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ENHANCING CAPACITY FOR LOW EMISSION DEVELOPMENT STRATEGIES (EC-LEDS CLEAN ENERGY PROGRAM)

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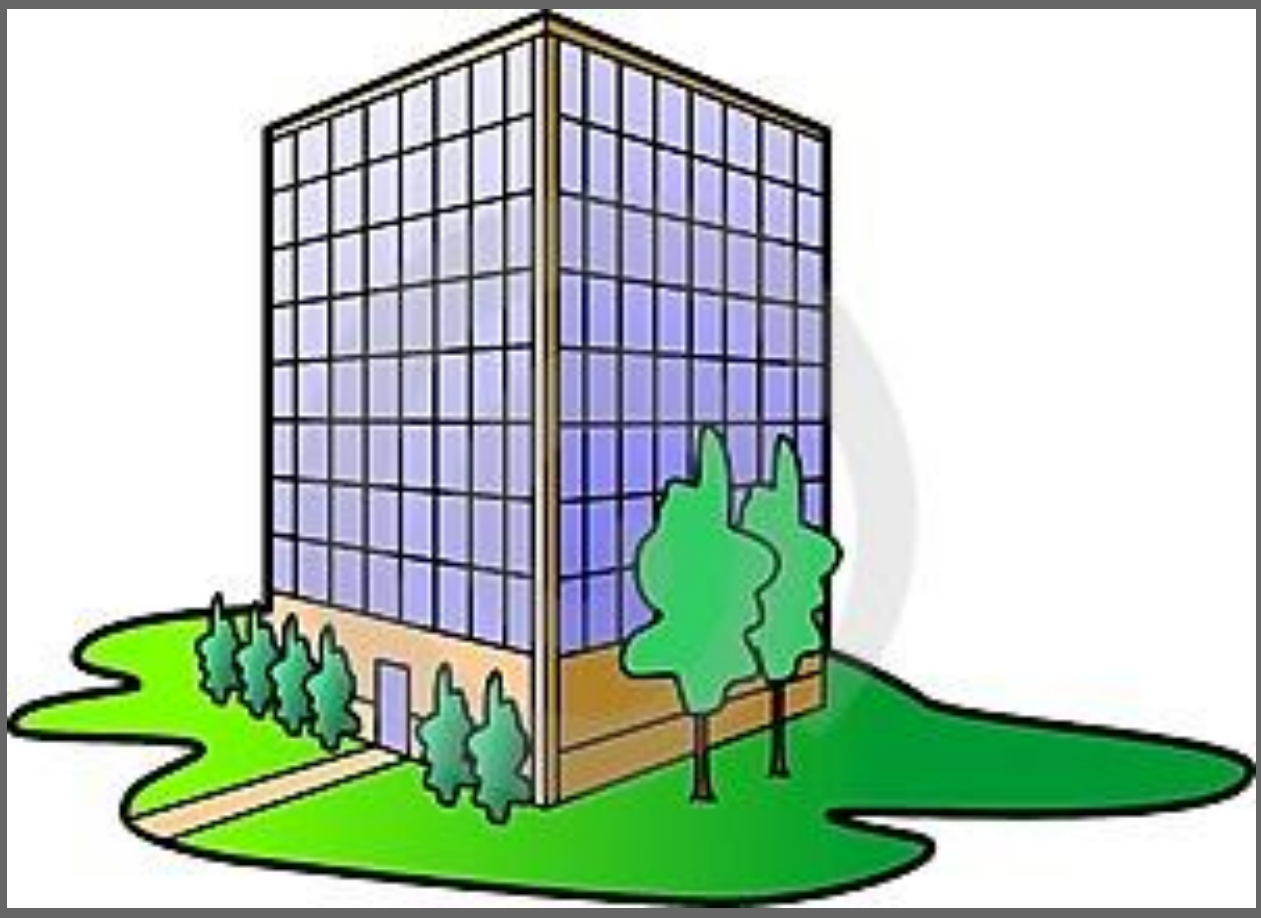
MRV FRAMEWORK AND METHODOLOGY



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ENHANCING CAPACITY FOR LOW EMISSION DEVELOPMENT STRATEGIES (EC-LEDS CLEAN ENERGY PROGRAM)

MRV FRAMEWORK AND METHODOLOGY REPORT

August 2015

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The report was prepared by Levan Natadze of Green Building Council Georgia with contributions from other staff members, and was reviewed by Inga Pkhaladze and Nino Lazashvili of Winrock International Georgia.

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ACRONYMS

Acronym	Full name
BMS	Building Management System
BREEAM	Building Research Establishment Environmental Assessment Method
CO2	Carbon Dioxide
DHW	Domestic Hot Water
EC-LEDS	Enhancing Capacity for Low Emission Development Strategies Clean Energy Program
EPA	Environmental Protection Agency (USA)
GBC	Green Building Council
GHG	Greenhouse Gas
IR	Infrared
M2	Square Meter
MRV	Monitoring, Reporting and Verification
02	Oxygen 2
RS	Rating System

EXECUTIVE SUMMARY

Worldwide, environmental matters have become a principle issue for businesses. To focus on environmental issues in the building industry, the market applies green or energy efficient building assessment systems to measure the sustainability of the facilities and their energy use. The systems are developed nationally or internationally. Buildings are assessed and certified according to pre-defined themes, which may vary from one country to another. Generally, once they are certified, buildings are re-assessed periodically to ensure they still conform to the requirements of the rating systems. Monitoring the rated parameters is required to reduce costs and enhance or maintain the efficiency of operating buildings. Verification of data provided during building energy labeling-- or green certification--should be carried out periodically according to the building type and complexity of its systems. Due to possible changes in building ownership, building management or for economic reasons, maintenance schemes can change, which also requires verification of initial parameters.

This report identifies the most effective scheme for verifying results achieved by labeling energy efficient buildings or certifying green buildings within the framework of the EC-LEDS project. Although the verification system has been designed as a framework to develop specific buildings' MRV Plans, it can be used widely in Georgia for similar buildings and by other stakeholders. The report aims to show how the monitoring and verification system/plan (MRV) can: a) reduce the cost of a certification audit; b) conserve energy and economize on energy costs; c) improve safety and health conditions of a building for its users; and d) reduce harmful CO2 emissions.

SECTION ONE: INTRODUCTION

Recently Georgia signed an environmental emissions agreement with the EU that will be followed by further Euro-integration. In practical terms, for the built environment sector, this agreement means increased environmental responsibility in the construction and operation of buildings. The EC-LEDS program supports energy efficiency and green building development and management by Georgian stakeholders.

According to the EPA definition, "green building" is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle, from site selection to design, construction, operation, maintenance, renovation and deconstruction. Green building is also known as sustainable or high performance building. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.

There are several assessment tools that focus on sustainable development areas. These include a checklist of areas such as water, indoor environmental quality, energy, transportation, etc. These assessment tools have been developed for different types of constructions: home, healthcare, education, public/offices, industrial, sport, hospitality and many others. In terms of application they can be for new construction and major renovation, or for the operation and maintenance of existing buildings.

The rating systems assess some issues by setting minimum performance indicators. Other issues can be assessed by comparison with building parameters defined by other/external standards or guidance. For example:

(a) a simple figure from building data compared to numerical requirement in the RS;

(b) the figure derived from multiple-type or calculated building data compared with a requirement or requirements' set in the RS;

(c) building data compared to an external reference document requirements (standard, guide).

However, even in the most successful cases, green certification or energy labeling of a building is a one-off process. The question is, What happens next? It is logical that some issues have to be addressed to ascertain or declare that a building certified/labeled years before is still green or energy efficient. Typically, after obtaining a certificate from a rating system operator, an audit will be carried out periodically to check the status of the sustainability of the buildings. The purpose of this Report is to propose a system or model for ensuring buildings continue to conform to the same standards they once adhered to.

The proposed monitoring and verification system/model creates a basis for tracking and assessing performance, planned energy economy measures, motivation for different stakeholders and verifiable results. The need to monitor may vary according to the purpose or use of the report, and the level/range of the tracking process, but verification of parameters in some form is needed in any case, and is a prerequisite for successful monitoring. Monitoring is fundamental for a better understanding of environmental and energy behavior of buildings. MRV helps to:
- leverage Efficiency Monitoring to help achieve social and environmental goals;
- enjoy peace of mind from permanent monitoring of environmental footprint, energy consumption and building systems;

- effectively communicate green and energy efficiency issues among principle stakeholders and the general public;
- plan for energy efficiency and sustainability programs to improve the stakeholders' green image;
- improve environmental education and sustainable behavior;
- maximize construction efficiency while minimizing operational and energy costs;
- report to donors or investors on the value per dollar invested in green or energy efficient built environment projects.

Monitoring building performance provides benefits to multiple parties--owners, occupants, investors and the general public. Benefits can include financial savings, increased engagement by building occupants, and the possibility to display and publicize the building data.

SECTION TWO: MRV PLAN - THE BASIC INSTRUMENT FOR FOLLOW UP

This section describes the concept of a monitoring, reporting and verification plan (MRV) as the main tool to successfully obtain building data once they it is certified or labeled. The overall concept provides a framework for developing a MRV plan for each building. As buildings vary in size, complexity, function and environmental performance strategies, their MRV plans will also vary, while at the same time a general approach developed by EC-LEDS project is used.

To continuously ensure that a building remains sustainable within the standards of the rating system, a particular post certification model is proposed. This information system encompasses different approaches and can be applied in commercial, institutional and residential buildings, providing sustainability data for building owners or the authorities concerning the rating system's organization, funders etc. This MRV frame model includes criteria which are variable over time.

The MRV plan is a document to be used by multiple stakeholders and also serves as a good practice guideline. The general purpose of the MRV model is to show and assess long-term impact and sustainability of results. The MRV frame and methodology has been developed especially for the sites certified or labeled within the EC-LEDS program, with completed, ongoing and future activities. Since the technical solutions are similar in nature, the MRV plan can be used by a variety of professionals, adding value to their green or energy efficient sites. This aligns with the EC-LEDS program goals.

MRV plans developed from these guidelines will help business managers or other concerned parties to:

- identify and explain excessive energy use;
- detect instances where consumption is unexpectedly higher or lower than should usually be the case;
- visualize energy consumption trends (daily, weekly, seasonal, operational…);
- determine future energy use and costs when planning changes in a business;
- diagnose specific areas of wasted energy;
- observe how changes to relevant driving factors impact energy efficiency;
- develop performance targets for energy management programs;

- manage energy consumption, rather than accept it as a fixed cost.

The ultimate goal is to reduce the environmental footprint and energy costs through improved environmental performance and energy management control. Other benefits generally include increased resource efficiency, improved production budgeting and reduction of GHG emissions.

This framework is applicable to all types of green and energy efficient buildings, certified as new developments or as existing buildings. Implementing site-specific MRV plans created on the basis of this framework will mean evaluating the site's environmental and energy performance of the building as a whole. It will also provide tools to achieve the plan's objectives. Besides the EC-LEDS program sites, users of this tool can be facilities owners/managers and public bodies.

SECTION THREE: THE MRV PROCESS, RESPONSIBILITIES OF THE PARTIES, TARGET AUDIENCE

In the EC-LEDS project funded sites, the process is as follows:

Table 1. Responsibilities of the parties – EC-LEDS

Stage	Description	Responsible party	Note
A	Collection of site's baseline documentation (certified or labeled)	Building owner	
B	Review of site documentation (certified or labeled)	Program partner or third party	
C	Development of the MRV plan	Program partner or third party	
D	Review and approval of the MRV plan	Decision made on case by case basis	
E	Data collection and verification	Program partner or third party	Includes on-site works. Some documents may be requested from the building owner.
F	Findings and recommendations developed, sent to EC-LEDS	Program partner or third party	
G	Feedback from the owner	Building owner	

Note: This approach can also be used by other donors.

In cases of the other sites that are not donors' projects the process is as follows:

Table 2. Responsibilities of the parties – general

Stage	Description	Responsible party	Note
A	Collection of site's baseline documentation (certified or labeled)	Building owner	
B	Review of site documentation (certified or labeled)	Outsourced institution or the owner	
C	Development of the MRV plan	Outsourced institution or the owner	
D	Review and approval of the MRV plan	The owner, the rating or labeling system administrator	
E	Data collection and verification	Outsourced institution or the owner	Includes on-site works
F	Findings and recommendations developed	Outsourced institution or the owner	

SECTION FOUR: BASELINE PARAMETERS

The baseline for building performance is to be defined case by case, depending on the following factors:

- the certification scheme requirements,
- list of assessed issues, and
- owner's requirements.

Different baseline issues/topics for BREEAM and LEED green building rating and certification systems are provided below, as well as for the Display operational energy labeling system.

The LEED system considers the following issues:

- Sustainability of sites
- Water efficiency
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality
- Innovation in design
- Regional priority

The BREEAM system considers the following issues:

- Management
- Health and wellbeing
- Energy
- Transport
- Water
- Materials
- Waste
- Land use and ecology
- Pollution

In both cases, the following systems are also considered:

- Comfort analysis: thermal comfort, natural ventilation, mechanical ventilation velocity, fresh air supply rates, oxygen levels
- Acoustics: reverberation time (noise attenuation), sound and vibration insulation.
- Daylight: daylight factor, external factors, voids parameters, window-to-floor ratio
- Overall real energy consumption: natural gas, electric energy, water sub-metering,
- Consumption by activity zones: natural gas, electric energy, water
- Renewables: solar heating and DHW, photovoltaic plants, unconventional heating system (geothermal), wind turbines, biogas items.
- Building's sustainable systems: sunspaces, sustainable insulation materials, solar shadings, heating system (centralized), under-floor heating system, rain-water recovery system.

For the Display energy labeling system baseline indicators can be: building area, number of occupants, occupancy load, type of occupancy, indoor air temperature, energy and water actual consumption according to supply sources, supply of renewable energy.

According to the applicable scope of monitoring (see the following sections), the actual monitoring parameters can also vary.

SECTION FIVE: SCOPE OF MONITORING AND VERIFICATION (ADMINISTRATIVE)

There are non-technical issues which may need to be included in MRVs for particular sites. This mainly concerns the ownership of the site and responsibility of the beneficiary. These can include private owners or public bodies. Contractually, a written contract or a memorandum of understanding can be drawn up. In any case, non-technical issues must include the minimum listed below.

Table 3. Scope of administrative issues

Issue	What to look for	Comment
Site ownership	Does the site have a single owner? If rented site, does the tenancy / lease / rent agreement cover the whole period of the MRV?	If the renting period is less, then the landlord can assure the responsible site management after rent agreement ends.
Site boundaries	Will the site boundary remain the same?	
Site surroundings	Are there any construction or planning permits issued around the site?	To look at Tbilisi municipal web page, in regions – to be checked with each municipality separately.
Building alterations	Are any alternations, renovations, reconstructions planned?	If yes, then how it will affect site's sustainability?
Responsibility for site maintenance	Is the responsibility for site's green maintenance clearly defined? Are the responsible parties known?	The responsible parties should be aware of their duties and responsibilities.

Administratively, a site-specific MRV for green and energy efficiency issues can be incorporated into a general/ other site specific management plan, which will make monitoring dependent on the project's interested implementer/donor. From the site owner's side, if a strong facilities management team and procedures are in place, all green building and technical issues can become a part of the site's facilities management plan.

SECTION SIX: SCOPE OF MONITORING AND VERIFICATION (TECHNICAL)

The following table shows the range of technical issues to be included in the MRV plan.

Table 4. Scope of technical issues

Issue	What to look for	Comment
Building envelope - door and window openings	Are the items in similar physical condition? Do the openings provide the same level of pressurization?	If needed, conduct Standard Door Blower's Test and compare actual and claimed results
Building envelope - daylight	Is the building envelope modified? Are voids' glass surfaces cleaned regularly to maintain transparency?	Check daylight factor, external factors, void parameters, window-to-floor ratio
Building envelope - insulation	Are external walls in the same good condition? Can they provide thermal and moisture insulation as initially planned?	
Temperature (air and surface)	Do the building systems provide designated temperature in peak periods (summer, winter)?	
Energy Performance indexes	Has any energy performance labeling, been conducted, e.g. Display?	
Off-site renewables	Does the site supply green energy to the grid or other sources as claimed or planned?	
On-site renewables	Does the site maintain claimed on-site renewable energy items? Do they produce energy as planned or claimed?	Condition of Solar Heating and DHW Photovoltaic plants Unconventional Heating System (Geothermal), wind turbines, biogas. Look for verified performance, e.g. metered data
Real energy and water consumption	What is the total energy use of the building?	

	What is the net energy use of the separate zones or facilities? What is the energy consumption for each end user?	
Heat island effect	Are all roof and pavement materials in similar condition? Is there any altered color or texture?	If renovations have taken place, then re-assess for heat island effect issues.
Shading	Are the shading devices operational? Do planted trees exist and provide shading for parking, yard and other open spaces?	
Acoustics	Reverberation time (noise attenuation)	The interior finishing materials are in original place, in good condition
Sound insulation between rooms	Sound transmittance	The interior insulation materials are in original place, in good condition
Sound insulation from traffic noise (roads, railways, airports) and service equipment	Building envelope, as well as surrounding vegetation is in original condition	Check for external factors changes (outside the boundary) It can be construction of roads, chance in district development.
Planned indoor comfort	What temperature and humidity ranges are maintained in the building according to the facilities management plan? Does it fit the range specified in certification/labeling documents?	
Comfort issues range	Thermal comfort, natural ventilation, mechanical ventilation velocity, fresh air supply rates, oxygen levels	
Heating efficiency	Are thermostatic valves or space thermal controllers operational?	
Lighting comfort	Do the building occupants actively use the lighting controls designed for them specifically? Are the controls still operational?	
Solar radiation	Does the site have well-maintained solar shading devices on voids, roof, landscape?	
Lighting	Does the lighting system provide luminance of the surfaces within the claimed min and max limits?	
Automatic Lighting Controls	Are the lighting controls in place and in working condition?	

Humidity (internal and external)	Are humidity measurements taken by owner/manager on a regular basis?	
Indoor CO2	Does the CO2 monitoring system work properly? If no system is installed does the manager have plans to manage oxygen levels with alternative methods (e.g. natural ventilation)?	
Water leaking detectors	Are the claimed detectors in place and in working condition?	
Building management system	Does the site have a BMS? Is the data properly collected and analyzed by dedicated personnel? Is the personnel's qualification sufficient to manage the building using BMS?	
Air distribution strategy	Is fresh air distributed in the system as planned?	
Waste management	Is the site managed according to an approved waste management plan?	waste separation, delivery to Brownfield's, reuse and recycling practice
Staff education - occupants	Does the owner / occupant provide regular staff trainings how to operate use the building in sustainable way?	
Staff education – facilities management team	Has the facilities management staff changed? Does the facilities management team have required qualifications to manage the site in sustainable way?	
Sub metering – heavy use areas	Are heavy use areas sub-metered: e.g. car wash, server rooms, catering facilities. Are the meters easy to read?	
Sub metering, consumption by type of utilities	Natural gas, electric energy , water	
Building sustainable systems	Condition of: Sunspaces Sustainable insulation materials Solar shadings Heating System (centralized) Under-floor heating system Rain-water recovery system Water management systems (storage, purification, collection...)	

SECTION SEVEN: FACTORS INFLUENCING BUILDING ENERGY AND ENVIRONMENTAL PERFORMANCE, RISKS INVOLVED IN THE MRV PROCESS

Despite the fact that there are now many design guidance and standards available, in many countries real energy consumption is not decreasing at the same rate with respect to energy savings, and in many areas it is even increasing. Buildings and their systems improve but building usage and activities in buildings can lead to an increase in energy consumption. Importantly, excess consumption may be caused by equipment malfunction, operator error, poor user behaviors, or lack of effective maintenance. Often there are significant discrepancies between the designed (or once recorded) and the real total environmental performance and energy use in buildings. These can be attributed to:

- climate
- building envelope (windows, wall, roofs, etc.)
- energy-consuming equipment and systems (building services)
- operation and maintenance of the building and its systems
- occupant behavior and activity
- requirements for the indoor environment

The last three factors, related to human behavior, can have an especially significant impact, even more than the former three. Therefore it is necessary to investigate all six factors together to understand building performance data. This provides essential guidance in identifying, maximum use of energy saving potentials and opportunities.

Other non-technical risks that may exist after site certification or labeling are change in building occupancy type, increased or decreased number of occupants, changing the building's function, changes in owner's or operator's environmental policy, surrounding developments or new legislative developments.

SECTION EIGHT: DATA COLLECTION AND ANALYSIS, METHODS TO BE USED IN MRV

As a site-specific guidance document, the MRV considers obtaining and processing the building data. Usually this can be represented as several different tasks:

- Survey of assets' technical condition during inspection of building's operation, and whether there are any emerging problems or wasteful operational practices
- Assessment of occupants' satisfaction - feedback from building users about how well buildings work (Structured interviews, surveys and questionnaires - whether user expectations have been met, are users comfortable, insight into user behavior, do they understand the controls and are they using them effectively?)

- Assessment of the management policy (responsibilities, planned and preventive maintenance schedules, waste management practices, procurement strategies)
- Survey of actual resource consumption, a breakdown of the energy used in a building by type of consumption e.g. heating, air conditioning, lighting

Information can be obtained by applying the following monitoring instruments:
- document review (reviewing building related documentation submitted by owner or occupant)
- interviewing the stakeholders (owner, facilities manager, occupants or others)
- visual inspection (envelope, building systems, landscape)
- obtaining figures from meters (power, gas, water)
- obtaining information from the third parties (municipality, building certifier/assessor, contractors)
- measurements, instrumental inspections and testing, if necessary.

The suggested sequence of the actions to be undertaken is as follows:
Stage 1 - identify target/the baseline
Stage 2 - conduct survey
Stage 3 - compare results, monitor variations
Stage 4 -identify findings
Stage 4 - produce recommendations
Stage 5 - distribute findings and recommendations among stakeholders
Stage 6 - review feedback
Stage 7 - take follow up action

At the findings stage, environmental and energy performance specialists, along with building managers, will identify the causes leading to variations in the consumption. This can be a change in behavior, a modification to the process, different exterior conditions, etc. These changes must be monitored and the causes identified in order to promote and enhance good behaviors, and discourage bad ones.

There is a wide range of instruments to be used. The following can be applied during measurements and testing:

- Thermal imaging camera
- Air tightness testing instruments
- Noise and vibration tester
- Humidity and air velocity tester
- U value tester
- Thermal tester (IR)
- Lighting and daylight tester
- Pressure tester
- O2 and CO2 level tester

SECTION NINE: SITE SPECIFIC MRV PLAN FORMAT, MAKING CONCLUSIONS AND PRODUCING RECOMMENDATIONS

A site-specific plan contains the following information at a minimum, in different sections:

- Facility definition and boundaries
- Project name
- Building name (may be same as project name)
- Site address
- Site contact details (owner, facilities manager)
- Monitoring report details (persons conducting monitoring and dates)
- All facility/procedure related contacts: (names, organization, title, contact information)
- Dates: site visits and monitoring period
- Basic building data: planning zone, land and building area, occupancy type
- Building description: Floor plan, floors, space uses, typical occupancy patterns, and building drawings
- Principal building function(s) zone by zone (education, food sales, food service, health care, lodging, mercantile, office, public assembly, public order and safety, religious worship, transportation, industrial, workshop, other services, warehouse and storage, parking, IT centre/hub)
- Site survey limitations
- Site survey exclusions
- Data submitted by owner/manager
- Observations
- Conclusions
- Recommendations
- Blank space for feedback from the owner

SECTION TEN: BENEFITS OF MRV, PUBLICITY OF DATA

Verification of the initial performance compared over time provides exact data on how current energy/water consumption, CO2 emissions, compare to the baseline. They also indicate the current level of indoor quality. Building occupants can play a major role in keeping overall building performance as planned or predicted. The buildings' occupants or users have the greatest impact on power, water and heat consumption, therefore it is a good idea to make them well aware, including them in the process and showing what is to be achieved together. If the occupants of buildings collaborate with the facilities management team, substantial reductions in energy and water consumption can be made.

Publicity makes the most out of building energy, water and environmental quality data. Anyone who can see energy consumption data on a daily basis gains a sense of awareness for the issues; and they

will be more conscious of their use of resources in the long run. Continuous performance monitoring results can also be used to display the owner's sustainability success thus motivating building users and visitors to continue to save energy, water and other resources. To this end, verified sustainable building builds on and increases the interest of other parties. In addition, making building performance data transparent enables owners to demonstrate their sustainability efforts both to building users and visitors, thus publicizing environmental approaches.

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