was unavailable for the following uses relevant to the LER:

1. Fan coil units serving the tenant spaces are powered by the ceiling tracks which also serve the lighting. The energy used by the fan coil units falls within the LER scope but is not separately metered.

- The second floor control room is treated as a separable energy use and excluded. Floor area data was provided, and electricity used for small power and lighting is metered directly. There are meters in place for hot and chilled water delivered to this floor, but insufficient metering upstream on the chillers, boilers etc to determine the exact proportion of the building's heating and cooling delivered to this space.

Figure 3-1: Data availability matrix: Palestra

			Palestra	
Availability of data required for LER	Key parameters needed for LER assessment	Units	Coverage	Accuracy
	Area of tenanted space	m2 NLA		
	Area of individual tenant spaces	m2 NLA		Not confirmed
	Services provided in common parts eg HVAC, lifts, other	Text		
	Services provided to tenants eg HVAC, other	Text		
	Operational hours for landlord services	hrs/wk		
	Hours of use for each tenant	hrs/wk		
	Electricity use by landlord and each tenant	kWh/m2/year		
	Gas use by landlord and each tenant	kWh/m2/year		
	Other fuel use by landlord and each tenant	kWh/m2/year	N/A	N/A
	Sub metering of tenant supplements	kWh/m2/year	Fan coil units + DHW	
	Sub-metering of exceptional uses	kWh/m2/year	Partial	Partial

Key:

Coverage	Accuracy
Full information provided or can be calculated	All information from robust documentation or metering
All critical information provided or can be calculated	All critical information from robust documentation or metering
Critical information is unavailable	Critical information/metering estimated for the purpose of the exercise

### 3.3 Energy efficiency comments

The Palestra building has a complex servicing arrangement, which includes a CHP unit, a fuel cell, a small amount of solar PV and wind turbines (Originally there were 14 wind turbines; two units are now operational). Verco's energy review examined the interaction of these systems. A comparison of the building's energy and carbon performance with the benchmarks taken from the building's 2013 DEC (Electricity 108 kWh/m<sup>2</sup> TUFA, fossil-fuel 112 kWh/m<sup>2</sup> TUFA), i.e. allowing for extended hours of use in some zones, is displayed in the charts below.

The building has a high demand for both gas and electricity. The high gas demand is partly due to the gas consumed by the CHP and the fuel cell. The electricity consumption is significantly affected by the presence of the TFL control room on the second floor, which operates 24/7 and has a high density of electrical equipment (this is represented by the blue dashed bar in the charts).

Both the energy and carbon performance of the building are higher than the TM46 benchmark – energy by 102% and 95% respectively. If the separable energy use is excluded, the energy consumption is 88% higher than the DEC benchmark, and the carbon emissions are 74% higher.



Figure 3-2: Palestra whole building energy performance

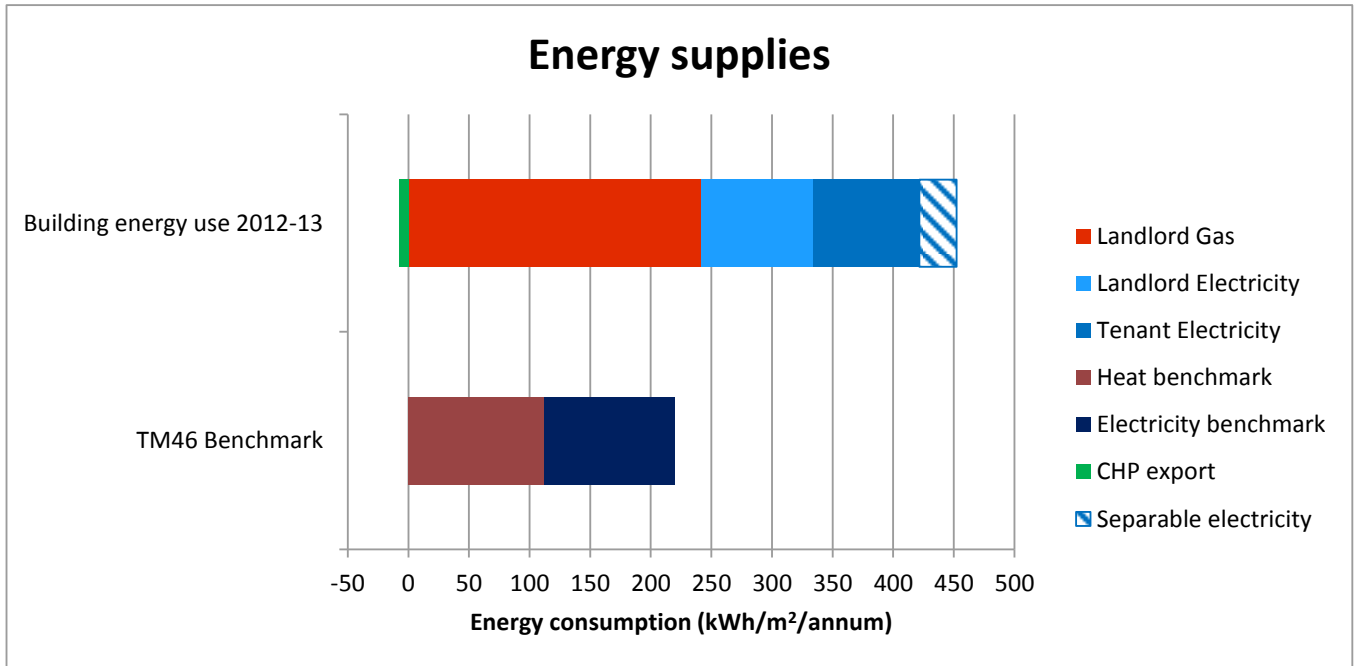
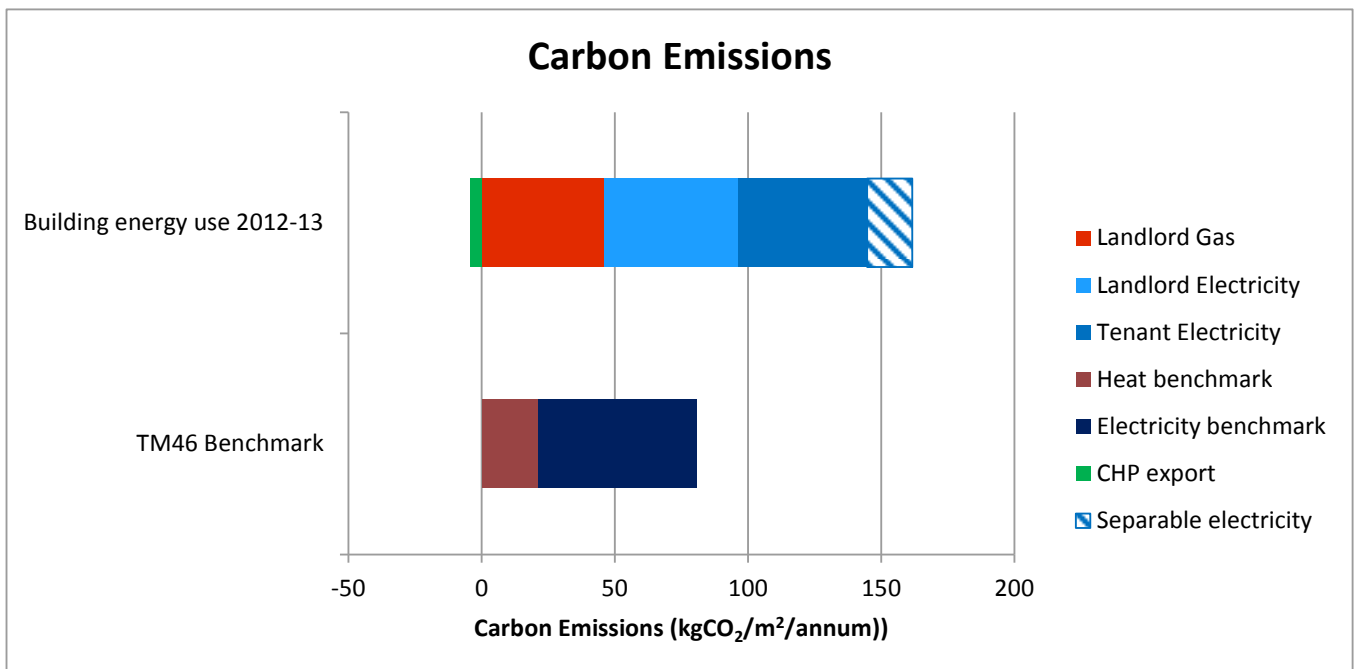


Figure 3-3: Palestra whole building carbon emissions



### 3.4 LER assessment

A review of the building’s services provision and metering was carried out. This identified a comprehensive level of installed metering that is sufficient to calculate an investment-grade rating.

The original LER score was 0 stars. Whilst adjustments against the original submissions were identified, primarily linked to the treatment of separables, the rating performance remains 0 stars.

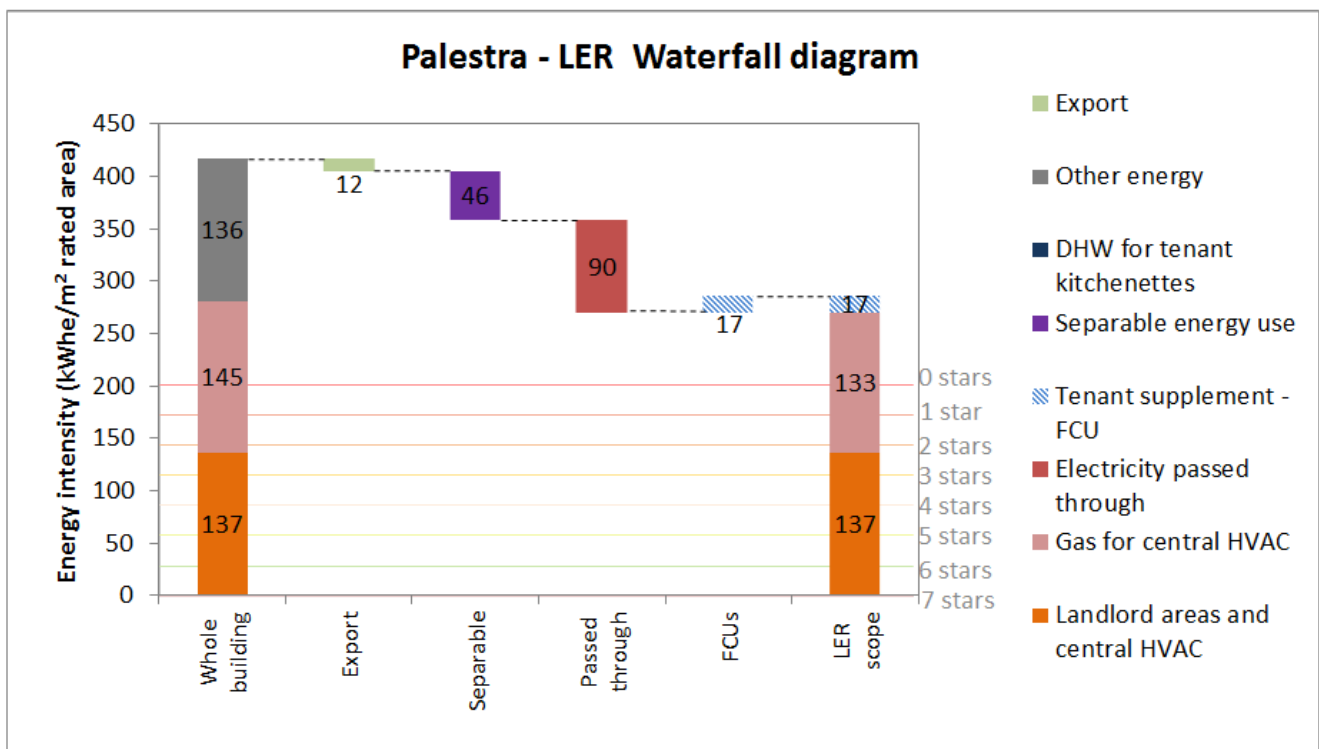
The energy performance of the building is presented in the table and graphic below.



**Table 3-1: Key quantities for the LER assessment**

Quantity	KWh	kWhe/m <sup>2</sup> rated area	Data	Effect on star rating
Electricity consumption	6,177,266	273	Actual	-
Gas Consumption	8,198,400	145	Actual	-
Export	270,046	12	Actual	+0.4
2nd floor server etc	1,043,462	46	Actual	+1.6
Pass through	2,033,387	90	Actual	+3.1
Tenant supplement - FCU	387,151	17	Estimated	-0.6
<b>LER Scope</b>	<b>3,217,522</b>	<b>142</b>	<b>Rating</b>	<b>0 Stars</b>

**Figure 3-4: Palestra LER waterfall diagram**



The following observations are made on the calculation of the LER for this building:

1. The landlord purchases all energy for the building and it is metered to a good standard.
2. 17% of the electricity consumption is deducted as a separable; as is the floor area of the second floor (circa 2,500m<sup>2</sup>).
3. Of the passed-through electricity, 21% is estimated to be in-scope but is not metered.
4. For this building, the fan coil units are estimated to use between 6 and 17 kWh/m<sup>2</sup> rated – equivalent to 0.2 to 0.6 stars adjustment of the LER score. The lower estimate is Verco’s own, based on the installed equipment. The higher estimate is a “typical” value estimated by Quinten Babcock at TfL.
5. Kitchenettes use local hot water for hot drinking water only. This is outside LER scope. All hot water to handbasins, dishwashers etc is fed from central plant, so no hot water additions are required in this instance.



## 4. Case study 3 – GE Capital: Livingstone House, Leeds

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### 4.1 Background and energy efficiency context

Livingstone House is a mid-sized, multi-let air conditioned office building owned by GE Capital Real Estate and managed by Savills. There are six floors of office accommodation, a basement car park and a rooftop plantroom. The reception space is double height.

The building covers a TUFA of 8,607m<sup>2</sup> (based on the building's EPC) over 6 floors, of which 6,660m<sup>2</sup> NLA is let out as office space. From a servicing perspective, each floor is broken into two wings – East and West, although in most cases bar the first, the whole floor is open plan.

The building was constructed in 2005/6, but not let until 2009, when it became fully occupied by two tenants in a short space of time. GE occupies the first floor and half the ground floor<sup>1</sup>. Yorkshire Water occupies the rest of the building.

A ground floor café exists within Yorkshire Water's tenant space which seats approximately 100 and serves 500 staff. It is not accessible to the public. It is served by the tenant's electrical supply but HVAC comes from the main heating and cooling systems for the building – the only HVAC modification for the kitchen is one extract fan.

The building was used as a trial case for GE Capital's "Operational Building Sustainability Toolkit". This provides a structured approach to energy management and control for multi-let office buildings. It includes regular profile reports checking for out of hours use, month on month comparison of energy use against previous years, and checklists to identify opportunities for improvements to building services and controls.

### 4.2 Building servicing and controls

The building has a relatively straightforward servicing arrangement. Heating and cooling to all tenant spaces is provided via 4-pipe fan coil units. Heating and central hot water (for toilets and showers) are supplied by three Wessex ModuMax 220 gas fired boilers, while chilled water is supplied by a single twin compressor Trane RTAC200 roof mounted chiller. Each wing of the building has separate air handling plant, incorporating frost coil, heating and cooling coil, and heat recovery via a thermal wheel. LTHW and ChW are also delivered via a separate riser to each wing of the building. Toilet extract is served by a single roof mounted unit. All these services are fed from the landlord's electricity and gas meters.

Landlord areas are provided with radiators; the foyer has under-floor heating.



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<sup>1</sup> This is not GE Capital Real Estate, but other subsidiaries of the GE parent company)

Lighting is primarily T5 and compact fluorescent, with PIR control in all areas bar two store rooms. There are two server rooms (one each for Yorkshire Water and GE Capital). The total NLA of the server rooms is 102 m<sup>2</sup>. The Yorkshire Water server room has independent split unit heating and cooling which is fed from their own electricity supply. GE Capital have installed additional split unit heating and cooling in part of their office space, leading to the decommissioning of a number of fan coil units supplied in the base build.

All central HVAC services are controlled from the BMS base station, which is located in the reception area. The base build BMS configuration only featured two heating zones (one per wing). This was insufficient to allow adequate control and led to local overheating or cooling. A significant review was undertaken following fit out including relocation of fan coil units and reconfiguration of master/slave groups. Currently, each floor is broken down into four main zones, with multiple FCUs operating in a master/slave configuration with a local control which permits the tenants to adjust the zone set point by  $\pm 2^{\circ}\text{C}$ . Meeting rooms are provided with separately controlled FCUs with local override to permit the HVAC to be switched off when not in use, however this is manual rather than automatic so relies on tenant input to be effective.

The main timer settings in the BMS permit heating, cooling and ventilation during the following hours, subject to an optimum start controller which will bring heating/cooling on early according to the prevailing weather:

- Monday 7am-5pm
- Tues-Thursday 7.30am – 5pm
- Friday 7.30am – 4pm
- Weekends Off

There are no exceptions to this, as tenants use the building relatively little out of hours and therefore accept that there will be no heating or cooling in these periods (bar frost protection).

### 4.3 Data availability

Data availability in this building is good. Floor area data for each individual tenant was provided based on a review of the floor plans by GE Real Estate employees. The total NLA is 6,660m<sup>2</sup> which correlates closely to the Valuation Office's data of 6,668 m<sup>2</sup>. Electricity and gas sub-metering effectively separates landlord and tenant as well as HVAC and non-HVAC uses with some minor exceptions, relating to hot water.

The only area where data was lacking was for energy consumed by fan coil units, tenant supplement to heating and cooling in the GE capital space and electricity for kitchenettes in the tenant spaces



Figure 4-1: Data availability matrix: Livingstone House

	Key parameters needed for LER assessment	Units	Livingstone House	
			Coverage	Accuracy
Availability of data required for LER	Area of tenanted space	m2 NLA		
	Area of individual tenant spaces	m2 NLA		
	Services provided in common parts eg HVAC, lifts, other	Text		
	Services provided to tenants eg HVAC, other	Text		
	Operational hours for landlord services	hrs/wk		Conf. BMS
	Hours of use for each tenant	hrs/wk		
	Electricity use by landlord and each tenant	kWh/m2/year		
	Gas use by landlord and each tenant	kWh/m2/year		
	Other fuel use by landlord and each tenant	kWh/m2/year	N/A	N/A
	Sub metering of tenant supplements	kWh/m2/year	Some HVAC, Fan coil units + DHW	
Sub-metering of exceptional uses	kWh/m2/year	None	None	

Key:

	Coverage	Accuracy
	Full information provided or can be calculated	All information from robust documentation or metering
	All critical information provided or can be calculated	All critical information from robust documentation or metering
	Critical information is unavailable	Critical information/metering estimated for the purpose of the exercise

#### 4.4 Energy efficiency comments

The evidence seen during the building walk-round indicates that there is a well-structured approach to energy management. The building and its plant are relatively new and in good condition, and the control systems are fit for purpose. The application of the sustainability toolkit and profiling reports is reported to have resulted in significant reductions in energy consumption.

Meter readings were analysed and compared with TM46 benchmarks for whole building performance. Charts presenting the electricity and carbon emissions over 2011 and 2012 are presented below:





Figure 4-2: Livingstone house whole building energy consumption

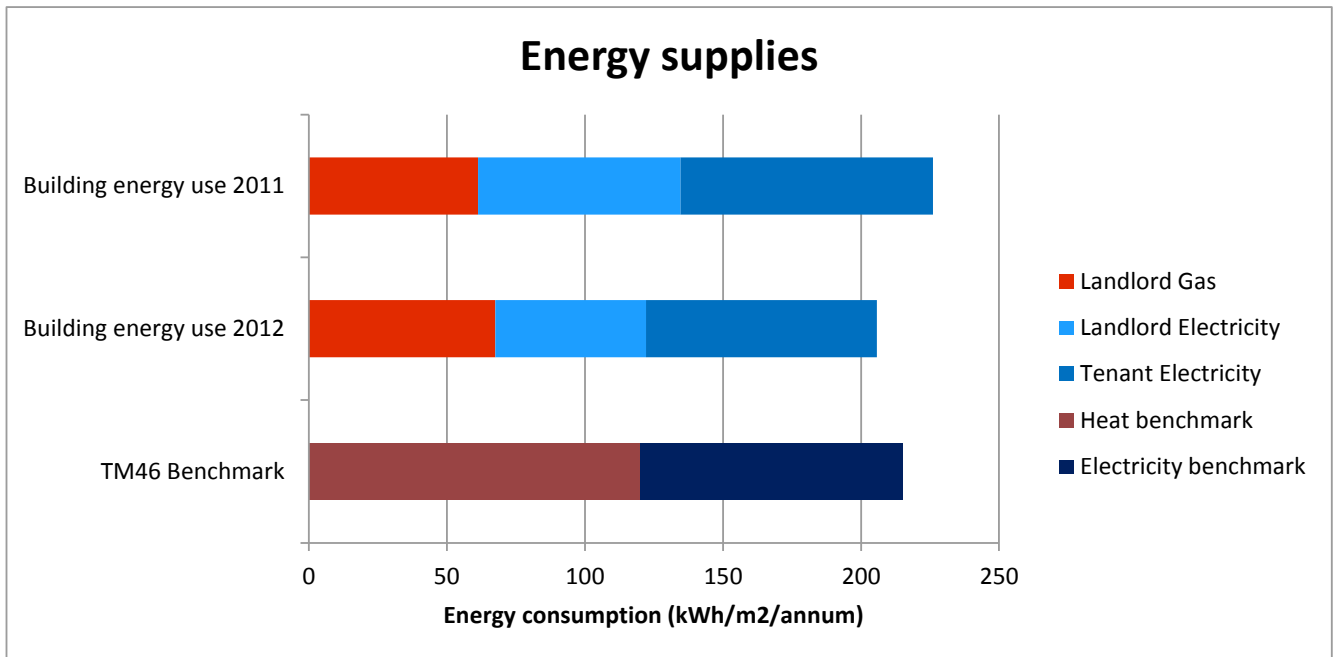
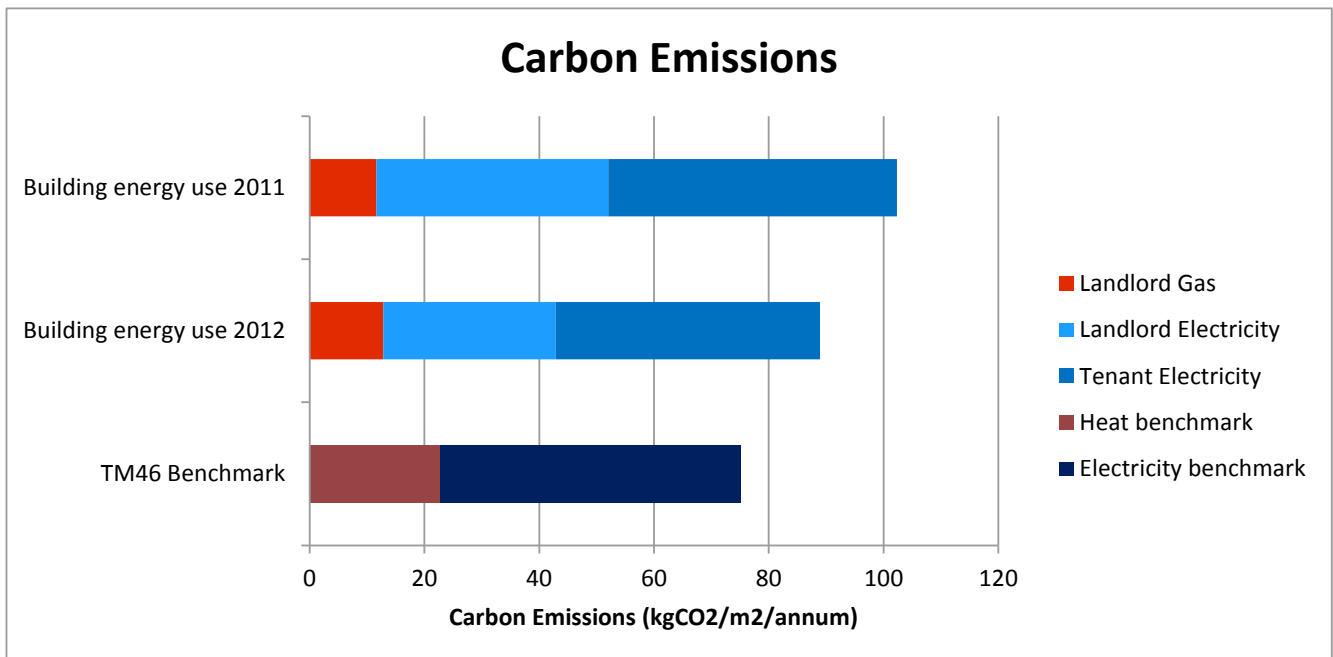


Figure 4-3: Livingstone House whole building carbon emissions



Key comments were as follows – all values are based on GIA in keeping with DEC benchmarking procedures:

1. The building's gas consumption is substantially below typical benchmark values.
2. Landlord electricity use makes up 40% of the total electricity consumption in 2012 (55 kWh/m<sup>2</sup>/year out of a total of 138 kWh/m<sup>2</sup>/year). ECON 19 benchmarks for HVAC electricity i.e. cooling, fans, pumps and controls for a type 3 office are 44 and 91 kWh/m<sup>2</sup>/year for good



practice and typical respectively, not including landlord small power and lighting – so the building appears to be performing reasonably well in this regard (close to Good Practice).

3. Tenant electricity use for small power and lighting appears fairly low at 84 kWh/m<sup>2</sup>/year when compared to benchmarks taken from ECON 19 for a type 3 office:
  - a. Lighting: 27 kWh/m<sup>2</sup>/yr (good practice is appropriate to this building)
  - b. Small power: 31 kWh/m<sup>2</sup>/yr (typical practice is appropriate to this building)
  - c. Catering: 6 kWh/m<sup>2</sup>/yr (typical practice is appropriate to this building)
4. Other energy consumption that is included in the tenant use includes:
  - a. Fan coils: 15 kWh/m<sup>2</sup>/yr (estimated)
  - b. Some additional HVAC – The GE capital server room is reported to be served from the main systems and is not sub-metered – in principle this could be deducted. In addition, local air con has been installed in certain parts of GE Capital's space.
  - c. Server rooms – not metered, but could be 5-30kWh/m<sup>2</sup>/year depending on scale
5. The building's overall carbon emissions performance in 2012 is slightly poorer than the TM46 benchmark, by 19%. As the building is air conditioned (and the TM46 benchmark represents a "typical" office), and the two server rooms have not been deducted, this is viewed as a good result.
6. An assessment of landlord gas consumption (based on meter readings in m<sup>3</sup>) gave a substantially higher value for 2012 than the consumption data submitted in the LER assessment – by around 20%. The deviation has relatively little impact on the overall carbon emissions however, as gas makes up only a small part of the total carbon footprint.

#### 4.5 Energy supplies and metering

The building's metering arrangement is well suited to calculation of an accurate LER score. As tenant and landlord spaces have their own fiscal meters for electricity, and only the landlord receives gas, both landlord and tenant metering is robust.

The complications arise when tenant supplements are considered. In this building, the following supplements have been identified:

1. Fan coil units throughout the building
2. Zip taps in tenant kitchenettes - fed from tenant electricity supplies but fall within landlord scope.
3. HVAC supplement in GE Capital's space where split units have been installed to replace the base build FCU services. This will slightly reduce the energy consumption for HVAC on the landlord meters. However, the tenant chose to make this change in order to achieve an increased level of servicing - so even if the split units were separately metered, the energy consumed would likely be greater than if the central services were retained. An addition based on metered data would therefore likely be punitive in this case.

#### 4.6 LER assessment

This review identified sufficient metering was installed to calculate a near investment-grade LER.

The review also observed that there had been misinterpretations with regards to the recording of tenant supplements in past submission relating to the scheme. An initial LER assessment indicated a score of 3.7 stars, based on data submitted for the Landlord's gas and electricity meters only. Our



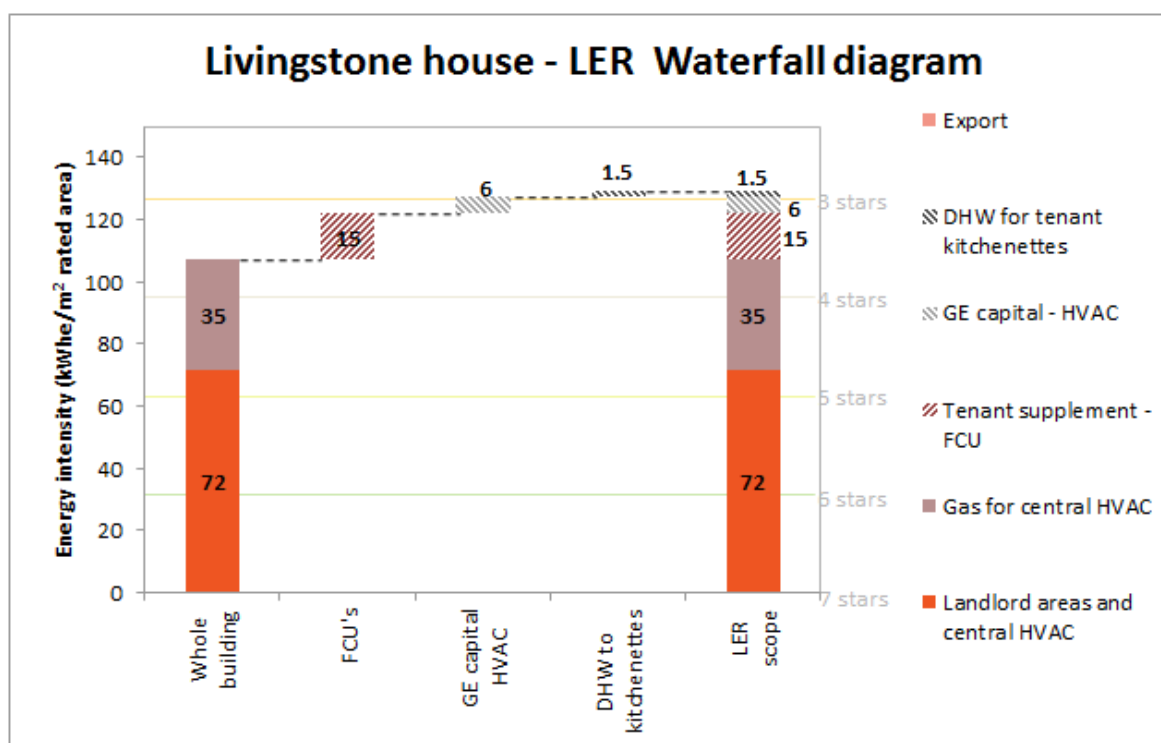
subsequent review of the building identified an LER score of 2.9 stars, once the tenant supplements are accounted for. This is a relatively small correction in the score.

The energy performance of the building is presented in the table and graphic below.

Figure 4-4: Key quantities used in LER assessment

Quantity	kWhe	KWh	kWhe/m <sup>2</sup> rated area	Data	Effect on star rating
Electricity consumption	1.0	470,061	72	Actual	-
Gas Consumption	0.4	581,241	35	Actual	-
Fan coil units	1.0	98,365	15	Estimated	-0.47
Tenant supplement - GE capital displaced HVAC (Gas)	0.4	25,821	1.6	Estimated	-0.05
Tenant supplement - GE capital displaced HVAC (Electricity)	1.0	25,821	3.9	Estimated	-0.12
DHW for tenant kitchenettes	1.0	9,836	1.5	Estimated	-0.05
<b>LER Scope</b>		<b>1,211,146</b>	<b>129</b>	<b>Rating</b>	<b>2.9 Stars</b>

Figure 4-5: Livingstone House LER waterfall diagram



Key comments on the LER assessment are as follows:

1. The landlord purchases energy for landlord areas and HVAC only
2. There are no deductions as there is no pass through energy.
3. For this building, the fan coil units are estimated to use 15 kWh/m<sup>2</sup> NLA – equivalent to 0.5 stars adjustment of the LER score.
4. Around 4% of the building NLA has had its heating and cooling displaced by split units taken from the tenant's electricity supply. This would improve the LER score by an estimated 0.17 stars.

5. DHW to kitchenettes was estimated at 1.5 kWh/m<sup>2</sup> by the Verco team based on existing benchmarks – this is approx. 1/20<sup>th</sup> of a star score and could be viewed as a de minimis quantity.
6. Adjustments for the floor area of the server rooms (102 m<sup>2</sup>) made negligible impact on the LER rating. The Yorkshire Water space is served by split units from the tenant supply, so its heating and cooling is excluded from the LER scope by default. The GE Capital servers are served by the main building's servicing, so in principle a small deduction could be made for heating and cooling to these spaces, but the LTHW and CHW is not sub-metered.

## 5. Case study 4 – Legal & General: 99 Gresham Street

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### 5.1 Background and energy efficiency context

99 Gresham Street is a 7-storey building with two levels of basement. It was rebuilt and extended behind part of an existing facade in the late 1990s and fitted out in 2000. It is managed by Jones Lang LaSalle (JLL) and maintained by Mitie.

The rented accommodation includes 7,848 m<sup>2</sup> NLA of office space on the ground to sixth floors, a 96 m<sup>2</sup> shop (currently occupied by Costa Coffee) on the ground floor south; and a 757 m<sup>2</sup> indoor golf and health club (City Golf) on the lower ground floor (open to the public), which also contains a (little used) garage for nine cars and six motor cycles. There is also a sub-basement. The balance of space in the lower ground floor and sub-basement includes plant, storage and offices for the facilities manager, Mitie and the Siemens BMS; and a room with the UPS for Davis Polk and Wardwell (DPW).

The tenants are mostly lawyers, operating internationally. People are often in at evenings and weekends and the reception is staffed 24/7. The ground, first and second floors are pre-let to the main tenant, DPW, and fitted out to a high standard, with products from the USA to mirror their offices there. Two other firms of lawyers occupy the third and fifth floors, with a private bank on the fourth. The sixth floor tenant is Tradeweb, which provides IT support for bond and derivative trading, and has a large (approx 120 m<sup>2</sup>) server room, which mirrors its operation in the USA. Turnover of tenants is small, with only the tenants on the fifth floor having changed during the life of the reconstructed building. There have been no voids in the past two years.

HVAC is largely by diffusion fan-coil units in the ceiling voids, piped with chilled water from two 500 kW York twin-circuit air-cooled packaged chillers in a roof compound. Perimeter fan-coil units also have LTHW coils, fed from three 300 kW Hoval cast iron non-condensing gas boilers in the roof plant room. Two main air handling units in roof plant rooms (with heat wheels that reportedly have not worked for many years) supply primary air to the fan coils from risers towards the north and south ends of the building. Supplementary ventilation plant serves the reception area, basement areas, toilets and car park. The record drawings show a total of 280 fan coil units with a total design duty of 34.5 cubic metres per second. Tenants have installed a considerable amount of supplementary plant, in particular for server rooms and a restaurant on the ground floor.

Typical weekday plant operating hours are 0600-1900 for the lower ground floor (City Golf); 0700-1900 for the ground and third floors; 0700-2200 for the first, second and fifth floors; 0600-1800 for the fourth floor and 0600-2200 for the top floor. In particularly hot or cold weather, the start times on Mondays are extended. For example, when we visited on 14 August 2013 the Monday start time was 0100, but this early summer start applied for seven weeks in July/August only, and avoided air conditioning running over the weekends. Supplementary services are requested by one or more tenants for most weekends, approx. 35 weekends a year for six hours each. In addition, press-buttons



in the riser cupboards on each floor will run the plant for 2 hours on request. At present this out-of-hours operation is not recorded or charged for. When it happens, zone dampers stay closed on all but the floors concerned and the air volumes are reduced by pressure control to inverter drives on the fan motors. However, the chilled water (and hot water when available) circulates to all the fan-coil units. The possibility of installing floor isolation valves was discussed and is being investigated.

## 5.2 Data availability

- **Office area.** L&G advised a NLA of 7,942 m<sup>2</sup>. We checked this against rating data on the Valuation Office Agency website [www.voa.gov.uk](http://www.voa.gov.uk), which includes a breakdown by tenanted area. The total of these figures for the offices is 7,848 m<sup>2</sup> NLA. However, if the Costa Coffee shop (96 m<sup>2</sup>) is included, the total (7,944 m<sup>2</sup>) is a similar value to L&G's. It should be noted that the electricity supply to the shop is submetered from the building's main supply. The shop area and its metered electricity is therefore deducted to calculate the LER rating.
- **City Golf** (basement). This has a submetered electricity supply and fan coil units, which take unmetered hot and chilled water from the landlord. The golf area and its metered supply is deducted to calculate the LER. If the hot and chilled water were metered, these could also be excluded. It is worth noting that the deductions of the retail areas worsen the LER by 0.3 Stars.
- **Gas.** This is supplied to the heating boilers only – entirely a landlord's service. In February 2013, L&G provided a value of 627,584 kWh. Using an estimated calorific value, monthly meter readings recorded on site suggest a slightly higher figure (646,000 kWh) for the twelve months to the end of July 2013. This is not surprising, given the unusually cold weather in Spring 2013.
- **Electricity.** The total annual electricity consumption recorded on site was 4,086,000 kWh in the year to 28 July 2013. Mitie take utility readings every month. It should be noted that on the site visit it was not possible to validate this data against utility invoices. In the draft LER, L&G entered a value of 171,189 kWh for landlord's services, a very small figure in relation to benchmarks, particularly taking into account the extended use of the building. The matter was therefore investigated further, as outlined below. This produced an amended total of 1,085,000 kWh of electricity for landlord services for the year (138.3 kWh/m<sup>2</sup> of office NLA). *[We now understand that the figure originally entered by L&G was mis-typed and should have been 1,071,189 kWh].*
- **Tenant supplements.** The main supplement appears to be electricity for the fan coil units on all the floors, which comes from the tenant meters. This could account for an estimated 15 kWh/m<sup>2</sup> of extra electricity per year. On the draft LER, electric reheat was also reported. However, this applies to fourteen 2 kW thyristor-controlled electric reheaters for the toilet air supplies only, and these are on the landlord's supply. However, the hot water for the toilets and tenant kitchenettes is reported by Mitie to be on the tenant meters. The original LER submission therefore needs correcting for the fan coils and HWS. An operating hours correction may also be required, but the extended hours are not well documented. On the day of the visit, JLL asked the BMS contractor to set up data logging of the extension times initiated by tenants' push-buttons.
- **Possible deductions.** Strictly speaking, the areas of the server rooms should be deducted, as having their own servicing, but these are relatively small, apart from Tradeweb's on the sixth floor. Tradeweb also has a link to the landlord's chilled water supplies. We understand that this was originally installed for use in an emergency. However, during the site visit, both the duty and standby cross-link were running, although the interlock registered OFF on the BMS. On further investigation, it transpired that the arrangement had been changed, with Tradeweb taking chilled

water from the building's central system when it is available and only using its own cooling systems when the landlord's supplies are off. However, there are no chilled water meters.

### Electricity distribution and sub-metering

The main electrical distribution panel has 50 outgoing ways, including 2 spares. 12 supplies go direct to tenants and 4 to rising busbars (which the record drawing shows serving a total of 19 tapoffs), leaving 32 supplies feeding items of landlord's equipment. Sub-metering is as follows:

- The design provided for future metering of each of the 19 busbar riser tapoffs. Additional tap-offs have since been added and all tenant supplies are reported to be metered.
- Only eight of the 32 landlord's tap-offs are sub-metered in the basement switchroom, labelled: Passenger lifts 1 and 2, Chiller 1, Chiller 2, Basement plant room and car park lighting, MCC 1, MCC 2, MCC 3 and MCC 4.
- In addition, DPW (the tenant of the ground, first and second floors), has four check meters in the basement switchroom, labelled Emergency lighting, Copy centre, Rooftop plant, Comms room.

The meters were read automatically by EDF, and the data sent directly to JLL for billing tenants. There were no results on site at the time of the site visit, but JLL followed this up and provided information on 5 September 2013. This shows 30 tenant submeters in all, which are summed as necessary and allocated to each of the six tenants. Key data for 2013 is summarised in Table 5.1 below. We understand that, from September 2013, the maintenance contractor reads all the meters.

**Table 5-1: Electricity sub-metering summary for the year Jul 2012 – Jun 2013: 99 Gresham Street**

Tenant	Activity	NLA m <sup>2</sup>	kWh/year	kWh/m <sup>2</sup> p.a.	Comments
Retail	Golf club	725	142,954	197.1	
Retail	Costa Coffee	96	60,624	632.1	
Office, G to 3 <sup>rd</sup>	Lawyers	4689	770,085	164.4	
Office 4 <sup>th</sup>	Bankers	1195	348,505	291.1	
Office 5 <sup>th</sup>	Lawyers	1072	192,477	179.6	
Office 6 <sup>th</sup>	IT services	892	1,457,174	1632.8	Large server room
TOTAL electricity Submetered to office tenants		7848	2,769,041	352.8	
TOTAL electricity	Whole building	8670	4,058,360	468.1	Excluding retail areas & electricity
TOTAL electricity	All office space	7848	3,854,782	491.2	Excluding retail areas & electricity
Landlord's electricity	All tenant electricity deducted from total	7848	1,085,741	138.3	Excluding all tenant submeters (office & retail) and all retail area.



**Table 5-2: Data availability matrix: 99 Gresham Street**

Key parameters needed for LER assessment	Units	Coverage	Accuracy	Comments
Area of tenanted space	m <sup>2</sup> NLA			With help from the Valuation Office database
Area of individual tenanted spaces	m <sup>2</sup> NLA			With help from the Valuation Office database
Services provided in common parts, e.g. HVAC, lifts	Text			
Services provided to tenants, e.g. HVAC	Text			
Operational hours of landlord's services	hrs/wk			Routine daily operating hours are recorded but on-demand evening and weekend use are not
Hours of use by each tenant	hrs/wk			Routine daily operating hours are recorded but on-demand evening and weekend use are not
Electricity use by landlord and each tenant	kWh/m <sup>2</sup> a			Landlord electricity calculated by deducting all tenant submeters from the utility total
Other fuel use by landlord and each tenant	kWh/m <sup>2</sup> a			Diesel for standby generator not included
Sub-metering of tenant supplements	kWh/m <sup>2</sup> a			Supplies of hot and chilled water to the golf centre not metered.
Sub-metering of exceptional uses	kWh/m <sup>2</sup> a			Chilled water supply to sixth floor tenant server room not metered. This accounts for an estimated 200,000 kWh of electricity per year.

**Key:**

	Coverage	Accuracy
	Full information provided or can be calculated	All information from robust documentation or metering
	All critical information provided or can be calculated	All critical information from robust documentation or metering
	Critical information is unavailable	Critical information/metering estimated for the purpose of the exercise

### 5.3 Energy efficiency comments

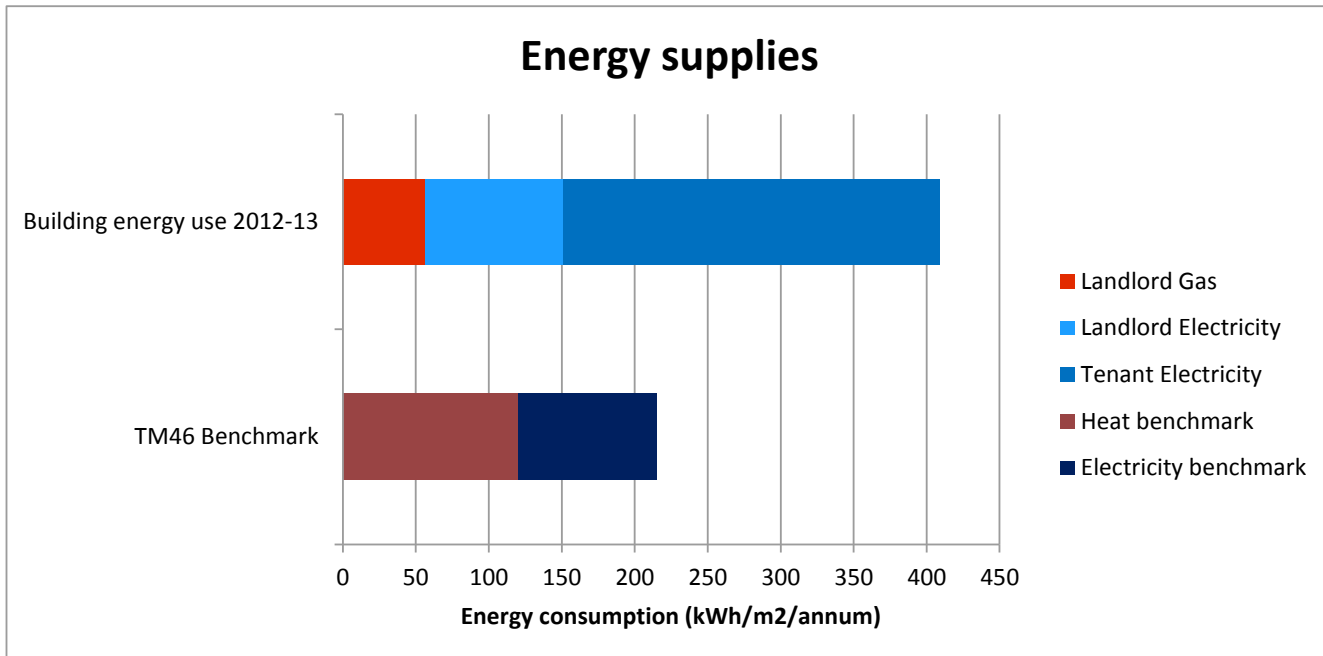
The building has now been occupied for thirteen years with quite intensive use, and some items of equipment are now in poor condition. Boiler No 2 has failed, the BMS is currently being upgraded and the chillers (which are also R22) are due for replacement. Mitie have also been replacing some lamps with LEDs and/or with occupancy sensors and have been seeking tenders for bringing the thermal wheels back into use – this is being investigated further in November 2013. In the stairs and car park, where lights used to be on 24/7, the LED lamp replacements also include microwave occupancy sensors which switch between dim (typically 10-20% of power) and bright levels, achieving further savings. The managing agents and maintenance contractors are keen to make further improvements, and expressed interest in the LER as a catalyst for further energy savings, with added opportunities for tenant engagement and better cost recovery.



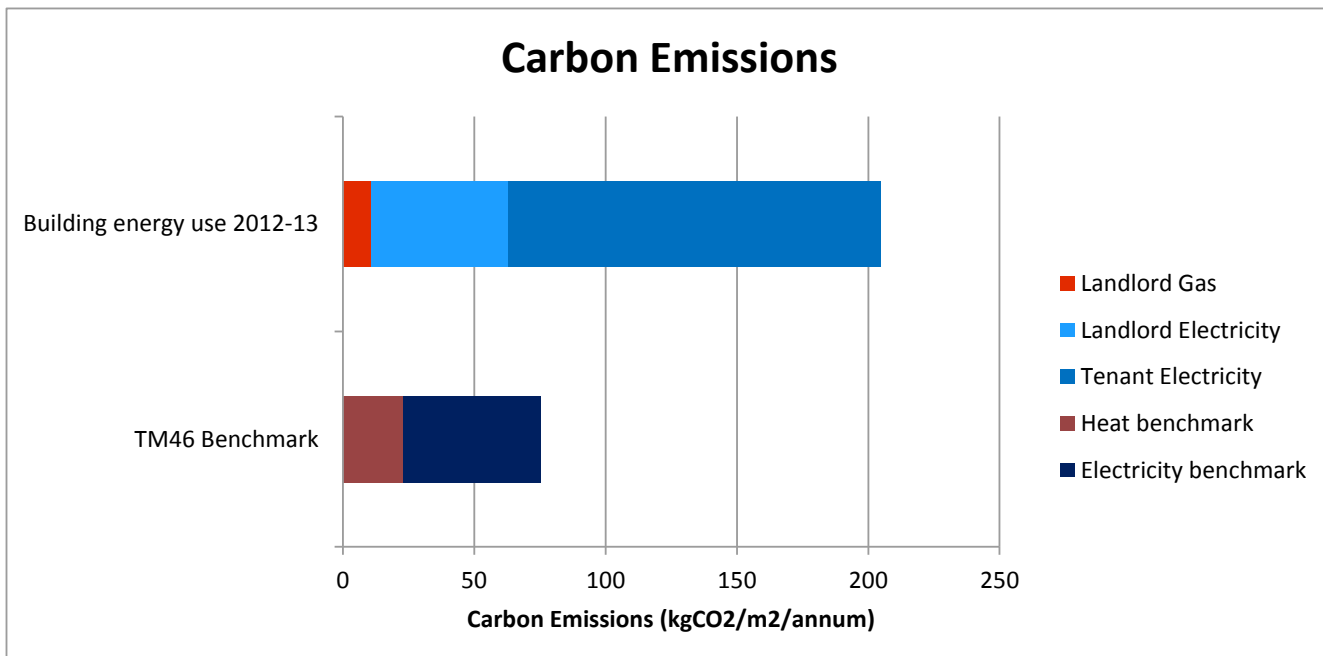


Meter readings were analysed and compared with TM46 benchmarks for whole building performance. Charts presenting the electricity and carbon emissions over the period Jul 2012 – Jun 2013 are presented below. Electricity for retail units (Costa and City Golf) is included in the tenant total.

**Figure 5-1: Gresham St whole building energy consumption**



**Figure 5-2: Gresham St whole building carbon emissions**



Key comments were as follows:

1. The building's gas consumption is well below typical benchmark values.
2. Landlord electricity use makes up 28% of the total electricity consumption (138 kWh/m<sup>2</sup>/year of a total of 491 kWh/m<sup>2</sup>/year). ECON 19 benchmarks for cooling, fans pumps and controls for a type 3 office are 44 or 91 kWh/m<sup>2</sup>/year for good practice and typical respectively, not including landlord small power and lighting – so landlord electricity use is relatively high.
3. Tenant electricity use for small power and lighting is very high at 258 kWh/m<sup>2</sup>/year. Over half of the electricity use by the office tenants is attributed to the 6<sup>th</sup> floor, Tradeweb, where electricity use by the server room and its dedicated air-conditioning is estimated to contribute in the region of 100kWh/m<sup>2</sup>/year to the overall tenant total (by comparison with “typical” use on the other office floors). Comparing to benchmarks taken from ECON 19 for a type 3 office:
  - a. Lighting: 27 kWh/m<sup>2</sup>/yr (good practice is appropriate to this building)
  - b. Fan coils: 15 kWh/m<sup>2</sup>/yr estimated
  - c. Small power: 31 kWh/m<sup>2</sup>/yr (typical practice is appropriate to this building)
  - d. Catering: 6 kWh/m<sup>2</sup>/yr (typical practice is appropriate to this building)
4. The building's overall carbon emissions in 2012 are substantially greater than the TM46 benchmark, by 173%. If Tradeweb's 100 kWh/m<sup>2</sup> was excluded (as an eligible separable) to cover this then carbon emissions would be 40% above the TM46 benchmark (i.e. a DEC rating of about F140). Tradeweb's server room also receives an unmetered amount of cooling from the landlord's chilled water system, estimated at a minimum of 200,000 kWh of electricity equivalent, or some 25 kWh of electricity equivalent per m<sup>2</sup>, which would bring performance closer to the benchmark.

#### 5.4 LER assessment

A review of the building's services provision and metering was carried out on 14 August 2013 by William Bordass Associates, with help from the managing agent (JLL), maintenance contractor (Mitie) and the BMS contractor. Further information on all tenant sub-metering was supplied by JLL on 5 September 2013. .

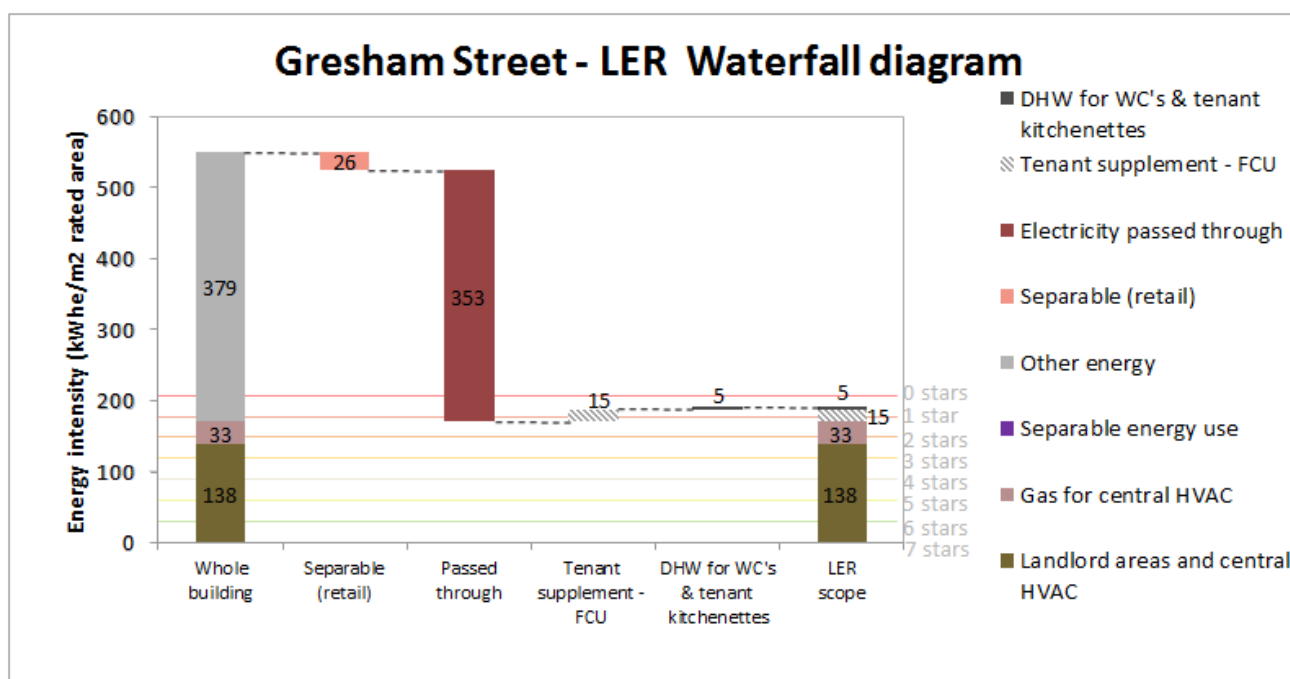
This review identified gaps in the electricity metering which will affect the LER score substantially, changing it from the original 5.1 stars to 0.5 stars.

The energy performance of the building is presented in the table and graphic below.

**Table 5-3: Key quantities used in LER assessment**

Quantity	kWh	kWhe/m2 rated area	Data	Effect on star rating
Electricity consumption	4,086,000	521	Actual to 28Jul13	Could be large
Gas consumption	646,000	33	Actual to 28Jul13	Small
Elec. passed through (offices)	2,769,041	353	Actual to 30Jun13	Large
Elec. passed through (retail)	203,578	26		
Gas passed through	None	0		None
Tenant FCU		15	Prelim estimate	-0.4
DHW for tenants: toilets and kitchenettes		5	Prelim estimate	-0.15
Estimated chilled water supply to Tradeweb server room	200,000 elec equiv.	25.5	Estimated 600,000 kWh of chilled water at CoP of 3	+0.7
Hours of use			Likely to increase if extra hours were recorded.	An improvement
Floor area (m2)			Good quality	None

**Figure 5-3: Gresham St LER waterfall diagram**



The following observations are made on the calculation of the LER for this building:

1. Gas makes up only a small proportion of the building's LER in-scope energy
2. Passed through energy in this building is very high, particularly for Tradeweb on the sixth floor, which accounts for over half the electricity supplied to all seven floors of office tenants. Probably 90% of Tradeweb's electricity is for its server room, which serves clients internationally and would be a separable under DEC rules, if it were itself to be sub-metered.
3. The additions from fan coil units and tenant DHW have been estimated, in total these represent around two-thirds of a star.
4. In principle the floor area for the server rooms should be deducted. However, this was not done because it was found that some of the chilled water for Tradeweb's servers was being taken from the landlord's supply and not their own services. The actual amount is not known, but we estimate it could be equivalent to at least 200,000 kWh of landlord's electricity per year. If properly metered, this would permit the improvement of the LER by at least 0.7 Stars.

## **5.5 Provisional conclusions and suggestions**

### **5.5.1 Items that required further investigation**

In the draft LER prepared in February 2013, the landlord's electricity consumption was substantially underestimated, at 171,189 kWh per year. On 14 August the figure was estimated as potentially being over 1,000,000 kWh. Subtracting the tenant sub-meter data provided by JLL on 5 September 2013 from the total electricity recorded on site confirms a figure in the region of 1,085,000 kWh per year.

### **5.5.2 Scope for further improvement**

With JLL, and Mitie, opportunities were discussed for more demand-responsive control with the BMS maintenance contractor, who immediately programmed the system to log out-of-hours push-button requests for extra HVAC by tenants and requests for backup cooling for Tradeweb's server room. Requests to reception could also be logged manually. Once operations are better understood, there may be a case for cutting back occupancy hours and charging tenants for extended hours when selected. To save more energy, it would be useful to fit zone valves to the hot and chilled water distribution systems to each floor. The pumps already have inverter drives, but to date the speed control facility has been used for commissioning only.

The site visit included a review of comfort or operational problems. Mitie reported that the building operated reasonably well, apart from:

- The thermal wheels on the two main AHUs are not in operation. Apparently their use was discontinued circa 2005, reportedly (but perhaps apocryphally) owing to recirculating smells, especially from a curry house. Recently, Mitie have sought to have them overhauled and put back into service, but have not yet been able to obtain a satisfactory quotation.
- In cold weather, particularly on Monday mornings, insufficient heat in the central areas of parts of the building that have cellular offices on the perimeter. Only the perimeter fan-coil units have hot water coils: inner zones are cooling-only. The problem is likely to have been exacerbated by the thermal wheels not operating.

- In hot weather, the cooling can struggle in cellular offices with high solar gains, i.e. on the east in the morning and the west in the evening on the upper floors; and on the third floor generally, as it is densely occupied.
- In hot and cold weather, the need to start the plant earlier on Monday mornings. Mitie said that, in their experience, tenants often preferred agreed start times to optimum start control.

The chilled water temperatures (5/8°C) are lower than otherwise necessary, owing to Tradeweb's requirements for its backup machine room supply. Tradeweb also appears to be receiving quite a large amount of chilled water free of charge from the landlord's supply. If this were to be metered, as well as the supply to the golf club, this might give quite a large improvement to the landlord's rating. There would also be opportunities for cost recovery.

## 6. Conclusions and observations from the case study exercise

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During the course of this exercise, a number of common issues have been identified. These either impact the LER score, or are areas that are likely to be a common area of difficulty for assessors.

These are summarised below:

1. All case studies exposed some problems with the data originally provided. This reinforces the need for a site visit by an expert, as of course happens with NABERS.
2. Often not all the queries that arose could be dealt with at the first visit, owing to an absence of data on site - for example with utility bills, automated meter readings, and tenant billing being handled from another office. However it was usually possible to obtain the missing data without needing to go back to the site.
3. Floor area data was sometimes uncertain, but could be checked by reference to the Valuation Office Agency's website. Identification of correct floor areas for the whole building and deductions is expected to be straightforward in the case of a real assessment as this could be scaled from plans or measured directly given adequate time on site.
4. Separate metering of all landlord's electricity was uncommon: it usually had to be obtained by subtracting tenant sub-meters from the total.
5. Some base building services were often found on tenant meters, particularly fan coil fans and domestic hot water cylinders, where it is possible to make estimates of annual consumption using rules of thumb, confirmed by manufacturer's and/or commissioning data. All four buildings required some degree of supplement for hot water use, however this had only a small impact on star rating in each case.
6. In terms of tenant supplements, all four buildings in the study required a supplement for fan coil units (one had terminal reheat). Where the energy use is for fans only, the adjustment is relatively small (max. ½ a star), but where terminal reheat is present the energy use was three times as high, and had an impact of more than 1 star on the final score. Where electrical reheat is found on tenant meters, this is more difficult to estimate, particularly if tenant consumption for other purposes is large.
7. Where the building contains retail spaces accessible to the public, these sometimes received services from the landlord. The LER protocol is to deduct both their floor area and their energy use. Normally their electricity was sub-metered, but hot and chilled water was not: if they had been, there would have been an opportunity for a better LER and for cost recovery from the tenant.
8. Server rooms were present in all four buildings. These were located in tenant demises, and in most cases were supplied with electricity from tenant supplies (either pass through or tenant counterparty) and did not require separate deduction from the LER. Where tenants had installed their own split units for server room heating and cooling these were also fed from tenant supplies and were therefore deducted by default. Separable areas which are served by landlord's heating and cooling services were noted as a possible issue in three assessments (Palestra, Livingstone House and Gresham St). While the floor area could be deducted for these areas, there was either no metering in place to measure heating and cooling supplied, or there was some doubt regarding its reliability. This has therefore resulted in a poorer LER score where deductions could not be made for this service due to lack of metered data. Estimation is not considered a viable approach for these cases. Reliable metering would also allow fairer tenant recharge.

9. Once an initial LER has been produced, it should become easier to do repeats, because design, operational and energy data should be more readily available.
10. Some facilities management teams and managing agents welcomed the LER, as they saw it assisting tenant engagement, better energy management and metering, and more accurate cost recovery.
11. Where deviations in LER score were noted between the pilot exercise and this study, the tendency was that the LER score was worse when investigated in further detail. However, it is noted that all the buildings studied are fully air conditioned, and in most cases are prestige buildings. A below 'typical' LER score (i.e. less than 3.5 stars) would therefore be anticipated.
12. In conclusion, the LER appears to be effective as the ratings produced on the four case study buildings were not unreasonable. However, it needs to be recognised that this is intended to be an investment-grade rating and not all buildings will have sufficient sub-metered information to allow a rating to be issued. There are also substantial costs in getting robust enough data to produce an initial rating, even in buildings where the data might have been expected to be good quality. But good energy management needs good data management and so this should be seen as an essential cost for property owners wishing to participate in a meaningful energy efficiency rating scheme.
13. The time allowed for the case studies did not permit a detailed review of the claimed hours of use; while there is no reason to suspect the values provided (which have been correlated with hours of plant operation where possible), this exercise has not been able to deliver an audit trail that would be considered sufficient to support an investment grade rating. This could be an area where more comprehensive record keeping would be required in some buildings if LERs were to be produced on a routine basis.