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*Will Cities Survive?*

# Developing a rating system for a net zero community

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*ABSTRACT: Net zero communities are becoming widely popular at the global scale. However, there is often ambiguity in its understanding and application. Different countries around the world have varying perceptions of net zero, each having their own standard of evaluation. Hence, it is crucial to generate a rating system that can act as a starting point in designing large scale net zero developments. The aim of this study is to select, analyse and compare five globally acknowledged energy rating systems for large scale developments and develop an amalgamated rating system that will act as an international guide to design and test net zero communities around the world.*
*KEYWORDS: Energy Rating systems, Net Zero Energy, Sustainable Communities*

## 1. INTRODUCTION

Net-zero energy and net-zero carbon are terms that have gained popularity over the past two decades, to such an extent that their usage is being expanded to the scale of communities and cities. Despite the subject's growing momentum there is ambiguity in its definition and understanding. Principles for net-zero have been defined for the building scale and energy systems that analyse and rate the sustainability of large-scale developments exist [1]. However, there isn't a set of defined benchmarks for testing the authenticity of net zero in larger scales of development.

This study aims to develop a system that can be used to test a prototype net zero community. For this, five globally acknowledged energy rating systems that are pioneers in building energy rating have been selected. These systems have been shortlisted as their application has been expanded to test large scale developments. This paper aims to bridge the gap between the principles of net zero buildings and energy rating systems, thereby developing a global rating system for a prototype net zero community.

## 2. ENERGY RATING SYSTEMS AROUND THE WORLD

Five globally acknowledged energy rating systems have been studied. Table 1 lists the selected rating systems, when these were launched, total credit points under each system and the certifications awarded by these.

**Table 1:**
*Selected energy rating systems and their specifications*

| Rating system | Launch | Credit points | Awards |
|---|---|---|---|
| BREEAM Communities [3] | 2008 | 126 | Outstanding /Excellent//Very good/Good /Pass /Unclassified |
| IGBC Townships [7] | 2010 | 200 | Certified/Silver/ Gold/Platinum |
| PEARL Community Rating system [9] | 2010 | 159 | 1 Pearl/2 Pearl/3 Pearl/4 Pearl/5 Pearl |
| Green Star Communities [6] | 2012 | 110 | One Star/Two Star/Three Star/Four Star/Five Star/ Six Star |
| LEED Communities and Cities [8] | 2016 | 110 | Certified/Silver/ Gold/Platinum |

These energy rating systems have been devised for large scales of developments like communities and neighbourhoods. The study found that systems such as LEED and Green star are not specific to geographic location and are used around the world (see Fig. 1). Some key examples that have used these systems include BedZED in Sutton, UK (see fig. 2) which was compared with BREEAM's system (Beddington zero energy development case study, 2007) and Dubai Sustainable City and MASDAR City (see Fig. 3,4) which use PEARL.

**Figure 1:** *World map showing selected energy rating systems and their use in different geographic locations (by author)*

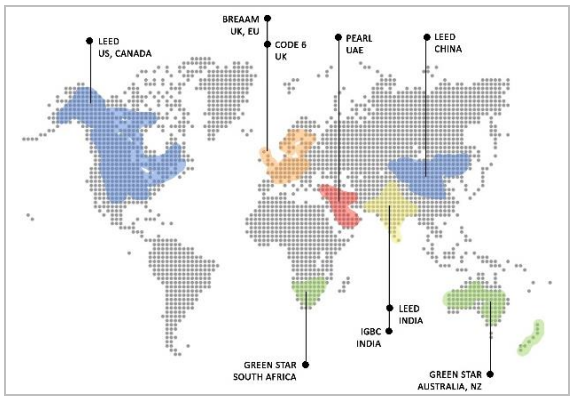



**Figure 2:** *BedZED in Sutton, UK - 'Excellent' BREEAM certification [4]*

**Figure 3:** *Dubai Sustainable City, UAE [5]*

**Figure 4:** *MASDAR City, UAE aims to achieve 3-4 Pearl rating [12]*

## 3. COMPARITIVE ANALYSIS OF ENERGY RATING SYSTEMS

Each of the selected rating systems was studied in great detail. The technical guide for each rating system was thoroughly analysed and the rating systems were tabulated as Code – Category – Points for each criterion of the five rating systems. Also, the systems were tabulated in parallel to enable comparative analysis between them. This helped identify similarities and differences in categories and weightings (in points) under each criterion. Based on the comparisons the following broad criteria were deduced for the new rating system.

- Social, economic and environmental wellbeing
- Ecology
- Site
- Urban planning and design
- Transport
- Energy and emissions
- Materials
- Water
- Waste
- Innovation
- Accredited professional
- Other

### 3.1. Criteria and Categories

The study indicated several similarities in categories such as energy, materials, urban design, water and waste, making it possible to establish a pattern between the systems and thereby, group them under similar criteria. However, some categories were moved from one criterion to another where it seemed fit. Table 2 indicates the comparison between BREEAM and PEARL rating systems for the 'Energy and Emissions' criterion [3,9].

**Table 2:**
*Rating systems assessed in parallel to identify similarities and differences in criteria – sample showing comparison of Energy and emissions criteria for BREEAM and PEARL*

| PEARL | | BREEAM | |
|---|---|---|---|
| Code | Category | Code | Category |
| RE R1 | Community energy strategy | RE 1 | Energy strategy |
| RE R2 | Building energy guidelines | SE 10 | Adapting to climate change |
| RE R3 | Energy monitoring and reporting | | |
| RE 6 | Renewable energy: onsite | | |
| RE 7 | Renewable energy: | | |

| | | | |
|---|---|---|---|
| | offsite | | |
| RE 8 | Energy efficient buildings | | |
| IDP 1 | LC costing | RE 7 | Transport carbon emissions |
| LC R5 | Minimum Pearl rated buildings within communities | | |
| LC 11 | Pearl rated buildings within communities | RE 4 | Sustainable buildings |
| IDP R2 | Sustainable building guidelines | | |

*Note:* Code RE under Pearl implies criteria 'Resourceful energy' and in BREEAM criteria 'Resources and energy'

'LC (life cycle) costing' and 'Sustainable building guidelines' have been moved from 'Integrated development process' to the 'Energy and emissions' criteria in PEARL (Code RE for Resourceful energy). Secondly, 'Adapting to climate change' which falls under the 'Social and economic wellbeing' category in BREEAM has been repositioned in this criterion. Also, Pearl rated buildings within communities from 'Liveable communities' is part of 'Energy and emissions' now.

### 3.2. Weighting of criteria

Once, the categories were repositioned to fit the appropriate criteria, the weighting (%) for each criterion was calculated as shown in Equation 1 below [3,6,12]. Note that 'High priority sites' falls under 'Land use and ecology' in LEED and 'land use' under 'Transport and land use' in BREEAM. These are now categorised under 'Site'.

$$\text{Weighting (\%)} = CP_{category} / CP_{total} * 100 \quad (1)$$

where, $CP_{category}$– Total credit points under criteria

$CP_{total}$ – Total rating system credit points

*Example a: BREAAM*

Criterion 'Site' has one category 'land use' (code LE2) and is weighted at 3 credit points. Total credit points for BREEAM are 126. By using equation 1, the weighting for site as percentage can be calculated as follows:

Weighting (%) for site = 3/126*100 = 2 (approx.)

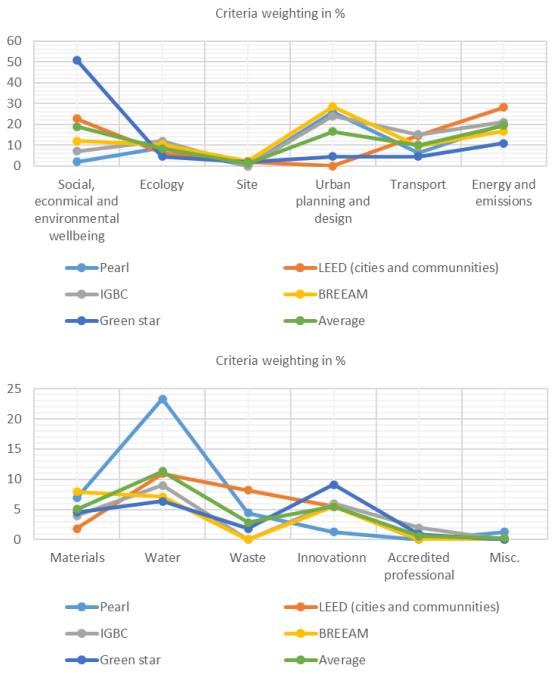
*Example b: LEED*

LEED too has only 'High priority sites' (code TR6) with 2 credit points under criterion 'Site'. Total credit points for LEED are 110. Using the above equation, the weighting percentage for LEED – 'Site' is as follows:

Weighting (%) for site = 3/126*100 = 2 (approx.)

To understand how the weighting system for the same criterion can vary vastly for different rating systems, the graphs shown in Figure 5 were developed. The graphs represent the percentage contribution of each criterion for the five rating systems. Some key findings are evident from the graph. Four of the five systems (except IGBC) highlight strategies on emissions. Urban design has been thoroughly strategized for most systems bar Green Star with Energy being prioritised in all systems along with socio-economic strategies. Of all criteria, Green Star prioritises Social, economic and environmental wellbeing with a weighting of 51%, followed by LEED at 23%. On the other hand, PEARL weights this criterion at 2%. Ecology had an average weighting between 6-16% in all systems. Two of five systems did not analyse site indicating a weighting of zero for the 'Site' criterion (PEARL, IGBC). However, this was compensated for in the urban planning and design weighting of approximately 25% in both systems. Other anomalies include PEARL's weighting of water at 23% compared to the average 7-11% of other systems, possibly due to location being linked to a scarcity of water and IGBC and BREEAM weighting waste at zero.

**Figures 5 a, b:**
*Comparative analysis of criteria weighting in % (by author)*



The data from the above analysis was used to arrive at the average weighting (as a percentage) for each of the criteria (see section 4, Table 4). 'Social, economic and environmental wellbeing' averaged to 19%, which is the highest weighting and 'Ecology' came to an average weighting of 8%. Site was at 1% which is the lowest weighting, possibly because two of the three rating systems have not addressed this criterion. 'Urban planning and design' came to 17% putting it as the second highest weighting. 'Transport' rounded to an average weighting of 10%. 'Energy and emissions' also had the highest weighting of 19%. 'Materials' rounded to a weighting of 5% with 'Water' at 11% and 'Waste' at 3%. 'Innovation', 'Accredited professional' and 'Miscellaneous' (accommodation for construction workers) criteria had averages of 5%, 1% and 0% respectively.

## 4. DERIVED RATING SYSTEM

Based on the detailed analysis of each rating system and comparisons between them a combined rating system has been developed. As described, the weighting of each of the above criterion was measured and an average weighting was calculated for each criterion to develop a weighting scale for the amalgamated rating system. The criteria for the derived rating system and their weightings are detailed in Table 4.

**Table 4:**
*Derived rating system criteria, average weighting from comparative analysis and derived weighting*

| Criteria | Average | Derived weighting |
|---|---|---|
| Social, economic and environmental wellbeing | 19 | 15 |
| Ecology | 8 | 10 |
| Site | 1 | 20 |
| Urban planning and design | 17 | |
| Transport | 10 | 10 |
| Energy and emissions | 19 | 20 |
| Materials | 5 | 5 |
| Water | 11 | 10 |
| Waste | 3 | 5 |
| Innovation | 5 | 5 |
| Accredited professional | 1 | |
| Misc. | 0 | |

A few changes have been made to the criteria in the derived rating system. Environment has now been paired with 'Ecology', leaving 'Social and economic wellbeing' as one criterion weighted at 15% and 'Ecology and environment' as one, weighted at 10%. Likewise, 'Site and urban planning and design' have been combined and weighted at 20% together. 'Transport' and 'Materials' weighting has remained the same. 'Energy and emissions' criterion is rounded to 20% with 'Water' at 10%. 'Waste' is weighted at 5% and 'Innovation', 'Accredited professional' and 'Miscellaneous' are now grouped together as the 'Other' criterion. It has a percentage weighting of five too. It can be noted that 'Energy and emissions' and 'Site, urban planning and design' now have the maximum weighting. This seemed appropriate as the aim is to design and test a net zero community, where energy and sustainable design are key. Although the new system's weighting has been changed, this is not drastic to the findings from the comparative analysis and average weightings.

### 4.1. Criteria categories in detail

The comparative analysis of the five rating systems showed many similarities between them. The consolidation of these systems helped group the various categories under the eight broad criteria listed above. The final step of the study involved detailing out categories included in each of these criteria. The categories for each criterion described below have been reiterated from the existing criteria of the five rating systems studied.

Social and economic wellbeing (15%):

- Integrative planning where stakeholders, especially the community are encouraged to engage in planning
- Adhering to local regulations
- Affordability of developing such a community and its economic impact
- Economic resilience and growth involving employment opportunities and community growth in terms of skills
- Heritage preservation, local vernacular is maintained, the community is encouraged to engage in socio-cultural initiatives

Ecology and environment (10%):

- Assessing ecosystem and conserving and restoring natural resources like water bodies and agricultural lands where appropriate
- Remediation of contaminated sites
- Preserving existing landscape, both hard and soft
- Assessing site topography and making best use of this
- Air, noise and light pollution control during construction

Site, urban planning and design (20%):

- Site selection and analysis which includes assessing solar and wind access, urban heat island, microclimate, outdoor thermal comfort
- Site zoning, layout, planning and sustainable urban design strategies developed based on site analysis
- Responsive planning that addresses needs of the community, to have a mixed-use development and services dedicated to the community
- Incorporating urban landscapes and local food production within the development
- Diversity in housing design based on demographic needs with accessible community facilities and inclusive design
- Energy infrastructure located within site to address lighting, heating and cooling needs

Transport (10%):

- Connectivity of community to public transport systems
- Sustainable transport and movement within community including pedestrian and bicycle networks and alternate fuel vehicles
- Adequate parking facilities

Energy and emissions (20%):

- Energy strategy to minimise energy demand at the building and thereby site scale
- On-site and off-site renewable energy supply planned
- Energy efficient building by incorporating sustainable design strategies and addressing thermal comfort
- Carbon emissions involved in operation and transport and analysing embodied carbon
- Include certified green buildings within the community

Materials (5%):

- Responsible sourcing of materials
- Recycling and reusing materials where feasible

Water (10%):

- Water strategy including assessing and reducing demand, efficiency in terms of supply, using smart water systems to assist with this
- Managing wastewater by addressing treatment and reuse of storm, grey and black water and harvesting rainwater

Waste (5%):

- Managing construction waste
- Solid waste management in terms of segregation and recycling

Other (5%):

- Innovation in design and technology
- Involvement of energy accredited professional
- Providing appropriate facilities for workers during construction

**4.2. Application of new rating system**

There is often ambiguity in starting a project that constitutes a large-scale net zero development. There is credible literature on net zero energy/carbon buildings and there are notable case studies around the world that claim to achieve net zero energy/carbon (see section 2). However, in-depth study on net zero communities is insufficient given the growing popularity of this term. It therefore proved essential to develop a guide for the same. The aim of this study was to develop a rating system that can be used as a guide/benchmark that would assist in designing and testing a prototype net zero community. This rating system is currently being used to design a community on the BedZED site as part of a larger study (PhD thesis of author). Developing this rating system proved useful as a starting point and guide to design and test a net zero community that will be situated in Sutton, UK.

The starting point for this was to identify existing benchmarks or rating systems that assess sustainable design and energy for large scale developments. The five rating systems selected are renowned for this and have therefore been used as base cases. While each of these systems is excellent in its own terms, combining these helped develop a rating system that acknowledges all the crucial aspects of sustainability. Criteria like waste, water and site that were addressed in detail in some and not so much in others would now be addressed thoroughly in the derived rating system thereby creating a guide that is more detailed.

It is to be noted that rating systems are often used from the conceptualisation stage, through the design and construction stages and into the operational phase of the development. Most criteria such as transport, site, urban planning and design, water and waste strategy, energy and emissions and materials can be controlled during the concept and design phases. Hence, if a hypothetical community was to be designed for say, the BedZED site, almost all of the criteria can be addressed during the design phase bar the ones

marked in red in section 4.1. Hence, this rating system acts as a genesis to design a net zero community.

## 5. CONCLUSION

This paper compared five important energy rating systems for large scale developments. A comparative analysis was conducted to identify a pattern of similarities between these energy rating systems. Based on this analysis a rating system that would be applicable for a large-scale net zero development was derived.

The five rating systems were tabulated in parallel to assess similarities and differences in categories and also their respective weighting in points. 12 broad criteria were evident in all five rating systems. These included social, economic and environmental wellbeing, ecology, site, urban planning and design, transport, energy and emissions, materials, water, waste, innovation, accredited professional and miscellaneous categories such facilities for construction workers and inclusive design. Simultaneously, the average weighting for each of these criteria was derived. Some categories were reallocated to criteria where appropriate. For instance, TR 6 – 'High priority sites' was moved to site from transport for LEED Cities and Communities.

The findings from the comparative analysis of the five rating systems helped derive a rating system that has eight broad criteria. Energy and emissions and site, urban planning and design have maximum weighting. It is to be noted that rating systems are applied from the conceptualisation of a project till the end of construction and even during the first year of operation. The amalgamated rating system considers the categories from conceptualisation till operation. Hence, when designing a net zero community some of these categories may not be applicable at the design stage but can be addressed only during construction. Overall, this derived energy rating system will act as a guide or benchmark that can be used to develop a net zero community in any location around the globe.

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