Towards integrated energy and environmental management of commercial buildings: The Onassis Cultural Centre (OCC) case

Effrosyni Giama¹, Athanasios Manoloudis¹, Agis M. Papadopoulos¹

¹Process Equipment Design Laboratory, Dept. of Mechanical Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece

Email: fgia@gmail.com

ABSTRACT

Buildings have a considerable environmental impact that corresponds to almost 30% of the global carbon footprint, with a prediction for future growth. To a large extent, although not limited to it, this is due to their energy consumption; in the EU this accounts for some 40% of the total final energy consumption. The EU therefore set a goal to reduce energy use by 20% by 2020, as part of the five headline targets of the European 20-20-20 Strategy. The goal was risen to 27% by 2030, as part of the new and more ambitious goals that were presented in 2018. Moreover, the European Commission has established since 2002 a common policy for sustainable buildings and low environmental impact materials, promoting energy efficiency and reduction of greenhouse gas emissions (GHG), expressed by means of a series of directives and regulations. The legislative framework for GHG emissions is supported by a series of international standards such as the Greenhouse Gas Protocol Initiative and the ISO 14064-6 series of standards which are fully compatible with the GHG Protocol and the Intergovernmental Panel on Climate Change. The Directive 2012/27/EU on Energy Efficiency is also important to mention, as it introduces obligatory Energy Audits in companies and organizations, as a major tool towards improving efficiency and promoting sustainability. Goal of the paper is to present and analyse the results of the integrated evaluation based on the energy and environmental audit of a very interesting public building, namely the Onassis Cultural Centre, in Athens, Greece. The building presented a real challenge with its daring architecture, the variety of uses it hosts and the state of the art equipment it features. Based on the audit’s outcome, the analysis the carbon footprint indicator was performed. The methodology followed will be presented in the paper, along with the opportunities we detected for improvements in the energy and environmental management, which was admittedly already at a very high level. From a scientific point it was very interesting to understand the patterns of energy use and to define the processes which contribute to more energy efficient and sustainable buildings, ensuring the low ecological footprint that is definitely part of integrated design of buildings. Finally, effective energy conservation and low carbon measures for public buildings are introduced and related to operating and production costs for buildings, making them hence more competitive.

1. Introduction

One of the major developments of the last decade is the existence of a quite explicit regulatory framework, setting specific goals and providing supportive laws, directives, standards and methodologies, focusing on clean energy, minimizing the energy consumption and reducing the CO₂ emissions. The timeline of the goals on energy and greenhouse gas emissions are in brief:

- 20-20-20 (20% improvement of energy efficiency, 20% greenhouse gas emission reduction compared to the ones of the reference year 1990 και 20% contribution to the energy used from Renewable Energy Sources)
Energy goal for 2030 (27%-30% improvement of energy efficiency, 40% greenhouse gas emission reduction compared to the ones of the reference year 1990, at least 27% contribution to the energy used from Renewable Energy Sources, 15% electricity interconnection target)

Energy goal for 2050 (greenhouse gas emission reduction 80%-95% compared to the reference year 1990)

Based on 2017 emissions’ level, there is a 22 % reduction from 1990 levels, which is more than the EU expectations for the target of 20 % by 2020. Based on the existing measures we are a bit far for the goal of 2030 but if we take some extra measures there is a possibility to reach the target. EU is not far from the targets set but there is some work to be done especially if we take into consideration the goals set for 2050 [1].

So there is undoubtedly a vision, a goal and a roadmap towards the decarbonisation, along with policies supporting the reduction of greenhouse gas emissions. An integrated decarbonisation strategy has many benefits, apart from the compliance with the legislation framework. Decarbonisation gives the opportunity to:

- Reduce operational costs due to energy use reduction.
- Reduce risks for the companies in face energy prices’ volatility and eventual supply uncertainty.
- Increase health and well-being, due to better indoor environmental quality, achieving higher customers’ satisfaction.
- Increase productivity of the staff and environmental awareness.
- Improve corporate identity and result marketing benefits, based on the visible commitment to reduce carbon emissions and environmental sensitivity.

The strategy towards Low Carbon technologies is usually driven either by economic and financial motives. The most significant motivation are economic benefits and the reduction of operational costs. Low Carbon Policy and technologies can be implemented in several systems, actually there is no limitation to systems boundaries. Therefore systems such as buildings, enterprises, production processes, etc. can be defined and analysed in terms of carbon footprint analysis.

Figure 1. Greenhouse gas emissions trends, projections and targets in the EU [1]
So keeping in mind that the EU energy roadmap is definitely focused on the promotion of low carbon economies, which is based on a specific legislative framework with certain and quantified goals concerning energy and CO₂, it is more than important to implement and focus on strategies, tools and methodologies that ensure the compliance with these targets. [2]

The energy and environmental certification processes promote environmental evaluation aspects relevant to the building’s life cycle, as an expression of the overall legislative framework for sustainable management of buildings. Therefore, and aiming to improve energy efficiency in the overall life cycle of buildings, emphasis must be given to the materials’ selection focusing on low environmental impact during the production process and the use of natural, recyclable or recycled materials, originating ideally locally, so as to minimise energy consumed for transportation and the resulting emissions.

Commercial buildings are buildings that, by definition, are intended to generate revenues and, in most of the cases, a profit, from capital value increase, rental revenues or both. There are sub-categories of commercial buildings, including but not limited to, offices, industrial buildings, shopping centers and hotels.

Even though the legislative framework for low carbon buildings is developing, the principal drivers for the decision to refurbish a building are still primarily the need to replace aging equipment and building elements and to improve the indoor environmental conditions for the occupants, in order to attract higher rental values and new tenants, and secondarily to reduce environmental impacts and CO₂ emissions.

Considering new buildings, low carbon design must be integrated into the general building design and introduce a new approach of energy design for buildings and construction in general. The design of most aspects of a building can make a difference to the energy performance, from the insulation of the envelope to the implementation of renewable energy technologies and low carbon technologies.

![Figure 2. GHG emissions by sector [3]](image)

Carbon Footprint Analysis (CFA) is a tool that promotes the aforementioned goals, as it focuses on quantifying the CO₂ emissions and their reduction and promoting sustainability and low environmental impact over the building’s life cycle. Carbon Footprint Analysis as a tool can follow other environmental tools and standards as they share common targets such as reduce environmental impacts and approach sustainability vision [4]. There are several tools and methods to establish integrated environmental management schemes such as Life Cycle Analysis (LCA), Ecolabel, Environmental Management Systems such as ISO 14001 and Energy Management Systems such as ISO 50001. The target of the different methodologies is in general terms the same nevertheless each one of the tools has different approach and general strategy. [5]
As part of promoting environmental policies in public buildings that function as landmarks, the Onassis Cultural Centre (OCC) has embarked on a 2 year programme, with the support of the Julie’s Bicycle organization, to develop its environmental programme, based on environmental thinking and action across its activities and establish the centre as an environmental leader. As part of this programme, OCC is working to establish a solid understanding of its environmental impacts including the energy use, performance and carbon footprint of its building and activities. This Energy Audit and Carbon Footprint Analysis is a key step in building this understanding and is based on a site visit and data analysis carried out for three years 2015-2016-2017. The audit and analysis is based on energy, water and waste data for OCC’s main building, but not its office which is in a separated shared building (OCC is moving to a new office also in a separate building in 2018), and estimates of employee and visitor travel.

The Onassis Cultural Centre’s construction was initiated in 2004. It is built on a privately-owned 3,000 m² plot on Syngrou Avenue in Athens, Greece, which is defined by four roads and covers an entire block. The Centre features 23.671.15 m² of interior space, which are distributed on 16 levels, 9 of which are below ground level. It houses two amphitheatres, with a maximum seating capacity of 880 and 220 respectively. They can be used for a wide range of events including theatre and dance performances, concerts, film screenings, lectures and conferences. Given the fact that they are used also for rehearsals of the various activities, they are operating for quite many hours annually. Further rooms can be used for lectures, educational programmes and round-table discussions, by using free-standing chairs. An exhibition hall of 700 m² is in the Centre’s underground level, specially-designed for exhibitions and other activities. The top store is housing the home to the Onassis Cultural Centre’s restaurant, which extends out onto the rooftop terrace during the summer months. [6]

2. Environmental Assessment: Measuring the Carbon Footprint Impact
Carbon Footprint Analysis is focusing on mapping greenhouse gas emissions throughout the products or processes, targeting at sustainability and economic benefits. A ‘carbon footprint’ is in that sense a measure of the greenhouse gas emissions associated with an activity or group of activities of a product or process.

The carbon footprint is a methodology to estimate the greenhouse gases emitted from the activities of a system studied. The system studied can be referring to production processes, industry activities, companies or organizations. The greenhouse gas gases based on Kyoto Protocol include Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), Hydrofluorocarbons (HFC), Perfluorocarbons (PFC) and Sulfur Hexafluoride (SF₆) [7,8].
- Carbon Dioxide (CO₂), which derives mainly from combustion processes and from materials’ production.
- Methane (CH₄), which derives from burning or deforming biomass (organic material) or refining and producing petrol and natural gas.
- Nitrous Oxide (N₂O), mainly from incinerating solid waste, spreading fertilizers, and/or various transportation means.
- Hydrofluorocarbons (HFC), occurring from industrial processes or and refrigeration and air conditioning.
- Perfluorocarbons (PFC), which derive as a byproduct mainly in aluminum production.
- Sulphur hexafluoride (SF₆), from electricity transmission and distribution equipment and electronic systems.

Each of those GHGs has a defined impact on climate change. So in order to compare different systems it is important to introduce a common measurement unit. And that is exactly the purpose of the ton of equivalent CO₂ (tCO₂e), which is defined as the concentration of CO₂ that would cause the same level of radiative forcing as a given type and concentration of greenhouse gas.

\[ \text{EnD} \times \text{EmF} = \text{CFI} \]  
(1)

The platform was based on the workbooks provided by the Intergovernmental Panel on Climate Change (IPCC) for national-level inventories, and it incorporates data from the Fourth Assessment
Report of the IPCC. The carbon footprint indicator derives from the energy used multiplied by the emission factor relevant to the type of energy or fuel used (16) at the different scopes [9,10]:

Scope 1: refers to direct emissions related to the organization’s operation and this can include: liquid fuels – petrol, diesel, paraffin and others associated with, for example, vehicles; and – gaseous fuel – liquid petroleum gas (LPG) and town gas. The second category refers to refrigerant gases used in air-conditioning units.

Scope 2: refers to indirect emissions deriving from the electricity used for the system’s operation for all the processes including transmission and distribution as well as in boundary transportation and stationary fuel combustion.

Scope 3: refers to indirect emissions related to the system studied such as waste management, transportation of employees, e.t.c.

3. Energy Audit: Measuring the Energy Consumption
In order to assess the building’s energy performance based not only on the data, but on the appreciation of the Heating-Ventilation-Air Conditioning, Lighting and the control systems real operational mode and condition, a Walk Through Energy Audit (Level 1 Audit) was performed. The audit was based on the data collected prior to the audit and on the interviews with the key personnel involved, aiming at: the collection of the data needed for a more analytical approach, the interpretation of the result of the theoretical analysis, the preliminary assessment of the potential for energy savings and the highlighting of the opportunities offered by conventional system maintenance work to implement energy saving measures. The findings per energy system and final use are presented as follows [11]:

3.1 Heating System
The heating of the building is achieved by means of two gas fired boilers with a nominal power of 1.100 kW each. Each boiler is connected with a natural gas burner with a power rating that varies between 300 – 1.750 kW. The operation status of the heating system is excellent, very well maintained and monitored, with the efficiency of both systems being over 92%. All crucial parameters of the building’s heating system are monitored by the Buildings Energy Management System (BMS). The heating production system feeds both Air Handling Units (AHUs) and Fan Coils Units (FCUs) via separate distribution networks. The distribution system (ductwork and insulation) of the heating power is in an excellent condition.

3.2 Air Conditioning - Cooling System
The cooling of the building is achieved by means of the following systems: 17 AHUs located at the roof terrace and the underground levels of the building. The total cooling capacity of the AHUs is 3.538,40 kW, feeding separate air distribution systems, 133 FCUs with a total cooling capacity of 483,40 kW and 20 additional small capacity air conditioning units of a total power of 53,6 kW, solely used for cooling spaces.

The production of the cooling power is ensured via the operation of two air-cooled liquid chillers each one of nominal cooling power 1.429 kW located at the terrace and of a heat machine of 1.756 kW at the underground level.

The separate cooling systems ensure the allocation of the cooling power to different operation zones, all of them thoroughly controlled and monitored by the Centre’s Building Management System (BMS). Both the operation and the maintenance status of the cooling systems are at an excellent level both in terms of maintenance and energy performance.

3.3 Lighting System
The lighting of the building is controlled by Siemens Instabus and BMS Design Insight. The lighting on the WCs, stairwells and the garages is activated by motion sensors. The halogen lamps have been replaced in the building with LED lamps as well. The exterior lighting of the facades of the building and the interior lighting of the golden shell are also equipped with LED lamps. At present there is an ongoing...
programme of replacing the remaining existing lamps with LED ones. Overall, the condition of the lighting system can only be characterized as excellent.

3.4 Building Management System
The OCC is equipped with a BMS Insight system. It allows the adjustment and control of the temperature and humidity of the air-conditioned spaces, as well as the speed of operation of the fans of the Air Handling Units via the respective inverters. In addition, the BMS enables: time programming, activation / deactivation of the air conditioning units to operate only when the spaces are in use, as well as controlling the energy saving scenarios during operation (e.g. free cooling and free heating based on external temperature compensation).

The Air Handling Units are equipped for energy saving purposes with Rotary Wheel heat exchangers, which, depending on the temperature conditions, transfer heating or cooling energy from the outlet air flow into the intake air flow, increasing or decreasing its temperature respectively. All critical factors (temperature, humidity, air flow speed and volume, operation status etc) are monitored by an extensive network of sensors and measuring devices, all connected and controlled by the BMS system.

4. The Onassis Cultural Centre Carbon Footprint
Carbon Footprint Analysis was implemented supported by Julies’s Bicycle Sustaining Creativity Software tool. Carbon Footprint Analysis follows the methodology of the IG Tools, an online tool developed by Julie's Bicycle specifically for carbon footprinting cultural and creative sector activities. Julie's Bicycle has developed a set of benchmarks to help organisations compare their environmental performance against the industry average for performing arts buildings, museums/galleries, offices and outdoor events. All benchmarks have been developed using data collected by Julie's Bicycle through Creative Green certifications, Creative IG Tool accounts and partner organisations from across the cultural sector. The benchmarks have been created using appropriate ‘relative’ metrics to make them more easily comparable to your organisation whatever its size or scale. The metric is per m², per year for buildings, and per audience day for festivals. [12, 13]

The data analysis concerned the energy and water consumption, waste management, transportation data for the personnel as well as for the visitors. The analysis is focused primarily on data for the year 2016 and the same analysis will also be conducted for the years 2015, 2016 and 2017.

In order to monitor and evaluate the environmental performance of the OCC building three different type of indicators were defined:
- Indicator 1 depicts the carbon footprint value normalised on the total building’s surface (TOTAL kgCO₂eq / m²)
- Indicator 2 depicts the carbon footprint value per performance (TOTAL tonnesCO₂eq / performance)
- Indicator 3 depicts the carbon footprint value per seat (TOTAL kgCO₂eq / seat).

The analysis results in the total carbon footprint emissions per month for the year 2016 considering parameters of energy, water consumption, waste management and transportation (personnel and visitors). The total mean Carbon Footprint for 2016 is 265 tonnesCO₂eq. The same analysis was implemented also for all the months for energy, water consumption, waste management and transportation for the years 2015, 2017 based on quantified input data.

The input data and the parameters quantified and used for the IG Tool implementation consider the main OCC building as well as the Hytra restaurant on the last floor. The energy, water and waste management input data derived from OCC database and consider years 2015, 2016 and 2017. Considering transport criteria the footprinting was calculated by the number of people visited OCC and the performance number at the two main stages of OCC.

The indicator 2 is based on the performances per month considering the central and the smaller scene of OCC and indicator 3 is actually the carbon footprint indicator normalised per visitor taking into consideration the number of visitors for the year 2016-2017 (114,885 visitors), 2015-2016 (132,262 visitors) and the total amount of performance by year. In correspondence to the results of 2016 similar
Calculations have been implemented for the years 2015 and 2017. Indicators 1, 2, 3 were separately observed by year and month. Nevertheless, mean values for the three years and for each month and indicator were quantified and presented in the figure 3 following.

![Figure 3. Mean Carbon Footprint Indicators per month and indicator](image)

Carbon Footprint indicators are strongly connected to energy consumption and attendance. Therefore, significant carbon emissions were calculated during summer in months June and July and something that is strongly connected to energy use mainly because of cooling. The input data derived from the Onassis Cultural Centre database. Considering energy (the input data are in detail presented to the energy audit report). Water consumption was referring to the restaurant use as well as the main building’s activities. It is also worth mentioning the existence of rainwater system as an effort to reduce the city’s water supply.

Waste production is about 266 weekly bin bags (from the restaurant and the main building 38 bin bags per day are produced). Considering transport there was an assumption for the audience transportation 40% of the audience is coming to the Cultural Centre by car and 60% by bus with an average distance of 10 km. Moreover, considering the personnel transportation two people are coming to work by bike and the majority by car and ten by bus.

![Figure 4. Breakdown of average carbon footprint emissions by source](image)
The important issue is actually energy efficiency, because it is strongly related to carbon footprint emissions as well as to operational costs. The carbon footprint indicator is in total compliance with the energy consumption so decreasing energy consumption will lead to carbon footprint and cost reductions. Considering the different parameters which influence the carbon footprint emissions, energy consumption is the key parameter for CO₂ emissions at 90% (fig. 5). The transportation process is another important issue for carbon footprint indicators but it is rather difficult to influence the visitors and the personnel to choose means of transportation. So apart from training, taking into consideration that there is car parking and bicycle parking, there is not many measures to be taken in order to introduce green means of transportation. In correspondence to year 2016 the same calculation has been implemented for the years 2105 and 2017. Considering the different parameters which influence the carbon footprint emissions, energy consumption is the key parameter for CO₂ emissions at about 92% for the year 2015. For the year 2017, the carbon footprint indicator is also strongly related to energy consumption and transportation. The is another important issue for carbon footprint indicators but it is rather difficult to influence the visitors and the personnel to choose means of transportation and contributes to the overall carbon footprint at about 10%. Finally, and taking into consideration the mean carbon footprint indicator by year it can be observed an small increase of carbon footprint indicator in 2016 (265 tn CO₂eq) compared to 2015 (257 tn CO₂eq).

The carbon footprint emissions are fully proportional to the energy consumption. There is a peak to energy consumption in June mainly because of cooling and electricity use and in autumn in December because of heating and gas consumption as it is depicted in figure 6 (reference year 2016).

![Figure 5. Energy consumption in relation to carbon footprint per month](image)

The carbon footprint indicator follows the energy consumption. Moreover, there is a clear division between the heating and the cooling period: Natural gas is being used for space heating exclusively, whilst electricity is being used for all other purposes (air-conditioning, lighting, office equipment etc.). A detailed analysis of the specific electricity consumption and also of the power utilization factor, which is depicted in Fig.7, indicates that electricity consumption is reasonable, given the extended operating hours and the increased indoor environmental quality requirements of the OCC. The annual average specific primary energy consumption of 394 kWh/m² is good, given the extended operation hours, the high standards for indoor thermal comfort conditions and air quality and the extended cooling period due to Athens’ warm climate.
Carbon management, including measurement, monitoring and capturing of emissions data, is very much needed when anticipating an increasing amount of reporting requirements and regulatory risks such as the proposed carbon tax. Conclusion ‘Standard’ and ‘methodology’ can have different meanings, and the ‘recipe’ used for calculating the carbon footprint should therefore be described clearly. There is not really a single perfect recipe – and the examples above indicate that the granular application can differ vastly, even when companies use similar recipes. The standards provide guidelines on the emissions accounting practice – just like in financial accounting. It is up to the company to decide what is relevant and applicable to its operations. What is really impressive is the power factor of no less than 0.985 and in many months of 1.0, which is a proof of practically no inductive power losses.

5. Conclusions
Sustainability in the built environment has emerged as a key issue amongst governments, policymakers, researchers and, not least, the public opinion. Increasing efforts and resources have been devoted to research and environmental policies in order to identify, evaluate and assess harmful environment impacts and try to reduce them. In this line of approach the role of cultural organizations and of important public buildings is of particular importance for two reasons: they are the landmarks of contemporary urban landscapes and they are ideal demonstration projects for the propagation of environmental consciousness.

This study discusses the environmental assessment of Onassis Cultural Centre’s facilities and activities and its contribution to carbon footprint, on a local and regional level. The carbon footprint analysis was used as a tool to define the processes, supported by Julie’s Bicycle’s IG Tools, taking into consideration parameters such as energy and water consumption, waste management and audience and personnel transportation. It is within this context, that Carbon Footprint Analysis has emerged as a more targeted method to assess the environmental impact and to foster sustainability in a broad range of activities. A preliminary interpretation of the results leads to two major findings: The OCC’s facilities are energy efficient and well managed, with some potential for improvement being detected, mainly in the heating requirement. It still has to be analysed to what extent this can be achieved without major interventions which are not justified by the building’s age and technology.

The environmental management of the OCC is certainly ahead of that in most similar buildings in Greece: this refers from energy and water to waste management but also, and this is quite impressive, to the attitude of the Centre’s management and staff. This is mirrored, in the Carbon Footprint Indices produced by this study. It can be deduced, that the energy consumption of the facility is the primary

**Figure 6.** Electricity and natural gas consumption per month
factor for the OCC’s Carbon Footprint: it accounts for more than 93% of it. The transportation of the OCC’s staff, in contrast, accounts for less than 10% (reference year 2016). The same results also derived from the data analysis concerning years 2015 and 2017. This is certainly good news, as it is within OCC’s reach to achieve improvements in the facility, whilst the urban transportation is an external factor. A detailed list of proposals on possible improvements will be delivered in the final study.

Moreover, and taking into consideration the mean carbon footprint indicator by year it can be observed an increase of carbon footprint indicator in 2016 (265 tn CO$_2$eq) compared to 2015 (257 tn CO$_2$eq).

Finally, it is noted, that the impact of organizing the OCC’s activities is an ongoing process giving emphasis mainly to training activities, awareness and attitude issues towards sustainability and quality of living.

References

[1] European Environment Agency, [https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-6/assessment-2](https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-6/assessment-2)
[2] (IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION COMMUNICATION COM(2018) 773)
[3] European Environment Agency, [https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-6/assessment-2](https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-6/assessment-2)
[4] E. Giama, Energy Performance of Buildings – Energy Efficiency and Built Environment in Temperate Climates, (Santamouris M., ed.), Life Cycle vs Carbon Footprint Analysis for construction materials, Chapter 6 (2016) pp. 95-106, ISBN 978-3-319-20830-5 ISBN 978-3-319-20831-2 (eBook), DOI 10.1007/978-3-319-20831-2, Springer Science & Business Media, New York
[5] E. Giama and A.M. Papadopoulos, “Sustainable Building Management: An overview of Certification Schemes and Standards”, Advances in Building Energy Research, 2012.
[6] [https://www.onassis.org/el/initiatives/onassis-stegi](https://www.onassis.org/el/initiatives/onassis-stegi)
[7] L. Cucek, J.J. Klemes and Z. Kravanja, “A review of Footprint Analysis tools for monitoring impact on sustainability”, Journal of Cleaner Production, 2012.
[8] A. Akbarnezhad, J. Xiao, “Estimation and minimization of embodied carbon of buildings: A review”, Buildings, 2017.
[9] M. Yu, T. Wiedmann, R. Crawford, C. Tait, “The carbon footprint of Australia’s construction sector”, Proc. Engineering, 2017.
[10] [http://www.sgt.gr/gre/SPG1/](http://www.sgt.gr/gre/SPG1/)
[11] L.Aye, T. Ngo, R.H. Crawford, R. Gammampila, P. Mendis, “Life cycle greenhouse gas emissions and energy analysis of prefabricated reusable building modules”, Energy and Building, 2012.
[12] [https://ig-tools.com/](https://ig-tools.com/)
[13] Low Carbon Retrofit Toolkit, A roadmap to success. London Better Buildings Partnership. BBP Green Lease Toolkit (2009) www.betterbuildingspartnership.co.uk/working-groups/green-leases/green-lease-toolkit