Complying with the Minimum Energy Efficiency Standards (MEES)

Advantages of using DSM software to calculate the EPC Rating

Introduction

The Minimum Energy Efficiency Standards (MEES) for commercially rented properties was introduced in March 2015 by the Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015. They come into force on 1 April 2018. From that date landlords of non-domestic private rented properties (including public sector landlords) may not grant a tenancy to new or existing tenants if their property has an EPC rating of band F or G, as shown on a valid Energy Performance Certificate (EPC) for the property. The case study is based on a survey of commercial properties currently rated as F or G and identifies the circumstances most likely to lead to a poor rating. The second part of the case study demonstrates the advantages of using dynamic simulation software when assessing packages of improvement measures necessary to comply with the MEES legislation.

Assessing Energy Performance

Energy performance ratings in the UK are calculated using the National Calculation Method (NCM). For simpler Level 3 and 4 buildings a government software engine called the Simplified Building Energy Model (SBEM) can be used to generate Energy Performance Certificates (EPCs). A more accurate Dynamic Simulation Model (DSM) engine is required for more complex Level 5 buildings, but the DSM tool can also be used to assess Level 3 and 4 buildings if a more accurate rating is required. As CIBSE certified level 5 Energy Assessors we have used both SBEM and DSM to demonstrate the improved EPC ratings that can be achieved in many buildings using the more accurate DSM method combined with hourly weather data. The DesignBuilder interface allows you to switch between DSM and SBEM within the same building model, enabling direct comparisons to be quickly made.

The DSM and SBEM calculations are performed in very different ways. DSM simulates the building hourly throughout the year using the CIBSE Test Reference Year (TRY) weather file, while SBEM uses monthly averages. Furthermore, DSM can accurately account for shading by adjacent buildings and reflections from such buildings. This function is totally absent in the SBEM engine. The DSM engine also models the sun's position hourly throughout each day producing more realistic daylight levels and hence more accurately calculates the savings from installing daylight sensors.

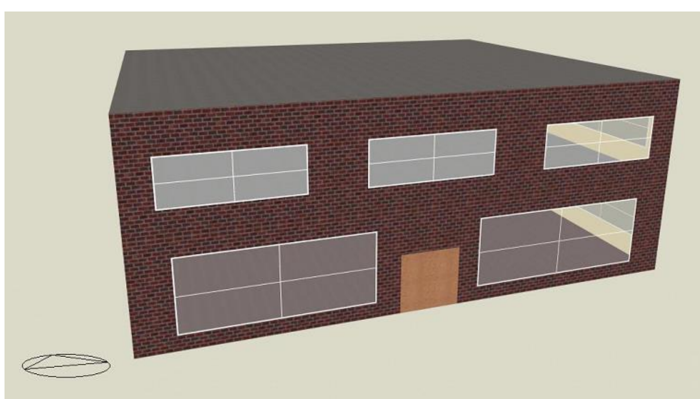
It is important to be aware that the EPC rating is based on CO_2 emissions and that the NCM assumes a CO_2 emission factor of 0.519 kg CO_2 per kWh for grid supplied electricity compared with 0.216 kg CO_2 for natural gas. Improvement measures to reduce electricity consumption will therefore be much more effective at improving the EPC rating than measures that reduce gas consumption.

Identifying Commercial Buildings with F or G EPC ratings

The Open Data Communities Energy Performance of Buildings Data site[1] has been used to identify buildings with an F or G rating. The site allows searching by the rating and provides the post code for the property. An online survey of a sample of F and G rated building suggest that some ratings are probably wrong. This was followed up with site visits to around 30 buildings to establish the age and type of construction and the services fitted. Some clear patterns emerged. In a few cases the building has been improved but the EPC has not been re-calculated. arbnco in their White Paper[2] have identified that inaccurate EPC ratings are a real threat to landlords. We urgently advise landlords with buildings having an F or G ratings to arrange for these properties to be re-surveyed and a new EPC rating calculated. In some circumstances, as illustrated below, using DSM rather than SBEM can improve the rating sufficiently to avoid having to invest in making energy saving improvements. The SBEM method will occasionally provide a better rating than DSM, so being able to easily switch between the two methods using the same model in one interface is valuable.

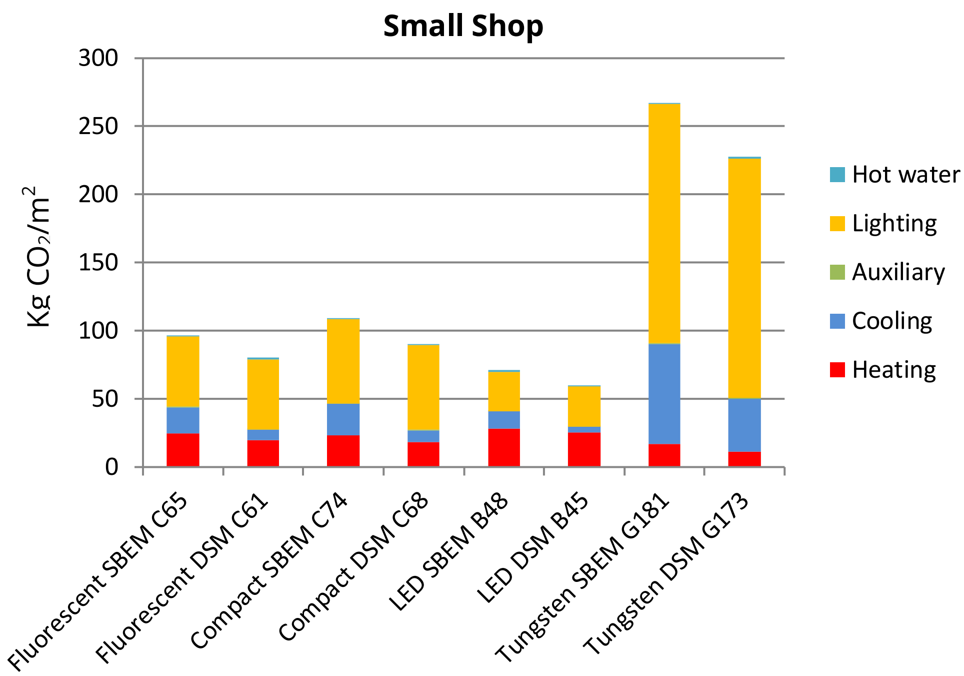
Many of the F and G rated buildings are relatively old, some dating from the early 1900s. These properties were typical of those found in long established high streets and are often small shops with offices above. Many have solid brick walls and relatively poor insulation levels. However, not all such buildings are rated as F or G and in the analysis below we consider two scenarios and identify the circumstances that lead to the poor rating and demonstrate what improvement measures are necessary to comply with MEES.

Scenario 1: Small Shop with Simple HVAC



Small shop with office above

Many small shops and offices found in a typical high street are heated by a boiler and radiators; with some having partial air conditioning using split air conditioning units. As noted many of the properties with F or G ratings date from the early 1900s and have solids walls. Walls are assumed to be solid brick with plaster on the inner surface, while the roof has a concrete slab with suspended ceiling but no insulation. We have also assumed a worst case scenario of single glazing, although many properties have had new windows fitted. These building elements can be quickly set up using the actual constructions data where known, or using inference and library options in the DesignBuilder DSM software. The inference and library options are incredibly useful when constructions data is not available and has to be estimated based on the building type and age. The boiler efficiency and split unit SEER are set to SBEM default values and infiltration is 25 $m^3/hr/m^2$, the default value in the absence of a pressure test. For such a building improving the fabric to the insulation levels required by the Building Regulations would be expensive and disruptive. One of the most cost-effective ways of improving the EPC rating is to upgrade the lighting system. The graph below shows how the EPC rating varies with different lighting types using the chosen option with efficacy values based on manufacturers' data rather than SBEM defaults.

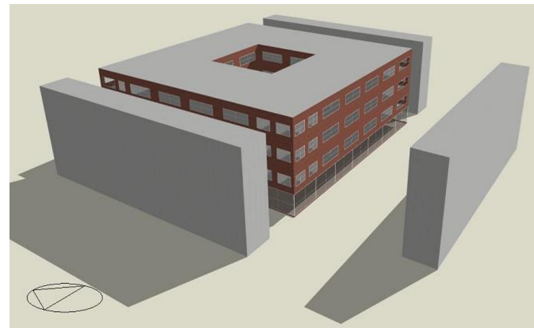


The result, which might at first appear surprising, is that this poorly insulated building with relatively inefficient services achieves an EPC rating of B or C provided tungsten lighting is avoided. It should also be noted the DSM produces slightly better ratings than SBEM in this case.

The reason for this result becomes apparent when we look at CO_2 emission by end use. Tungsten lighting, usually in the form of halogen spot lamps, found most frequently in the retail sector, are very much less efficient than other forms of lighting. The increased heat output from the lighting also increases the demand for cooling with the result that most of the energy is sourced from grid electricity leading to the G rating. For those shops with halogen lighting leading to an F or G rating the solution is obvious, replace the halogen lighting with modern LED lighting. In many instances there are direct LED replacement lamps that will fit into the existing luminaires. Based on LED lighting systems we have installed the cost is around £10 per m^2 including installation with a payback of 2 to 3 years.

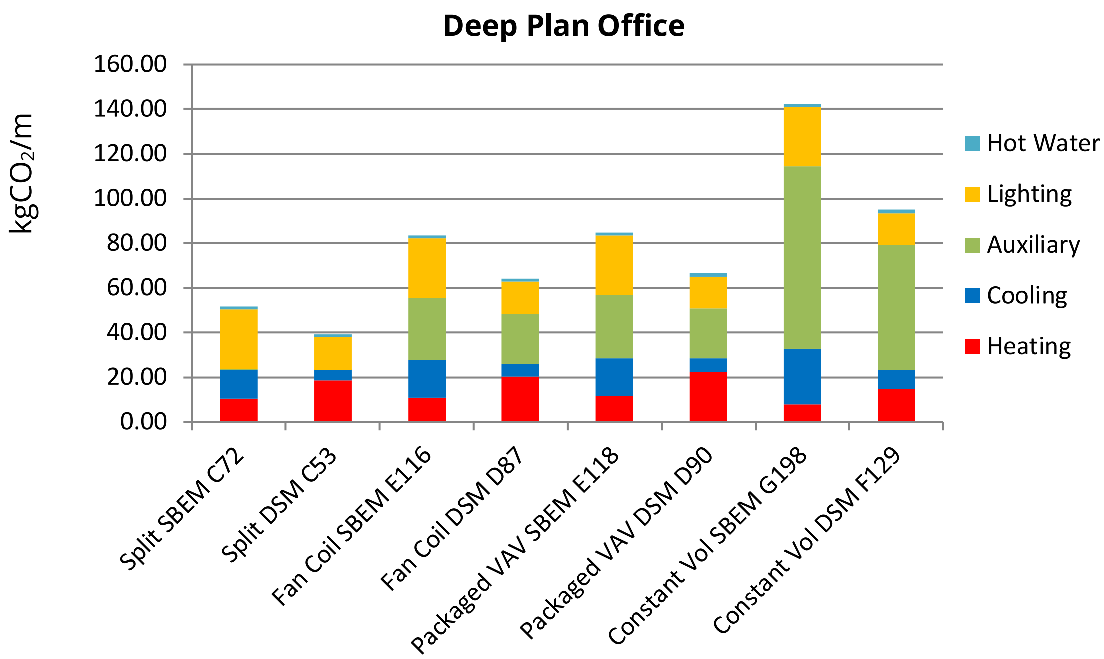
Scenario 2: Larger Properties with Centralised HVAC

For this scenario we consider a relatively deep plan 1980s office building located above shops in a town or city setting where it is surrounded on three sides by adjacent buildings as illustrated. It has a central courtyard to allow daylight to penetrate into the building and is assumed to be air conditioned and mechanically ventilated.



We have used DesignBuilder’s construction library method to set the building fabric and glazing to comply with Part L of the Building regulation for England and Wales 1980/85. Lighting is taken to be fluorescent with magnetic ballasts having efficacy of 60 Lumens per circuit Watt with a luminaire light output ration of 0.6 which we find to be typical of lighting of this period if it has not been upgraded.

The HVAC system must be selected from the list in the NCM. The algorithms in the NCM then allocate an auxiliary energy to account for the electricity used by fans and pumps which can be considerable and hence have a big effect on the EPC rating. We have calculated the EPC rating for a number of different HVAC systems using both DSM and SBEM engines. As can be seen below the DSM tool consistently produces better EPC ratings than SBEM in this instance.



The reasons DSM produce better rating than the SBEM tool are apparent when we look at the degree of shading by adjacent buildings and self-shading for this building as illustrated above. This degree of over-shading is not uncommon for many buildings sited in towns and cities. The shading considerably reduces heat gains in summer leading to a lower cooling load and also a lower auxiliary energy. SBEM does not consider the shading effect of external buildings and objects which gives DSM a significant advantage for cooling-dominated buildings. There is a corresponding increase in the heating demand in winter (assumed to be sourced from natural gas) but the net effect of the more realistic modelling is to considerably reduce the CO_2 emissions. Shading can increase need for electric lighting which increases CO_2 emissions.

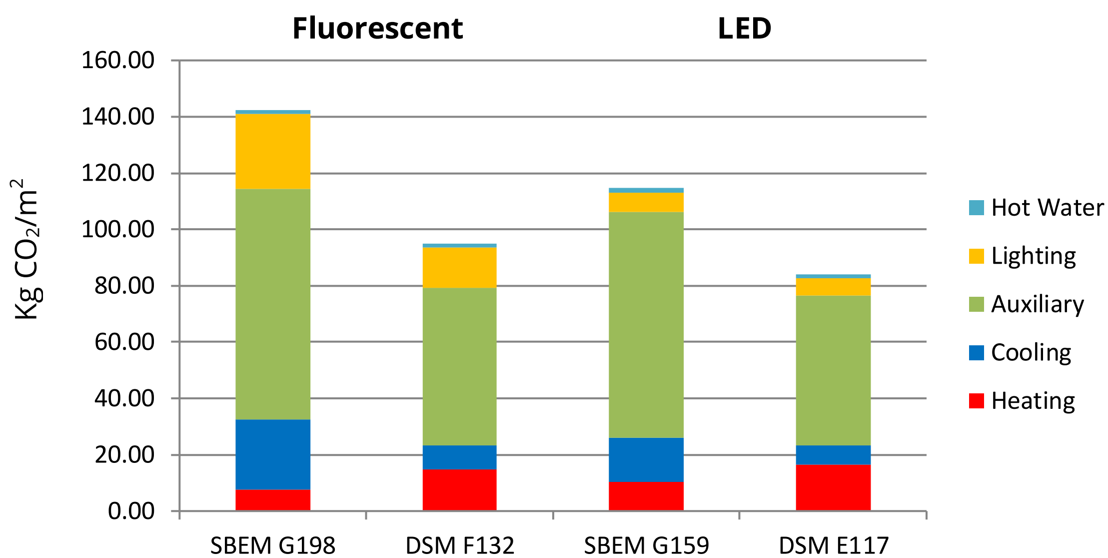
Complying with MEES when the HVAC system has large auxiliary energy assigned in the NCM

Where the HVAC system has a low auxiliary energy assigned in the NCM, it is relatively easy to achieve an E rating or better even if the building is poorly insulated. For VAV and constant volume systems the large auxiliary energy can lead to an F or G rating even for relatively well insulated buildings. In these circumstances the DSM engine offers a distinct advantage over the SBEM engine as it produces a rating that is often better by at least one band. The more accurate modelling possible with DSM may be all that is necessary for some buildings to improve the EPC rating so that the building complies with the MEES legislation.

When advising landlords on the most cost-effective measures to achieve compliance it is necessary to take account of the guidance in Approved Document L2B. Where the measures include the provision or extension of a controlled fitting or controlled service and or the replacement or renovation of a thermal element, the minimum standards set out in L2B must be followed. Where the insulation of the building fabric is poor it would be good practice to improve this before considering replacing the services so that any new plant can be sized to satisfy the reduced demand in the improved building. In the context of MEES however, refurbishing the fabric of the building could be costly and disruptive to tenants leading to other improvement measures to take precedence.

Improving the building without replacing the HVAC system

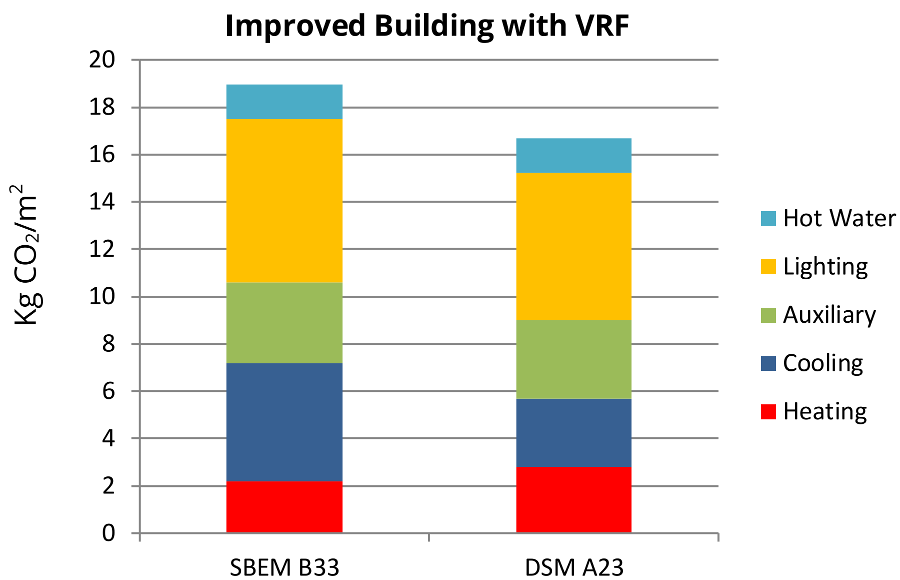
Each building is different and there are many possible combinations of improvement measures that could be applied to comply with MEES. We consider what measures would be necessary to achieve an EPC rating of E or better for the scenario 2 building above fitted with a constant volume HVAC system rated as F129 using DSM and G198 using SBEM. The building already has filled cavity walls and double glazing, so although poor by today's standards improving the insulation would not be cost effective. The easiest improvement measure to implement is to replace the old fluorescent lighting with modern LEDs and at the same time install combined daylight and occupancy sensors. The graph below compares the rating for the improved building calculated using DSM and SBEM engines.



The much-reduced energy consumption of LEDs compared with fluorescent lighting leads to a reduction in the cooling load. This in turn reduces the auxiliary energy with the result that CO_2 emissions due to electricity consumption are much reduced and the EPC rating is improved. The benefits of the more accurate modelling using the DSM engine (for this scenario) are clearly demonstrated in the E rating achieved with DSM compared to a G rating for SBEM.

Replacing the HVAC system in the improved building

Modern Variable Refrigerant Flow (VRF) systems providing heating and cooling with separate mechanical ventilation are considerably more efficient than constant volume and VAV systems. In the NCM VRF systems are treated as a split system. We have calculated the benefit of replacing the constant volume system in the improved building with a VRF system with a heating SEER of 3.5 and cooling SEER of 4.5 which are readily achievable. The system is assumed to have separate mechanical ventilation with heat recovery. The EPC rating is A23 when calculated using DSM and B33 when using SBEM.



The improved rating obtained with DSM compared to SBEM is once again demonstrated. With efficient building services even this relatively poorly insulated building can achieve an excellent EPC rating.

Making the business case for improvement measures to comply with MEES

The compliance tools SBEM and DSM should not be used to predict actual energy savings from improvement measures. These tools do not account for all energy use in a building and only consider regulated energy end uses under standardised occupancy and operating conditions. The actual energy consumption in a building can be very different from that predicted by these tools. This is especially true in modern offices with a high density of IT equipment.

We recommend using alternative methods that can account for all energy uses in a building for calculating the savings from improvement measures such as DesignBuilder EnergyPlus simulation software. As level 5 Energy Assessors we follow the principles set out in CIBSE TM 54[4] to account for all end uses of energy in the building (not just the regulated energy uses in the NCM). This allows more meaningful estimates of energy savings to be made which can be ranked in order of cost effectiveness and presented to landlords as the basis for a business plan to improve the building to comply with the MEES legislation.

Where there is significant capital investment we recommend using Life Cycle Cost Analysis (LCCA) to calculate the net present value over the life of the investment, which can be done using the DesignBuilder model. This is particularly relevant for measures with a long life time such as LED lighting which can last 15 years, greatly reducing maintenance costs.

All feasible improvement measures should be assessed and the most cost-effective package of measure put forward for funding taking into account the impact on the tenant's business and the possible increase in the value of the property after the improvements.

Conclusions

The scenarios presented in this case study illustrate how the differences between the DSM and SBEM methods can impact on EPC ratings. Where there is significant shading the more accurate modelling possible with DSM produces EPC ratings that are typically better by one band and in some cases two bands than those produced by SBEM. Re-calculating the EPC using DSM instead of SBEM may be all that is necessary for some buildings with EPC ratings of F or G to comply with the MEES legislation. The cost of the re-assessment using DSM would be more than offset by avoiding the cost of improving the building while also avoiding disrupting the tenants.

Where the EPC rating calculated using DSM is still an F or G, the business case for improvement measures should be assessed using methods such as DesignBuilder EnergyPlus software. This should represent the building as actually occupied and operated and account for all energy uses in the building not just the regulated energy uses in the NCM.

The new MEES legislation comes into effect 1 April 2018. Now is the time to act to avoid loss of business through not being able to renew a lease or let a new lease and possibly substantial fines.

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References

1. Open Data Communities Energy Performance of Buildings Data available for DCLG at https://epc.opendatacommunities.org/non-domestic/search.
2. White paper issued by arbnco entitled Minimum Energy Efficiency Standards (MEES) – The implication for rent reviews, lease renewals and valuation.
3. The Building Regulations 2010; Approved Document L2B 'Conservation of fuel and power in existing buildings other than dwellings'
4. CIBSE TM54 'Evaluating the operational energy performance of buildings at the design stage'