8 Equipping Better Buildings

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Learning goals

This chapter is dedicated to buildings and how to equip them better from a sustainability perspective. After studying this chapter, readers will have the ability to:

1. Discuss buildings and their impact on profit, people and planet;
2. Describe the main sustainability challenges faced by building developers considering the correct accreditation tools, the use of building materials, the use of equipment and financing of development projects;
3. Provide examples of ways to address some of these challenges;
4. Identify good practices in sustainable building.

Introduction

When discussing hotels, it is very difficult to do so without conjuring an image of a beautiful tower in a city centre or perhaps a majestic chateau in the countryside. Regardless of the initial image, chances are that the first thought was of a building of some kind. These types of buildings have existed for as long as the profession of hospitality has existed and have often demonstrated little regard for energy efficiency or the larger economic, environmental or social impacts of the built environment.

Sustainable building attempts to break with these practices by reducing negative impact and, when possible, restore the balance between the social, environmental and economic dimension of sustainability. By understanding the main challenges in this topic, one can begin to address them by considering the past and present in order to build for the future. Early efforts to bring change to the building sector in the 1960s through the 1980s generally focused on single issues such as energy efficiency and conservation of natural resources, but a movement to formalize led to the rise of committees and institutes in the late 1980s to the mid 2000s.

This included the American Institute of Architects (AIA) forming the Committee of Environment in 1989 and the United States Green Building Council (USGBC) forming in 1993 and them piloting their Leadership in Energy and Environmental Design (LEED) programme in 1998. Today green building features can include high-tech, modern practices such as geothermal heating as well as simple and often time-tested practices like attention to building orientation and design.

In this chapter, challenges and solutions of sustainable accreditation of buildings, selection of the best materials and equipment and financing options will be explored alongside some best-case practices of the same.

In reading this, please keep in mind that technological and organizational advancements in the areas covered here are developing at an increasingly fast pace. Though we have chosen examples carefully, it may be that at the moment that you are reading this, options are available that are better from a sustainability point of view than the ones presented here. Therefore, to enable you to evaluate existing and new options we would like to remind you of the general sustainability principles presented in Chapters 1 and 2: avoiding harm and doing good. When applying these principles to buildings one should consider the design, construction, usage and end-of life phases. In the design and construction phase, avoiding harm means designing the building so that it may take the most advantage from its position, for example, by letting sunlight in so that less artificial light is needed; respect as much as possible the local flora and fauna on the location, during construction and in landscaping; choose materials and building methods that consume as little natural resources as possible and minimize any health and safety risk for the people involved. Doing good in this phase would mean choosing a regenerative or restorative building, i.e. one that is purposefully designed to improve the surrounding environment by, for example, restoring a site's natural hydrology; providing for lost wildlife and plant habitat or producing more energy than the building itself consumes. A restorative building, moreover, chooses materials that, following the cradle-to-cradle philosophy, can be reused without loss of quality or can be safely disposed of in the natural environment. It is in the design phase, too, that one can choose options that permit repurposing of the building if it is no longer needed as a hotel. During usage, similar considerations are at play: reduce the use of natural resource and services, and care for the health and safety of staff and guests. In the end-of-life phase, if the building cannot be repurposed, demolition should be managed so that materials are recovered for new uses.

We have chosen the examples in this chapter by keeping the general sustainability principles in mind, and by considering the same principles we hope that you will be able to evaluate any new options available for hotel building in the future.

As any other chapter in this book, this one starts with a discussion of sustainability challenges; proceeds to best cases and closes with highlighting tools to address the challenges.

Main sustainability challenges

Below we will discuss what we consider to be the most pressing sustainability challenges in hotel building: accreditation of 'green' buildings; materials and energy; equipment and financing sustainable buildings.

Accreditation systems

There are several views and definitions on what makes a building sustainable and with that, there are several ways in which a building's impact may be measured. Some may focus on either environmental, economic or social impacts and others on a combination of those.

From an environmental perspective, it is estimated that buildings use about 30-40% of all primary energy, which is the energy contained in raw fuels before they are converted for human use. It should be moreover considered that "most of this energy is derived from fossil sources, and the hotel sector's contribution to global warming and climate change is estimated to include annual releases between 160 and 200 kg of CO_2 per m^2 of room floor area, depending on the fuel mix used to provide energy. Global hotel-based CO_2 emissions were assumed to be at the level of 55.7 Mt in 2001, while the estimated annual energy consumption for a European hotel of 39 TWh, would result in emissions of more than 10 Mt of CO_2 each year" (Hotel Energy Solutions, 2011: 2).

Buildings are energy intensive in all phases of their life. It is therefore logical that, from an investor's perspective, the best known economic argument for building with sustainability intent is the decrease in operating costs. These refer to the costs of the energy used by a building in its life-cycle for heating, cooling, lighting and ventilation. They also incorporate various maintenance activities and factors including insurance and property taxes.

In a social perspective, it is estimated that people spend 90% of their time indoors and poor health issues, allergies, asthma, acute respiratory illness have been associated with poor building design (Lackman and Bourdeau, 2008). Alongside the individual suffering associated with building-related illness, there are also major social costs. In the United States alone, the annual amount of these costs has been estimated at 58 billion dollars (CEC, 2008).

Consider that a developer intends of being sustainable with their construction choices; how can they be sure that they have made the right ones? This discussion may be the reason for confusion and is why there are institutions that allow clear definitions and set procedures to indicate the sustainability of a building. For the past few decades, building professionals have been refining their expertise and consolidating their efforts in the area of sustainable building design. To ensure coherence as well as consistency, and to respond to the need for a documented approach, tools and methodologies have been developed and are now recognized as a key element of achieving green building practices. Since the early 1990s, a number of organizations have developed green building rating systems that provide specific performance objectives and frameworks for assessing overall building design and performance. Each of these rating systems allocate points in areas such as energy use, water use, pollution, material and product inputs, indoor air quality and occupant comfort, transport, site ecology, and other sustainable design features. Their differences stem from the standard development process, philosophy on particular issues, and stringency (CEC, 2008). The challenge is in choosing which of the multitude of available systems is best. Whether the investors reasoning is principle based, financially based or a combination of the two, there are considerations to be made.

Materials and energy

Form a 'no harm' perspective, in the process of design to delivery of a (hotel) building, the aim is for an optimum use of resources such as energy, water and materials while reducing building impacts on human and environmental health. However, there are direct environmental impacts that result from the construction and operation of buildings including greenhouse gases and other air emissions related to energy use, water use and discharge, storm water runoff and impacts related to building materials (for some figures see Chapters 14 and 15). All these impacts represent sustainability challenges and will be briefly addressed in this sub-section.

According to a report from the University of Michigan, there are three lifecycle phases related to the flow of materials through the life of a building. Phase 1, the pre-building phase, describes the production and delivery process of a material up to, but not including, the point of installation. This includes extraction, processing, packaging and shipping of materials. Phase 2, the building phase, refers to a building material's useful life and in that factors such as construction, installation, operation and maintenance are considered. Phase 3, the post-building phase refers to the building materials when their usefulness in a building has expired, with considerations of recycling and reuse (Jong-Jin and Rigdon, 1998). The figure below shows these phases; the main areas in which impact may occur and options for reusing and recycling of materials.

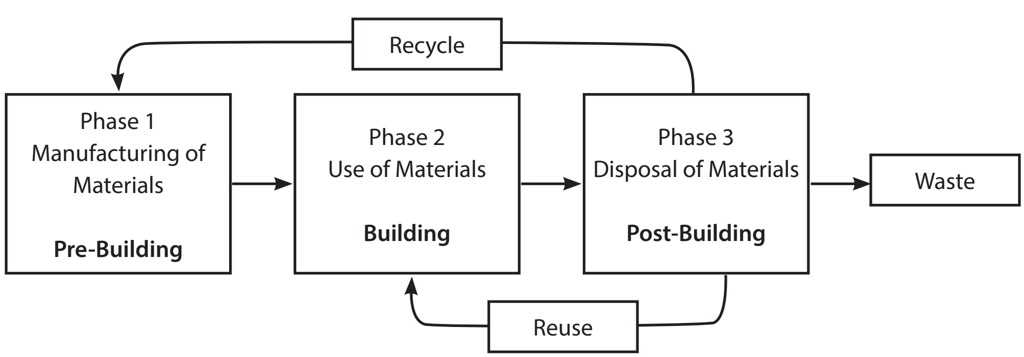

Figure 8.1: Lifecycle of materials (Designed by the author on the basis of an illustration by Jong-Jin and Rigdon, 1998).

A report prepared by the Secretariat of the Commission for Environmental Cooperation (CEC) states that data collected from Canada, Mexico and the United States show the negative environmental impacts of buildings. In Canada, buildings are responsible for 33% of all energy used, 50% of natural resources consumed, 12% of non-industrial water used, 25% of landfill waste generated, 10% of airborne particulates produced, and 35% of greenhouse gases emitted. In Mexico, buildings are responsible for 17% of all energy used, 25% of all electricity used, 20% of all carbon dioxide emissions, 5% of potable water consumption and 20% of the waste generated. While in the United States, buildings account for 40% of total energy use, 12% of the total water consumption, 68% of total electricity consumption, 38% of total carbon dioxide emissions, and 60% of total non-industrial waste generation (CEC, 2008). In the construction of buildings, it is therefore important to consider the materials used in an effort to reduce or eradicate these impacts.

Individual and social costs connected to building-related illnesses have already been mentioned. To these we should add social issues that may arise all along the chain, such as forced labour or unsafe working conditions. In Chapter 15 on Food and Beverage, for example, the unsafe working conditions for stone workers in China have been pointed out (Bjurling *et al.*, 2008). Similar issues are known for other building materials such as wood: forestry is in fact at high risk of forced and child labour, especially in Latin America (ILO, 2001) and Indonesia (ILO, 2010).

Looking at the post-building phase, from an environmental perspective waste and non-proper disposal of materials is a major issue. Socially, if buildings are not repurposed or dismantled, they may become ruined and unsafe. Ruined buildings may affect the whole surrounding community because by giving the impression that nobody cares they may encourage vandalism and other forms of asocial behaviour (Wilson and Kelling, 1982).

Equipment

When building a property, the developer has choices of the equipment to use in day-to-day operations. This equipment choice ranges from small to large units that are complimentary to the ideals of the developer, and in this case, responsible practices in looking after people, the planet and profit.

When looking at equipment sustainability challenges, there are three main areas of concern in the procurement, use and maintenance of operational equipment; and these are waste, energy and water. Waste includes hazardous material and operators should aim to reduce, reuse and recycle it. The issue of energy has already been raised earlier and will be discussed further on, as will water, which includes domestic and facilities use.

Waste is estimated to cost the United Kingdom approximately €48 per ton in landfill costs. A typical hotel guest generates one kilogram of waste per night with more than half of it in paper and plastic (Green Hotelier, 2009). From an environmental perspective, waste is problematic due to the carbon emissions generated, the amount of resources lost and landfill take-up.

Water scarcity is a well-known problem the world over and as global institutions, hotels have the moral responsibility to address this issue. Only 1% of global water is available in rivers, lakes and groundwater and it is this 1% that may be used while the remaining 99% is in oceans, the Poles and in glaciers. In many hotels water is known to account for 10% of the utility bill (Tuppen, 2013). This cost implication does not account for the double usage, in that water must first be purchased fresh, hence the utility expense, and then also disposed of as waste, which also has cost considerations.

From a socio-cultural perspective, it is important to note that the choice in equipment needs to be as thought out as the intention. For example, a property I am familiar with, located in South Africa, made a well-intended and expensive investment in a geothermal system. This system worked, until it didn't. By that I mean that whenever there were maintenance problems, the local support needed to fly experts in from the United States, and one could argue that the footprint of placing and maintaining the system was counter-efficient to the system itself. Never mind the feelings of frustration from all parties that had to work with it!

Financing

It is well known in the hospitality industry that a tremendous amount of energy, water and other resources are required to run a property and serve its guests. Research done by Hotel Energy Solution in 2011 states that hotels rank in the top five of energy consumers in the tertiary building sector with an estimated annual usage of 305-330 kilowatts per square meter versus a typical urban apartment building which uses 260 kilowatts per square meter (HES, 2011). Older hotel facilities can be especially costly to operate from an energy use and efficiency perspective, as they generally lack newer technology designed with sustainability in mind. Despite the potential benefits the hospitality industry may enjoy with the implementation of sustainability improvements, there have been significant obstacles to the development of energy efficiency and water conservation measures.

The most obvious obstacle is simply the significant additional capital investment required from a hotel developer. Many are concerned that adopting green features into their buildings will involve high upfront costs. Compared to conventional buildings, green building projects are often perceived as having higher initial design and construction costs (Mahendriyani, 2016).

Additionally, the developer may have concerns regarding their ability to recoup their investment within an acceptable time frame, as well as have challenges in accessing the financing necessary for these initial costs. With regards to framing an acceptable payback period, it is difficult because the nature of hotel valuation is difficult. Payback is one of the simplest methods in measuring a return on investment, as the calculation is simply the number of years the cash flows would take to payback the initial investment. Hotels may be valued purely as real estate or just the business or both, and this can be either 3-5 years for the business or as much as 15 years for the total package (Sviatlana, 2011).

Later in this chapter, we suggest tools and possible solutions to each of the three main considerations in the challenges of equipment use and selection, and explore financing options and opportunities.

Best cases

Case 8.1: Accreditation systems: Van der Valk and BREEAM – Deliberate sustainability

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Van der Valk is a Dutch hotel chain for which sustainability in their buildings and in their operations is important. For a recent development, the Van der Valk hotel in Leeuwarden (the Netherlands) that opened in January 2018 with 115 rooms, they received the BREEAM Excellent certificate based on the building plans drawn in 2015. BREEAM is the leading organization for assessing the sustainability of buildings, and awards an internationally renowned certificate based on a buildings' technical specifications and its ability to minimize impacts on the environment. The Van der Valk chain does not require new hotels to be built according to this standard, nor does Leeuwarden municipality have any demands with regard to sustainable building. Regardless, the owners of the Van der Valk Leeuwarden hotel opted for this BREEAM certificate, because they believed it is the right thing to do. The BREEAM Excellent certificate is the second most sustainable level within this certificate, and this level on average saves 32% CO_2 emission compared to non-BREEAM certified buildings.

The BREEAM certificate follows very stringent guidelines, and to obtain it, Van der Valk Leeuwarden had to implement several measures in their hotel construction. Some actions that Van der Valk had to take are by now considered quite standard such as using only FSC certified wood, installing heat pump systems for heating, and LED lighting. However, the owners also implemented less standard measures such as using triple pane glazing. As a consequence, the new hotel has no need for gas, and is self-sufficient in its energy needs. Cooking for example is done with induction, thus using electricity rather than gas. However, Van der Valk Leeuwarden does have two small kettles as a backup.

In some instances Van der Valk had to look for a workable balance between the BREEAM requirements and the usability of the building. For example, the hotel could have earned extra points by using gypsum and iron profiles for their walls. However, the choice was made for bricks as they absorb sound better. To demonstrate how serious Van der Valk Leeuwarden is in their implementation of the BREEAM Excellent certificate, one can consider that the hotel deliberately chose not to use solar panels (yet). According to the hotel, it is an easy way to score extra points and they would rather use this only if other more stringent options do not work out as planned.

Part of assessment that leads to a BREEAM certificate in the Excellent category is the reduction of maintenance. For example, hotels' walls, and especially corners, are damaged by vacuum cleaners, suitcases and housekeeping trolleys. This is common knowledge in hotels, and therefore the corners are reinforced. At Van der Valk Leeuwarden, they sought an even more robust solution: implementing an integrated RVS slat. They measured the height of the damages at other hotels (25-30 cm) and implemented the RVS slat up until the height of the damages, and no more. This measure avoids damage to the wallpaper and corners and thus reduces future maintenance, and also avoids using more natural resources than needed.

In the grounds of the hotel there was an old barn they had to tear down. Hotel Van der Valk Leeuwarden realized that rather than having this debris removed, and order new debris to put under their parking lot, they could use the debris from the barn. This insight allowed for a closed resource loop, as well as preventing unnecessary transport.

Interesting to note is that during the building phase, Van der Valk Leeuwarden consulted with the local neighbours about the progress of the construction, the sustainability of the building, and their concerns and wishes with regard to the hotel. For example, the possibility to build a bike path behind the hotel was discussed, as well as possible future uses for the archaeological protected farm which is on the building's premises and social activities with and/or in the hotel.

Overall, hotel Van der Valk Leeuwarden has not only demonstrated true commitment to building their hotel in a sustainable manner but has also shown that building sustainably is a suitable and viable option for hotels.

If you are interested, more information about their BREAAM certificate can be found on their website (http://www.breeam.com).

Case 8.2: Materials and energy: The Madaster Foundation and 'Material Passports'

Thomas Rau is a silver-haired architect based in the Netherlands but originally of German descent. To simply call him an architect would be a disservice to his accomplishments, as many have called him an innovator, a visionary and an inspiration. His decision to settle in the Netherlands was inspired by his love for architecture as he found that it had some of the most charming architecture that he had ever seen. Thomas Rau is also co-founder of Madaster, a foundation that aims to eliminate waste, starting in the building and construction sector.

In February 2017, the Madaster foundation was launched in Amsterdam with the aim of preventing building materials from ending up as waste, by giving that material an identity whereby one may know exactly how much of each material was used and where the remainder is. This effort of giving waste an identity is done through a Material Passport for buildings, thus ensuring a closed system of accountability where resources should not be wasted. Rau has stated that waste is a raw material that has ended up in anonymity.

The Material Passport gives waste anew an identity. The Material Passport service offered by Madaster is an automated process that is monitored and supervised by the foundation, where they promote and oversee the development and usage of the Passport while ensuring security, privacy and availability of data. The foundation is of the belief that a building is a deposit of materials that hold an intrinsic value at a product, component and material level. By listing and valuating all materials used, it creates opportunities to save costs, and increase re-usage of materials, to reduce and ultimately eliminate waste.

Liander is a Dutch network company whose head office in Duiven was designed by Thomas's firm, RAU Architects. It is a sustainable building that generates more energy than it consumes and has a Material Passport. Triodos Bank in Driebergen (The Netherlands) is another of the architectural firm's projects and is being realized at the time of writing (January 2018). It goes a few steps further by not only registering the materials but also recording how the value of the materials develops over time, with the principal belief that if financial value is placed on the materials, then destroying them would be akin to destroying capital. Another major project under this principal is the delivery of a Material Passport for the renovation of the Schiphol Tunnel in Amsterdam.

It is clear that Rau is a radical who believes that waste is not a necessary evil but rather a commercial construct developed through the practice of deliberate product obsolescence. In an interview with fd.nl, Thomas Rau gives an example of the light bulb, noting that one of the first ever light bulbs still burns today and that this technology is not only available but inexpensive. He states that the collusion of light bulb manufacturers led to a decision that bulbs should be deisgned to burn for more than 1,000 hours, therefore creating a need for repurchases from consumers. And ultimately, waste. (See also p. 17.)

The Materials Passport of a building can be downloaded via the online platform (https://www.madaster.com/en). The aim is to have 10,000 buildings registered in the Netherlands with the promise that other countries will promptly follow suit.

Case 8.3: Financing: The Hilton Universal City and PACE – Partner in responsible financing

Hilton Universal City (Hollywood, USA) is located within walking distance of several major film studios, the Universal CityWalk Hollywood shopping and entertainment centre, and Universal Studios Hollywood theme park, which attracts more than six million visitors a year. This 23-story building has nearly 500 guest rooms, a top floor presidential suite, and 32,000 square feet of flexible meeting space. There are several public courts and gardens surrounding the property and banquet facilities located above a three-story hillside parking garage. Additional amenities include a lobby bar and restaurants, an outdoor pool, business centre, and a fitness facility.

The hotel was built 30 years ago and improvements were necessary for the property to remain competitive in the current hospitality market. Initially, the goal was to focus on 'low hanging fruit' upgrades that offered a quick payoff. Before long though, the Hilton Universal City executive board saw an opportunity to expand the scope to encompass upgrades with a much longer payoff, including improvements such as elevators and control systems. Additionally, the hotel aspired to reach LEED certification and PACE was the solution that helped in reaching that goal. PACE (Property Assessed Clean Energy) financing is an innovative way for commercial property owners to pay for energy efficiency upgrades, on-site renewable energy projects, and water conservation measures. PACE funding can cover 100% of a project's costs, and is repaid over a term of up to 20 years. This financing is broadly applicable to commercial, industrial, agricultural, multifamily housing and non-profit properties. Since 2009, in the United States the size of commercial PACE projects has ranged from $2,000 to $7 million. Several real estate market leaders have used PACE to fund energy efficiency upgrades to their buildings. In the Hilton case, long-term PACE financing made a deeper retrofit possible and the final project price tag includes construction costs, fees, and other expenses. The major goals for a new expanded project included:

- Increase guests' comfort and overall experience;
- Improve overall building performance;
- Replace old equipment – heating, ventilation and air conditioning (HAVC), lights, water pumps, etc.;
- Reduce energy costs;
- Reduce operating and maintenance costs;
- Improve the environment;
- Adhere to the 'Hilton global' standard of sustainability and design.

The idea for the project was born at a US Green Building Council workshop in Los Angeles attended by the building owner's sustainability manager. A conversation then began between the building owner and PACE program on ways to fund fairly modest upgrades to address maintenance that had been deferred for the past 10 years without incurring additional debt.

Hilton's comprehensive retrofit included energy efficiency glass installations and new LED lighting, which is expected to reduce energy consumption by 50%. Additionally, 500 low-flow showerheads were installed and 250 bathtubs with showers were replaced as part of the conservation upgrade to save the equivalent to one month of the property's current water usage. Older HVAC systems were replaced with new energy efficient ones.

The hotel management was very involved with planning and project design. The contractors were selected through a competitive bidding process and ReNewAll, a Los Angeles County PACE project developer, assisted Hilton in the selection process by pre-screening and interviewing the candidates. Hilton's general manager, Mark Davis notes, "The interest and commitment to sustainable energy and saving earth resources are largely due to being informed. It was a great opportunity to share how easily PACE empowered our decision to commit to this responsible effort on our journey to improve the property's saving of valuable resources. We are indeed grateful for the professionals who supported and collaborated in making this project a reality." (PACE, n.d.).

This project serves as a great example of proactive use of rebates. The initial energy audit identified a number of possible rebate opportunities on the state and federal level. The local utility, Los Angeles Department of Water and Power, offered $80,000 in incentives for replacing an old chiller. The hotel applied the $80,000 towards a new 125-ton chiller. On the federal level, the Section 179D of the Internal Revenue Code for Commercial Building Tax Deductions allows for the deduction of 40 cents per square foot for the replacement of old lights with LED fixtures. Overall, the Hilton took advantage of nearly $1.1 million in federal rebates. The value of the improvements along with the additional value of added net operating income was in excess of $13 million and the value of the property increased by more than $30 million.

The PACE assessment equalled $7 million with a term up to 20 years. The net operating income for year one was a $335,000 increase (afar PACE Assessment payment) and a return on investment of 78%. The total project return was $12.5 million and the building value increase was approximately $30 million while the list of improvements included:

- Four elevators - full system upgrade;
- 520 HVAC fan motors in guestrooms;
- HVAC controls system;
- Eleven refrigerators & freezer motors;
- Two 450-ton chillers;
- LED lighting upgrade;
- Lighting controls;
- Glass replacement in select areas;
- 250 bathtubs and showers;
- 500 shower heads;
- Dynamic tinting glass units;
- High capacity washers and dryers;
- EV charging station.

Overall, this project addressed a number of concerns, including deferred equipment maintenance, compliance with the Hilton global design standards, and adherence to sustainable practices while solving the financial conundrum.

Adapted by Thulani Xhali from PACE/Hilton case study (PACE, n.d.)

Tools to address challenges

In this section tools to address the challenges in accreditation system, use of materials and financing sustainable buildings will be presented.

Accreditation systems

As it has been highlighted in the section on challenges, in the construction and use phases, buildings consume a vast quantity of energy. Moreover, they may negatively impact people's health and safety. Sustainable buildings address both challenges, through energy and water management, waste management, materials recycling, resource conservation and protection of biodiversity. They also do this by being highly sensitive to the well-being of the occupants and incorporating features that promote their comfort and health. To assist financers, owners, and managers in choosing the best available option, various countries have developed 'Green' building standards in accordance with their environment. As not all regions are equal from a social and environmental perspective, some of the green building standards in the world are discussed below with a focus on Europe (BREEAM), Asia (CASBEE) and the United States (LEED).

BREEAM

The first standard that we will present here is BREEAM (Building Research Establishment's Environmental Assessment Method), the standard referred to in Case 8.1. BREEAM was launched in 1990 in the United Kingdom and has become a widely used means of reviewing and improving the environmental performance of a range of different building types, for not only hotels but also offices, homes, industrial units, retail units and schools. The organization determines the BREEAM rating based on quantifiable sustainable design achievements. When a building is assessed, points are awarded for each criterion and the points are tallied for a total score. The overall building performance is awarded a 'Pass', 'Good', 'Very Good' or 'Excellent' rating.

BREEAM major categories of criteria for Design and Procurement include (Fowler and Rauch 2006):

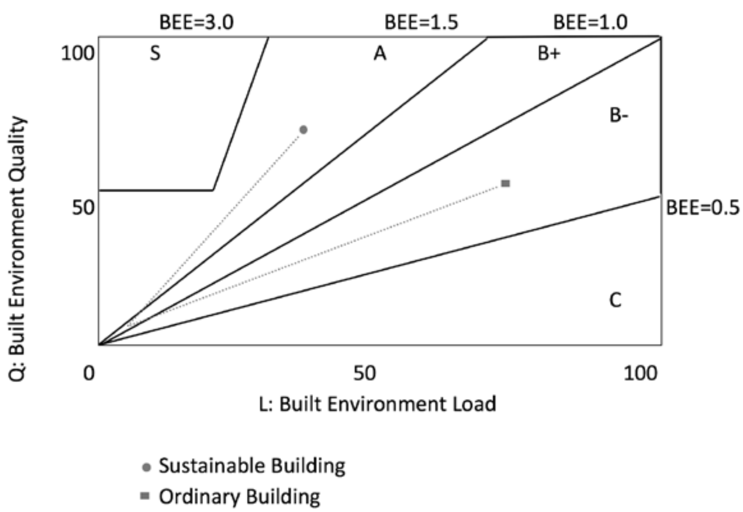
- **Management**: commissioning, monitoring, waste recycling, pollution minimization, materials minimization;
- **Health & Wellbeing**: adequate ventilation, humidification, lighting, thermal comfort;
- **Energy**: sub-metering, efficiency and CO2 impact of systems;
- **Transport**: emissions, alternate transport facilities;
- **Water**: consumption reduction, metering, leak detection;
- **Materials**: asbestos mitigation, recycling facilities, reuse of structures, facade or materials, use of crushed aggregate and sustainable timber;
- **Land use**: previously used land, use of remediated contaminated land;

- **Ecology**: land with low ecological value or minimal change in value, maintaining major ecological systems on the land, minimization of biodiversity impacts;
- **Pollution**: leak detection systems, on-site treatment, local or renewable energy sources, light pollution design, avoid use of ozone depleting and global warming substances.

CASBEE

CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) is the second standard we present. It was developed in Japan and introduced in 2004. The system requires documentation of quantifiable sustainable design achievements, which are assessed by trained architects who have passed the CASBEE assessor examination.

The community of assessment tools is based on the building's life cycle: pre-design, new construction, existing buildings, and renovation. Results are plotted on a graph, with environmental load on one axis and quality on the other and the best buildings will fall in the section representing lowest environmental load and highest quality. Each criterion is scored from level one to level five, with level one defined as meeting minimum requirements, level three defined as meeting typical technical and social levels at the time of the assessment, and level five representing a high level of achievement. An example of such a graph is given below.



Graph 8.1: Example of a CASBEE Graph (Adapted by author, based on Fowler and Rauch, 2006)

CASBEE major categories of criteria include the following: Building Environmental Quality and Performance (Fowler and Rauch 2006);

- **Indoor environment**: noise and acoustics, thermal comfort, lighting and illumination, and air quality;
- **Quality of services**: functionality and usability, amenities, durability and reliability, flexibility and adaptability:

- **Outdoor environment on site**: preservation and creation of biotope, townscape and landscape, and outdoor amenities;
- **Energy**: thermal load, use of natural energy, efficiency of systems, and efficient operations;
- **Resources and materials**: water conservation, recycled materials, sustainably harvested timber, materials with low health risks, reuse and reusability, and avoidance of CFCs and halons:
- **Off-site environment:** air pollution, noise and vibration, odour, sunlight obstruction, light pollution, heat island effect, and local on local infrastructure

LEED

The last standard presented here is LEED (Leadership in Energy and Environment Design). LEED is owned by the US Green Building Council and promotes a whole-building approach by recognizing performance in sustainable site development, water savings, energy efficiency, materials selection, and indoor environment quality. Documentation of the quantifiable sustainable design measures are provided to the US Green Building Council, the developer of the LEED rating system, for third-party verification. The assessors have been trained and must pass an assessor examination.

The LEED Reference Guide presents detailed information on how to achieve the credits within the following major categories (Fowler and Rauch 2006):

- **Sustainable sites**: construction-related pollution prevention, site development impacts, transportation alternatives, storm water management, heat island effect, and light pollution;
- **Water efficiency**: landscaping water use reduction, indoor water use reduction, and wastewater strategies;
- **Energy and atmosphere**: commissioning, whole building energy performance optimization, refrigerant management, renewable energy use, and measurement and verification:
- **Materials and resources**: recycling collection locations, building reuse, construction waste management, and the purchase of regionally manufactured materials, materials with recycled content, rapidly renewable materials, salvaged materials, and sustainably forested wood products;
- **Indoor environmental quality**: environmental tobacco smoke control, outdoor air delivery monitoring, increased ventilation, construction indoor air quality, use low emitting materials, source control, and controllability of thermal and lighting systems;
- **Innovation and design process**: LEED accredited professional, and innovative strategies for sustainable design.

Although there are differences in how the world sees the priority of sustainability in buildings, the fact that throughout the planet, accreditation boards exist is a clear indicator that this topic is a priority. These accreditations provide consistencies in conversations whether they are being had in the east or the west. Consistencies such as similar views on the use of energy resources, the use of water, the management of materials, recycling and the importance of design in construction. One could argue the legitimacy of points versus levels versus credits and how they are weighted, but what matters is that they all encourage more sustainable building.

Materials and energy

In an effort to address the energy and material concern of sustainable buildings, there are some key options when considering what to use in these buildings. These are discussed below looking at materials first, then at energy and then at sustainable options in landscaping and repurposing buildings.

When considering materials, the first step in addressing energy and water consumption is reducing it, for example by insulation and the use of water- and energy-saving mechanisms. Before construction begins, the developer should consider the differences in building materials and new developments such as the so-called *bio-based* materials. Generally speaking 'bio-based' means that materials are derived or made from renewable resources, with the understanding that these resources are harvested taking into account the time they need to recover. In this sense, sustainably harvested wood and wool also count as bio-based. Yet, more specifically, bio-based refers to innovative materials of mineral or vegetable origin and to materials enhancing industrial by-products coming from recycling, such as concrete made of elephant grass (Nakanishi *et al.*, 2016). Bio-based materials are durable, recyclable without loss of quality or safe to dispose of in the environment, and answer high performances requirements, such as thermal, hydric, physical or mechanical ones. Compared with traditional materials such as concrete and aluminium, generally speaking, bio-based materials embed less energy (Jones and Brischke, 2017). Although bio-based are the ideal, there is the reality of availability and affordability, and for that one must consider alternatives. For this, concrete, wood, insulation and glass are discussed as the main material components of a building.

Concrete is a building material which is made entirely from water, cement, gravel and sand. Concrete is used either as a binding material to fix bricks or can be poured into modular elements which can be connected and put into form. In order to create cement, clay and limestone are heated 1045°C and are then ground into powder. Due to the intense energy usage while creating cement, concrete it is one of the most energy intense building materials on the market. Building with concrete provides a very durable and long-lasting structure, though, that can be used over and over again. Concrete can be produced today with different characteristics depending on the individual need. Lightweight or high-performance concretes do not only have different production steps but entirely different utilization. For a residential property, different characteristics are needed than for bridges for example. Although there is intense energy usage of concrete in its production, the materials allow for recycling. In this regards the material, when produced can be reused in further construction projects (Baunetz Wissen, 2016).

When considering using wood it is important to note its origins. While local types of wood are generally accepted to be sustainable when forested correctly, using tropical wood can have a contrary effect. It is not only important to choose a sustainable type of wood but also to ensure that the forestation companies are fair employers and transparent in their market approach. Sustainability includes, in fact, a three-dimensional approach where care is required not only for planet and profit but also for the human component. Especially types of woods originating from jungles cannot be considered sustainable, due to deforestation, the destruction of living space of varied species, the negative impact this may have on the lifehood of the local inhabitants and the risk of forced and child labour (ILO, 2001 and 2010). Certification, such as that from the Forest Stewardship Council, should therefore be sought when using wood. Wood has the advantage that it has an high strength to weight ratio, and that depending on the type and treatment it can have great insulation characteristics. Bamboo, for example, can be used to insulate, as walls, floors or even as construction side scaffolding (Baunetz Wissen, 2016).

When it comes to choosing which insulation to use, three main types are applicable. Options are organic, mineral or cellular insulation materials. When choosing organic, choices include lamb's wool, wood, cotton, coconut leaves, flax or other natural materials with similar attributes. Even though these options are organic at their core, they need to be treated with different chemicals like flame retardants for fire protection or biocide in order to prevent the natural fabrics from vermin infestation. Moreover, some of these materials, require a vast amount of water and pesticide to be grown, and even more so for non-organic varieties (see the example of cotton in Chapter 15). Attention to certification, both environmental and social, is therefore essential when looking for a sustainable insulation option. (Baunetz Wissen, 2016).

The right type of glass can significantly improve the energy usage of a property. When considering window glass, it is important to adjust the need to the individual destination. When making use of insulating glass the windows are made out of two or more panes which have an air barrier built between them. They possess insulation properties, which can significantly help to decrease the energy usage needed to heat or cool down rooms. In very sunny and heated areas it can make sense to use shaded windows, which reflect the sunlight and allow for a lower energy intput for air conditioning (Baunetz Wissen, 2016).

Through proper insulation, energy needs are reduced. Reduction makes it easier to cover the remaining energy needs with renewable sources, such as wind and solar energy. In fact, consensus has it that the first step to be taken is to design so that the energy consumption during the usage phase of a building is reduced. Electricity consumptions entails, basically, everything from lighting, appliances, IT, air conditioning, and so on. The sustainable solution entails two separate approaches in order to identify potential savings, either to create the demanded energy on the property or to look for energy efficient technology. First, we want to look at the option of creating energy on the property itself.

Depending on the location of a property the number of sun days differs greatly. Thus, the energy concept for any property must meet the demands of its usable energy sources that it can tap into locally. When there is an abundance of sun, solar panels should be considered, where strong winds are common wind use collectors, when there is a stream or river nearby the use of a water generator should be taken into consideration. In areas like northern Europe, where each of these sources can be found and are unevenly distributed, a mix of those energy collecting technologies should be considered. Independent consulting companies can help determine the optimal mix and they can help find subsidiaries and public funding.

The residual energy needs should then be as far as possible covered by renewable energy, i.e. energy that is not derived from fossil fuels.

Designing to reduce energy consumption mainly means taking advantage of the building location so that, for example, sunlight may enter the building for illumination and the roof is properly orientated for the maximum yield of solar panels and heating systems. Here we will briefly touch upon these considerations.

The most commonly used technology to generate clean energy is the installation of solar panels on the property. In order to be able to generate the best yield, these solar panels are commonly installed on the roof top. They can generate up to 1,000 kWh per year per individual module (Mertens, 2015). A property in a sunny area can easily produce more energy than needed. The extra generated energy which is not repurposed for heating or warm water can be directed back into the local electricity network and thus generate extra revenue. Solar panels have come a long way and are now producing energy in some areas of the world at lower cost than fossil fuels. A study undertaken by the Fraunhofer Institute predicts an average cost level of 4-6 cents per kWH by 2025 generated by solar energy alone. A kilowatt-hour electricity in Germany, for example, costs at the moment on average 29.17 cents (Podewils, 2015).

There are multiple examples of hotels that have already made changes towards their energy production with the use of solar panels.

Even though wind turbines are mainly used in offshore parks and in long rows on land, small turbines can be installed on properties as well. The investment is feasible when a certain amount of wind can be estimated. Due to their size and design these turbines need to be viewed as a small addendum to the energy mix.

LED lightning is considered to be the best choice in low-energy lighting. LED stands for light-emitting diodes and are at their core the most sustainable light source based on technology. LED lights can last up to 50,000 hours (>5 years). Depending on the wanted illumination factors (measured in Kelvin) the cost reduction compared to equivalent conventional light bulbs can be up to 90%. Not only does the reduction of energy save costs but the decrease of waste creates an additional positive effect for the environment. The average household electricity bill can be lowered by up to 8% when making use of LED lamps.

When considering heating systems different options are feasible. Currently the majority of properties still use oil or gas heating systems, which not only make the operations dependant on the fluctuations on the energy markets and thus offers a variable in the costs calculations, but also negatively affect the environment with greenhouse gas emissions. Therefore both for financial and environmental reasons, when considering replacing an old heating system or planning a new property, developers should consider more sustainable systems. The most feasible option depends again mostly on the individual circumstances of the property. The developer first needs to establish the demand of heating for the property. This varies, based on the climate surrounding the property, the degree of insulation, the type of windows, the availability of radiant barriers and type of outlets. Options for sustainable heating systems include wood based and solar powered systems, heat pumps, district heating, and heat recovery or cogeneration systems. In the following we will take a closer look on these available systems and their benefits.

Wood pellet heating systems are considered sustainable for different reasons. First, when burned the wood pellets are CO_2 emission neutral. Due to the use of fast growing trees such as poplars or willows, which are grown in short rotation forestry, these trees can be harvested after three to six years. Wood pellets are not only CO_2 friendly but cost less than oil. The wood pellets price per kilo in January 2018 was €24.17 cents per kilo, while oil cost €55.23 cents per litre (Holzpellets, n.d). A study of 13 business style hotels in Germany found the estimated average heating consumption was 72 kWh per square meter (Voss, Bernard, 2015). Oil generates an average of 9.8 kWh per litre with a litre price of 0.5523 €/l; wood pellets are estimated to produce around 4.8 kWh per kg, with a cost price of 0.2417 €/kg. On this basis, heating with oil would cost €4.05 per square metre while the wooden pellets cost €3.63 per square metre. Considering the cost and CO_2-foot print of distribution, a wooden pellet heating system is the most sustainable, when its production source is as close by as possible and wood is properly harvested.

The principle of a heat pump is basically the same as the idea of a fridge – just the other way around. Small heat differences in the depth of the ground, for example, are harvested and transported into storage. The differences in heat can be stored and then used in order to either heat up the building or do the opposite and cool it down. With intelligent construction such as pipelines in the floor and the façade, heated or cooled water can be pumped through the entire building in order to generate the desired temperatures. When establishing an energy mix in the property, the needed electricity to run the heat pump comes out the solar panel electricity production. The advantages of this system are not only the sustainability but even more important in regards to a hospitable operation that the perceived temperature is not transported through air flow, as for example in classic air conditioners, but distributed through the entire building structure. In order to generate the best possible outcome, this system is best installed when a hotel is constructed.

A district heating system is one in which energy is generated in a central power plant and then distributed via an underground network directly to residential or commercial properties. When in place, this system allows the end user to obtain heating without having to install and run their own heating system. Due to the increased burning of bio mass and wooden pellets in those central facilities, the generated heat can often be considered sustainable. When offered in the region, this system not only provides a green solution for the heating demand but also is very cost effective since no extra maintenance needs to be considered.

Designing a building sustainably means also, as observed above, considering its end-phase. Two main options may be considered here: design for repurposing and design for demolition. In time the purpose of buildings may change. Consider, for example, the consequences of the on-going stream of people in developing countries leaving rural areas and occupying the ever-larger growing international metropolises in the pursuit of a better life. Urbanization poses significant essential challenges, which must be met by the local authorities in order to provide the infrastructure of growing cities and houses to the new city dwellers. Repurposing buildings in the inner city or its direct outskirts may then be an option. In developed countries, the ageing population is looking for properties suitable for their needs, such as having no thresholds between rooms and lift. Hotel properties, if properly designed, may be easily repurposed to meet these challenges.

From a sustainability perspective, designing for demolition means choosing for a cradle-to-cradle (or circular) approach instead of a cradle-to-grave. This means, as in Case 8.3 above, to consider materials as intrinsically valuable and wasting them as a destruction of capital. Materials and methods of construction should therefore be chosen that allow for easy dismantling of a property structure so that (almost) all materials can be reused without loss of quality. Unfortunately, most buildings have not yet been built considering repurposing or circularity. Even then, demolition may be carried out so as to recover materials as far as possible, recycle and re-purpose them. This strategy is financially and environmentally sound. Financially, because saved materials may be either reused to build a new or sold. Environmentally because energy may be regained from existing building materials in order to reduce the embodied energy in the next new built building. Recycling has been found to have the highest energy saving potential (53%), followed by reusing (6.2%) while incineration gave only a minimum energy saving of 0.4% (Ng and Chau, 2015).

Finally, when planning or revitalizing, a hotel property developer should consider the environmental impact on the local flora and fauna. Water reduction in the hotel industry has a long history and is generally seen in the activity of recycling and composting. Recycled water can decrease the water costs significantly and composted organic waste can be used as a fertilizer for the landscaping needs on the properties. Planting local and water non-intensive plants, which also support the local variety of insects and animals, can have significant impact on the positive environmental effects of any property. Not only do guests value biodiversity but also municipalities and local government are often very much in favour of a rich variety of plants and animals. These efforts are not only seen very positively on a community level but can greatly enhance the acceptance of comprehensive building applications and support from local authorities.

Besides the obviously positive impact on local biodiversity, the right choice of trees, plants and bushes can greatly reduce landscaping costs and contributes to the long-term development and growth of the landscape itself. When typical local trees, for example, are planted as young plants, the gradual growth over time will improve the architecture, design and the overall impression of the property. Resort properties in the countryside as much as inner city hotels can, for example, get involved with bee-keeping. Not only can the necessary demand for honey be self-produced, marketed and maintained but more importantly the property performs active duty to the community.

When properties are located in the countryside, it is of great benefit to consider starting their own small-scale fields for home grown herbs, vegetables and fruit. Providing these infrastructural opportunities allows and offers the kitchen operations, for example, to get more involved with local greens, experiment with products and greatly reduce costs for ingredients. Besides the obvious opportunity to distinguish the F&B offers from its competitors, the social environmental impact on employees and guests cannot be overstated (see also Chapter 15).

Concluding, though some options such as bio-materials and design for repurposing may be at the moment still a bridge too far for the hospitality industry, there are several ways to lower the economic, social and environmental impact of building by wisely choosing materials and energy solutions that follow the circular economy of cradle to cradle.

Equipment

As the challenges section included discussions about equipment and how to choose it, this section aims to address these challenges through identifying equipment options for the various areas of a hotel's rooms division and food and beverage departments by focusing on waste, energy and water examples.

When it comes to implementing sustainable strategies at the front office, the topic of the key card may be considered for the waste perspective. A report from the company Sustainable Cards, states that a typical 200-bedroom hotel in the United States goes through approximately 12,000 plastic key cards per year and these are added to the 1,300 ton plastic landfills (Nastu, 2009). A replacement option for plastic key cards are green key cards which exists in a variety of sustainable options but are ultimately made up of recycled PVC, paperboard, corn and/or wood. Another option for consideration is a mobile key card instead of handing over environmentally unfriendly plastic cards. A hotel may offer to transfer a digital code to a guest's smartphone with which he or she can enter the room. Mobile key is a relatively new form of accessing rooms and will be found mostly in recently constructed properties but new technology has also made it a viable option as an inexpensive retrofit.

In the restaurant, one may consider the use of linen as a sustainable action point in reference to the energy perspective. To meet the global demand of linen from cotton every year, 256 cubic kilometres of water is needed. This vast amount of water would be enough to provide every human on the planet with 120 litres of water per day. Even though only 1/40th of the world's agricultural area is used to farm cotton, a quarter of the pesticide consumption is allocated at cotton production (see also Chapters 14 and 15). Programs like the *Sustainable Cotton Project* are not only about reducing the amount of toxins that are used in production, but are able to increase the yield from an average of 210 kilograms per hectare of conventional production, to up to 285 kilograms with the initiative *Cleaner Cotton* (Virtuelles Wasser, 2017). Therefore, the first step should be to identify in which capacity linen is actually needed, within an F&B outlet. When a restaurant concept dictates linen, there are certified green linen alternatives on the market, which should be considered. In this regard, it depends on the structure, size of woven threads and the level of difficulty in cleaning. If linen is not to be given up on the table, reducing its use to napkins and sparing table cloths can be a cost saving and first approach for existing outlets.

In the kitchen, a heavily used appliance is the dishwasher and this is useful for the water perspective. When it comes to washing dishes, innovation has produced machines which can reuse water by making use of built-in water treatment unit where dishwashers can not only reuse water and use less chemicals but can also clean glasses and crockery in the same appliance. By reusing water on the same basis as car wash companies do, water waste can be dramatically reduced. Innovative companies are driving so-called energy recovery concepts. Exhaust air heat exchangers in combination with waste water heat exchangers build into dish-washing machines are now able to harvest the energy of the already heated (and paid for) waste water to quickly heat fresh water up to 42 degrees Celsius. With this technology, not only can the air quality in the stewarding department be greatly increased (with direct benefits for people's health and comfort) but furthermore operating costs can be reduced up to 24% per year (Ehrhardt, 2012).

There are many considerations to be made for equipment and the above are some examples of things to be taken into account. This broad scope of considerations is made more easily digestible through product specific standards and certification programs. A 2012 report from HVS sustainability solutions (Goldstein and Primlani, 2012) highlights some of these. They are summarised in Table 8.1.

Table 8.1: Taken in part from Goldstein and Primlani, 2012

Product-Specific Standards and Certification Programs		
Energy Star www.energystar.gov	U.S. Environmental Protection Agency	Voluntary governmental program that provides free benchmarking services to a variety of building types. Also rates appliances and provides resources for owners/operators.
Green Seal www.greenseal.org	Green Seal	Develops life-cycle based certification of products and services. Provides green building guidance for public housing facilities and environmental certification for hotels and lodging properties.
Green Tag www.ecospecifer.com.au	Ecospecifier	Database of vetted products in infrastructure, residential, commercial, industrial, and other construction. Subscription based service.
Greenguard www.greenguard.org	Greenguard Environmental Institute	Evaluates emissions from interior products and building materials.

The persistent theme in managing sustainability in equipment is the wish to reduce the amount used, to reuse what is possible and then recycle what is left. The combination of considerations leads to a decision that all people involved know has been thoughtfully reached so that the products can be used with good conscience.

8

Financing

As the challenges section included discussions about the higher than conventional initial costs as well as difficulties in accessing financing, this section aims identify options to address these challenges.

One such option is loans. According to Etrecia Van Dyk, Provincial Sales Manager at Ooba, South Africa's largest bond originator, a building loan is used to financially support the construction of a building on a piece of vacant land or to finance additions and renovations to an already existing property. When it comes to building loans, it's important to bear in mind that a portion of the approved loan amount is retained by the bank and the funds are advanced to the borrower in stages as progress payments during the construction period (Ooba, 2017). In recent years, loans specifically geared towards sustainable (building) initiatives have been developed. For example, Bridgeway Capital, an American firm that provides capital and business education to markets that will result in positive economic and social impact, has a Green Loans initiative. This initiative assists local building owners and developers with the implementation of sustainable building practices in order to create green buildings and achieve LEED (Leadership in Energy and Environmental Design) certification. These loans are flexible, long-term, and offer low rates (Bridgeway Capital, 2017).

One of the most effective and more popular strategies to encourage sustainable building is to stimulate the market through financial or structural incentives. *Structural incentives* work by encouraging developers to practice sustainable building through rewards such as additional density bonuses or expedited permitting processes. At low or no cost to the municipality, building green can be made a more attractive option to developers. *Financial incentives* are in the form of tax credits, fee reduction and waivers, low interest loans, revolving loan funds and grants to developers who propose and build sustainable buildings.

Technical assistance may be offered by many municipalities through allowing access to free planning or certification training and assistance, and this assistance may allow a developer who is unfamiliar with green building practices to build green. In some municipalities, developers who are LEED certified may be offered marketing assistance via signage, awards, websites, press releases, and other means as an incentive for developers to build according to sustainable standards (USGBC, 2017). For instance, Sustainable development bonuses in the City of Pittsburgh provide benefits for LEED certified buildings and include floor areas and maximum building heights exceeding base standards by up to 20% (Library Municode, 2017).

A third option is formed by sustainable, responsible and impact investing (SRI). SRI is an investment discipline that considers environmental, social and corporate governance criteria to generate long-term competitive financial returns and positive societal impact. Leading up to and including 2015, $8.72 trillion was invested according to SRI strategies in the United States alone. There are several motivations for SRI, including personal values, institutional missions, and the demands of clients. Sustainable investors aim for strong financial performance, but also believe that these investments should be used to contribute to advancements in social, environmental and governance practices. They may actively seek out investments such as community development loan funds or clean tech portfolios, that are likely to provide important societal and environmental benefits (USSIF, 2017).

Conclusion

In this chapter, we have discussed sustainability challenges concerning a hotel building with a focus on certification, materials and energy use, equipment and financing. In the introduction and in discussing sustainable solutions we have shown the new frontier of restorative building and bio-based materials. The best cases have shown that several ground-breaking measures are already implemented in hotels. Yet, some of the most innovative options may still be a bridge too far for the hotel industry, so here as a conclusion we wish to tie the discussion together by presenting an ideal image of a hotel that is not only trying to reduce its negative impact on the environment, but also aims at nullifying it by choosing for zero-emission. A zero-emission hotel is a property that generates as much energy on its own as it consumes. The way to go is to actively increase the generation of renewable energy through technology and decrease at the same time consumption by intelligently replacing, updating or eliminating out-dated energy consuming appliances or structures. The advantages of such a property are not only the sustainable overall balance with its positive effects on its surroundings and for the environment, but also, that it allows for a very stable energy cost prediction. When done correctly the heat and cooling be air-based, and the hotel will be powered by a hybrid solar system which generates electricity through sunlight and generates warm water, equipped with a short-term energy storage facility and a long-term phase change material, has double glazed windows and has a sun blocking curtain façade.

So, what would a zero-emission hotel look like? We assume that the property is planned as a medium sized inner-city business hotel in the 4-star category in an urbanized area with 70 rooms. The investors have laid out their projections through financing options and the positive exploitation of grants and benefits. It is paramount for the funding that the building itself could potentially be repurposed for other commercial use in case the hotel operation would default. The building will be built in order to facilitate a BREEAM-certificate and will be built with a bearing façade, centralized riser slots, a flat roof and the rooms will be formed by non-bearing but insulated walls. The insulation will be composed of mineral materials. Hardwood floors will be in used all the rooms. The developers have outlined that a wood pellet central heating system will be used in the basement to produce energy. The basement will also hold space for a water treatment plant in order to provide clean drinking water, as well as reduce the harmful waste by-products. The windows will be treated and double sided, in order to provide a lower vulnerability to UV-beams and temperature changes caused by weather outside the rooms. The bearing walls will be constructed out of a steel and concrete structure. The façade will not only be bearing but also equipped with a cooling system. Through this system hot and cold air will be pumped in order to regulate temperature changes. Via solar panels on the roof the electricity will be generated and the overproduction will be sent into the electricity supply system. The rooms will be equipped with green key card wall slots which activate lights and lamps in the room, motion sensors will automatically provide light, when needed. All lamps and lights will be LED-based with warm light characteristics of around 2,700 Kelvin. Finally, the equipment and fittings will be chosen based on their water saving qualities, energy saving qualities and waste reduction qualities.

The above is an attempt to tie the discussed concepts together. There may be many alternatives to creating such a property but the aim is to opt for the most sustainable solution.

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