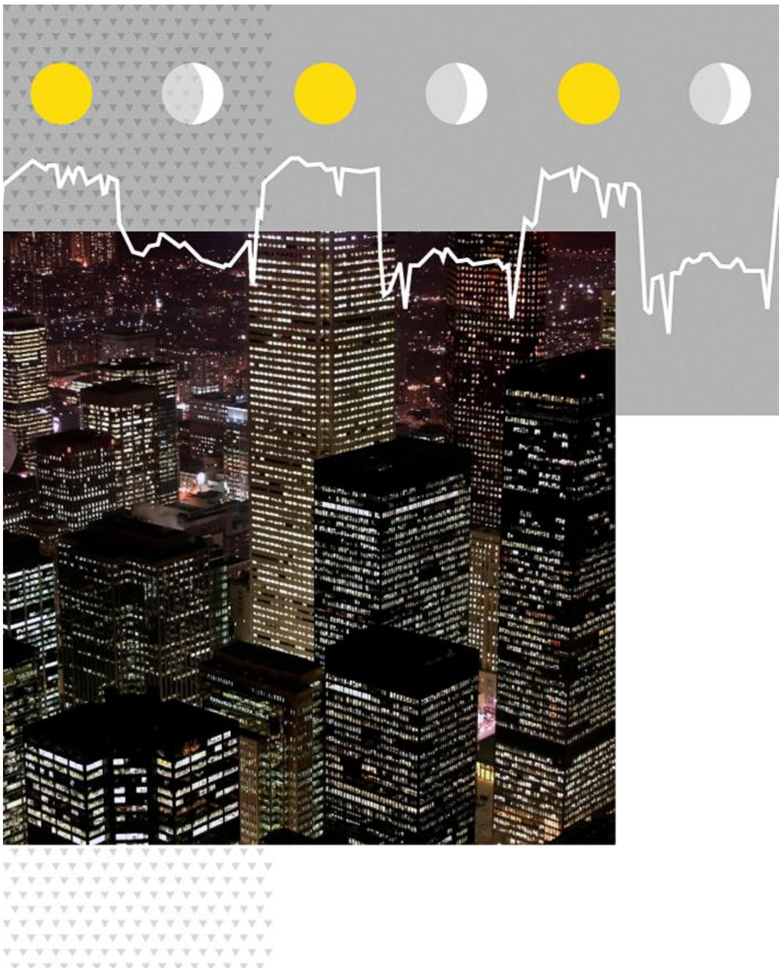
Issues considered in developing the LER

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



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1. Introduction

1.1 Background

The Better Buildings Partnership (BBP) strongly supports the roll out of Display Energy Certificates (DECs) to the private sector, but believes that, in their current form, they may not achieve their vital aim of driving market change in reducing energy consumption, in addition to their primary purpose of reporting operational energy use. Our members believe that by making energy performance data accessible and simple to understand it will influence both owners and occupiers to increase efficiency. The BBP has, therefore, taken the findings of the UKGBC Task Group Report ‘Carbon Reductions in Existing Non-Domestic Buildings (March 2011)’ and has initiated a project which it hopes will result in the development of a methodology which can be used to produce a robust ‘Landlord DEC’.

In this context, the BBP is seeking to develop a Landlord’s Energy Rating (LER). The project will focus on the multi-let office sector, but the intention is to address other sectors over time. The LER aims to differentiate energy efficient office space in the marketplace, creating the potential to feed through into market valuations, as the NABERS[1] Energy system is reported to be doing in offices in Australia. The LER project is looking to build upon the existing Landlord’s Energy Statement[2] (LES) and be consistent with the DEC operational rating, to develop a LER which provides additional granularity to that available from whole building or tenant DECs by focusing on the energy use which can be influenced by the landlord.

By virtue of sharing a common data collection platform, the LER is designed to be completed at the same time as a whole building and/or tenant DECs, although the LER delivery system may remain separate, at least initially. It is hoped that it could be complementary to compliance with other legislative requirements such as CRCEES and potentially the requirement for energy audits under the EED.

As the first step, Verco has been commissioned to prepare a detailed specification for the LER. The issues considered in developing the specification are the subject of this report. Because the primary objective of the BBP is to develop an authoritative label to benchmark the energy performance of the landlord’s services provided to office buildings, where these include shared HVAC services to the whole building (tenanted areas and common parts), this scenario forms the focus of the issues reviewed in this report.

Nevertheless, there are some BBP members who would be interested to explore the option for benchmarking the landlord’s services to the common parts only, where these are the sole extent of landlord energy provision to the building. The potential to do this will be reviewed during Stage 2 when the planned data collection exercise will try to establish the proportion of buildings in BBP member portfolios where this situation pertains and the availability of the floor area and energy data for the common parts which would be prerequisites for such a benchmarking approach.

[1] National Australian Built Environment Rating System
[2] www.les-ter.org.uk

2. Proposed characteristics for an LER scale

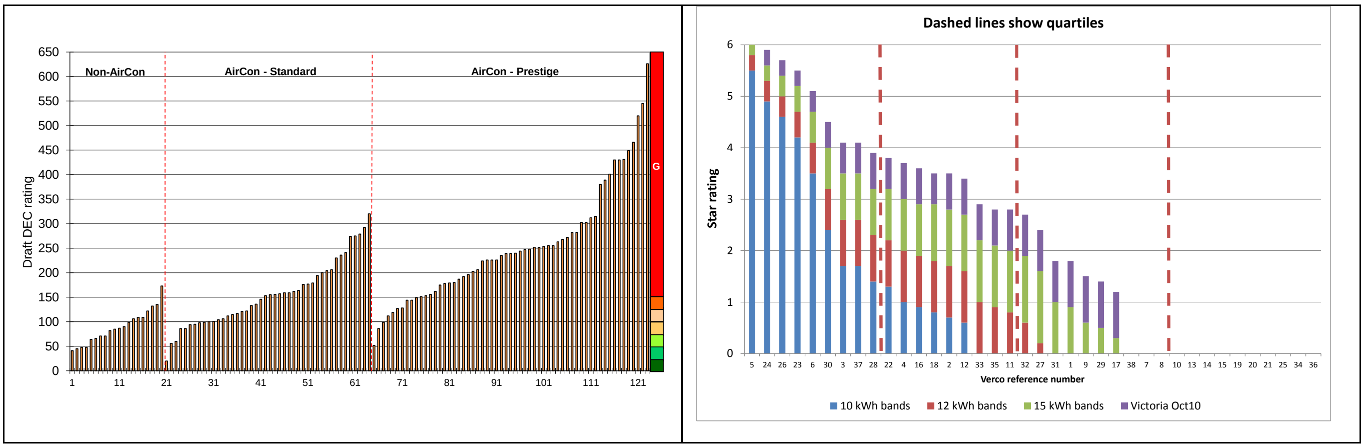
2.1 Issue 1: Which primary performance indicator should be used?

The primary performance indicator is employed as a high level, instantly recognisable label that can be readily understood by technically unaware stakeholders and members of the public[3]. There are two very different contenders for the LER's primary performance indicator:

1. **A to G grades,** supplemented by a numeric rating, as used by DECs
2. **Star ratings,** with added resolution, e.g. the half stars used by NABERS Energy, or decimal stars, e.g. 3.2 Stars.

The fundamental difference between these indicators is that the A to G option effectively embodies both 'carrots and sticks', whilst the star scale is predominantly acting as a 'carrot'. There are two reasons for believing this:

1. **The A to G scale is transparent about the performance of all buildings, even the worst.** The A to G scale, together with the numerical "operational rating" indicator (the percentage of the benchmark value), effectively goes from zero to infinity (see Figure 1a). This means it gives a quantitative rating however poor the performance[4]. By contrast, star ratings are designed to reward good performance, to allow fair-to-relatively poor performance to get a foot on the ladder, but not to expose the really poor performers (see Figure 1b): the zero star band covers everything from those almost good enough to get a star through to the very worst performers in the country.



Figures 1a and 1b Examples highlighting how DEC A to G scale (a) is reverse of star scale (b)

2. **The A to G scale acts as a carrot for good buildings but like a stick for poor buildings.** The A to G scale places typical performance in 2007 at the D-to-E boundary, making a D grade better than average. It is plausible to consider that a building in say the A to E bands is being encouraged to do better coming from a fair to good current performance, a 'carrot'

[3] Supplementary indicators, such as kWh/m^2 of electricity and of other fuels, are an essential output of any energy rating system to gain an understanding of the energy performance. These are considered in section 6 on the content and graphic design of the Certificate.

[4] It should be said that poor is usually regarded as reflecting energy inefficiency, but unless there is an appropriate benchmarking methodology, poor may in some circumstances reflect a high intensity of energy use, but not necessarily an inefficient one.

approach. However, buildings graded F or G, and particularly those with a high G rating, are being told they are poor and should be doing better. This acts more like a stick.

A key finding from a review of DECs for DECC[5] supports this assessment. It reveals statistically significant evidence that the cohort of better rated buildings (grades A to D) has tended to improve its ratings year on year, while the ratings of the higher-energy buildings (grades E to G) are tending to get worse on average (though, of course there are notable exceptions). Technically this is counter-intuitive, because poorer buildings should be easier and more cost effective to improve. What it seems to be saying is that technical factors are often being trumped by human factors. It is reinforcing the view that where there is a champion who is focused on energy performance, you are likely to have good performance, getting better. Where you don't, building energy use is neglected and the bad get worse. Equally, one might conclude that the better buildings respond to the carrot incentive more positively than the poorer buildings react to a stick.

Another issue with the A to G scale is that, in practice, people intuitively seem to compare the grades with other letter scales (e.g. for exam results and credit ratings), where a D is poor or worse; or with new consumer products where many are now A or better, owing to an over-generous initial calibration of the scales and rapid product improvement cycles[6]. So even a D rating can be mistaken as poor by members of the public or building occupants; and even by clients, facilities managers or building energy managers, as energy assessors frequently report.

A further source of potential dismay about DEC (and potentially LER) ratings of grade D or worse arises because the A to G scale for non-domestic EPCs appears to be more generous, with all new buildings achieving an EPC grade of C or better, and relatively few existing buildings falling below E. Even more importantly, there is no long tail of high G ratings as occurs for DECs in many sectors (see Figure 2). Few people outside the world of building energy professionals understand the difference between an EPC and a DEC, nor why they can give very different results for the same building.

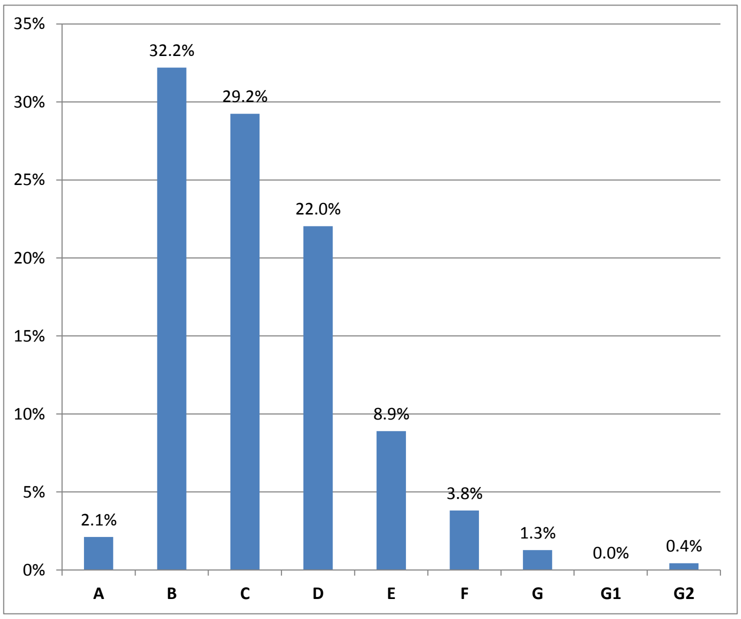


Figure 2 EPC ratings for buildings with a DEC
(G here means ratings of 151 – 175, G1 is 176 – 200 and G2 is 201 – 225)

[5] Wider Public Sector Emissions Reduction Potential Research, Camco, July 2011, available from http://www.decc.gov.uk/en/content/cms/tackling/saving_energy/what_doing/what_doing.aspx

[6] The DEC Grading scale learnt from the product labelling experience and was built to support the long-term objective of buildings that were truly zero-carbon in operation.

Apart from the psychological aspects of an A to G descriptor discussed above, there may be a deeper concern at the poor end of the rating scale. For example, an analysis of 123 whole buildings in London belonging to 11 members of the BBP found that 73 would be graded G, with nearly 40% having ratings over 200 (twice the benchmark) and almost 25% over 250. There is a view that a system that leaves 25% of a particular cohort of buildings at least 40% away from getting out of the bottom grade risks being ignored by property owners and fund managers or at best relegated to a compliance tick box. However, this is not the full story, first because the analysis was preliminary and did not take into account hours of operation, mixed use and separables that the DEC methodology already incorporates for intensively-used buildings and secondly because the level of sub-metering required to produce individual tenant DECs was not available so the high energy use of the G-rated buildings due to tenants could not be analysed. A key advantage for policy makers and property portfolio managers of the A to G scale is its transparency at the poor end of the scale, allowing the most carbon intensive buildings to be exposed; once the emotional impact of being in G is put to one side, it can also reward year-on-year improvements in terms of a better numerical rating, e.g. from G 200 one year to G 180 the next.

In summary, although a mandated energy performance communication like a DEC must speak to everybody involved in contributing to performance outcomes, the star scale was successful in gaining market traction in prime offices in Australia[7], perhaps partly because it in effect removes the G rated buildings from the radar. This may not be ideal from a national policy perspective, given that these buildings produce a significant proportion of a sector's emissions. However, the behavioural evidence from DECs and NABERS suggests that the LER, whilst it remains a voluntary initiative, will engage the commercial market more effectively by adopting the 'pure carrot' approach of stars. A star rating will also serve to distinguish an LER from a DEC, and accommodate any incompatibilities between the two scales, which may be inevitable while the systems are running-in.

Issue 1 Recommendation: Use stars for LER's headline label

Reasons

1. A to G scale goes from zero to infinity, and can give operational rating however poor the performance. Stars reward good performance, but present the laggards as a flat zero.
2. Even a D rating can be mistaken as poor by the unaware (4* feels better than a D).
3. A to G scale acts as a carrot for good buildings but like a stick for poor buildings.
4. Evidence from DECs reveals (counter-intuitively) that people in the more energy-efficient buildings respond to pure carrot incentive (intrinsic to stars), whilst the majority of those with poor ratings (F&G) ignore the stick.
5. A to G scale for non-domestic EPCs is more generous than the scale for DECs, creating further dismay in market about poor DEC grades…this would apply equally to an A-G LER.
6. Star scale was successful in gaining market traction in prime offices in Australia, perhaps partly because poor performance buildings are less exposed (than those with G rated DECs).
7. Stars will distinguish the LER from DECs, avoiding any confusion between the two during any pilot trial, and accommodate any incompatibilities between the two scales, which may be inevitable while the system is running-in and being calibrated.

[7] Review of the NABERS Energy scheme in Australia, Verco report to BBP, July 2012

2.2 Issue 2: Should the scale be linear?

It was decided to make the DEC rating scale linear so that it could be as simple as possible to interpret and to make comparisons (e.g. a 20% reduction in CO_2 emissions produces a 20% reduction in the building's rating). For the same reasons, the A to G grades have equal bandwidth. Inevitably, equal grade bandwidth sacrifices some possibly desired characteristics such as providing higher grade resolution for the best buildings[8].

The Republic of Ireland uses an identical DEC methodology as the UK (and the same benchmarks) but the A to G scale has finer resolution, with the letter grades subdivided into 15 bands: 3 each for grades A, B and C (e.g. A1, A2 and A3, etc.), 2 each for grades D and E, but just a single grade for F and G[9]. This might work well in the future when many buildings have been upgraded and are operated efficiently, but it highlights the difficulty of setting a scale which gives adequate resolution at both ends of the scale, both before and after the desired market transformation has taken place.

The NABERS Energy for offices scale is also linear from 1 to 5 stars, with the median value set at 2.5 stars when the office scales were established in the late 1990s. In August 2011, the best performance end of the scale was extended from 5 to 6 stars. The calculation of the 6 star level was taken as 50% of the emissions at the 5 star level, or in other words a half-way point to the ultimate goal of zero emissions, potentially to be given 7 stars. 5.5 stars is set at a 25% reduction in emissions from the 5 star level. The change in philosophy creates kinks in the scales at the 5-star point. However, more recent NABERS Energy benchmarking scales (e.g. for shopping centres and hotels) are fully linear, and it is planned that a linear scale will eventually be retrofitted to offices.

There is thus a consensus that the grading scale should be linear with equal bandwidths and that the best performance should be aligned with net zero energy.

Issue 2 Recommendation: Use linear scale with equal bandwidths

Reasons

1. Linear scale makes it as simple as possible to interpret and to make comparisons (any numerical improvement in points score represents the identical amount of energy saved).
2. There are major difficulties with non-linear scales when it comes to mixed-use buildings.
3. Providing higher grade resolution (non-linear scale) at the good end of the scale makes it difficult to set a scale with adequate resolution at the other end, both before and after the desired market transformation has taken place. Domestic EPCs have this problem.
4. The NABERS Energy for offices scale is linear from 1 to 5 stars. In August 2011, the scale was extended from 5 to 6 stars, creating kinks in the scales at the 5-star point. However, more recent NABERS Energy benchmarking scales (e.g. for shopping centres and hotels) are entirely linear. A fully linear scale will eventually be retrofitted to offices.
5. Consistency with the linear scale for DECs.

NB It is also recommended that the very top (best performance) end of the scale is aligned with net zero energy[1].

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[8] For example, a 10 point improvement from a rating of 25 represents a massive 40% reduction, whereas for a building rating 200 it is only a 5% change. But from a national policy perspective they represent an equal amount of carbon dioxide emissions saved.

[9] Assuming the median falls, as intended, at the D/E boundary, such an arrangement allocates 11 bands or sub-bands to one half of the stock and only 4 to the other half.

2.3 Issue 3: Scale metric

The scale metric defines the units used to quantify where a building lies on the scale. There are three main contenders for the LER's headline indicator, all of them employing area normalisation[10]:

- $kgCO_2/m^2$
- kWh of energy weighted according to source, for example electricity equivalent/m^2
- A non-dimensional scale

The metric used by NABERS is $kgCO_2/m^2$. Carbon dioxide still just about resonates as the most obvious metric to be used for rating the energy efficiency of buildings in the UK. However, it is far from perfect and has been coming under increasing criticism as a single indicator. In particular:

1. It is problematic to define the correct carbon intensity factors for energy sources. Electricity, natural gas and biomass are especially difficult.
2. Carbon intensity factors can also vary markedly at different times of the day or year, or for different sources of supply in the case of biomass. They may also vary considerably from year to year. In addition, UK government policy is to reduce the average carbon intensity of electricity from the UK grid from its current annual average value of around 530g/kWh to less than 100 g/kWh by 2030[11]. Gas may come increasingly from imported LNG or even fracking and renewable sources. The claimed carbon neutrality of biomass is under increasing scrutiny.
3. There are many government policies relating to carbon, most of which employ different carbon intensity factors, making it impossible to align with all of them.
4. It makes international comparisons of building performance impossible, mainly because of the huge variations between the carbon intensity factors for electricity in different countries.
5. It raises questions about whether the rating scheme is assessing greenhouse gas emissions or energy efficiency: too much focus on carbon can distract from improving energy performance – both in specification and for management. There is a strong case for the LER to be an indicator of energy efficiency – rewarding the landlord's design and management.

The second option is to use an energy/m^2 headline indicator. There are several options:

1. To report and benchmark separately by **energy source**, and in particular to split out fuel and electricity, the approach used for example in energy consumption guides such as ECON 19. With growth in district heating and cooling systems, ideally heat would be split out too, but often heat and fuel are combined, as is the case with DECs. Alternatively, energy statements from district heat suppliers could include the fuel and electricity content of the energy supplied.
2. To combine into a single indicator of **delivered energy** [known as site energy in the USA]. Though simple, this has many drawbacks, especially not recognising that a unit of electricity has a much higher thermodynamic value (and cost) than a unit of heat.
3. To combine into **primary energy**, the raw input energy (e.g. at the wellhead), as used in much EU policy and practice[12]. Primary energy factors can be somewhat elusive, though less elusive than carbon factors.

[10] The area to be used for normalisation is discussed in section 7.1
[11] Committee on Climate Change: The 4th Carbon Budget - Reducing emissions through the 2020s, Dec 2010
[12] The term used in North America is **source energy**, with a slightly different definition, e.g. at the refinery gate

4. To combine into “**standard weighted energy”**, as used in the British Property Federation Landlord’s Energy Statement (LES). This uses simplified factors similar to those of primary energy, but has the advantage of consistency and the potential to be used anywhere in the world.
5. To combine into kWh of **electricity equivalent**, measuring the amount of electricity used and adding an equivalent amount to account for any other fuels used. The approach is similar to standard weighted energy, but uses a real world rather than an artificial metric and is therefore more user-friendly (a kWh of electricity is a unit everyone can relate to).

Electricity ‘equivalence’ could be calculated using the ratio of carbon intensities between each fuel and electricity, an approach adopted in parts of the DEC methodology. For example the carbon intensity ratio between a kWh of natural gas and a kWh of electricity using the factors used by DECs is 0.352. Or, as for standard weighted energy, it could simply employ a weighting factor which is roughly commensurate with the environmental, thermodynamic and financial ratios between electricity and other fuels. For fossil fuels, one might multiply the fossil fuel kWh by a factor of between 0.3 to 0.4 and for delivered heat by 0.4 to 0.5. At first sight, this may appear clumsy, but it has significant advantages:

1. For air-conditioned offices, the majority of the energy cost and CO_2 emissions arising from landlord’s services is due to the use of electricity. Indeed, in the significant minority of all-electric offices, electricity use **is** the key performance indicator.
2. It avoids most of the issues inherent in using CO_2, because the key energy carrier, electricity does not need a weighting factor.
3. Looking to the future, it is being forecast by most commentators, and by the government, that the relative importance of electricity is only going to increase.

Another possibility is to use a non-dimensional scale, as for DECs. This is particularly appropriate in a system created for multiple building types which have intrinsically different energy intensities per m^2 as one can use a standard approach across the whole range of different building types[13], including mixed uses. As with DECs, a non-dimensional rating is easily calculated by dividing an absolute metric for the measured energy performance, such as $kgCO_2/m^2$ by a benchmark in the same units. For DECs, this ratio is multiplied by 100 to give a simple numeric rating. The same approach could be used with stars. For example, each star could cover 25 points. 7* might be allocated to ratings from 0 to 25, the border between 4* and 3* would be at 100 and 1* would be from 150 to 175. The similarity with DECs should be helpful and the metric adds resolution to the star scale.

While none of the options is perfect, on balance there does seem to be a strong argument for using kWh of electricity equivalent/m^2 as the headline indicator, and having a simple but defensible set of standard weighting factors for non-electric energy carriers[14].

[13] With a non-dimensional scale, the bandwidth naturally aligns with the energy intensity of the sector being rated. With an absolute metric, the bandwidth needs to be adjusted for building types with significantly different energy intensities such as hospitals and supermarkets, as happens with NABERS Energy.
[14] There is no reason why dimensionless scales cannot also be used behind the scenes to allow an approach to be consistent across sectors – this is the difference between content and presentation.

Issue 3 Recommendation: Scale metric should be kWhe/m², using standard weighting factors for non-electric energy carriers. Weighting factors of 0.4 for fuels, and 0.5 for heat, would make the LER 100% compatible with the Standard Weighted Energy factors already used in the LES.

Reasons

1. For air-conditioned offices, the majority of the energy cost and CO_2 emissions arising from landlord's services is due to the use of electricity. Indeed, in the significant minority of all-electric offices, electricity use is the key performance indicator.
2. It avoids most of the severe issues inherent in using CO_2, because the key energy carrier, electricity does not need a weighting factor.
3. Looking to the future, it is forecast by most commentators, and by the government, that the relative importance of electricity will only increase.
4. It facilitates international comparisons of building performance.
5. It fits best with a scheme that is rating energy performance (not CO_2 emissions) – though CO_2 can always be used as a secondary indicator.

2.4 Issue 4: Extent of the scale

If one elects to go with stars, there are two decisions to make about the star scale in order to decide its resolution and extent:

1. Choosing the maximum number of stars, ie at net zero energy. This could be perhaps 5, 7 or 9 stars.
2. Whether to increase resolution by allowing the use of half stars or decimal stars (e.g. 3.7*)

The argument for more stars stems mainly from a wish to extend the coverage of stars further into the poor performance spectrum (for a fixed bandwidth, the more stars available, the wider the coverage). However, once a scale exceeds 7 stars, it becomes hard mentally to tell the rating immediately. The best-known star scale is the one used for hotels across the globe. Historically it had a maximum of five stars, for instant recognition as one passed by[15]. NABERS also started with five stars, but now has six and plans to go to seven. The benefit of instant recognition from the star label can be seen in the snapshot from the NABERS Energy certificate shown in Figure 3 with its current six star maximum. With more than seven stars, such a pictorial representation is in danger of becoming irritating (the brain has to start counting), rather than a potential iconic badge of honour. We believe that a 7* scale offers the best compromise between coverage and readability. The UK DEC certification system also uses a 7 point scale (A to G). Using a 7 point scale for the LER provides for a level of compatibility between the two schemes.

Figure 3 Snapshot of the star rating graphic in a current NABERS certificate

Issue 4 Recommendation: Use a 7* scale

Reasons

1. The argument for more stars stems mainly from a wish to extend the coverage of stars further into the poor performance spectrum (for a fixed bandwidth, the more stars available, the wider the coverage). However, once a scale exceeds 7 stars, it becomes hard mentally to tell the rating immediately.
2. We think that a 7* scale offers the best compromise between coverage and readability.
3. This provides compatibility with DECs, which also use a 7-point scale, A to G.

[15] In passing, we reflect for a moment on how transformative it would be for the energy efficiency of hotels if the hotel industry took a leaf out of the Property Council of Australia's book and required 4* and 5* hotels to achieve a certain operational energy performance to keep their star rating. We also note that in the last decade, in some jurisdictions, the maximum hotel rating has been extended to seven stars, some would say dubiously.

2.5 Issue 5: Scale resolution

Even with a 7* scale, it will be essential to offer some variant of fractional stars to increase the chances that a year-on-year improvement can be rewarded by a change in rating. The advantage of NABERS' half star approach is that it can be clearly represented pictorially which would not be possible for decimal stars. With a maximum set at 7*, half stars create a 14 band scale[16]. However, even 14 bands falls a long way short of the 25 point resolution for each of the A to F grades available in DEC ratings plus an unconstrained continuation of the scale in the G band. We therefore believe that decimal stars should be shown in the part of the LER certificate where the current rating is compared with those for previous years. This would provide a 70 point scale. For the graphic on the certificate, the rating would be rounded down to the nearest star, ie 3.9* would show pictorially as 3*.

Issue 5 Recommendations: Use decimal stars in calculations and year-on-year comparisons

Use whole stars for graphic on certificate

Reasons

1. With maximum at 7*, half stars create 14 band scale, including 0.5 stars. Even 14 bands falls a long way short of 25 point resolution for each of seven grades available in DEC ratings. Decimal stars provide a 70 point scale for year-on-year comparisons.
2. The decimal star rating is arithmetically more consistent with the integer operational rating scale used for DECs than a fractional scale, albeit it must be recognised that the scale has reversed, in that a higher value reflects a better energy efficiency.
3. The majority of users will only be concerned with headline performance, so rounding down to whole star for headline performance presentation will meet their needs. The system can easily be built with the facility to switch to rounding down to half stars if this is decided in the future.

[16] NB The NABERS scale has 13 points because the first step on the scale is at one star, not 0.5 stars.

2.6 Issue 6: Scale calibration

The final step to define the LER scale is to set the bandwidth. With the proposed choice of scale metric, this boils down to how many kWh of electricity equivalent per m^2 should separate each star. In principle, to maximise the resolution available, one is trying to calibrate the scale so that the median of the national office building stock sits at the mid-point (3.5* for a 7 star scale) and ideally, the very best performers are within striking distance of the top of the scale (net zero energy in this case). Alternatively, one might recognise that typical current performance cannot yet reach these goals, anticipate that the rating process itself will incentivise improved performance, and accept that the median may take some time to reach the scale mid-point, for example getting there in five or ten years' time, as building performance is upgraded.

For a linear scale already anchored at zero for the best performance, the most transparent method for setting the bandwidth is to fix one more point on the scale. Even this poses a significant challenge: setting the point too ambitiously would mean that a significant proportion of the stock would not even get on the bottom rung of the scale; if the point is set too leniently, one may reward mediocre performance unduly and be out of step with the DEC scale. There are two fundamental choices for calibrating the scale:

1. **Statistics**: this would involve calculating the median for a sample of the target stock and assigning this value to a particular star level. NABERS initially set its median at 2.5* on a 5* scale. It would be most logical to set the median of a 7* LER scale at 3.5*. However, as discussed above, it would also be justified to set today's median at say 2.5*, in expectation that within 5 years the median would have improved to 3.5*, ensuring the scale remains fit for purpose for at least a decade.
2. **Criterion**: a key requirement of the BBP is that the LER scale should be consistent with whole building DECs. This can be achieved transparently by calculating the allowance in the DEC benchmark for landlord's services and assigning this value to a particular star level. It can be expected that the median energy use of the target stock will be higher than the DEC allowance[17], and so it is possible that 4* would be an appropriate initial level for this point.

We recommend setting the bandwidth by combining both these mechanisms: starting with the criterion approach and reviewing this in relation to what evidence is available from the statistics.

2.6.1 The DEC allowance for landlord services

The standard TM46 DEC whole building electricity and non-electricity benchmarks for offices in kWh per m² GIA are shown in column 2 of Table 1. These benchmarks were originally derived from the energy end use breakdowns in ECON 19, roughly as shown in column 3 where the normalisation has been switched to treated floor area, because this is the denominator used by ECON 19. The whole building values have been converted to kWh per m² NLA in column 4 and allocated between landlord and tenant in columns 5 and 6. Columns 7 and 8 show the landlord's share converted to kg CO_2 per m² NLA and kWh electricity equivalent per m² NLA (kWhe/m^2) respectively.

[17] The target stock for an LER is expected to have more air-conditioned buildings than the national stock of offices for which DECs have been designed, and many London buildings are more intensively used, not least because tenants need to exploit their higher rental value to benefit their businesses.

Using our preferred metric, Table 1 shows that the total landlord share of the TM46 DEC benchmark is 103.7 kWhe/m^2. A 1% increase to this benchmark for landlord's services would take it to 105 kWhe/m^2. This would be a very convenient value for the 3.5 star point on a 7 star scale, giving a width of 30kWhe/m^2 per star band or 15 kWhe/m^2 per half-star band.

Energy end use	Whole building TM46 benchmark	Whole building with ECON 19 end use breakdown	Whole building with ECON 19 end use breakdown	Tenant energy	Landlord services	Landlord services	Landlord services	Landlord services
	kWh per m² GIA	**kWh per m² TFA**	**kWh per m² NLA**	**kWh per m² NLA**	**kWh per m² NLA**	**kg CO_2 per m² NLA**	**elec.equ. per m² NLA**	**% of total**
Gas for heating+hot water		126.3	150.0	0.0	150.0	29.1	60.0	100.0%
Gas for catering		0.0	0.0	0.0	0.0	0.0	0.0	
Heating and hot water - electric		0.0	0.0	0.0	0.0	0.0	0.0	
Refrigeration and heat rejection		7.0	8.3	0.0	8.3	4.6	8.3	100.0%
Fans, pumps and controls		21.0	24.9	0.0	24.9	13.7	24.9	100.0%
Humidification - if fitted								
Lighting		27.0	32.1	25.7	6.4	3.5	6.4	20.0%
Office equipment		23.0	27.3	27.3	0.0	0.0	0.0	0.0%
Catering and vending		5.0	5.9	5.9	0.0	0.0	0.0	0.0%
Other electricity		17.0	20.2	16.2	4.0	2.2	4.0	20.0%
Computer room - if appropriate								
Total gas	120.0	126.3	150.0	0.0	150.0	29.1	60.0	100.0%
Total electricity	95.0	100.0	118.8	75.1	43.7	24.0	43.7	36.8%
Total weighted energy						**53.1**	**103.7**	**56.3%**

Notes: TFA = 95% of GIA; NLA = 80% of GIA

Table 1 Energy allowance for landlord services in the DEC benchmark for offices

A 15 kWhe/m^2 per half-star bandwidth would calibrate the LER scale as follows:

Electricity level		**Stars**
kWhe/m^2 NLA		
Start	End	
0	15	7
15	30	6.5
30	45	6
45	60	5.5
60	75	5
75	90	4.5
90	105	4
105	120	3.5
120	135	3
135	150	2.5
150	165	2
165	180	1.5
180	195	1
195	210	0.5
> 210		0

As a first check, in Figure 4 we compare this scale with the NABERS Energy scale for Victoria State (i.e. mostly Melbourne) expressed as electricity equivalent; and with scales based on 10 and 12 kWhe/m^2 per half-star bandwidths. The proposed LES scale is slightly tougher than the Victoria scale: 20 kWhe/m^2 or 0.5* tougher at 4* and 30 kWhe/m^2 harder at 1*.

To interpret Figure 4, it is helpful to think that where the line meets the x-axis is the take-off point for getting on the star scale. The flatter the gradient of the line, the more lenient the scale.

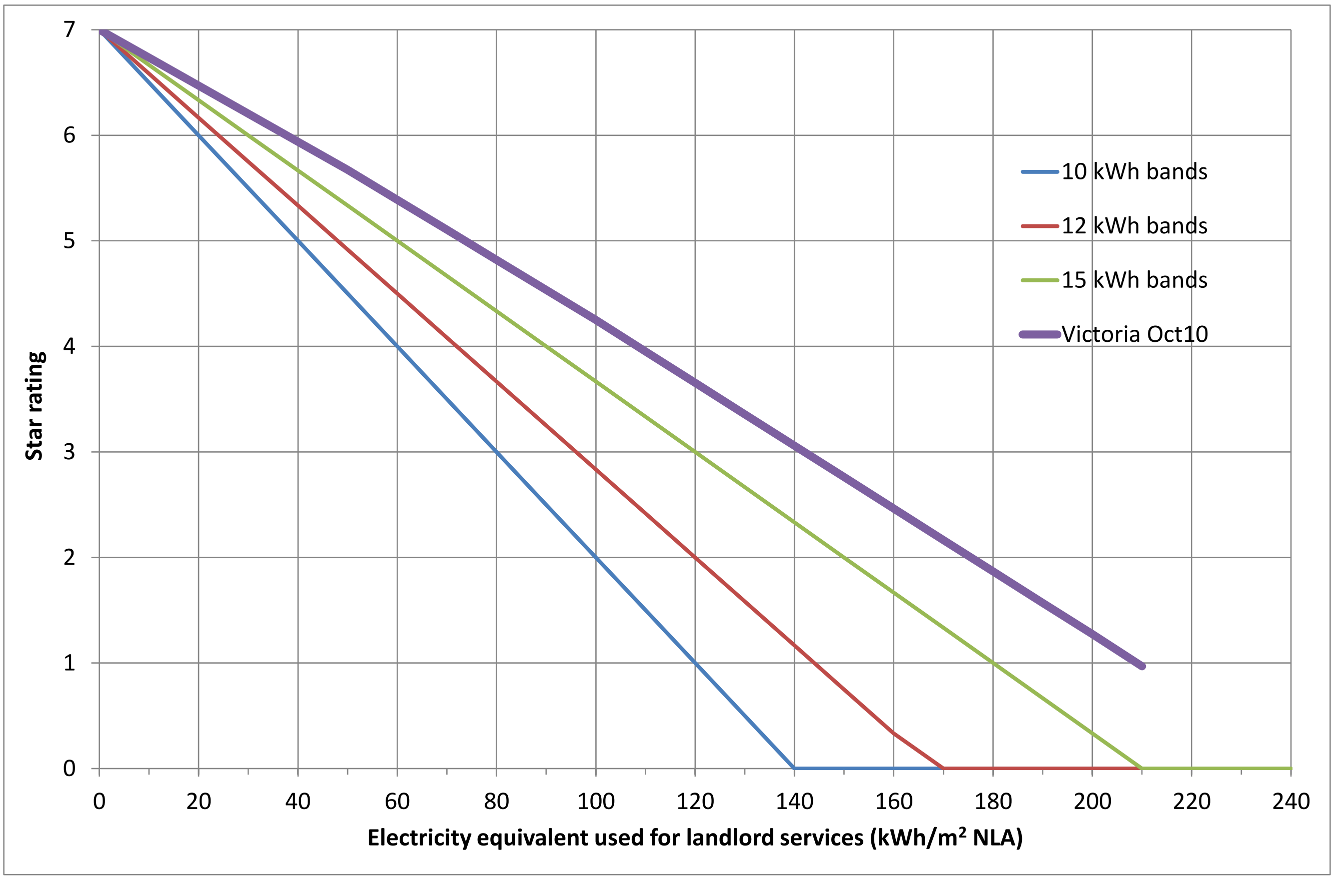

Figure 4 Comparison of possible different bandwidth scales with the star scale for Victoria

Issue 6 Recommendation: allocate 30 kWhe/m^2 per star band

Reasons

1. Fully consistent with DEC benchmark for offices
2. A convenient round number which extends the scale up to 210 kWhe/m^2 (zero stars).
3. Similar bandwidth to that used by NABERS Energy
4. Setting the point more ambitiously would mean that a significant proportion of the stock would not get on the bottom rung of the ladder.
5. Setting the point more leniently might reward mediocre performance unduly and be out of step with the DEC scale

It is noted that the benchmark allowance for landlord's services of 105 kWhe/m^2 at the 3.5*mid-point of the scale is made up of 45 kWh/m^2 of electricity (45 kWhe/m^2) and 150 kWh/m^2 of gas (60 kWhe/m^2).

2.7 Data for a sample of London buildings

Our recommendation for the calibration of the LER scale has been checked by applying the scales to the data for 36 London office buildings belonging to three different landlords. This analysis is highly preliminary, not least because no account has been taken of the contracted or actual hours of landlord's energy services nor for the impact of heating and cooling degree days. We did, however, take into account voids, where these were documented. Figure 5 shows the results in terms of the number of buildings with different star ratings, using a half star resolution.

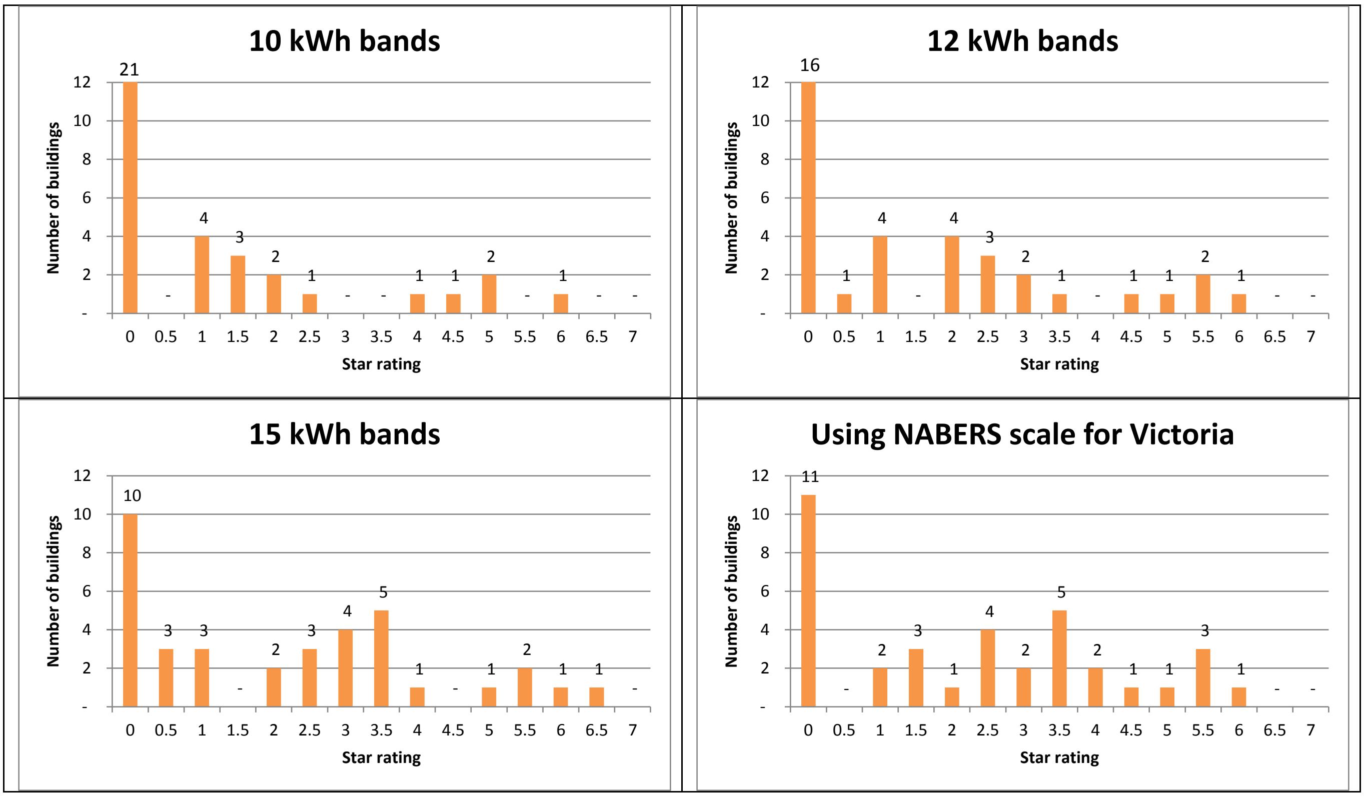

Figure 5 Data for sample of 36 London buildings from 3 sources (half star resolution)

For an easier visual comparison of the four graphs in Figure 5, the y-axis scale is the same, though this means that the column for zero stars goes off the scale for the 10 and 12 kWh bands, as denoted by the numbers at the tops of the columns. The 10 and 12 kWh bands rate respectively 58% and 44% of this sample with zero stars, whilst the preferred 15 kWh band rates 28% at zero. Rounding down to whole stars would lose the 0.5 star rating and increase the proportion of zero star ratings to 36%. The more lenient NABERS scale for Victoria has no 0.5 star rating, so rates 31% of the sample at zero.

Figure 6 shows the results for each of the 36 buildings in the sample, using the full decimal star rating. For each building, the rating improves as a more lenient scale is applied, by the amount shown in the Figure.

The results from this sample confirm that a 15 kWhe band width would set about the right standard, with a similar proportion of zero stars as in Melbourne. However, it is strongly appreciated that the sample is far too small to be definitive and it will be necessary to review this finding after a much larger trial with data from all BBP members.

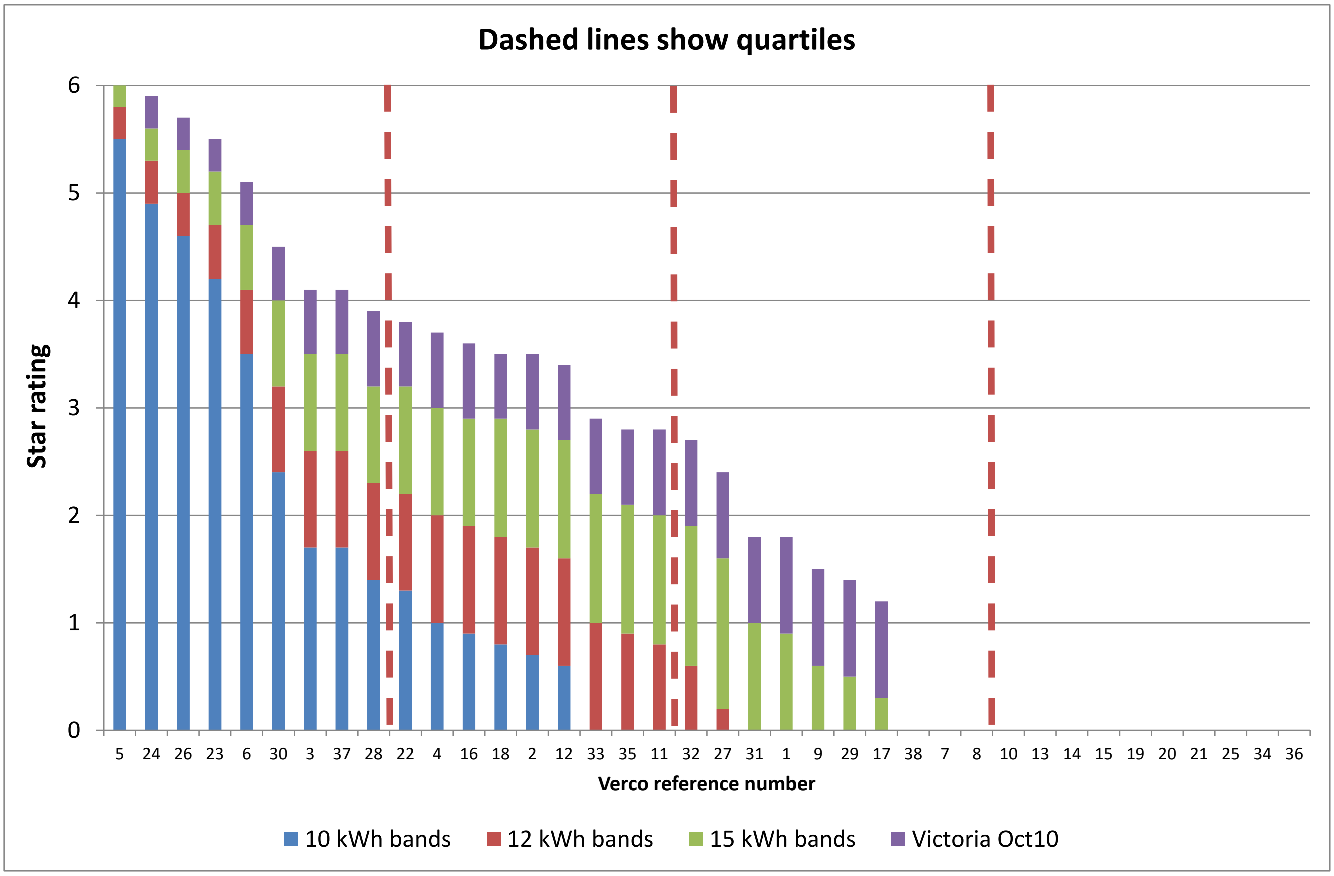

Figure 6 Variation of decimal star rating of the 36 buildings with bandwidth

3. Proposed calculation methodology

3.1 Core calculation

The method has three basic steps:

1. Calculate the kWh of electricity equivalent arising from all types of energy imported across the site boundary over a 365-day year in order to provide the landlord's services and divide by the total occupied net lettable area, NLA(o), to give the 'Actual' kWhe/m^2.
2. Adjust the 3.5 stars benchmark of 105 kWhe/m^2 to take account of requested hours of service per week and the local heating and cooling degree days for the year to produce a tailored kWhe/m^2 3.5 stars benchmark.
3. Divide the Actual electricity equivalent by the tailored benchmark to produce a non-dimensional performance ratio (NDPR) and calculate the decimal star rating (DSR) using the formula:

   For NDPR ≥ 2, DSR = 0

   For NDPR < 2, DSR = 7 – (3.5 * NDPR)

4. The DSR is rounded down to determine the whole (or half) star rating.

3.2 Detail for getting the Actual kWhe per m^2

The mechanics of this step are essentially the same as those used for DECs[18] except that electricity equivalent weighting factors are used instead of carbon intensity and the denominator employed is NLA(o) not GIA. The calculation of NLA(o) is described in the LER specification. It is noted here that using (a form of) NLA has three key advantages in the office sector:

1. The figure is more likely to be available and accurate, as it is the basis for calculating rent.
2. It enables a more efficient building design in net-to-gross terms, to be recognised in the rating.
3. The property industry prefers it, as representing the "business area" metric of the building.

The electricity equivalent weighting factors to be used are as follows:

Electricity	1.0
All fossil fuels	0.4
All thermal energy	0.5

As discussed in section 2.3, this permits a direct comparison between buildings with different mixes of fuel types, which may have similar efficiencies but very different CO_2 performance and takes some account of the upstream conversion efficiency from fuel to heat.

3.3 Adjustment for hours of use

It is proposed to make the same allowance for extended hours of use as is employed for the adjustment of the DEC benchmark for offices, shown in Figure 7, but only for the weeks (and fractions thereof) a space is occupied. The benchmark allowance for void periods will be zero.

[18] Note that, as with DECs, 'Green Power' purchases are treated the same as other grid electricity.

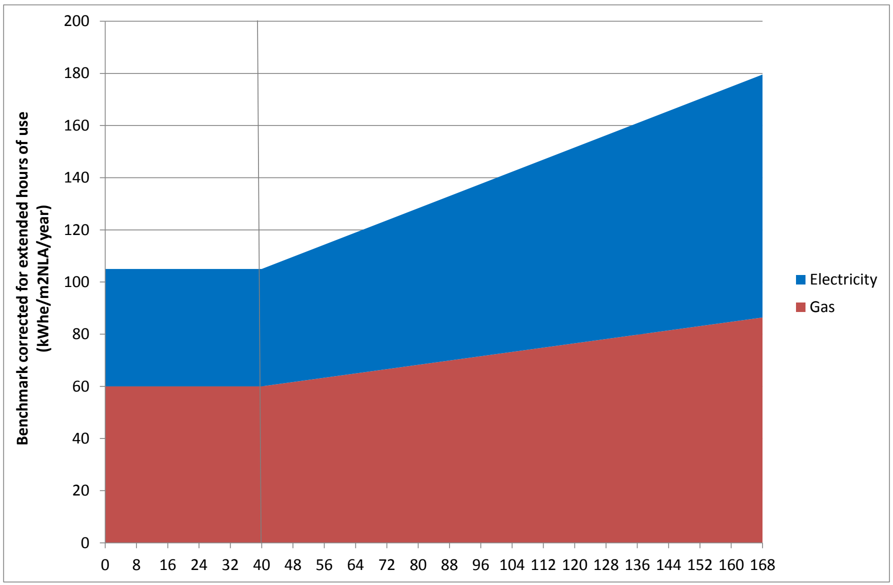

Figure 7 Adjustment of benchmark for extended hours of use, as used for DECs

In the DEC methodology, the mathematical representation of the adjustment of the benchmark for hours of use is as follows:

For $h \leq 40$, $BM_{h\ adj}$ (gas) = 60 kWhe/m^2/yr; $BM_{h\ adj}$ (electricity) = 45 kWhe/m^2/yr

$BM_{h\ adj}$ (total) = 105 kWhe/m^2/yr

For $h > 40$, $BM_{h\ adj}$ (gas) = $51.75 + 0.2063 * h$; $BM_{h\ adj}$ (electricity) = $29.953 + 0.3762 * h$

$BM_{h\ adj}$ (total) = $81.703 + 0.5824 * h$

Where h = average weekly hours of contracted service.

The neutral point occurs (ie no adjustment is made to the benchmark) for up to 40 hours of contracted service per week, or 8 hours per day for a 5-day week, as shown by a vertical line in Figure 7. For full 24/7 occupancy, the benchmark increases by 71%. There is no reduction in the benchmark allowance of 105 kWhe/m^2/yr for periods when a building (or functional space) is void[19].

The proposal for the LER is to consider each functional space in turn, divide the year into occupied and void periods, allocate zero benchmark allowance for void periods and for the occupied periods adjust the benchmark in the same proportion as used for the DEC benchmark for offices, as follows:

$BM_{h\ adj}$ (gas) = $W.(51.75 + 0.2063 * h) / 52$; $BM_{h\ adj}$ (electricity) = $W.(29.953 + 0.3762 * h) / 52$

$BM_{h\ adj}$ (total) = $W.(81.703 + 0.5824 * h) / 52$

Where h = average weekly hours of contracted service during occupied periods (see section 5).

And W = number of weeks the functional space is occupied in the year of measurement.

[19] This is viewed as a weakness technically, but the merits of an alternative which does account for voids or empty buildings must be balanced against the extra effort that would be involved and the disincentive that the more assiduous an assessor was in identifying void periods, the worse the DEC rating would become.

3.4 Adjustment for heating degree days

It is proposed to use the same adjustment for heating degree days as is employed for the adjustment of the DEC benchmark for offices. For each functional space, the benchmark allowance for occupied spaces is adjusted for heating degree days in the same way as the DEC benchmark for offices: take 55% of the fossil fuel benchmark ($BM_{h\ adj}$ gas) and adjust in proportion to the ratio of actual degree days to typical degree days base 15.5˚C for England and Wales for the occupied period.

$$BM_{adj\ HDD} = BM_{h\ adj}\ (elec) + 0.45 * BM_{h\ adj}\ (gas) + 0.55 * BM_{h\ adj}\ (gas) * (HDD_{actual\ base\ 15.5} / HDD_{Typical})$$

3.5 Adjustment for cooling degree days

There is no established formula applicable to UK office buildings for adjusting a cooling benchmark for cooling degree days. We therefore propose an adjustment for cooling degree days based on a theoretical calculation of the energy needed to cool incoming fresh air and examination of detailed operational data for one large office building in London. Clearly this approach will need testing against further data in Stage 2 of the LER development. The office building studied by Verco indicates that chiller energy consumption starts to increase with the average daily external temperature when this temperature exceeds about 10 or 11˚C, as shown in Figure 8.

We propose making an allowance for cooling the specific heat of the external air based on degree days base 10.5[20] and the following theoretical calculation:

Fresh Air change rate (l/s/person)	12
Occupant density (m^2 NLA per person)	10
Fresh Air change rate ($l/s/m^2$)	1.2
Volume of air change (m^3 per hour)	4.32
Floor to floor height (m)	3.5
Air change rate per hour (ach)	1.23
Density of air (kg/m^3)	1.29
Mass of air change ($kg/s/m^2$)	0.00155
Specific heat of air (J/kg/K)	1004
Specific heat flow of air change ($W/K/m^2$)	1.554
Typical CDD (degree days base 10.5 per year)	1100
Specific heat flow of air change ($kWh/m^2/year$)	41.03
Chiller system CoP[21]	2
Chiller electricity ($kWh/m^2/year$)	20.52
Energy per CDD (kWh per $CDD/m^2/year$)	0.0187
Allowance in LER for cooling ($kWh/m^2/year$)	8.313

And the final tailored benchmark adjusted for hours of use and both HDD and CDD becomes:

$$BM_{adj} = BM_{adj\ HDD} + (CDD_{actual\ base\ 10.5} - CDD_{Standard}) * 0.0187$$

Where $CDD_{actual\ base\ 10.5}$ is actual cooling degree days for the occupied period

And $CDD_{Typical}$ is the typical cooling degree days for England and Wales for the same period.

[20] Cooling degree day values are readily available from degree day suppliers to base 10.5, 15.5 and 18.5˚C
[21] A conservative value has been used to reflect all system seasonal inefficiencies and to recognise that the calculation does not address the relative humidity of external air.

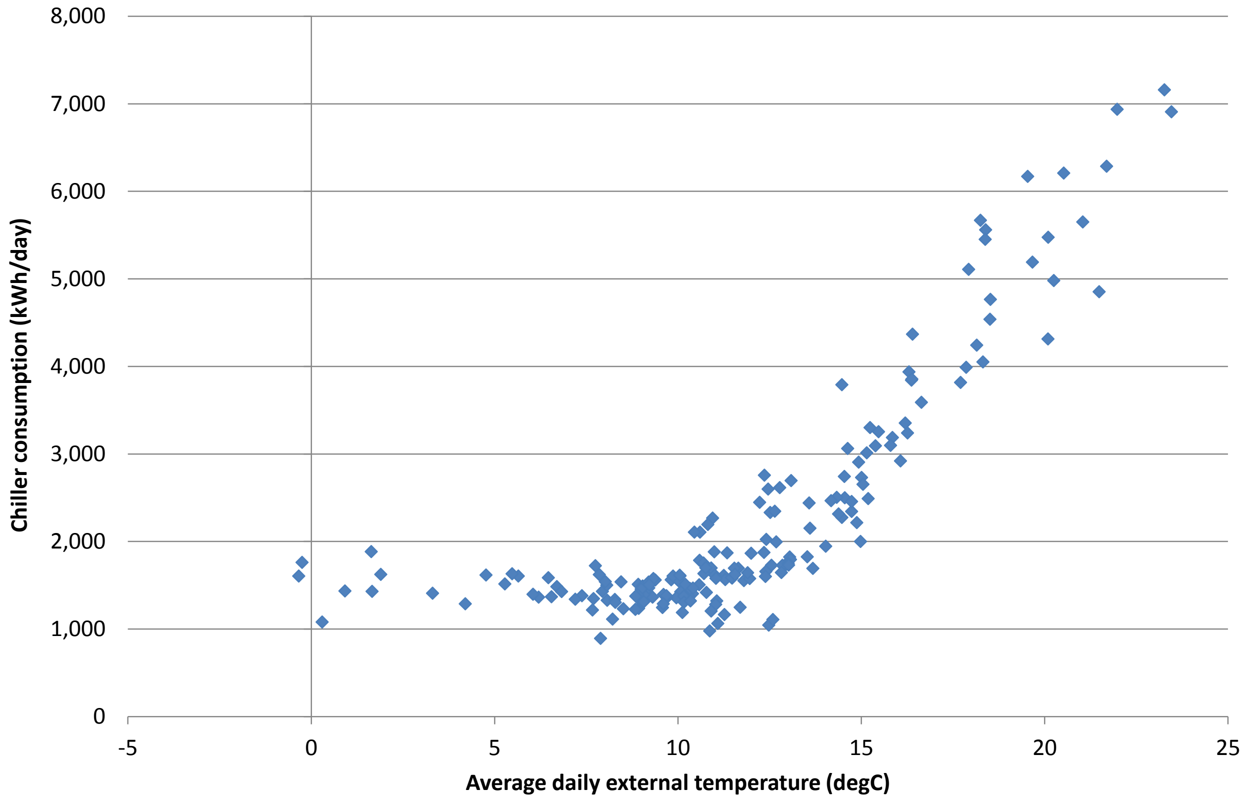

Figure 8 Chiller energy use vs external temperature for one large office building in London

NB It is recognised that the data for just one building should not form the only basis for deciding the formula for any benchmark adjustment for cooling degree days. But it is also important to point out that any proposed adjustment to the benchmark is unlikely to be significantly affected by which degree day temperature base is employed in the formula. The issue is to produce a formula which creates a proportionate adjustment in the allowance for cooling justified by the external temperature during the rating period, both in terms of an increase for warmer than average conditions and a decrease for cooler conditions. In average conditions, the formula should produce no adjustment.

4. Data collection tool

4.1 Development of the LES

It is proposed to employ the Landlord's Energy Statement (LES) as the primary data collection tool for the LER process. In stage 2 of the LER development process, it is anticipated that the existing LES will be used and that supplementary questions will be posed via a separate document to capture the following:

1. Clarity about the metering employed in the building and how the available meter data has been used to derive the actual landlord's energy for services in LER scope. The ideal response, or the evidence an LER assessor might be expected to produce, would comprise a full meter tree and a statement defining the calculation of the energy that is in LER scope.
2. Clarity about where and how much HVAC is provided by the tenant eg fan coil units or perimeter heating on tenant meters[22]. The ideal response would describe the technical details of such tenant supplements, quantify the service provided by the landlord (eg, for fan coil units, chilled water at 16˚C) and quantify the supplement provided by the tenant (eg fan power, top-up electric heating, etc.)

The nature of the responses will determine the changes required to the LES in order for it to be used for the LER. It is proposed that adjustments and refinements to the LES should be made as part of stage 3 of the LER development process. The proposed updating of the LES is anticipated to produce a common data collection platform, which when fully completed during an assessment, will enable the LER to be produced at the same time as a whole building and/or tenant DECs, although the LER delivery system may remain separate, at least initially.

4.2 Derivation of the energy used for landlord's services

In most office buildings, the amount of energy used to provide the landlord's services is derived in one of two ways (see Figure 9):

1. Directly from a Landlord's sub-meter that serves the main plant and common parts. For example, there can be direct wiring plus two sets of rising busbars: one for the landlord and one for the tenants. However, the wiring can become haphazard as things are added and the electrician uses the most convenient option.
2. By calculating the difference between the total energy supplied through the building's utility meters (those which are not dedicated to a tenant) and the metered sum of all energy supplies passed through to the tenants. This is likely to be advantageous for the LER methodology as it will incentivise landlords to maximise the proportion of tenant energy that they directly meter, making the LER more accurate. Where tenant energy is not directly metered, the LER will naturally become worse than its true value.

By contrast, where a landlord's service is 'skinny' ie it is supplemented by energy coming off the tenant meters[23], the LER will be unfairly better than a true value would reveal. Typical landlord's services that can be wired onto tenant meters are fan coil unit fans, local air handling plant, electric

[22] It may be expensive to find out if and how much this is present for some existing buildings – which may make them difficult or impossible to rate reliably, at least in the early stages of LER implementation. NABERS elected not to rate many buildings, and helped to drive the market towards more consistent and transparent standards.
[23] In principle, it is reasonable for HVAC services to be arranged in this way, in so far as it guarantees that the energy used by the tenant is paid for by the tenant. However, this situation contrasts with that in Australia where landlords are more likely to provide space which is "safe and comfortable for office work".

perimeter heating, electric reheat and HWS in WCs and refrigerant based heating and cooling systems[24]. We propose that the data collection tool will identify these circumstances. In principle, we believe it should be possible for the rating tool to estimate and then include the energy contribution to in scope landlord services provided by the tenant, based on some harsh assumptions (to ensure the LER rating is conservative). This needs to be investigated during Stage 2. In any case, we recommend that an LER certificate would show where ratings have been made on the basis of such estimates. Or it may not be possible to rate buildings of this kind.

One issue is that some tenant supplements may be for an intensive use and the energy involved should not all be included in an LER assessment. The LER should be based on the provision of a standard set of landlord's services, for example to meet the BCO specification. It may need to be left up to the assessor to judge where tenant supplements should or should not be included.

Where there are no sub-meters for the energy passed through to tenants, it is unlikely that the LER process can be used. Where tenants have their own utility meters for the energy used to meet their HVAC needs, it is unlikely that the LER process can be used without the full co-operation of the tenants.

4.3 Renewable Energy Generation

It is noted that the calculations described above will allocate all the benefit of any on-site renewables to the landlord. In some instances, occupiers may make a partial or full contribution for the cost of such systems and may wish to claim the benefits. Ideally, in these cases the renewable energy should be supplied directly to their premises which, like supplies through tenant utility meters, would leave it outside the boundary of the LER. More complex arrangements in which it is appropriate to share the benefits should be dealt with by special calculations by the LER assessor[25].

On-site electricity generation equipment, such as CHP or tri-generation, can also benefit a landlord if the electricity equivalent of its outputs exceed the electricity equivalent of its input fuel. However, the LER process does not need to measure the inputs and outputs specifically for such equipment.

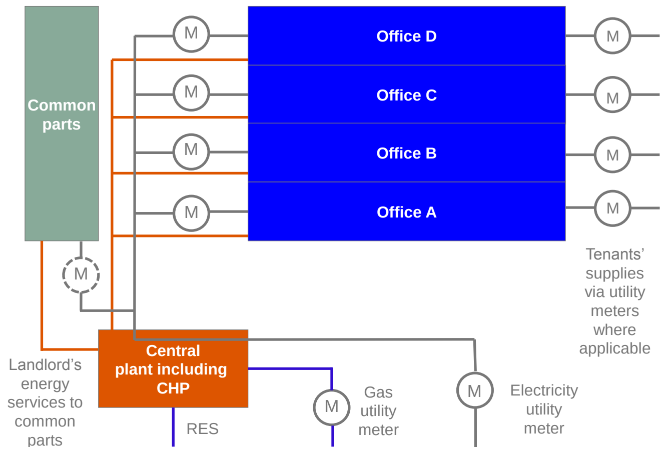

Figure 9 Schematic illustrating one metering arrangement able to derive an LER

[24] Many buildings are now being fitted out with distributed refrigerant based systems, encouraged by the EPC rating system which favours such solutions. The incentive to reduce the energy use of these systems remains with the tenant and as such, the associated energy is better measured and charged through the tenant's meters.
[25] It is suggested to deal with these on a case by case basis to build up a case law rather than deciding a definitive position in this outline specification.

5. Graphic design/content of certificate

The information recommended to be shown on an LER Certificate is shown on the next page and compared with the information included on a DEC and on the NABERS Energy certificate.

Additionally, it is proposed that the following technical table should be included on the certificate in small print or shown on a second page:

	This year	Separable	This year net of separables	LER total[1]	LER total normalised
Units	kWh/yr	kWh/yr	kWh/yr	kWhe/yr	kWhe/m2 NLA(o)/yr
Electricity					
Fossil fuel					
Heat					
On site RES electricity					
On site RES heat					
Total					

[1] Standard weighting factors used (kWhe/kWh): Electricity 1.0, Fossil fuels 0.5, Heat 0.4

A detailed comparison with the performance of the landlord's services in the previous 2 years might also be included on a second page (or the following information combined into the above table):

	Units	**Year - 2**	**Year - 1**	**This year**
Electricity	kWh/yr			
Fossil fuel	kWh/yr			
Heat	kWh/yr			
On site RES electricity	kWh/yr			
On site RES heat	kWh/yr			
LER Total	kWhe/yr			
LER Total	kWhe/m^2 NLA(o)/yr			
3.5 star benchmark	kWhe/m^2 NLA(o)/yr			
LER star rating	Stars to 1 decimal place			
CO_2 footprint[1]	tonnes CO_2/yr			

[1] CO2 intensity factors used (g/kWh): Electricity 550, Natural gas 194, LPG 234, Oil 265, Coal 291, Biomass 25.

The following information is not currently included on the certificate:

- EPC (asset) rating
- Whole building DEC rating (if done at same time)
- Energy saving recommendations
- Building use, e.g. office, call centre, trading floor
- Density of occupation (this is difficult and/or expensive to measure robustly and prone to 'gaming')
- Energy running costs.

The design of the LER certificate is really the province of professional graphic designers. We recommend that the design and final content is addressed in Stage 2, after provisional graphic design options have been produced.

Parameter	What and where on DEC	What and where on NABERS	What and where on LER
CERTIFICATE	Top	Top	Top
Logo for certificate	Display Energy Certificate How efficiently is this building being used? HM Government	Australian Government COMMERCIAL BUILDING DISCLOSURE A National Energy Efficiency Program	LONDON LEADING TO A GREEN LONDON BETTER BUILDINGS PARTNERSHIP **Landlord's Energy Rating for offices**
ADMINISTRATIVE DETAILS FOR BUILDING	Building occupier Building Name Building Address Certificate No. (RRN)	BUILDING DETAILS Building name: Infrastructure House Owner's name: Brookfield Australia Funds Management Limited Building address: 111 ALINGA STREET CANBERRA ACT 2600 Net Lettable Area of the building 16,176.9 m² Certificate no.: B0736-2012/1 Issue date: 8/06/2012 Current to: 27/04/2013 CBD assessor name: Sam Moffitt CBD assessor no.: CBDA0023	Building Name Building Address Certificate No. No. floors above ground Year of initial completion Year of last major alteration Photo
KEY PERFORMANCE INDICATORS	A to G grade using rainbow graphic Operational Rating Total CO2 this and previous 2 years graph OR this and previous 2 years graph	NABERS ENERGY RATING NABERS This building has achieved 4.5-STAR NABERS ENERGY RATING** (excluding GreenPower) Rating scope: Base building Rated area: 14,555.0 m² Rated hours: 50.0	LER whole stars - very large graphic Decimal stars this and previous 2 years NLA Main heating fuel Building environment (a/c,MM,NV) Hours of service per week Void factor Description of separables
SUPPLEMENTARY INDICATORS	Annual elec kWh/m2 Benchmark elec kWh/m2 Annual non-elec kWh/m2 Benchmark non-elec kWh/m2 % elec from renewables % non-elec from renewables	BUILDING CONSUMPTION & EMISSION DETAILS Annual emissions: 710,885 kg CO²-e per year Annual emissions intensity: 48.8 kg CO²-e/m² per year Annual consumption: 3,696,970 MJ per year	SEE SEPARATE TABLE
ADMINISTRATIVE DETAILS FOR THIS ASSESSMENT	Main heating fuel Building environment total useful floor area Asset rating Assessment software Property reference Assessor name Assessor number Acceditation Scheme Employer name Employer address Issue date Nominated date Valid until Related party disclosure	NABERS ASSESSOR DETAILS Assessor name: Sam Moffitt Assessor number: 26020 ABOUT NABERS ENERGY RATINGS 0.............. Very poor 1.............. Poor 2.............. Below average 2.5 to 3.... Average 4.............. Good 5.............. Excellent 6.............. Market leading	Building owner Building owner's address Assessment software Assessor name Employer name End date of assessment year Valid until Certificate status (provisional/official) Certificate quality (measured/part estimated)

6. Plans for the further LER development stages

The core tasks for the further development stages of the LER are listed below.

Stage 2a: Implementation of a prototype and testing (~4 months)

Issue LES + supplementary data collection form to BBP members for initial feedback

Issue LES + revised supplementary data collection form to volunteering BBP members for completion

Develop preliminary graphic design of LER certificate

Develop prototype LER calculation tool in Excel including an indicative LER certificate

Process energy performance data collected from BBP members through tool and review results

Develop 'case law' based on experience with preliminary application of the LER

Propose adjustments to the LER methodology based on empirical evidence

Delivery of final prototype tool, documentation of how it works and compendium of 'case law'.

Stage 2b: Refinement of prototype to enable estimation of tenant supplements (~2 months)

Determine method to enable the estimation of tenant supplements

Develop prototype LER calculation tool in Excel which implements tenant supplement method

Repeat data collection exercise with BBP members

Compare impact of modification on portfolio performance

Propose adjustments to the LER methodology based on empirical evidence

Delivery of final prototype tool along with updated documentation of how it works

NB Before stage 3 can be initiated, BBP will need to weigh up the pros and cons of different market-based models for software and other infrastructure delivery, and select their preferred option.

Stage 3: Preparations for roll-out (~9 months with multiple parallel activities)

Write a full specification with all terms carefully defined

Upgrade the LES to accommodate all adjustments and refinements necessary to act as data collection tool for the LER

Develop and test LER implementation software (web based application)

Develop guidelines on how to complete an LER and a training package for LER assessors

Establish/appoint an organisation to manage the training and accreditation of LER assessors

Develop QA and audit procedure

Develop a central data register and an ‘official’ process for issuing accredited LER certificates

Create a public access web site where issued LER certificates can be viewed and downloaded

Stage 4: Roll-out (activities required in addition to on-going LER assessments)

Manage accreditation of LER assessors

Manage arrangements for certificate delivery, QA and audits

Promote objectives and energy performance improvement outcomes of LER scheme

Police compliance requirements (if and when these are introduced)