Determining the Policy and Performance of Green Buildings within the Department of National Defence, Canada

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Abstract

This study summarizes the current strategies that are being employed by the Canadian Department of National Defence (DND) with regards to green buildings. The ultimate goal of this research is to evaluate the current policy with regards to green buildings and to obtain real energy performance data of such infrastructure in order to help bridge the gap between policy and practice, and provide guidance on green building implementation strategies. Additionally, this project will examine if a green building rating system (i.e. LEED) sets an adequate sustainability standard for the many unique infrastructure requirements of a national defence organization.

Keywords: National Defence Sustainable Defence Strategy, green buildings, energy monitoring.

Résumé

L'étude résume les stratégies du ministère canadien de la Défense nationale (MDN) en matière de bâtiments écologiques. L'objectif ultime de la recherche consiste à évaluer la politique actuelle et à obtenir des données réelles sur le rendement énergétique de ce type d'ouvrages, afin d'aider à combler le fossé entre politique et pratique et de formuler des recommandations sur les stratégies de mise en œuvre d'une politique de bâtiments durables. Le projet a aussi pour but d'évaluer si un système de classification de bâtiments écologiques (LEED) établit des normes de durabilité adaptées aux nombreuses exigences uniques des infrastructures d'une organisation de défense nationale.

Mots-clés : Défense nationale, Stratégie de développement durable de la Défense, bâtiments écologiques, contrôle de la consommation d'énergie

1. Introduction

Green building/sustainable development strategies are those which address the environmental, social and economical aspects of a building, in an attempt to lessen the negative impacts of the infrastructure. The purpose of this project was to provide a critical analysis of appropriate green building/sustainable development strategies for new construction and large renovation projects, to examine their suitability for the Canadian Forces (CF) and to further attempt to determine the performance of an existing green building. This investigation outlined the challenges of achieving current mainstream green/sustainable building accreditations due to the unique environments (including infrastructure in the Arctic, isolated areas, and overseas) within the CF. These challenges require solutions which are specifically designed for implementation

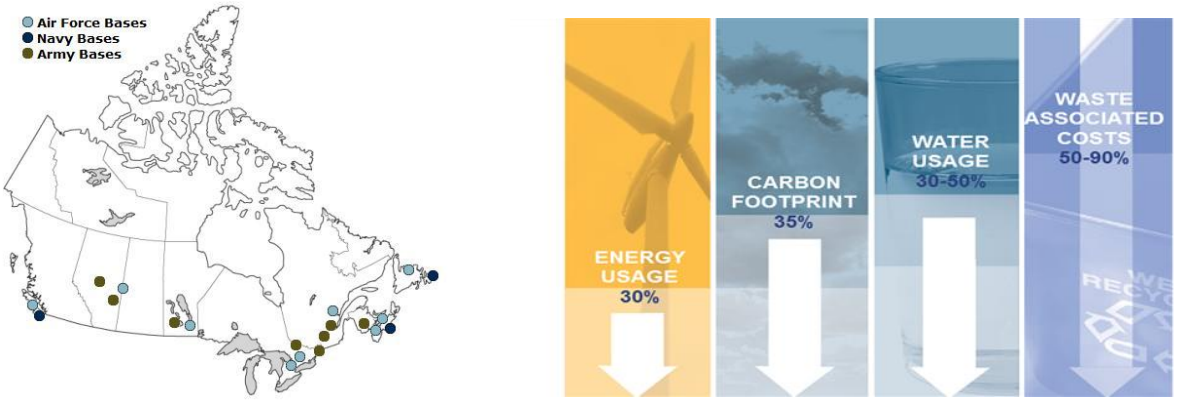
within the CF, and not simply solutions which have been “imported” from similar industries. As such, a proposed DND) Sustainability Standard is outlined to assist the CF in achieving the objectives of green/sustainable building initiatives without compromising the ability of DND/CF to carry out regular activities. The three main research questions investigated were:

1. What are the unique requirements of the CF with regards to green/sustainable buildings? (Part 1);
2. What should be implemented in a sustainable development strategy for the CF in order to achieve green/sustainable building objectives? What are the constraints of current DND policy, and how can those constraints be overcome? (Part 2); and,
3. Determine if the performance of an existing, LEED-accredited green building is achieving sustainability claims and targets.

These questions were investigated in order to illustrate the importance for the DND to consider implementing green/sustainable building strategies that are specific to DND and may be lacking in current rating systems, which would in turn create a Sustainability Standard; one that is more representative of the type of infrastructure DND owns and operates.

2. Background

DND is the largest building owner in the federal government by quantity (i.e., number of buildings), holding more than 43 percent of the federal inventory. Installations exist in every province and territory and are located in 217 cities/municipalities [1]. Under the purview of the Canada First Defence Strategy, over the next 20 years, DND will replace 50 percent of its existing infrastructure. Considering that the DND holds some 21 000 buildings, 2.25 million hectares of land, 5 500 km of roads and 3 000 km of water, storm and sewer pipes, it can be said that the activities of the DND will impact the whole of Canada [2] (Figure 1a). These impacts may also translate into international concerns, as many of the issues are trans-boundary by nature (i.e. air quality).



(a) (b)

Figure 1. Green Buildeings: a) Current Infrastructure Projects for the DND (Source: [3]) and, b) Claims of Improved performance [4].

Implementing a green building strategy into policy can achieve many savings and if properly designed can achieve many positive results. According to the Commission for Environmental Cooperation, buildings in Canada are responsible for: 50% of natural resources consumed, 33% of all energy used, 12% of non-industrial water used, 25% of landfill waste generated, 10% of airborne particulate produced, and 35% of greenhouse gas emitted.

An improvement in the environmental performance (Figure 1b) of the building industry is clearly an important step towards a more sustainable future. Buildings constructed utilizing a holistic approach, and following the green building philosophy, have the potential to yield significant environmental, economic, and social benefits for all stakeholders; including owners, occupants and the general public. Relative to traditional buildings, green buildings claim to be:

a. Are more energy and water efficient;
b. Generate less greenhouse gases and other pollutants;
c. Use less non-renewable materials and use materials more efficiently;
d. Produce less solid and liquid waste;
e. Produce less light pollution;
f. Mitigate the potential for urban sprawl and heat-island effects;
g. Are designed to be more adaptable to changing uses;
h. Provide numerous economic benefits, especially long-term;
i. Provide positive corporate image; and,
j. Utilize healthy indoor environments to promote productivity, employee morale, and employee health.

While not all green/sustainable buildings will exhibit all of these advantages, if the most appropriate design and construction decisions are implemented it will be possible to maximize the benefits of building green. Many of the claimed advantages commonly associated with green/sustainable buildings are desirable for the CF. Selected studies [5] and the preliminary results of this study suggest that overall energy savings may not be as claimed.

2.1 Sustainable Development within the DND

There are several Directive Orders within the CF that require sustainable, and environmentally friendly activities/practices/procedures within all facilities owned and/or operated by the CF. However, there is one document in particular which contains the necessary requirements to assist the CF with modifying its practices with regards to new construction of buildings and major renovations. In 2003 the Department of National Defence (DND), in its Sustainable Development Strategy (SDS) 2003, outlined a target (D1) to integrate the green building concept into the design process by having a percentage of eligible new building projects incorporate the green building concept. This target was a very important first step towards integrating green engineering into DND. The 2006 version of the SDS has taken the green building objective a step further with strategic commitment 2.1 (SC.2.1). This latest initiative has set goals for projects valued at over $10 million to achieve a LEED silver or better standard and for projects valued at under $10 million to achieve a Green Globe 3 out of 5 or better standard. These are also part of the requirements of the 2010 Federal Sustainable Development Strategy (FSDS), to achieve accreditation within generic green/sustainable building systems [6]. Currently, there is no available information substantiating the DND's decision to adopt LEED and Green Globes rating systems, aside from the fact that they are widely used in North America.

2.2 Leadership in Energy and Environmental Design (LEED)

To address the demand for standardization and certification of green buildings and green building methods, members from all sectors of the Canadian building industry came together to form the Canada Green Building Council (CaGBC). Today, the CaGBC administers the LEED rating system, which has been developed to provide a means of recognizing green building achievements for buildings utilizing a wide variety of differing green building concepts. The

LEED Green Building Rating System [4] provides clear targets and criteria for the design, construction, and operation of a green building. The rating system is a points-based system where points are awarded for meeting specific performance criteria which are designed to outperform typical practices. Projects are awarded a rating level based on the number of points achieved where Platinum is awarded for 52-70 points, Gold for 39-51 points, Silver for 33-38 points or Certified for 26-32 points. The prerequisites and credits are organized into five principal categories as follows: Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Materials and Resources (MR), and, Indoor Environmental Quality (EQ).

2.3 LEED Challenges

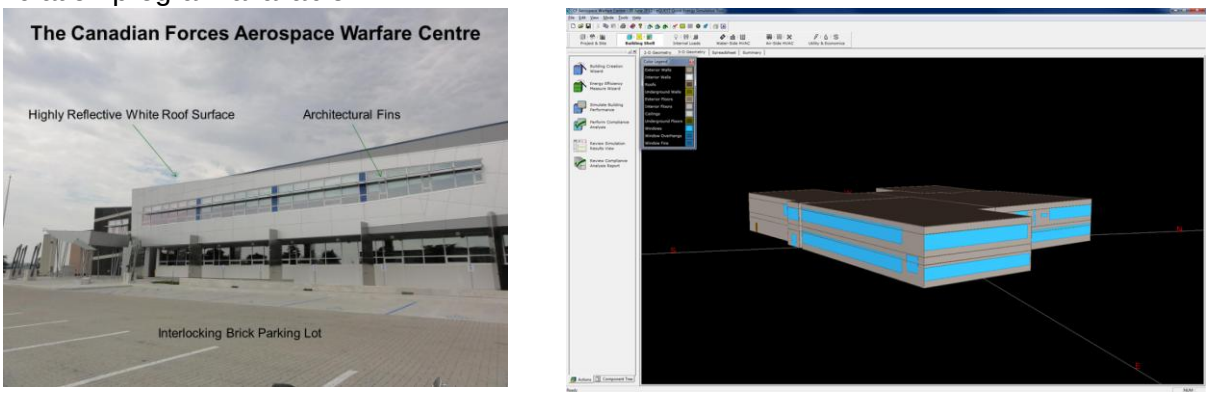
The LEED rating system has been at the forefront of rating systems within North America. This system, although legitimate, popular and intended to be applicable for all of Canada, has its limitations. Canada is composed of a vast and diverse terrain with a wide range of climactic and geographical environments. These facts provide a significant challenge for the implementation of a standardized, national green building rating system.

As the DND owns facilities all across the Country and is the second largest owner of infrastructure within the Federal government, the regional challenges of implementing LEED are of significance. As well there are a broad range of building types and specific requirements within DND. The LEED Canada-NC 1.0 rating system attempts to address regional issues by focusing on the green building intent of the various credits rather than on requiring specific green building techniques which may or may not be nationally applicable. This is a severe limitation. The idea is that a project's design team will determine the specific techniques and technologies to be implemented (to achieve the prerequisite or credit) based on the specific site conditions, including the regional climactic and geographical/geological environments.

In order to ensure the integrity of the LEED rating system, the credit and prerequisite requirements are defined with some degree of rigidity, such that achievement of a credit or prerequisite will result in the desired positive effect. Essentially, while a designer may choose any technique or technology to achieve a particular LEED prerequisite or credit, they must ensure that they meet the specific requirements outlined for the prerequisite or credit. For some prerequisites and credits, these requirements may have limited flexibility [7]. This rigidity poses several challenges when discussing green building on the national scale. Firstly, a specific technique or technology may have significantly differing contributions to meeting a LEED credit depending on the location of implementation. For example, any techniques relying on solar contributions will have significantly different impacts on achieving credit requirements in the North than in the South due to differences in the sun path and solar altitude. Secondly, the ability to meet specific prerequisite or credit requirements will vary significantly from site to site. The climactic factor itself will ensure that the same building built in one location in Canada will not achieve the same LEED rating as the exact same building situated at another location within Canada. As a result, it may be considerably more challenging to achieve a particular rating at one site than at another. In extreme situations it simply is not possible to meet the requirements of a prerequisite or credit, given the site conditions and activities. For example, the use of shower facilities at the workplace in hamlet locations may not be reasonable (a LEED credit). The use of bike racks (a LEED credit) or being situation next to a bus route (a LEED credit) may not be feasible in Northern locations. As well, a reduction in building energy use may be much more difficult to achieve in special use infrastructure due to the nature of the military activities within the building.

2.4 Monitoring LEED Building Performance in DND

An assessment of the building performance of the CF Air Warfare Centre (designed to LEED Gold Building) located in Trenton, Ontario has been underway since 2011. The design and construction of this training building (comparable to a school) occurred through a design-build process. The building was designed and built according to the Federal Building Code. Relevant specifications include: 5875 m^2 of project floor area, 3500 m^2 building footprint, 2 floors and 104 Occupants (Figure 2a). The building uses a building automation system that manages the building's air systems, plant systems, floor controls, and other systems, and is designed to integrate various types of information, such as the status of mechanical equipment, temperature and humidity levels, CO_2 levels, lighting, fire safety, and security, with a view to maximize the performance of the building. The automation system was used in order to determine the energy use (primarily) of the various systems associated with the building. eQUEST 3.64 [8] was used in order to simulate the CFAWC building and conduct the numerical analyses associated with this study (Figure 2b). eQUEST is a software package that is provided by and utilized by the US Department of Energy. This software package has been continuously developed over the past 20 years, and is the most widely trusted building energy simulation program available.



(a) (b)

Figure 2: The Canadian Forces Aerospace Warfare Centre (CFAWC): a) Image of Building, and, b) Simulation of CFAWC Building using eQUEST.

3. Rating Systems

Building Rating Systems (Figure 3) were created to assess the negative consequences infrastructure has on society by evaluating the infrastructure performance in a number of areas,

Figure 3: Examples of National and International Rating Systems

e.g., energy consumption, waste production, indoor air quality etc., in order to improve efficiency. They are used as a tool to track performance and provide building owners and developers with a guide to assist in building more sustainably.

3.1 Limitations of Green Building Rating Systems

There are many benefits to green building rating systems, such as LEED. Among other things, they provide clear direction for environmentally friendly initiatives. Since the idea of green buildings movement is a relatively new, rating systems can be used as measures or indicators of sustainability, tracking progress throughout the building industry [9]. However, it is important to question whether or not rating systems are the best options for the CF, as generic rating systems may not always accomplish the environmental savings alleged. Each project has its own unique set of parameters and issues, and therefore, it is not a best practice to rely on one particular set of criteria for priority setting, i.e. selected rating systems have a higher portion of points awarded for energy savings, than site selection, or some prerequisites require recycling, while this may not be the most effective use of time/money. Achieving a particular certification, can often times result in a "points grab", which does not encourage builders to buy into the true meaning of the sustainable building philosophy. This creates a shift in focus from environmental concern, to one of just a perception of greenness. Perhaps the idea of a generic points system is the issue, rather than the actual content of any particular system

4.0 Research Approach

In terms of policy, Mixed-Method Research (triangulation) was used for this research as it provided the opportunity to gain information about the current status of green buildings within the CF, feedback and recommendations from personnel associated with the issues surrounding green buildings, as well as comparisons to existing rating systems. A Literature Review, and document analysis were conducted to gain insight into existing sustainable building rating systems, and policy documents were analyzed for ideas that would be most applicable and useful to the CF. Long/semi-structured interviews with relevant personnel within the federal government, private companies, and those who have experience or knowledge on the subject of green buildings, were also used. The participants were interviewed to determine how the CF can best achieve its sustainability targets with respect to the construction of buildings. Interviews were meant to determine what is lacking in current systems that may be hindering the progress of implementing green building strategies, and the actual 'benefits' of such infrastructure. Table 1 lists the interviewees (i.e. subjects), along with their organizations. The subjects are only identified by a number, and corresponding organization. In terms of building performance one (of many) of the indicators that were used was to determine the energy usage of the building for comparison purposes was the Energy Use Intensity (EUI). The CFAWC's EUI was determined by assessing the total energy consumed in one year and normalizing it to the total floor area of the building.

Table 1: List of Long Interview Participants and Affiliated Organizations

Number of Long Interview Participants	**Organization**
9	DND
2	DND-civilian
3	NRCan
1	Green Globes
1	LEED
2	Independent Consultant

5. Results and Discussion

This section contains the numerous results from the data that were collected and analyzed as part of this research undertaking. These results identify all the major themes reflected by the interviews and supporting literature, regarding the essential components of a DND-specific building rating system, as well as challenges of implementing green/sustainable policies into the CF. Also included are preliminary results from the numerical analysis conducted for the CFAWC. These results were compiled based on the researcher's data collected, and research into the specific operations and needs of the DND. In addition, the authors have over 25 years of practical experience working within DND and are well aware of related issues/factors. In support of this overall objective, the results cited herein are the main results as determined through the rigorous methodology that has been applied in this research study.

5.1 Results– Part I

This first research question aims to determine the needs of the CF with regards to a sustainable building strategy. Figure 4 indicates the proportion of respondents who do not believe that the application of current building rating systems achieve the intended savings, or properly fulfill sustainable building philosophies. Of these respondents, an overwhelming majority are DND personnel. This indicates that within DND, the way in which infrastructure is currently being managed is felt to be unacceptable.

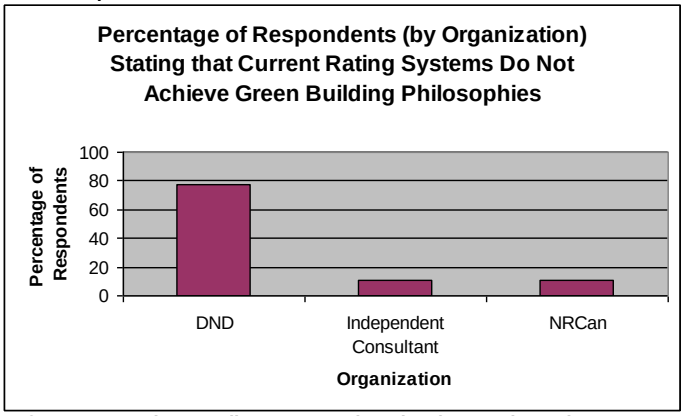


Figure 4: Percentage of Respondents (by Organization) Stating that current Rating Systems do not Achieve Sustainable Building Philosophies

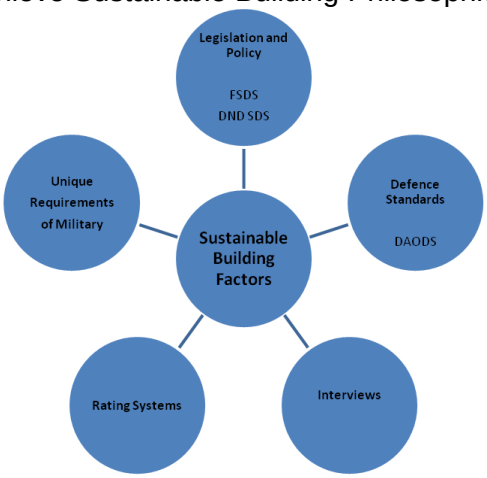


Figure 5: Strategy used for determining factors proposed in DND SDS.

Based on interviews, and supporting literature, the following section describes a series of factors that are believed to be important for inclusion in a DND specific sustainable building rating system. These factors were then compared against current ratings systems, and evaluated by the way in which these rating systems applied that factor.

An existing rating system (and subsequent credit/criterion) was selected that best applied each of the factors highlighted through the research (interviews, literature, and researcher's experience). The parameters of the existing rating system credit/criterion selected were based on their applicability to the military, ease of use/implementation, and perceived environmental, social, and economic benefits of that credit. Figure 5 further illustrates the process for selecting these factors. These factors and chosen rating systems have been summarized in Table 2 below. Within Table 2, 'N/A" means it was not addressed effectively by any system. The rationale and substantiation of the selection of the rating system of choice is the focus of the subsequent sections.

Table 2: Evaluation of Factors to be Included in the proposed DND Sustainable Development Rating System.

Factor	Rating System of Choice
Administrative	
Flexibility of Criteria	Green Globes
Performance vs. Prescriptive indicators	Green Globes
Third-Party Verification	All
Integrated Design Process	BREEAM
Lifecycle Analysis	DGNB
Greenhouse Gas Emissions	
Reduction in Energy Usage in Buildings	BREEAM
Vehicles: Reduction of GHG from Vehicle Emissions	LEED
Encouragement of Virtual Meetings	N/A
Water Quality	
Reduction in Water Usage	Green Star
Human Health Consideration of Water	Swedish Rating Tool
Wastewater Management	Green Star
Materials and Resources	
Waste Reduction	DGNB
Recycling/Separation of Operational Wastes	BREEAM
Green Procurement	Green Globes
Recycling e-waste	N/A
Indoor Environmental Quality	
Air Quality	LEED
Indoor Temperature Controls	BREEAM
Odourless and Low Emissions Products	Green Star and LEED
Acoustic comfort	BREEAM
Indoor Design	DGNB
Views	LEED
Lighting Controls	LEED
Site Selection	
Regional Consideration	DGNB
Environmental Integrity of the Site	BREEAM

Factor	Rating System of Choice
Location to Amenities	DGNB
Security	N/A
Social/Cultural Aspects	
Cultural Sensitivity	DGNB
Social Impact on Adjacent Properties/Architecture	Green Globes and DGNB
Operation/Maintenance/Education	
Monitoring	N/A
Commissioning	BREEAM
Education	N/A
Employee Awareness	Green Globes
Training	BREEAM
Flexibility of Building Use	DGNB
Measurement and Verification	DGNB
Building Durability	DGNB
Economics	
Life Cycle Cost Analysis	BREEAM and DGNB
Innovation	
Innovation	All

Based on the conclusions drawn from Table 2, it is evident that there is not one rating system that provides DND with all the required factors/ criteria in order to effectively address sustainability within their infrastructure. As well, it is evident that perhaps LEED and Green Globes are not the most effective rating systems for use within the DND.

5.2 Results – Part II

This section addresses the research question: What should be implemented in a sustainable development strategy for the CF in order to achieve green/sustainable building objectives? What are the constraints of current DND policy, and how can those constraints be overcome?

Challenges of implementing sustainable building strategies within DND were raised due to the current practice and structure of the CF. The following results outline ways in which the DND can better implement building strategies into management plans. Any policies created within DND must account for its unique command structure as it will have a direct influence on operations and influence on all long-term aspects. The command structure is based on making quick and efficient decisions, and when there is a five-year or ten-year sustainability plan, the current structure is limited in terms of addressing that issue, i.e. the posting system. DND needs to establish a strategy and framework that will address its current budgets, structure and priorities. Issues and recommendations to mitigate these issues to make strategies more effective are summarized below in Table 2.

Sustainable building tools cannot stand alone, and must be part of a wider sustainable building policy initiative through the DND. Obtaining sound feedback and input to the CF and the DND, can, in turn, be introduced at the Federal Level. This can be accomplished through the creation of a DND specific Sustainable Building Strategy. Policies which aim to progress the use of sustainability concepts within infrastructure practices should use these concepts when designing policy, not just for the design of infrastructure itself. The current CF LEED and Green

Globes policy certainly has its shortcomings in this regard. This research has illustrated the need to re-evaluate the method of policy creation within the DND, to include more relevant and further reaching concepts of sustainability.

Table 3: Issues and Required Actions for DND Building Management Plans

Cited Issue	Action Required
Short-term polices regarding sustainable development	Consideration of high turn-over rates, and long-term budgets.
Lack of ownership and accountability	Requirement of executives and directors to have their end of year assessments affected if they are not implementing sustainable practices.
Lack of spending on pilot projects and research and development	Long-term budgets.
Lack of Training and Education	Ensure clarity of policies and provide training programs to ensure proper execution of tasks.
Lack of Communication	Creation of policy must consider all factors of building design and user group requirements. Communicate requirements to all levels and between departments (green building policies should be shared between Environment and infrastructure).
Unclear Objectives	Ensure all parties understand terminology and concept in policies and plans. Requirement of consistent monitoring and re-evaluation of policies.
Not flexible	Create a policy flexible enough to include both large and smaller infrastructure projects.
Lack of incentives	Provide Incentives for managers and directors to implement sustainable building strategies.

5.3 Selected Results – Part III

Based on the observed electrical consumption of the CFAWC over a period of several months, the EUI was determined to be within the range of 235 to 243 $kWh \cdot m^{-2} \cdot year^{-1}$. In order to establish a performance baseline with which to compare the energy performance (one of many topics of interest) of the CFAWC, the Energy Information Administration Commercial Building Energy Consumption Survey [10] from the USA was utilized. The CBECS organizes the EUI of similarly categorized buildings from across the USA. The mean values of the nominally identical infrastructure from years 1990-2009 have been determining and are included in Table 4 with variable heating components. Table 4 is a combination of a series of building EUI references that are pertinent to the CFAWC. This table was constructed in order to compare the CFAWC performance (actual and modelled) with respect to the electrical EUI of other, relevant sources. The EUI values that were prepared for the builder using the Model National Energy Code of Canada for Buildings [11] are also included. As see in the results summarized in Table 4, the CFAWC under-performed in terms of the average values cited. The observed performance is similar (within 5%) of that predicted by the design team. However, what is concerning is that the energy usage is greater than 25% or nominally identical infrastructure of the same function, geographic location and older infrastructure. These results are preliminary and building performance monitoring is ongoing as well as numerical analyses.

Table 4 EUI for as Determined or Equivalent to CFAWC by Function

CFAWC Building Energy Usage Determination	**EUI (**kWh·m^{-2}·year^{-1}**)**	**Reference**
Observed, Recorded Performance	243 ekWh·m^{-2}	Observed Electricity Data Collected by Research Study
Modelled Value from Research Study	361 ekWh·m^{-2}	eQUEST 3.64
Modelled Value of CFAWC contractor - Baseline	325 ekWh·m^{-2}	Reference (NRC, MNECB 1997)
Modelled Value from CFAWC contractor – Green Building	231 ekWh·m^{-2}	Modelled Value from CFAWC contractor
EIA - By Function (office)	186 ekWh·m^{-2}	US Energy Information Administration (2009)
EIA - By Year 2000-2003	182 ekWh·m^{-2}	US Energy Information Administration (2009)
EIA- By Region – Northeast USA	133 ekWh·m^{-2}	US Energy Information Administration (2009)

6. Conclusions

The results of the interviews of the DND personnel, federal employees and relevant experts also, further defined the unique requirements and policy of the CF in this regard. Examining buildings within a SD framework from the macro (holistically) to the micro-scale (CF specific), the author investigated the development of current sustainable building rating systems and strategies. The author's research has contributed to the examination of current green / sustainable building rating systems and their widespread application. The trends and themes that were thoroughly examined and determined helped contribute to the academic discourse in the field of sustainable buildings assessment. The results (i.e. the most viable and relevant components (or cited factors) of a variety of rating systems in regards to green building and sustainable development concepts) reiterate the fact that proper critical analysis, and a trans-disciplinary approach is required for selecting the most optimal rating system indicators and criteria; especially for use by the CF and DND, with their stated unique requirements. The aim was to tackle and suggest a solution for a 'real-world problem', as the tool should be used to improve the performance of buildings. Scientific knowledge from many fields needs to be collated and analyzed in order to extract the most important aspects to be considered in the tool. In addition, appropriate policies and support are required to foster the progress of sustainability strategies. The following conclusions can be drawn from the results of this research:

a. The unique needs of the DND were identified, and investigated on how this uniqueness affects the application and effectiveness of rating systems;
b. Core, Relevant SD factors / criteria were determined through a thorough, comprehensive and international selection process that could be used as the foundation for a proposed DND sustainable buildings rating systems;
c. A sustainable development framework was established;
d. Areas of improvement, with regards to SD, for DND infrastructure were identified;
e. Research addressed shortcomings and proposed sustainable building policy protocol; and,
f. The claims of improvement of building energy performance have not been seen to have been achieved using EUI as an indicator.

7. Acknowledgements

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