The Use of Environmental Accounting to Determine Energy Saving in Mpumalanga Hotels, South Africa

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Abstract

This paper presents an energy characterisation framework that is based on environmental and carbon management accounting principles and practices that promotes green growth in societies. Primary data was collected through survey questionnaires, observation checklists, energy account records, light meters and thermometers. In addition, an exploratory literature analysis was done. The collected data was analysed through descriptive and correlation statistics, aimed at testing the theoretically developed energy saving characterisation framework. The paper revealed that the use of one or two energy saving indicators as a base for characterising services and institutions as being energy saving is misleading. Thus, the paper concludes that energy saving characterisation should be based on a confirmed reduction of energy demand, cost and carbon footprint. However, the paper points out that the selection of energy saving technologies and characterisation of activities as energy saving method can be based on the ability of such an activity to reduce one or more of the three indicators. Ultimately, the adopted framework integrates environmental and carbon management accounting principles and practices.

Keywords

Energy saving hotels
Green growth
Environmental accounting practices
Carbon accounting

1 Introduction

Energy saving is fundamental for the achievement of sustainable social, economic and environmental livelihoods of societies (Machete, et al., 2015; Fink, 2011;South African Bureau of Standards, 2005). Reducing input energy consumption (energy saving) is a major driver towards cheaper, reliable and sustainable supply of energy for social and economic development of communities (Mensah 2006, 2008). With the advent of the Sustainable Development Goals (SDGs), specifically Goal 7, access to energy by all is set to be achieved globally by 2030 (United Nations, 2015) and this cannot be done without energy saving. Input energy demand reduction or saving is one of the green development strategies used to reduce biophysical environmental resource exploitation, greenhouse gas (GHG) emission to the atmosphere, environmental externalities and the production costs of institutions (Machete, 2015). Energy saving is also a strategic area for climate change response and sectorial green growth policy focus (Gotz and Schaffer, 2015).

In the hotel industry, energy saving seeks to, among other objectives, save the environment and promote the creation of green jobs for local communities. For these reasons, the characterisation of energy saving hotels should serve to confirm that the characterised hotels have reduced their input energy related costs, demand and carbon footprint. A number of existing hotels known as energy saving, often derive their characterisation from inconsistent methods used to determine energy saving (Xie, 2014; Van den Bergh et al., 2013). One hotel would measure energy saving based on its reduction in input energy quantity used over a defined period of time, while another gauge its saving from energy cost and/or carbon footprint reduction, respectively. This variability in the determination and/or characterisation of energy saving in hotels, create an unreliable and doubtful meaning of the importance of energy saving and its meaning among hotels, both among hotels themselves and the general society (Jouvet and De Perthuis 2013; Li and Xia, 2013). Given the current global energy shortages, energy saving remains key across all sectors of the society (Cooperman et al., 2011). Hence, a consistent and reliable impact based framework is required to give meaning to energy saving hotel characterisation. Such a scientifically reliable energy saving framework that is able to addresses short, medium and long term energy challenges facing the society is needed (Machete et al., 2015).

Although cost saving and maximisation of profit margins are the most known benefits and drivers associated with the implementation of energy saving in hotels (Donev et al., 2012; Stevens and Rea, 2001; Albino et al., 2014), previous studies identify energy saving as a major environmental and health risks prevention strategy (Hansen, 2001; Hoffmann et al., 2008; Machete et al., 2015). The genesis of and relevance of energy saving as an environmental health tool stems from its carbon emission reduction effects and the correlation between carbon emission and environmental health (Machete et al., 2015; Fink, 2011; Stevens and Rea, 2001). The later confirmed the energy efficiency strategy of the Republic of South Africa, which identifies input energy saving as a strategic objective that would help to "improve the health of the nation"(South African National Department of Energy, 2013). However, an energy saving hotel characterised solely based on its reduction of energy quantity and costs, to the exclusion of GHGs emission reduction does not advance, nor promote public health (Onut and Soner, 2006; Hoffmann et al., 2008).

Due to its socio-economic and environmental significance, energy saving remains a central green development subject of academic and research interest (Ke and Yi-Ming, 2014). Energy saving hotels are attractive to a myriad of global green tourists (Mensah, 2006; Nuntsu et al., 2004). For these reasons, the classification of hotels as energy saving serves as a green marketing tool which has an impact on the market share of a business like hotels (Zeng et al., 2010). Thus, in this paper, the exploratory discourse stems from the observed dichotomy in the inconsistent methods and frameworks used to characterise services and institutions as energy saving beyond rhetoric of energy saving. If not demystified, the dichotomy could reverse the gains and increasing uptakes of green growth initiatives implemented in various sectors of the society (Messner, 2015). In the wake of recurrent energy crisis globally and nationally, the consequences of the dichotomous energy saving frameworks could result in a complete socio-economic meltdown. Failure by hotels to derive direct economic benefits from the implemented energy saving strategies have previously been identified as one of the factors discouraging small entrepreneurs from investing in energy saving technologies (Mensah, 2006). As a result, this paper associates the failures by hotels characterised as energy saving to realise benefits of their energy saving technologies to inconsistent and unreliable energy saving characterisation frameworks which do not yield tangible socio-economic and environmental benefits.

The Efficiency Valuation Organization (2010) defines energy saving as a reduction in input energy consumption. Machete et al., (2015) clarify the later definition through the formulation of energy demand, cost saving and carbon as indicators of energy saving. These three form the basis for a comprehensive and scientifically sound energy saving characterisation framework in this paper. Hence, the characterisation of a hotel through this framework will serve as confirmation and/or guarantee of a reduction in energy demand, cost saving and carbon footprint by the characterised hotel. Similarly, such a framework needs to incorporate financial and non-financial indicators. Although the latter framework is not sector specific, it was explored and tested in hotels. The selection of hotels stemmed from their role in the world's socio-economic growth, as reported by Ali et al., (2008). In addition, Farrou et al., (2012) points out that hotels are among the highest energy-consuming industries and buildings together with university residents and hospitals. Literature also indicates that the entire life cycle of a hotel depends on energy availability, without which this industry is non-existent (Rosselo-Batle et al., 2010). Thus, energy saving in the hotel industry is key to the hotels themselves as well as national energy demand side management.

On the financial end, Ali et al., (2008) reveals that energy costs are the second highest operational cost in hotels, after personnel costs. Dube (2001) points out that 80% of small, medium and micro enterprises in South Africa fail within five years of their operations due to high operational costs. It can be deduced from these two studies that high energy use in hotels is a significant contributing factor contributing to high operational costs that may lead to business failure. Energy saving is the second highest priority area for operational cost reduction in hotels attempting to prevent business closure. The need for the sustainability and protection of local hotels (through energy saving) as key employment providers to local communities needs to be emphasised. The secondary social impact of energy saving towards poverty reduction within communities, strengthens the argument that energy saving is a pro-development instrument.

In contrast, existing energy saving characterisation methods and frameworks use a mere reduction in grid supplied electricity to characterise a service or institution as being energy saving. Such characterisation is often confined to hotels' reduction in energy demand, and often inclusive of cost reduction. Very seldom, these frameworks consider carbon footprint reduction as one of the parameters for the characterisation of energy saving. This omission is attributable to the tendency of shifting from a low carbon to high carbon energy source in the name of energy saving that is experienced among institutions, despite the global outcry and visible consequences of climate change.

In the wake of existing energy shortages, unreliable supply, frequent energy supply interruptions and rapid increases in energy prices in South Africa, many hotels are compelled to reduce their energy demand and explore alternative energy supply. Without a framework that can be used to assess energy saving methods and their efficacy, it remains virtually impossible for hotels to choose between different systems offered in the market place. An authentic energy saving characterisation framework will be useful to evaluate the efficiency of technology and its suitability to be classified as energy saving method. Similarly, the framework should be used by institutions in setting their energy saving targets. Thus, without this framework, hotels' investments in energy saving may be a fruitless and wasteful expenditure that yields no tangible social, economic and environmental benefits (Jindou 2012; Ke and Yi-Ming,2014). Zografakis et al., (2011) classified energy saving methods into low and high cost schemes. This classification was primarily based on the amount capital investments required for the implementation of energy saving. Zografakis et al., (2011) further concludes that high cost energy saving methods does not necessarily translate to high savings. Consequently, Zografakis et al., (2011) recommended the use and selection of low or non-capital based energy saving methods. In addition to the cost based selection of energy saving methods, this paper included environmental and energy demand indicators, as highlighted earlier in this paper (Tick et al., 2014; Hoffmann et al., 2008). Therefore, the aim of this study was to assess the use of environmental accounting to determine energy saving in Mpumalanga hotels, South Africa

2 determination of energy saving

The development of an energy saving characterisation or determination framework was founded on the definition of input energy saving and three parameters discussed earlier in this paper (South African Bureau of Standards, 2011). The primary objectives highlighted in the study include reduction in negative social, economic and environmental risks of input energy use. It was pointed out that a comprehensive and authentic energy saving framework should be useful for the assessment of efficacy of different methods and/or technologies used for energy saving. It was also argued earlier that the three energy saving parameter should include monetary and non-monetary indicators (Zeng et al., 2010; Tick et al., 2014). The above description of the framework evokes the need for the incorporation of environmental management accounting (EMA) and carbon management accounting (CMA) tools and instruments. Therefore, this study adopts both the EMA and CMA as major sustainable development tools that inform the energy saving framework adopted in this paper. Flowing from this, this paper discusses each of the sustainable development tools and their relevance in the energy saving characterisation framework.

2.1 Environmental accounting principles

Environmental management accounting refers to the collection, analysis and interpretation of physical and monetary information for internal decision making (Schaltegger and Csutora, 2012; Shi et al., 2015; Wang and Chang, 2014). Like energy saving, EMA consists of monetary environmental management accounting (MEMA) and physical environmental management accounting (PEMA) principles. In this paper, MEMA and PEMA are referred to as monetary and non-monetary energy saving indicators.

2.1.1 Monetary indicator

Monetary indicator is the collection, analysis and use of monetary information for decision making about input energy performance (Burrit and Saka, 2006). This indicator is used to measure the monetary costs, savings and earnings arising from input energy use. The significance of this indicator is to translate energy use into monetary performance in the form of financial savings, costs and/or earnings (Colenbrander et al., 2015; Jouvet and De Perthuis, 2013). Translating non-financial to financial performance helps business managers who are often interested in direct monetary impact rather than physical performance of energy use. This third energy saving indicator is often the second highest used indicator, followed by carbon footprint. It is often the main driver for the implementation of energy saving in most institutions.

2.1.2 Non-monetary indicator

A non-monetary indicator is concerned with the collection, analysis and use of physical input energy information in internal decision-making (Machete, 2015). The indicator focuses mainly on the physical mass balance of energy flow in terms of energy demand (measured in kilowatts - kW) and its carbon footprint (measured as kilogrammes of carbon dioxide equivalent - $kgCO_2e$). In the energy saving characterisation framework, this parameter responds to energy demand and carbon footprint reduction of a service or institution (Burrit and Saka, 2006). Hence, in energy saving framework, PEMA accounts for two measurable indicators that should be tested during characterisation namely: energy demand and carbon accounting (Machete, 2015).

2.1.3 Energy demand

Energy demand is a non-monetary energy-saving indicator that is synonymous with material flow accounting (Burrit and Saka, 2006). It is a quantitative variable that is measured in watt (W). Energy demand is the most common indicator used in the characterisation of energy saving (Wong et al., 2015; Xu et al., 2015). This paper identifies energy demand as a first indicator in the characterisation of energy saving that precede financial and carbon footprint.

2.2 Carbon accounting

Carbon accounting (also known widely as GHG accounting) is the second non-monetary energy-saving indicator (parameter) used to measure the cause-effect between energy consumption and its associated environmental impacts (Machete et al., 2015). The determination of renewability and non-renewability of energy sources are primarily based on the carbon equivalence per unit of energy produced, used and/or saved. The evaluation of this indicator during characterisation justifies the relevance of energy-saving as a climate change response strategy, simply based on the ability of energy saving to reduce energy related carbon emissions to the atmosphere. Since carbon accounting is one of the sustainable development tools commonly used in environmental studies, it is discussed in detail in the next section of this paper. Carbon accounting is the systematic collection, analysis, reporting and use of carbon transactions for decision making (Nhamo and Shava, 2015). Although carbon accounting as an indicator has already been covered under EMA, the discussions of carbon accounting as a sustainable development tool are explained below and remain relevant to this study. The theories and practices of carbon accounting are similar to financial accounting, with some exceptions. The main difference is that carbon is the currency in carbon accounting, while a money is the currency under financial accounting. Thus, all concepts applicable in financial accounting like transparency, accuracy, verification, levels of assurance and materiality have the same meaning in carbon accounting. Similarly, carbon can be viewed as a sub-section of EMA. Thus carbon accounting replicates EMA principles and practices. However, carbon is the currency in carbon accounting, while it is a physical parameter under EMA. However, energy demand remains a physical parameter in both carbon accounting and EMA.

Similar to financial indicators which are preferred by financial managers, carbon footprint is a key indicator for environmentalists. During carbon trading, GHGs are converted into an equivalent of carbon dioxide (CO_2). The CO_2, is a major GHG among the six well-known GHGs that cause climate change, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), per fluorinated compounds (PFCs) and hydro fluorocarbons (HFCs) (Burrit and Saka 2006). Carbon, is therefore a generic concept used for all GHGs. However, carbon dioxide equivalent (CO_2e) is the most globally acceptable unit of measure for GHGs in the carbon market (Schaltegger and Csutora 2012) as this conversion allows the markets to attach the monetary value to carbon as traded per unit of CO2e. Thus all GHGs are expressed in kilogram (kg) of CO_2e. In its application, carbon footprint of energy use is based the multiplication of energy demand by the carbon factor of a defined energy source. A carbon factor is the sole distinction parameter of the environmental friendliness of different energy sources (Van den Bergh et al., 2013; Colenbrander et al., 2015; Nhamo and Shava, 2015). Lastly, the GHG protocol, adapted from the International Standard Organisation (ISO 14064) classifies GHG emission sources into three scopes. Emission scopes serve to guide the extent of control over GHG emission (see table 1).

Table 1 Three carbon emission scopes

Source type	Scope1	Scope 2	Scope 3
Classification	Direct emissions from sources controlled by energy user.	Indirect emissions from purchased energy.	Emissions from other procured goods or services other than energy.
Description	This includes emissions from power generators.	This includes grid supplied electricity.	It includes transport and delivery related emissions.

Source: Adapted from Nhamo and Shava (2015)

Based on table 1, each institution has a direct and absolute control over its scope 1 emissions and has a choice of avoiding or reducing its scope 2 and 3. Ultimately, the use of carbon footprint as an energy use indicator helps institutions to determine their energy related levels of negative environmental impacts. Therefore, given the three input energy saving indicators, EMA and CMA discussed in this paper, figure 1 presents an adopted energy saving characterisation framework, as espoused by Zeng et al., (2010)

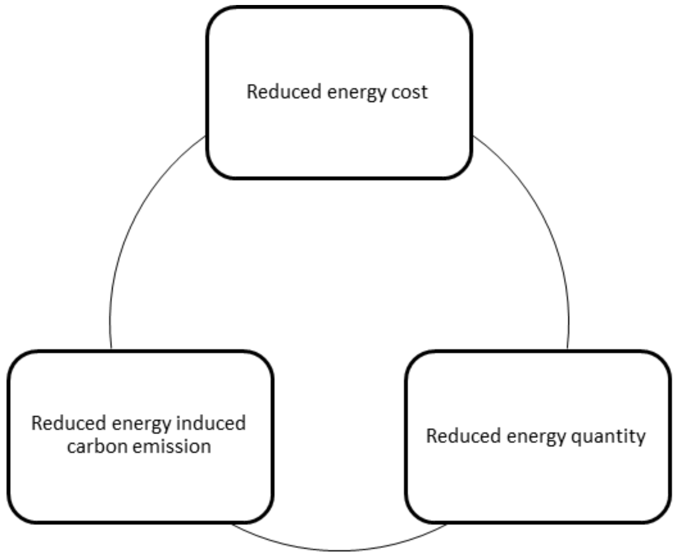


Fig 1. Environmental accounting framework of energy saving characterisation

Figure 1 presents the triple indicator of energy saving framework which is based on a guaranteed reduction in energy use demand, cost and carbon emission. Under the framework presented here, the reduction in all three indicators are used to characterise a service or institution as being energy saving.

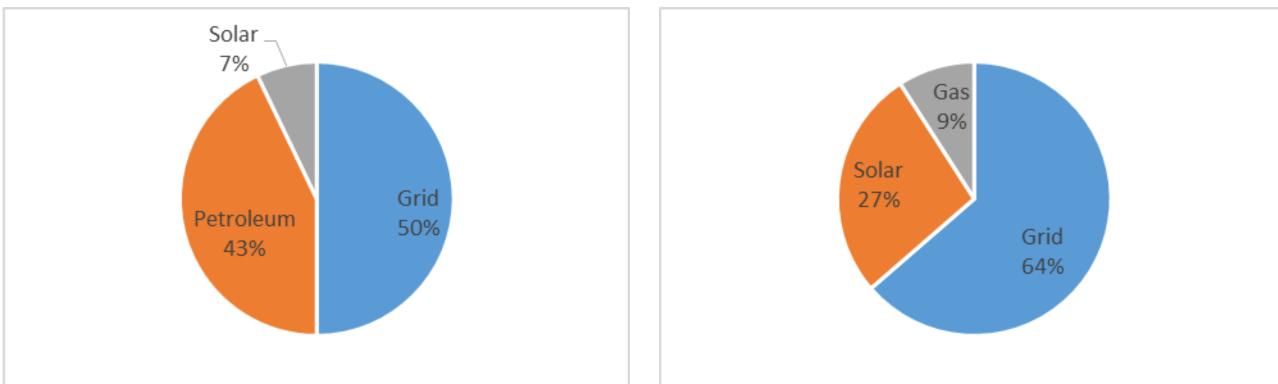
3 Methodology

The study was conducted in Mpumalanga Province of South Africa. At the time of the study, there were 103 star graded hotels under the guesthouses category by the Tourism Grading Council of South Africa in 2013. Consequently, purposeful sampling was used to select eight star graded energy saving acclaimed hotels from all three districts areas of the province. Most importantly, the selected hotels represented all three climatic zones (1) cold interior, (2) temperate interior and (3) hot interior of the province. Climatic zones representation of hotels are important for the study because they are major drivers of energy demand and selected of energy resource or type for use in most communities. Thus energy consumption levels among hotels of similar sizes or capacity would vary significantly due to the variability of their location's climatic zones. Willingness to participate survey was used to select the eight hotels for in-depth study (Leedy and Ormrod, 2010; Mouton, 2013). Audio recording of interviews, observation checklist, historic energy account records and direct physical measurements of energy consumption were used as data collection tools for the study (Creswell et al., 2009). Descriptive and correlation statistics analysis were followed in the analysis of collected data through Microsoft Excel 2013 (William and Mohamed, 2012; Machete et al., 2015).

4 Results and discussion

4.1 Energy source used in the hotels

Three primary energy sources, namely: the national grid electricity, petroleum and solar were found to be the main energy sources used for indoor lighting in the selected hotels. National grid electricity is the leading energy source in many hotels followed by petroleum and solar, respectively (figure 2 a). The use of petroleum fuels such as paraffin, petrol, diesel and candles appeared common as a backup energy resource for running power generator or direct lighting these hotels. For water heating, national grid electricity accounted for 64%, solar 27% and liquefied petroleum gas (LPG), referred to as gas in this paper accounts for 7% of the total energy use (figure 2 b).



(a) Indoor lighting (b) Water heating

Fig 2. Types of energy used in the selected hotels

The results show that half of the total indoor lighting energy use in the selected hotels was provided through the national grid. On average, the study revealed that a non-energy saving hotel room use 6.5 kW of electricity using incandescent bulbs of 100W for an average period of 13 hours. Similarly, 14.4 kW for hot water production is used per required how water quantity per room (60L) at 42^{o}C, produced through a normal 150L geyser with 3 kW electric resistant element, operational for 6 hours over a booking cycle. The average unit price or cost of electricity per kWh, among these hotels was R1.57, with carbon emission factor of 0.91kgCO2e per kWh.

From figure 2, the selection of different types of energy sources for indoor lighting and water heating provide both positive and negative energy saving impacts to the social, economic and environmental space. In table 2, the impact of energy types used in the selected hotels on all three energy saving indicators (environmental accounting principles) are presented.

Table 2 Carbon and cost impact of each energy types used by hotels

Energy use	Type of energy	Carbon footprint	Operational cost	Energy quantity
Indoor lighting	Petroleum	High	High	High
	Grid electricity	Medium	Medium	Normal
	Solar	Zero	Zero	Normal
Water heating	LPG gas	High	High	High
	Grid electricity	Medium	Medium	Normal
	Solar	Zero	Zero	Normal

From table 2, it is evident that the use of petroleum as alternative for indoor lighting and LPG as alternative to electricity grid for water heating provides a high risk for high energy quantity consumption per unit, high operational cost and high carbon footprint. Consequently, such a decision by the hotels represents a limited or lack of understanding of energy saving.

4.2 Energy saving levels

From figure 2, it is evident that three or four energy resources are used across each operation in the selected hotels. The selection of different energy resources is often driven by the hotels' drive to save energy (Zeng et al., 2010). Figure 3 presents the consumption and saving levels of lighting services of the selected hotels.

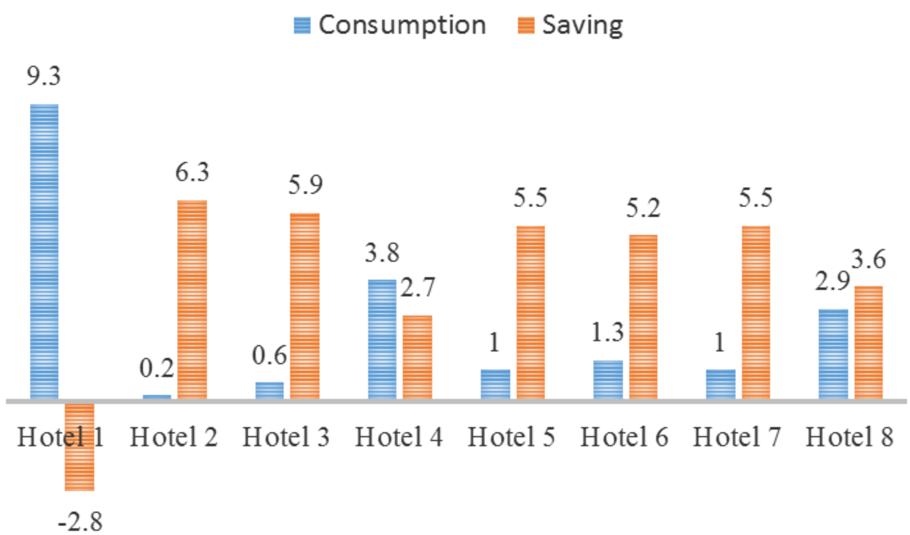


Fig 3. Energy consumption and saving levels lighting services

It is important to note from figure 3 that hotel 2 has the lowest energy consumption and the highest energy saving levels. This is the only one among the selected hotels using solar photovoltaic panels for indoor lighting. Hotel 1 recorded a negative energy saving (loss) on its indoor lighting account. It is worth noting that hotel 2 only uses grid electricity as its primary energy source for lighting, while it uses petroleum as a back-up. Figure 4 presents hotels' energy consumption and saving levels for their water heating.

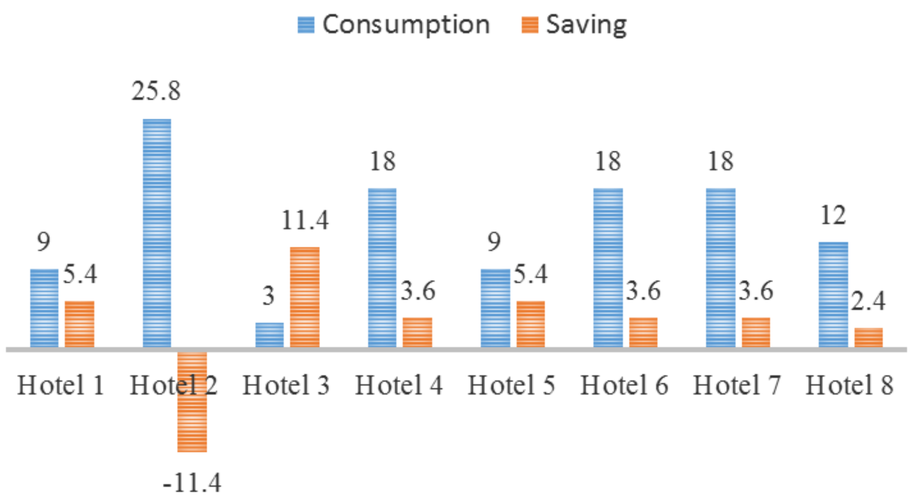


Fig 4. Energy consumption and saving levels water heating services

Once more, hotel 1 and hotel 2 are of interest in figure 4. Hotel 1 uses solar geysers for water heating, with grid electricity as back-up. In contrast, hotel 2 uses liquefied petroleum gas as the sole energy for water heating. Consequently, hotel 1 has the second highest energy saving levels for water heating, after hotel 3 which is also using solar geysers. However, hotel 2 uses the highest quantity of energy for water heating and wastes a lot of energy as well. It is evident therefore from these results that the use of environmental management accounting principles in the characterisation or selection of energy saving hotels can reduce energy waste and improve returns on energy saving investments in quantity, cost and carbon reduction.

4. Conclusions

This paper highlighted the significance in the use of environmental accounting principles in energy saving characterisation. The absence of authentic energy saving characterisation framework is identified as a major conundrum towards the realisation of sustainable development of communities. The conundrum results in inconsistent, unreliable and falls characterisation of services and institutions as being energy saving. Despite the classification, these institutions never derive any financial and non-financial benefits from such characterisation. Consequently, energy saving is viewed as a rhetoric than a social, economic and environmental development tool for all sectors of the society. However, the energy characterisation framework presented in this paper incorporates all social, economic and environmental development indicators into one. Hence the adoption of environmental management accounting based energy saving characterisation framework counteracts the conundrums associated with unreliable benefits of energy saving. Thus, the paper concludes that energy saving characterisation should be based on a confirmed reduction of energy demand or quantity used, cost and carbon footprint. This paper recommends the use of this improved and integrated energy saving characterisation framework because of its multiple and green growth benefits to general communities and hotels.

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