DEVELOPMENT OF A SUSTAINABLE MATERIAL ALIGNMENT FRAMEWORK

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Abstract

As sustainable building rating systems and energy codes become more widely adopted, there is an increasing industry need to evaluate sustainable products with regards to such systems. In order to effectively undertake this evaluation, an alignment exercise is necessary to document the credit requirements and relevant product types, not only for categories specific to materials, but in all categories. This paper presents the development of a framework to allow the alignment of materials with credit requirements of a sustainable building rating system, and expands this framework to align with prescriptive requirements for energy codes and standards. Two case studies are presented in this paper. The first illustrates product (using MasterFormat specification numbering) alignment with LEED®® v4 credits and pre-requisites. While this case study considers all credit categories, there is a particular focus on the materials credits and the particular issue of environmental product declarations. The second case study illustrates how the same framework can be used to align material types with the prescriptive requirements of the ASHRAE 90.1 Energy Standard. Differences between rating system and prescriptive standard alignment are discussed, along with the application of the resulting alignment to inform specification language. Lessons learned from this exercise are presented, along with a high-level review of credit type alignment with dominant global sustainability rating systems for both non-residential and residential sectors. Finally, the implementation of this alignment strategy to develop an online tool to identify whether materials align with credit requirements is presented.

Keywords:

LEED® v4, ASHRAE 90.1, sustainable building materials, alignment strategies, MasterFormat

1 INTRODUCTION

With the growing trend in reducing the initial and recurring embodied energy in buildings [1], there is a need for verifiable and transparent documentation regarding the manufacturing of green building products [2]. Sustainable building rating systems, such as LEED®, have responded to this by implementing credit categories based on product manufacture, distribution, and environmental performance, such as environmental product declarations, health product declarations, corporate sustainability reports, and many other forms of product disclosure [3]. These changes have forced practitioners to look much more closely at these documents than they previously might have, and become more conscious of the products they are using in their buildings. With the required tasks of keeping up with new technology and relevant codes and energy standards, there is a major time constraint for practitioners to search for new products, and become well-versed in assessing their validity [4].

This paper presents the development of a scalable methodology that allows materials (classified using the MasterFormat specification system) to be aligned with sustainability rating system credits and energy standard requirements, that form the basis for a commercial tool ("EcoSpex") to guide sustainable material selection. A comparison LEED®® v4 with other sustainability rating systems and energy standards – commercial and residential – is also presented as background research.

2 METHODOLOGY

At the outset of this project, a previous version of the alignment tool had been developed for LEED® 2009 and MasterFormat and this formed the basis for future alignment efforts. Five key activities were identified to develop a robust alignment methodology as illustrated in Figure 1. In order to best identify gaps or shortcomings in the methodology and its supporting documentation, a new research assistant was brought onto the team for Activity 5. This individual was unfamiliar with the work done to date as WELL® as the industry partner's existing process, but was a building science graduate student with a strong knowledge of building materials and energy codes.

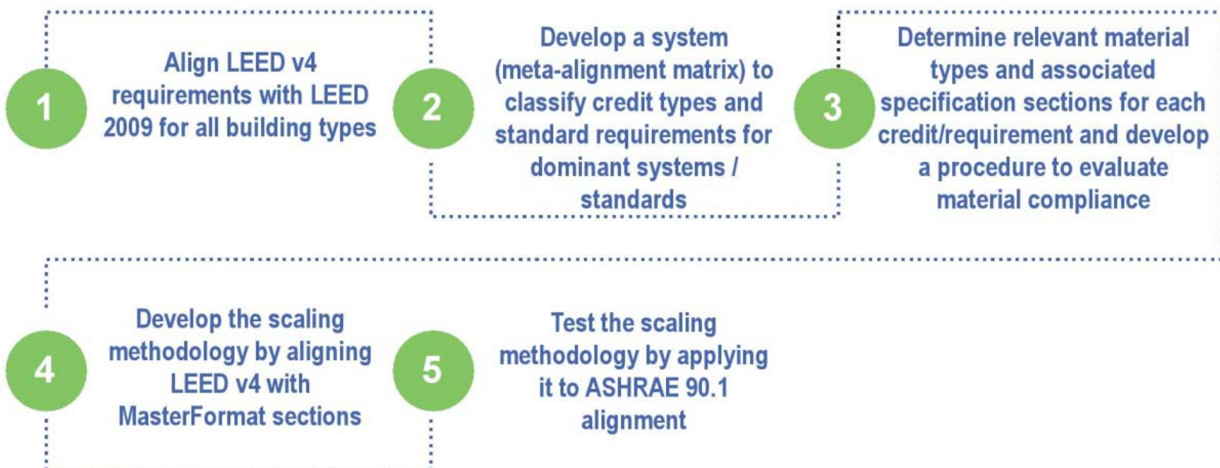

Fig. 1: Alignment Framework Development Methodology

2.1 Activity 1: LEED® v4 vs LEED® 2009 Comparison

As part of the launch of LEED®® v4, the US Green Building Council (USGBC) published several documents comparing LEED® v4 credits to the previous LEED® 2009 system. To ensure a comprehensive understanding of the new credit requirements, the research team reviewed each credit in detail in both systems and developed a detailed matrix summarizing only those credits that are attainable by selecting and installing a specific material, system, or product. For example in LEED® V4, the Heat Island Reduction credit is achieved by selecting specific materials that have high SRI and SR properties. Conversely, a LEED® credit that would **not** be affected by material selection is 'MR Prerequisite: Construction and Demolition Waste Management Planning', which relies on organizational policy and the selection of one product over another is irrelevant to such a credit.

2.2 Activity 2: Development of the Meta-Alignment Matrix

In order to establish the basis for future scaling, a meta-alignment matrix (Fig. 2) was developed to align individual systems and standards with LEED® v4 credits. This matrix was developed as a spreadsheet with four tabs (commercial energy, residential energy, commercial sustainability systems, and residential sustainability systems). On each tab, each column is associated with one system or standard while credit types are listed in each row. The relevant credit names and detailed requirements for the associated system/standard and credit type are then input in the intersecting cells. Finally, the last column lists materials and associated MasterFormat sections for each credit type.

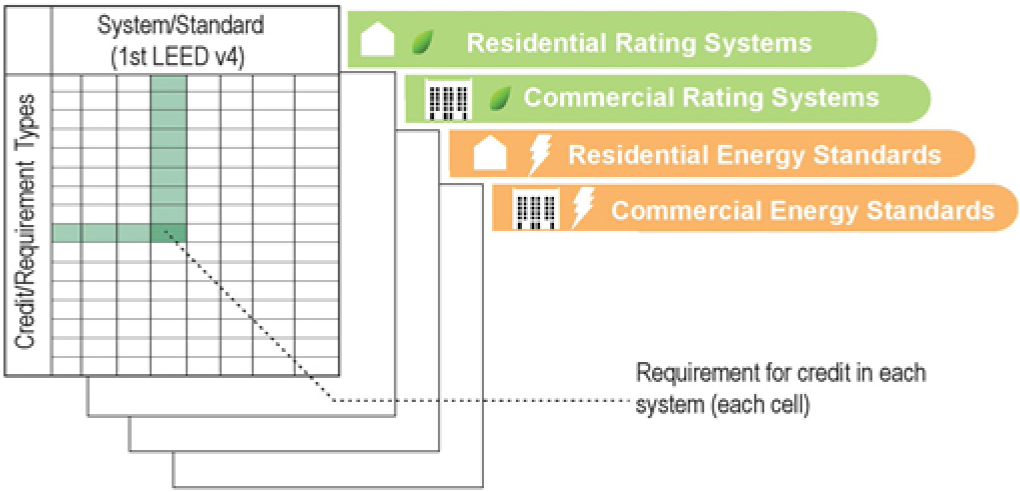

Fig. 2: Meta-alignment matrix.

Commercial System Comparison

For commercial building types, the following sustainable rating systems were analysed: LEED® v4, BREEAM UK / International, BEAM PLUS, Green Star, Green Globes, Living Building Challenge, and the WELL® Building Standard. With the exceptions of the Living Building Challenge and the WELL® Building Standard, the credit categories in these systems were substantially similar. For the latter two systems, a much more detailed review was required of the individual credits to align them with the most appropriate LEED®v4 credit(s) as different groupings were used. For example, limitations on volatile organic compounds are defined in the “AIR” category of the WELL® Building Standard [5].

The overall energy performance credit was the most difficult to align between different systems due to the dramatic variation in requirements and metrics (Fig. 3), however because building performance is a matter of design and cannot be determined by the selection of a specific material, this was less important. Of particular interest to material evaluation, all of the system considered provided credits for building material transparency, excluding Green Star. Similarly, all but Beam Plus considered life cycle impact of materials.

Credit Types Across System	LEED v4	BREEAM UK/Int
Energy & Atmosphere Related		
Energy Efficiency	**Minimum Energy Performance + EA Optimize Energy Performance** Minimum Energy Performance prerequisite as well as the EA Optimize Energy Performance credit where points are achieved by demonstrating a building's improvement (predicted efficiency) compared against ASHRAE 90.1- 2010 baseline case	**(Ene 01) + (Ene 08)** Credits are based on the predicted energy performance of the building compared to the performance of an equivalent National building that complies but not improves current building energy performance standard. Uses a metric that is unique to this framework, EPRINC, a ratio that defines the building performance in terms of its CO2 emissions, energy demand and primary energy consumption.
Co² Emissions	**EA Green Power and Carbon Offsets** Encourages greenhouse gas emissions reduction through the use of grid-sourced, renewable energy technologies and carbon mitigation projects. Points are achieved by engaging a contract for a minimum of five years for at least 50% of the project's total energy.	**(Ene 01)** Uses a metric that is unique to this framework, EPR^{INC}, a ratio that defines the building performance in terms of its CO^2 emissions, energy demand and primary energy consumption.

Fig. 3: Commercial Rating System Comparison Matrix (partial view showing energy performance credits)

Residential System Comparison

The following sustainable rating systems were included in this analysis: LEED® v4, ICC-700, Green Globes, Passive House, and ENERGY STAR. With the exception of ENERGY STAR and Passive House, the credits in each were organized into the following categories: energy and atmosphere, indoor environment related, water, materials and resources, and site related, the relevance of the latter category being limited to credits such as reflective roofing to mitigate the urban heat island effect. In examining the energy category, all systems allowed for flexibility of design, but required certain criteria to be met such as prescriptive insulation and window performance criteria. LEED® v4, ICC-700, and Green Globes allot credits for material re-usage and transparency, however Green Globes omitted site-related credits. Passive House does not address requirements for Indoor Environment with the exception of filter quality [6].The most significant difference between the rating systems is that while systems such as LEED® allow for varying degrees of certification based on the number of credits achieved, all Passive House and ENERGY STAR requirements must be met in order to obtain certification [7].

Energy Standards

Energy standards were much more consistent than sustainability rating systems but required the development of additional subcategories to fully capture these standards' requirements, beyond the credit categories in LEED® v4. Due to its global prominence, ASHRAE 90.1 was used as the basis for these subcategories and requirement alignment for the commercial energy standards and ASHRAE 90.2 was used for residential standards. Another critical standard that was analysed was the International Energy Construction Code; ASHRAE has taken great effort to align with this code to reduce confusion in the construction industry [8]. Additional codes and standards considered included the International Green Construction Code (IGCC) 2012, National Energy Code for Buildings (NECB; Canada) for commercial buildings, and IECC 2015, IGCC 2012, and the National Green Building Standard (US ICC-700) for residential buildings. Alignment of these standards was straight forward due to the consistency of requirements and organization, as well as previous harmonization efforts between these standards.

2.3 Activity 3: Assignment of Materials to Credit Types and Standards Requirements

To simplify the expansion of the alignment to new systems, individual materials and MasterFormat sections were mapped to credit types. Identifying relevant materials for each credit type was relatively straight-forward, however for the energy performance-related credit types, materials alone cannot achieve optimized energy performance as this is highly dependent on design. For such credits, materials used to improve building energy efficiency, e.g. envelope components or high-efficiency equipment, were considered to be aligned. For energy standards, prescriptive measurements are typically included and made this evaluation more straight forward with the exception of insulation. Since R-value is based on material thickness, all suitable insulations were considered to contribute to achieving the requirement.

2.4 Activity 4: LEED® v4 Alignment to MasterFormat (Case Study 1)

The CSI MasterFormat specification system was used for alignment as each product fits uniquely within one of its categories. The Uniformat system was also considered, however the variation in assemblies introduced complexity and third-party materials beyond the control of individual manufacturers and was determined to be less suitable for this project.

Because the scaling methodology used LEED®v4 as the basis of comparison with all other systems and standards, the LEED® v4 to MasterFormat alignment matrix served both as a usable tool as well as the basis for future scaling to new systems and standards. Currently in LEED® v4 there are 56 total credits, including regional and priority credits. This represents all credits present within each different rating system and construction type. Of these 56 credits, only 40 are affected by material selection in Activity 1 and thus were included in this matrix. In addition to credit requirements, the documentation required to demonstrate credit compliance were included in the alignment tables. This inclusion simplified material verification within the tool.

Materials were categorized by different credit categories, which were then associated to specific Master format section at the highest level with consistent requirements to minimize the required effort. For example, all wood windows (section 08 52 00) aligned to the same set of credits, but included the potential alignment with 'Certified Tropical Wood' that would not apply to all windows (section 08 50 00) and thus this differentiation was necessary. Each subset of materials was then evaluated for their potential to support achievement of different credits. The specific credit requirements and documentation required for certification is then listed for each intersection MasterFormat section and credit. The manufacturer or supplier must then prove this by showing documentation demonstrating this surface reflectance. This credit also illustrates how a single credit may have multiple options for achievement. In this case, each option is considered as a separate column in the alignment matrix as illustrated in Figure 4.

LEED v4 Alignment to National Master Specification		Heat Island Reduction - Option 1 - Low Slope Roof	
	National Master Specification Sections	Requirements	Certification / Documents Required
		Option 1 Meet the criteria of the equation for the credit to achieve point(s) Measures: Roof: • Low slope less than or equal to 2:12, that has a (SRI) > 64 after 3 years or an initial SRI> 82 • Install a vegetated Roof	• Roof area calculations • Site plan(s) with elements and measurements, including LEED project boundary, building footprint, roof and hardscape area, and area of each roof and nonroof measure • Manufacturer's documentation of SRI
07 50 00	Membrane Roofing		
07 51 00	Built-Up Bituminous Roofing	Material has a surface reflectance index (SRI) > 64 after 3 years or an initial SRI> 82	• Manufacturer's Documentation of SRI
07 52 00	Modified Bituminous Membrane Roofing	Material has a surface reflectance index (SRI) > 64 after 3 years or an initial SRI> 82	• Manufacturer's Documentation of SRI

Fig. 4: MasterFormat to LEED® v4 Credit Alignment Requirements (partial view)

The completion of the LEED® v4 to MasterFormat alignment will allow Ecospex to use the document as a template in their material and product verification database. The final alignment matrix includes over 7600 identified requirements for specific materials and forms the basis for the query engine to drive both the material verification process and the designers' material search interface.

2.5 Activity 5: Testing of Scalability by implementing for ASHRAE 90.1 alignment (Case Study 2)

Once the LEED® V4 alignment was completed, the second test was implemented in which the same process and framework was used to test the procedure on aligning the ASHRAE 90.1 2010 prescriptive standards to National Master Specifications. The difficulty in using the ASHRAE 90.1 standard from the LEED® v4 alignment document is the fact that former is an energy standard, while the latter is a sustainable rating system, which encompasses more than just energy. While the sustainable rating systems address the issues of energy performance, ASHRAE goes beyond and specifies very detailed requirements such as performance standards, tables, and exceptions [9].

Thus for the purposes of this exercise, only the energy category of the LEED® alignment documents was used to compare. In the ASHRAE 90.1 alignment, the following MasterFormat divisions were specified; 07 - Thermal and Moisture Protection, 08 - Openings, 14 - Conveying Equipment, 23 - Heating, Ventilation, and Air Conditioning, 26 - Lighting, and 48 - Electrical Power Generation.

Similar to the LEED® v4 alignment, the thirty (30) ASHRAE requirements affected by material selection were assigned to columns and MasterFormat sections were listed in rows. Over 250 individual equipment category requirements were identified within 30 requirement categories in this matrix.

3 APPLICATION OF THE ALIGNMENE METHODOLOGY

The alignment matrices developed form the basis for the development of a sustainable materials database with two interfaces: one for the manufacturer and one for the designer. First, material verification is supported through an online portal where manufacturers indicate the product they are uploading and its MasterFormat section and are prompted to indicate whether or not the product they are uploading complies with the specific credit requirement for that material subset as tabulated. For each affirmative answer, the required documentation for compliance (also tabulated) must be uploaded. Note that for energy standards, all requirements must be met, whereas in LEED®, compliance with an individual credit requirement is permissible. These are then checked and verified products are included in the searchable database. Designers may then query the product database by material type, desired credit(s)/energy standards, or both. Compliant products in each category are then displayed in order to guide sustainable material selection.

4 CONCLUSIONS

In the initial phase of this project, the purpose was defined as developing a framework that would allow the alignment of the LEED® v4 rating system to MasterFormat and provide a framework for future scaling. As a pilot case, the LEED® v4 alignment was successful. In testing this framework using ASHRAE 90.1, the overall methodology proved sound and provided a strong basis for this development. Given that ASHRAE 90.1 is an energy standard with significantly more detailed prescriptive requirements, certain modifications in approach were required:

1. Additional sub-categories were created in the energy standard alignment matrices to reflect the additional prescriptive requirements.
2. A significant number of LEED® v4 credits were omitted as they are not reflected in energy standards.

Future research would benefit from an exercise to align a second sustainability rating system using the presented methodology. Similarly, testing this methodology to align a second energy standard based on the ASHRAE 90.1 alignment would be beneficial as it would provide a greater depth of insight into the effectiveness of this methodology.

5 ACKNOWLEDGMENTS

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