Best practice guide for managing performance in new and structurally renovated buildings

Executive summary

In the next 40 years the global demand for energy will double. Commercial buildings must adopt a new way to manage energy performance for the long term. Key to this methodology is monitoring and measuring energy use across the entire facility. This paper offers best practices on how to develop a high-ROI energy performance system that keeps both new and renovated buildings operating at peak performance.

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Schneider Electric

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Document Objectives

The purpose of this document is to clarify best practises in the construction and use of a building with optimized actual energy performance over the life of the building in order to reduce investment and operating costs.

This document proposes solutions to help attain the desired energy performance while optimizing comfort for the occupants.

This approach ensures that buildings can be managed on the basis of a **green lease** logic involving the owners, occupants, and users.

- When well adapted, the installation can produce **significant energy savings** over the whole life of the building with a **visible impact on the balance sheet** of investors and tenants.

- The creation of an **energy performance package** lasting from the programming stage through to commissioning, even during design and construction, guarantees traceability and adherence to requirements.

- The building continuously integrates new types of use, such as dynamic management of shared and individual commercial work spaces, electric vehicle recharging infrastructures, decentralized energy production (renewable energies, for example), and also cutting-edge management on the basis of a sustainable district logic and its connection to Smart Grid systems.

- Solutions must meet the requirements for **openness, integration, and upgradability/maintainability**, in order to satisfy the most exacting requirements in terms of operation and maintenance.

- The building's overall actual energy performance can only be assured by implementing a range of **services** (maintenance, remote supervision, Energy Bureau, etc.).

This information is aimed at professionals in the real estate, project management and construction sectors who are looking for a reference document to help them control energy performance over the long term.

Introduction: The Building of Yesterday and the Building of Today: a Revolution in Expectations

Energy, a challenge facing the whole planet
Various geopolitical events such as oil price increases, nuclear disasters, impacts from human activity, rising population numbers, rural exodus, increased cost of raw materials, etc are driving us to question how we use energy, how it is produced, and our energy mix.

Our planet faces an energy challenge the like of which we have never seen before. Between now and 2050, the demand for energy will double as a result of population, economic, and industrial growth throughout the world. At the same time, we will need to halve our greenhouse gas emissions to avoid the dramatic consequences of climate change. We are all affected: private citizens, companies, public bodies, etc. We all need to work together to design and implement the key solutions to this challenge.

With companies and organizations in flux, the commercial building needs to be reinvented
Companies are regularly confronted with profound changes in their external environment: technological and regulatory changes, along with fluctuations in economic and competitive conditions. At the same time they need to manage their own internal developments, changes in their organization, structures, processes, and management methods.

At the present time, the building is static in a world that is in flux. Just like the companies themselves, the buildings that house them are being transformed. The spread of communication and building management system technologies is an illustration of this. But this is not enough. Although companies expect their employees to be ever more reactive and more mobile for even better performance, the modern building has remained relatively static in a world that is in flux.

Imagine an innovative new type of management that adapts the building to its organizational needs by objective and by project with increasing interaction for a more collaborative style of working. To guarantee that teams will perform well, it also needs to take into account individual expectations and offer people a comfortable, healthy, and safe workspace. Finally, this next generation building can only be designed with awareness of the need to optimize the costs of design, operation, and maintenance.

The energy value chain is undergoing a complete revolution
The traditional electricity grid, which is simple and linear, with centralized production of energy and passive consumption is morphing into a more sophisticated, interconnected and interactive model: the *Smart Grid*. However, for this grid to be even smarter, users need connectivity, simplicity, and safety in the form of access to a safe, reliable energy source that guarantees optimum operation of their installations, infrastructure and equipment.

Smart grids are poised to revolutionize our energy use. By transforming the existing grid into a smart interactive grid, they will change our behaviour, influenced by four new elements:

- **Renewable energies** integrated in the structure and in the district allow each consumer to produce their own energy, and are giving rise to the need to connect disparate supply sources to the central grid.
- **Active energy efficiency** and **energy management** make energy visible, and offer everyone the possibility of altering their own consumption.
- **Electric vehicles** are revolutionizing people's perception of mobility, both for public transport and private cars.
- **Real-time management of the grid** makes it possible to anticipate consumption and adapt the offer in consequence and it allows the user to modulate their consumption and become an environmentally responsible participant.

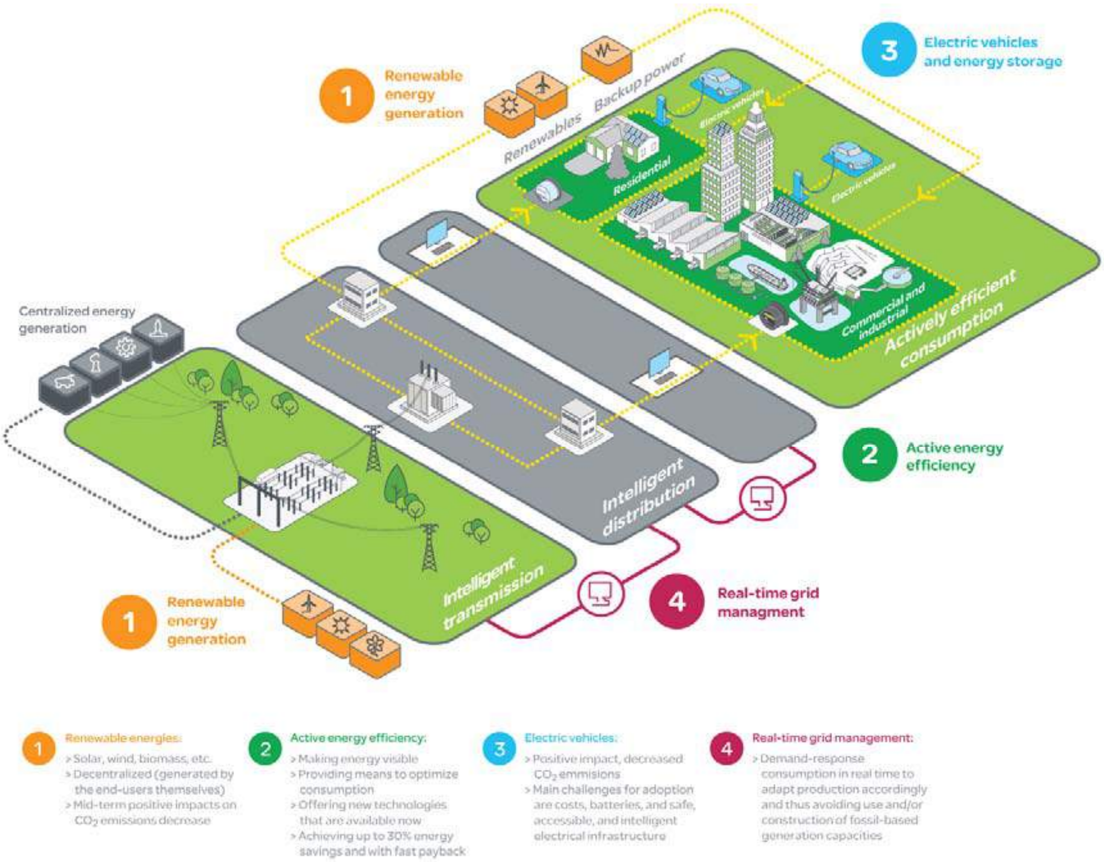
Building technologies in the process of change
Since the 1970s, buildings have been equipped with building management systems (BMS).

Since the 1990s, two major trends have been transforming the market: consumer-oriented technology and standard fieldbuses. Globally, three protocols have been standardized: LonWorks,® BACnet,® ModBus,® and KNX.® They are used by numerous manufacturers in multiple applications. New technologies (multi-technology, fiber optic solutions, etc.) offer more secure communication methods (client/server or peer-to-peer communications). Current developments involve: Web technologies (XML, etc.), Radio communications (ZigBee®), IP convergence (Power over Ethernet, or PoE), and motion measurement (radio frequency identification, or RFID).

Schneider Electric, a player committed to performance management

Faced with ambitious targets in its home region of Europe in terms of energy savings and reduction of CO_2 emissions, Schneider Electric is part of a drive to promote sustainable development and performance management, offering technologies and solutions for:

- Optimizing a site's energy consumption.
- Demand side management (DSM) in interaction with the smart grid.
- Integrating new decentralized sources of production and storage (photovoltaic panels, solar panels, geothermal, biomass, etc.).
- Integrating new types of use (electric vehicles for example).
- Dynamic management of shared and individual work spaces.
- Raising awareness via information portals to encourage the various participants and users to alter their behaviour.



1. Optimizing investment and the value of property through smart design

Key points

- Make investment decisions that ensure a sustainable "green" increase in the asset's value
- Formalize your energy performance ambitions
- Create an energy performance or energy management package to decompartmentalize the participants
- Aim for integration, convergence and openness

1.1. Investment Logic

Economic approach
Real estate concepts (building only, campus, etc.) must conform to the economic logic of the market.

The first objective is to optimize the cost of construction:
- Reducing design study times.
- Reducing construction and execution times.
- Reducing time taken to lift reservations.
- Integrating technologies that offer the best mix of functionality/intrinsic value/implementation costs.

The second objective is to optimize the value of the asset.
For example, in a rental market, the aim is to secure rental income and maximize the market resale value.

Three main factors are involved:
- A "green" image (certification on construction, green lease, monitoring and optimization of actual consumption).
- Low operational and maintenance costs.
- Adaptability to a maximum number of uses (open-plan, partitioned offices, labs, telecentres, call centres, etc.).

The technical and technological choices directly influence the aforementioned factors.

Spotlight on "Green Value"
The report by the Green Value Group of the Grenelle Building Plan on the office sector diagnosed a higher potential return and certain benefits of a "green" building due to the possibility of:
- Higher rents.
- Lower expenses.
- A higher resale price.
- Higher "rental liquidity" (faster marketing, fewer vacancies).
- Higher "sales liquidity" (faster selling, less refurbishment work).
- Easier financing (lower risk, less major upgrading work).
- Potentially higher employee productivity.
- Corporate communication about "green" buildings.

The link between environmental performance and property value is likely, provided that the "green" building abides by the fundamentals of the real estate market:
- A quality location and quality access to public transport.
- The building facilitates efficient and productive business operations for occupants

This "green value" can take two forms:
- An added value for green buildings, in upward-trending real estate markets.
- A discount for non-green buildings in downward-trending markets. The "green value" will be more readily apparent in low-activity real estate markets than in high-activity markets.

According to some studies, certified buildings have, on average, three percent higher rents, six percent higher rental income (rent multiplied by occupancy rate), and a 16 percent higher resale price.

1.2. Definition of Actual Energy Performance

Grasping the concept of performance
Performance is the result of a good mix
of Functionality/Upgradability/Maintainability/Controllability/Price.

Performance is achieved when:

- The envisaged performance targets are clearly stated in the program.
- The technical design precisely spells out the architectures and technologies, and justifies the choices made with calculations and simulation (ideally dynamic and in closed loop mode).
- The construction surveys include a detailed engineering phase directly related to the envisaged performance targets.
- Implementation on site (installation, connection, parameter setting) is executed with a high level of quality.
- Start-up is executed using a detailed and accurate "commissioning" type logic.
- Long-term performance monitoring is envisaged.

System overview
A building is a system (made up of sub-systems) in which optimum performance is tied to the design. Local optimization of one or more sub-systems does not result in overall optimum results.
During operation, optimum performance is not usually achieved for the following reasons:

- Control and monitoring profiles and values not optimized in terms of engineering and debugging.
- Multiplicity of systems.
- Interfaces between technologies poorly managed during design or implementation.
- Limited interoperability between systems.
- Component obsolescence.
- Absence of structured data that would allow targeted preventive or corrective action plans to be created.

Technology overview
Technology is used to deal with the following aspects:

- Energy Efficiency & Equipment Security Management.
- Control of energy production equipment.
- Control of fluid distribution.
- Final control of HVAC-blinds-lighting.
- Distribution and protection of high voltage and low voltage electricity.
- Secure energy.
- Video surveillance.
- Access control.
- Intruder detection.
- Connectivity and networks.

Control, a major driver of actual energy performance
Schneider Electric has embraced active energy management (Heating, cooling, domestic hot water, lighting, power socket and ventilation systems) according to:

- The climatic conditions.
- The building conditions of use (ensuring optimum interaction of loads at equivalent or even higher comfort levels).

Active building systems have been part of the design from the outset and can therefore adapt to changes in how the building is used.

This is achieved by:

- Precision instrumentation (temperature probes, presence sensors, etc.).

- Implementation of systems consolidating all the individual-level data and defining the control strategy.
- Long-term monitoring services (metering, report generation).

1.3. Creation of the Energy Performance System

The new regulatory (RT2012) and voluntary provisions [HQE,® (High Environmental Quality); BBC-Effinergie,® (Low Energy Building), ASHRAE Standard 90.1, etc are an opportunity for real estate professionals (developers, investors, specifiers, manufacturers) to propose high-performance buildings. To date, building construction projects have mostly been run traditionally, by division into siloed technical systems. In this context, it is difficult to make all the participants take responsibility for reaching an initial performance target and sustaining it.

Energy and environmental concerns now cross the divide between the various trades and specialist professions involved in creating a building. When constructing a high-performance building, the traditional technical systems need to be adapted. It is therefore necessary to **create an "Energy performance" or "Energy management" system** (including for example all the energy metering functions). This specification must be drawn up before the other technical systems. It will be imposed on them as a reference framework for their own specifications, and it will serve as a reference document throughout the project to check the conformity of the systems.

Overall philosophy
The Energy Performance package is the answer to sustainable attainment of real estate performance:
- Construction or structural renovation project.
- Energy optimization project.
- Equipment security optimization project.

A single team is involved right from the programming phase through to acceptance on the basis of a single project management logic.

Ensuring that the objectives of the Energy Performance package will be met, the "smart" aspects of the targeted real estate product are outlined with an emphasis on consistently linking technologies and methods.

Detailed approach
It seems to be necessary to define new tasks:

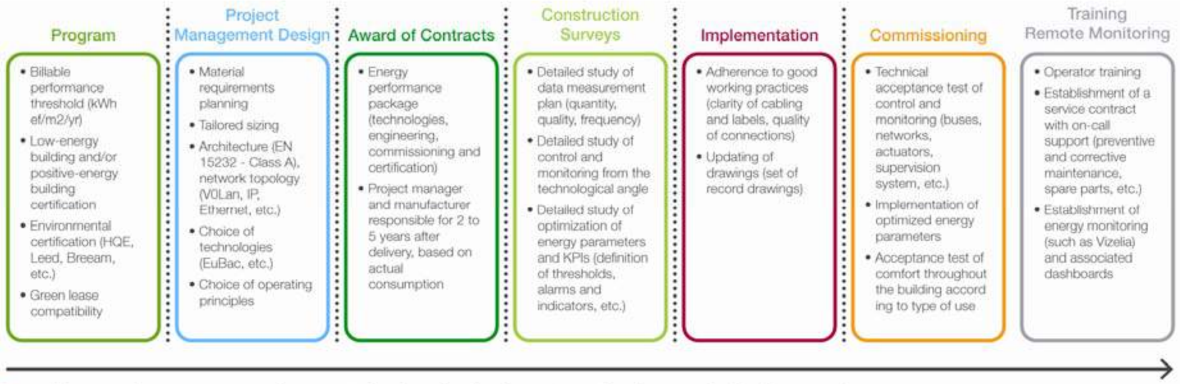
- During the programming and outline phase, by:
  - Defining the objectives and main principles of the project from the environmental and energy viewpoint (especially for energies, division by zone, network architecture and metering).
  - Defining the building occupancy profiles.
  - Calculating the projected energy consumption for each regulated type of use that will be used to create the Energy Performance Diagnostics and will serve as a benchmark for analysis of consumption in the first year of operation.
  - Preparing for environmental certification.

- During the design phase, by:
  - Designing the Building Management System (BMS) and coordinating the specifications of the other systems so that they are consistent with the project objectives.
  - Defining the implementation procedures, and procedures for maintaining this performance.
  - Defining the procedures for acceptance of the work, from the energy viewpoint.

- During the building execution and commissioning phases, by:
  - Project energy monitoring to meet the fixed energy performance objectives.
  - Controlling and supervising acceptance.
  - Supervising performance and operating tests.
  - Creating the conditions for maintaining performance during operation.

- Monitoring procedures for implementing and maintaining performance.

- During the certification operating phase:
  - Appointment of an Energy Manager.
  - Certification of operation (BREEAM-In-Use, HQE Operation, LEED EBOM, etc.).
  - Certification of the energy management system (ISO 50001, ISO 16001)
  - Certification of actual energy performance (Energy Star, Green Star, etc)
  - Implementation of a consumption monitoring process, conforming to IPMVP.
  - Implementation of a green lease.

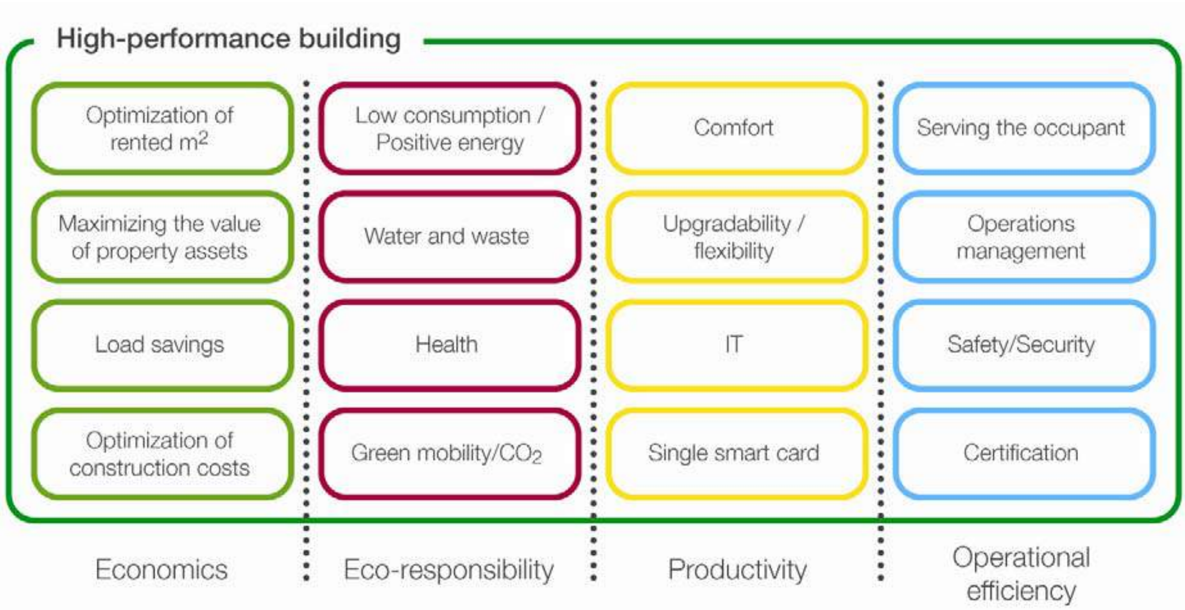


Tracking performance requirements in the design/construction/commissioning cycle

1.4. The various performance management components

The overall building performance is achieved when all the elements of which it consists communicate, interact and influence one another in a balanced way.

There are several types of performance component:
- Economics.
- Eco-responsibility.
- Productivity.
- Operational efficiency.



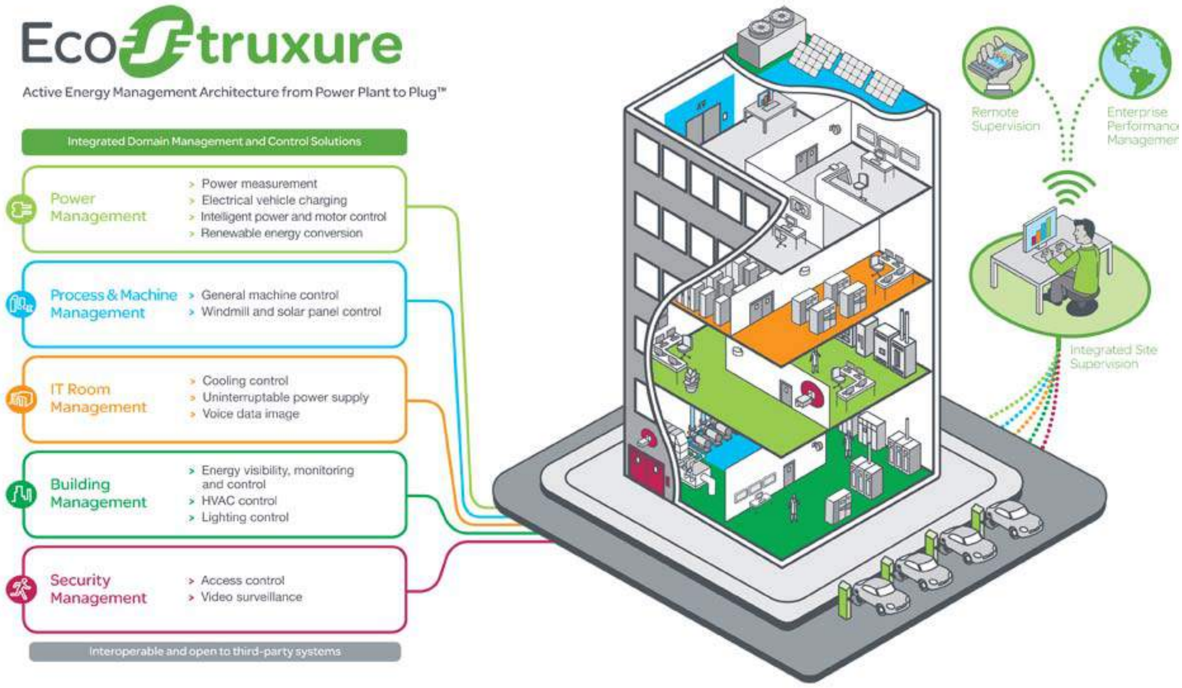
1.5. Integration, Convergence, Openness

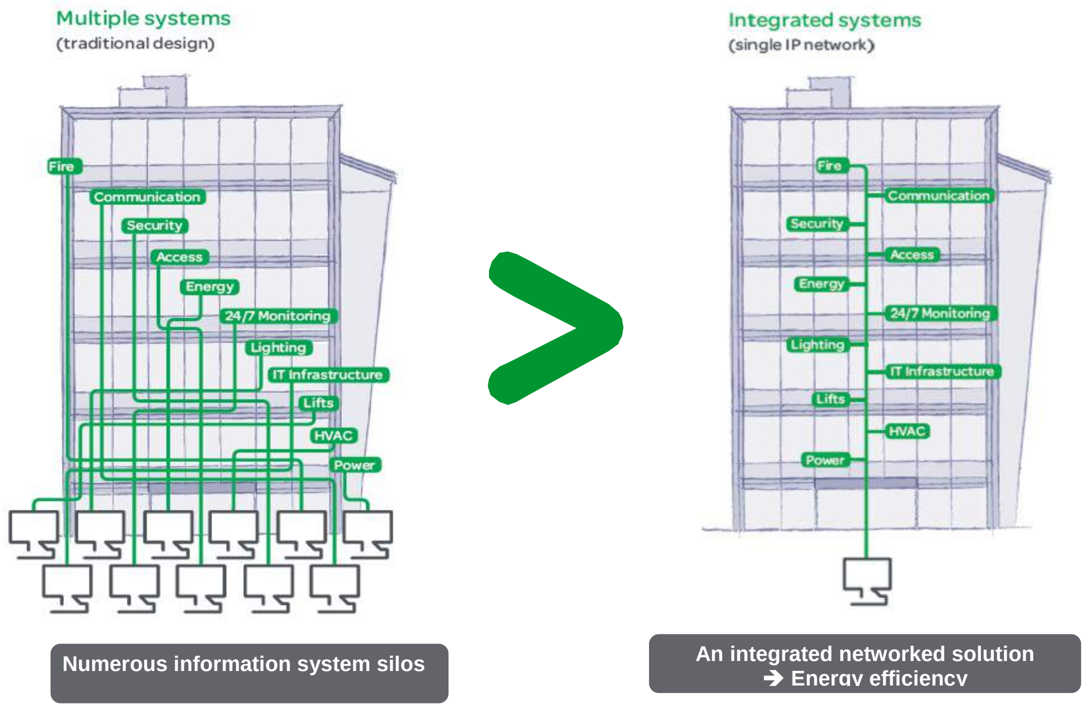
The increasingly complex nature of systems and increased volume of data to be processed make it necessary to constantly search for simpler architectures. There are three benefits from this:
- Reduction of invested capital.
- Reduced operating costs.
- Enhanced operational performance.

When all the building management systems communicate with one another and share information, it is possible to:
- Reduce maintenance, upgrading, and training costs.
- View all the building management systems from a single terminal.
- Manage the building easily and securely via the Web.
- Use the existing building network for all systems and thus cut operating and administration costs.
- Improve user safety with a coordinated alarm strategy.

Some examples of the resulting benefits:
- Occupants gain entry to the site using their smart card. The system automatically activates the lighting and air conditioning in zones they are authorized to access.
- Controllers communicate with equipment such as refrigeration units, variable air volume systems, etc., in order to coordinate the control of different devices.
- From their PC, using their Web browser, occupants can modify the temperature setpoint for their office and its time program (within limits set by the "Energy management" team).

- The operating staff can access alarms and reports concerning all parts of the installation (intruder detection, fire detection, HVAC, BMS, safety, etc.) via a single interface.
- Environmental control, intrusion detection, access control, video surveillance, and process management can be integrated in a single system.





1.6. Property management and asset environmental performance information systems

On the scale of a property asset portfolio (campuses, offices, sales office networks, shopping malls, logistics, etc.), it can be useful to roll out an Energy Information Management System (EMIS) to supervise the portfolio's environmental performance (such as StruxureWare Energy Advanced).

This EMIS system can be used to update the database daily for each asset (data room) and to facilitate Due Diligence and especially Technical Due Diligence operations during transaction operations. This system, connected to the BMS for each property asset, based on Web technologies and remote data hosting (secure platform), is presented in the form of portals configured according to the different types of user.

For people involved in asset management and property management, these systems produce overview screens (dashboards) where they can view the key performance indicators (KPI), organize management and/or certification processes in conjunction with the tenant(s) during "green committee meetings."

These systems can be connected to property management systems such as Schneider Electric’s Energy Operation (drawings, certificates, audit reports and diagnostics), or D5X ORGABAT® for Virtual Desktop Infrastructure (VDI) management.

2. Technologies and Techniques to Achieve Energy Performance

Key points

- The "Energy performance" system will guide the specifications of the other systems.
- Metering is the initial step prior to any proposal of solutions.
- Legal requirements will determine the overall framework for all specifications.
- Setting up an information and decision-making system, such as remote energy monitoring and control system that automatically acquires and presents metering data.
- Putting in place a tool for raising user awareness
- Space management and actual occupancy data enable a more responsive environment
- The access control, intruder detection and video surveillance functions will ensure the safety of people and equipment and the security of the site.

2.1. Power engineering

The building's future actual energy performance is impacted by the choice of use, architecture, and technologies initiated in the program/outline/preliminary design phases.

The building technical systems are the "active" contributors to this performance. They must be the subject of a technical design guided by a single power engineering approach to define the most coherent combination possible of production and emission concepts, sizes, technical and technological solutions.

This approach is managed by the responsible manager of the Energy Performance project management package.

2.2. Accurate, relevant zoning, key elements of monitoring

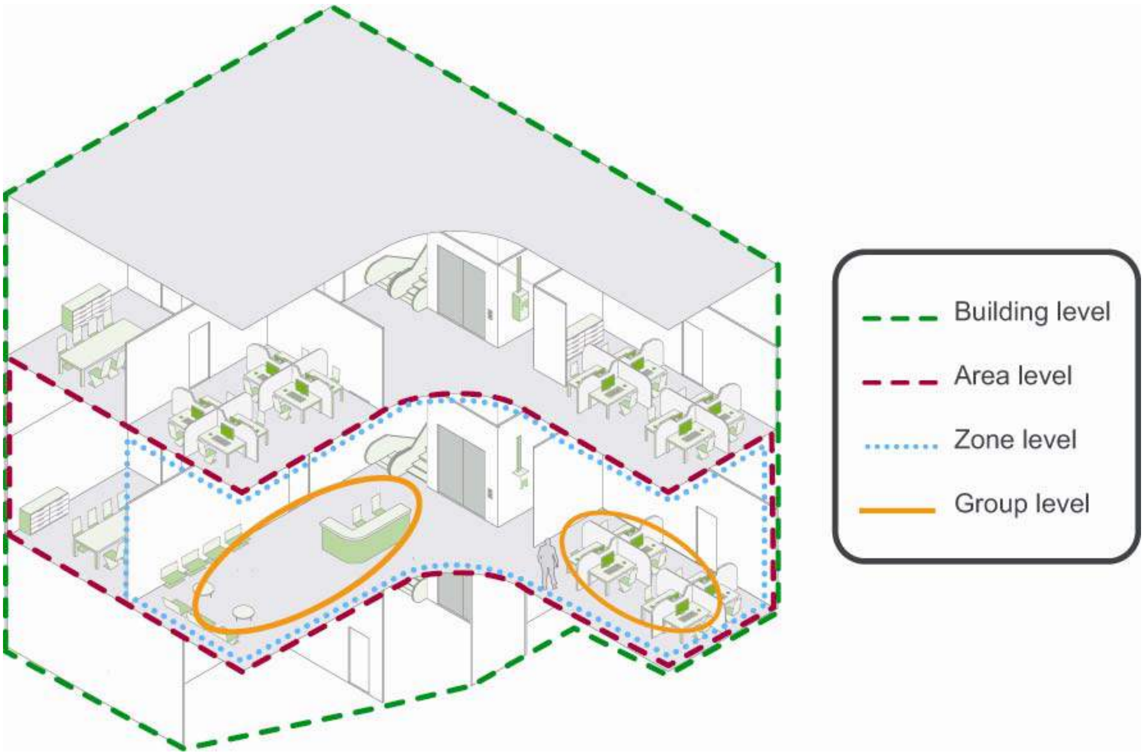
Breaking down the building into homogeneous usage parts

The system architecture must be typologically consistent with breaking down the building into zones and its potential flexibility.

This breakdown consists of two successive phases:

- Phase 1 – **Physical zones**
  - Zones corresponding to distinct, homogeneous activities and heavy consumers.
  - Exterior, parking lot (charging stations for electric vehicles), staff cafeteria, communal areas, tenanted areas, offices, laboratories, etc.
  - The optimum being to be able to break down the architecture into rooms, tenant areas, special purpose areas (laboratories), and levels for vertical buildings.
  - To allow more detailed and accurate measurement and control, and to preserve the layout flexibility in an office building, for example: each office zone is broken down into modules whose width is a multiple of the layout grid.
  - This means that the lowest level of the system architecture needs to present a modularity compatible with the definition of building's flexibility.

- Phase 2 - **Functional uses** divided by physical zone:
  - Heating, cooling, ventilation, domestic hot water (DHW), lighting, office automation, resettable process areas (laboratories), cooking (staff cafeteria), etc.
  - Any solution offering a level of integrated control of functional uses and minimal modularity of physical zones is to be recommended.



Distinguishing between measured use and controlled use

- The number of measurement points and the relevance of the controlled points determine the performance of the control system, and hence that of the energy efficiency and demand response actions.
- These measurement and control points used over the life of the building are defined right at the design stage.
- For example: the thermal uses in each zone that can play a part in demand response should be measured (load curve, zone temperature) and controlled by the BMS, which performs energy efficiency actions or satisfies a request for demand response from the Smart Grid service supplier.

Defining scenarios, internal and external interfaces, reporting

- Define the "smart building" control functions.
  - Use the minimum necessary HVAC and lighting, right where users are.
  - Assign temperature setpoints, specific working hours for each tenanted area or for each special purpose room (laboratory) so as to meet the actual needs of users, and analyze the demand response possibilities for each zone and type of use.
  - Divide up the energy costs fairly between tenants.
  - Sign up interested tenants to demand response.
  - Attain optimum energy consumption by taking account of a dynamic tariff energy grid that can vary each day.
- Optimize on-site consumption in the case of local production where there is no obligation to purchase.
  - Define demand response scenarios to limit the power demand stipulated in the supply contract or to satisfy requests from the Smart Grid service supplier.
  - Define measurement and reporting (dashboard) functions and their users.
  - Define interfaces with other building management systems, related to energy and environmental performance.
  - Use of Power over Ethernet equipment (telephone, IT) for example to power IP telephones on the basis of actual use of the areas.
  - Access control systems, meeting room or office booking systems where hot-desking is used, so as to link operation of the HVAC and lighting to when they are actually being occupied.
- Define interfaces with systems outside the building:

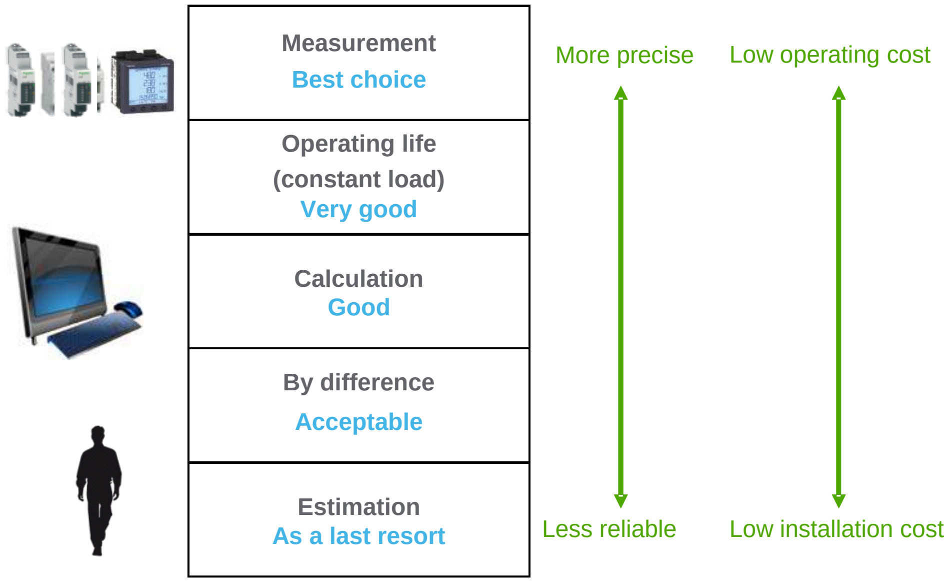
- Global energy and environmental reporting tools covering a real estate development that are increasingly necessary for companies to manage their consumption and emissions of CO_2.
- Remote operating tools.
- Smart Grid service supplier systems: Obtaining information (price grid or demand response request/instruction) and information feedback (load curve for demand response use, zone temperatures, etc.).
- Property management tools for real estate management professionals.

Regulations covering the requirements for a metering system vary by region and geography. For example, in France, the basis for an energy consumption metering system is governed by **article 31 of RT2012**, that stipulates:
"Buildings or parts of buildings for non-residential use must be equipped with systems for measuring or calculating energy consumption:

- For heating: per 500 m² section of SURT (usable surface area as defined by the RT) concerned or per switchboard, or per floor, or per direct outlet;
- For cooling: per 500 m² section of SURT concerned or per switchboard, or per floor, or per direct outlet;
- For domestic hot water production;
- For lighting: per 500 m² section of SURT concerned or per switchboard, or per floor;
- For the power socket network: per 500 m² section of SURT concerned or per switchboard, or per floor;
- For ventilation systems: per ventilation unit;
- Per direct outlet of more than 80 amps."

The table below summarizes the five methods for defining energy measurement and metering equipment. This should be chosen according to the required accuracy, initial installation costs, and costs arising from operation.

The various measurement point techniques.
Their hierarchical priority in terms of precision, reliability and cost



The physical values to be measured for each building are:

Electricity
- Measurements at the point of delivery in the building and for each type of use at each subsidiary distribution board in each zone.
- Measurements (or base calculation according to the operating time and the load controlled) for each type of use in each zone.

Heat energy and cold energy
- Measurements of calorie consumption per zone.
- Measurements of heat production (efficiency calculation).
- Temperature probes on incoming and outgoing supplies.
- Measurement per zone.
- Calculation per office/zone.

Water
Measurements of water at the point of delivery are supplied to DHW cylinders. If the cylinders are individual and supplied with electricity from the tenanted areas, a networked meter technology should be chosen (special outputs in the distribution board).

Energy produced
The meters should be placed downstream of the generator production.

Temperatures
- Ambient temperature sensors in the offices (1 sensor for 2 grids) and communal areas.
- Weather station (outdoor temperature, sunshine, wind speed, rain, etc.).

Air quality
- CO_2 level.
- Relative humidity.
- Air renewal.
- Etc.

Lighting
- Lighting level (compensating for natural lighting with a full-spectrum artificial light).

Gas
- Measurements at the point of delivery of gas. A networked meter technology should be chosen.

2.3. Automation Systems and Interactions

Building Management System, open and upgradable
Due to flexible design architecture, products compatible with one another and an open software platform, the solution puts system optimization within reach of the masses. This approach provides the end user with indispensable tools for reducing development times, investment costs and running costs. The solution ensures compatibility between electrical distribution management, server rooms, processes and machines, building management and physical security.

The BMS is the simplest solution to improve energy consumption monitoring and to optimize this for any type of building. It encourages smart energy management, and results in simplified systems, financial savings and a reduction in energy losses, thanks to its fine-tuned settings.

Room Control, control by the end user
Improvement of the work environment is a key factor in employee efficiency and is also a factor in developing their loyalty. The main criteria for a pleasant work environment are:
• The thermal environment (HVAC, natural light).

• Lighting (blinds, artificial lighting).
• Air quality.
• Management from the user workstation.

Control and monitoring of all these aspects are designed on the basis of the zoning imposed by future use (open-plan, individual offices, meeting rooms, walkways, toilets, lounges, etc.). Room control technology (Roombox, STIBIL®) can be used to tailor comfort to people's precise needs, on the basis of actual occupancy. Compared to the climatic conditions measured locally inside and outside the rooms, it provides coordinated management of heating/cooling, control of indoor and outdoor blackout systems, and artificial lighting compared to natural light. It ensures secure distribution (Roombox) and local energy metering by type of use that is fully compatible with the RT2012 stipulations. It is flexible, and adapts to room reconfiguration by setting local (Roombox) or remote (STIBIL) parameters. It has a native interface with the BMS via LON or KNX.

Power management system
In the case of campus-type sites with multiple buildings (universities, R&D centres, head offices, hospitals, etc.), the overall site management system also has a power management system dedicated to the HV network and LV power networks.

The building management system gives the user an overview of the network and its operating status by interfacing BACnet/IP or TCP/IP with the power management system. The power management system manages network reconfigurations in real time (via automatic loop reconfiguration), reactive energy management, and network stability.

Interaction with IT on PoE
The building management system can also control the energy consumption of systems powered by Power over Ethernet (PoE) by means of interactions with the active network equipment.

Managing demand response at the workstation
In each office, individual lamps, printers, and screens can be plugged into one or more power sockets in conjunction with radio communication technology, eliminating the need for any further wiring. The system can automatically control switching off these individual devices remotely in the event of prolonged absence (overnight, weekend). If necessary, the user can use an override function to force each socket on.

The RFID tag: a performance measurement and management tool
These different types of information can relate to:
• Asset management (IT equipment, furniture, etc.).
• Space management (meeting rooms, workstations).
• Energy management by adjusting operation of the BMS according to the readings from the RFID tags.
• Security management, where an alarm trips when an unauthorized person enters a secure area, when a device (a computer for example) with an RFID tag leaves a predefined zone, etc.

In addition, the RFID tag database used in conjunction with devices (computer equipment for example) can be interfaced unconditionally with the enterprise management databases (specifications, part numbers, purchase value, management of the installed base, etc.).

2.4. Management of Energy Efficiency

The BMS must be incorporated from the outset of the building design phase in order to ensure total consistency between the system architecture and its features, and between the fluid systems and the ultimate objectives.

- It must be possible to control loads with pinpoint accuracy.
- Metering and measurement equipment must be implemented.
- As far as possible, control, distribution and metering functions must be integrated in the building design and execution.

Improved management of information and enhanced automation makes it possible to collect and consolidate a huge variety of operational data and then archive it in a central database for the purposes of assessment, reporting, energy forecasting and supplier negotiations.

Improved access to information via integrated solution strategies allows access to specific operating data that was previously too difficult or too expensive to recover.

Improved reliability of the electrical supply makes it possible to react to potential emergency restrictions by protecting critical systems and shedding or staggering non-critical electrical and mechanical applications.

The BMS provides the information necessary to identify problems or the conditions in each location before acting so that the right person is sent to the right place at the right time — and only when necessary.

The BMS offers customers the option of linking the various building systems so as to have a joined-up overview. The BMS benefits from powerful tools that enable it to control the building in a more efficient unified manner:

- Acquisition of multi-site data.
- Energy analysis and aggregation tools.
- HVAC system monitoring to reduce energy consumption.
- Supervising/monitoring generators and critical backup systems.
- Comparing costs, studying loads and lighting trends.
- Studying energy quality problems, improving the power factor.
- Reducing energy consumption at key times of day.
- Identifying hot spots and problem areas.
- Minimizing investment in electrical equipment on new projects.

Some of the shared information includes:

- Operation: real-time voltage, current, power readings (kW, kVAR, kVA), power factor and frequency, alarms, temperatures, flow rates, setpoints.
- Consumption: total KWh and maximum power.
- Energy quality: voltage and current harmonics and voltage disturbances.
- Trends & forecasts: graphic trend charts, forecasts for selected parameters.
- Equipment status.

2.5. Real-time Energy Information System for the User

The purpose of the BMS system is to provide people with tools so they can maintain, improve, and control the building energy performance level and participate in demand response in the context of a smart grid.

In addition to the traditional functions, the systems offer:

- **Actual data**: Reflecting the actual building energy performance.
- **Permanency**: Operating continuously throughout the life of the building, without interruption.
- **Finesse**: Enabling everyone to understand and to act; enabling responsibilities to be shared between the participants.
- **User-friendliness**: Capacity to share knowledge between the participants; only delivering data useful to each person, presented in a suitable format, to the place where they need it.
- **Flexibility**: Adapting to changes of use (change of assignment) including tenanted areas and occupants.
- **Economy**: Reducing operating costs over the whole life of the building, minimizing investment costs.
- **Reliability:** Collecting actual consumption measurements, with data read without error or omission, that cannot be contested.
- **Safety**: Data storage and protection, management of access rights, management of access tracking.

- **Openness:** Being capable of importing (e.g.: unified degree days, demand response instructions) and exporting (e.g.: multi-site comparison, load curves, etc.) Web data, remote management and control.

The real-time Energy Management Information System (EMIS) or remote energy monitoring system is a device that automatically acquires and presents data from meters and sub-meters or other measuring devices. It creates reports, analyses discrepancies, produces alarms, and can be used to forecast operating budgets.

The acquisition of consumption and installation cost data can be used to implement measures to attain the energy performance in a sustainable manner.

The BMS incorporates a set of software applications, in particular:

- An energy monitoring module; this provides total visibility of all the building consumption with the following functions:
  - Monitoring of energy supplies.
  - Analysis of energy use.
  - Splitting of energy costs.
  - Sub-invoicing of energy.
  - Report of compliance with regulations.
  - Printout of consumption profiles.
  - Modelling of energy impact.

- An energy management module that controls the energy flow throughout the building using the following functions:
  - Adaptation of energy supplies according to the demand in each zone.
  - Management of the building structure storage capacity (inertia).
  - Management of the energy supplier data (tariffs, time bands, load shed order).
  - Incorporation of external weather data.

This module also includes tools to help optimize energy consumption, metering, and control of energy performance. It offers tracking software functions by successively acquiring, archiving, distributing, and graphically displaying historical data from technical installations managed by the BMS.

It offers quick, concrete solutions in the following fields:

- Technical monitoring of the installation status (e.g.: checking operation of sensors, various measurement probes, energy meters)
- Demand side management (DSM) via comparative analysis of:
  - Energy consumption, taking account of unified degree days or other influential parameters.
  - Ambient temperature taking account of unified degree days, and of room occupancy.

Overall, it produces an analysis of the fluid consumption situation by:

- A summary of all the data managed by the software, synchronizing and overlapping any parameter types over a given time period.
- Help with assessing future consumption.
- Control and reduction of consumption costs.
- Less wasted energy and optimized settings.
- Increased responsiveness by fast accurate identification of anomalies encountered.
- Improved staff comfort by controlling the environmental conditions (temperature, relative humidity, air quality, light level, etc.).

Controlling energy consumption enables:

- Monitoring and control of consumption in real time thanks to a real-time connection to the BMS system.
- Use of instrument panels to display the overall building energy efficiency.

- Encouragement of every employee by giving them the means to access, from their own PC, the operating scenarios for the various types of use available to them:
  - Ambient lighting according to the presence of people and the desired lighting level.
  - Setting comfort setpoints for the heating and air conditioning systems.
  - Scenarios for positioning the electric blinds according to the natural sunlight and the season (summer, winter, mid-season, etc.).
  - Energy and environmental label corresponding to individual comfort settings (cellular offices) and shared comfort settings (open-plan offices).

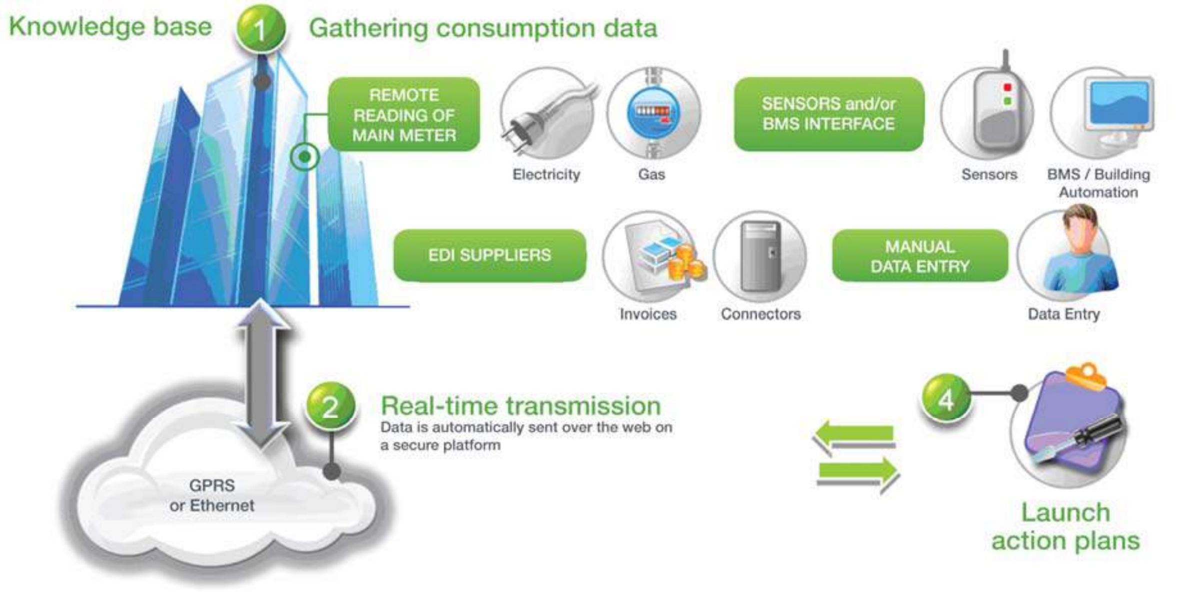
Knowing about all the energies on site helps to:

- Raise user awareness.
  - Via a real-time display.

- Offer improved energy savings.
  - Optimized air-blast management.
  - Optimized lighting management.
  - Lower gas consumption due to losses on the supply.
  - Food refrigeration management.
  - HVAC system operating schedules optimized in real time.
  - Benchmarking of multiple sites, multiple buildings => energy optimization.

- Maximize user comfort.
  - Adjustment of room temperatures.

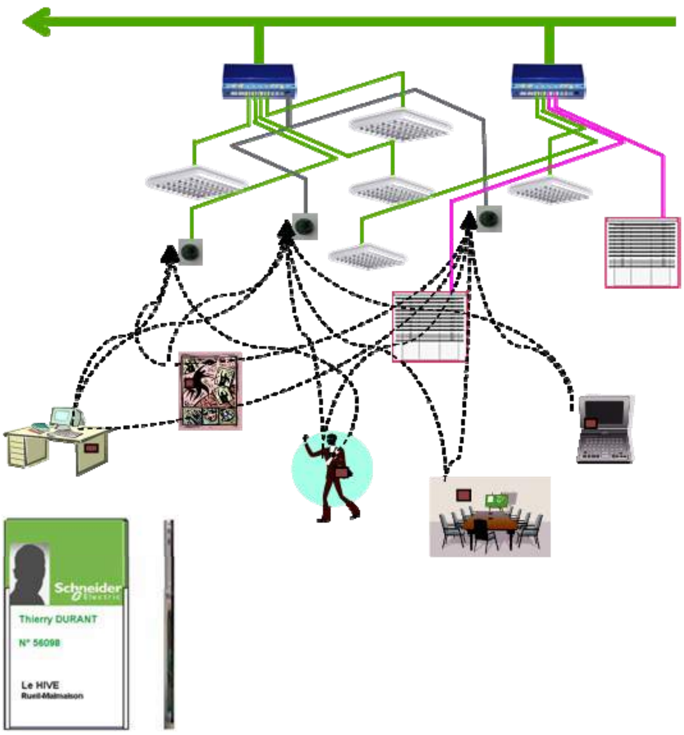
Active energy metering is also an obligation of many regional regulatory requirements. In addition, the system measures reactive energy, lists installation events, and collects all the information needed to monitor all the building uses in order to check the actual energy performance.



2.6. Optimizing Comfort and Space by Managing Occupancy

Local occupancy/light level detection
At minimum, lighting systems should be controlled according to actual presence and the light level.

Motion measurement using RFID
- Association of RFID tags with “mobile individuals”: employees, visitors, suppliers, etc.
- Tags inserted into building access smart cards: identification and location using distributed intelligence.
- Integration into D5X STIBIL units: Sensors and detectors are fitted to the ceiling and provide RFID, occupancy, light level detection.
- Location of individuals in different areas of the building.
- Measurement of the occupancy of premises.



Pooling of energy efficiency systems, motion measurement using RFID and safety systems
Safety is engineered into the overall solution. Interaction between safety solutions (video surveillance, intrusion detection, access control), air conditioning, and lighting control ensures a very high level of comfort and safety. A smart card, a biometric signature, or a validated password is needed to access the site, light up pathways and trip the air conditioning in the employee's work space. Here are some examples of applications:

Parking lot management
- Measure the occupancy rate (adjust ventilation, collect statistics, regulate predicted ventilation in parking lots, help spread out vehicles with announcements on panels, number of free spaces signs, etc.).
- Count vehicles, measure the parking lot occupancy rate.
- Access the parking lot using license plate recognition (via video link).
- Check parked vehicles.
- Video surveillance can identify vehicle locations and also intervene in the event of vandalism or any incident.

Work space
- Real-time energy management in open-plan offices: availability and status of computer networks on arrival and departure of employees, adjustment of HVAC, lighting, blind closing, office automation equipment, etc.
- Real-time information on building occupancy rate (decision-support parameters for comfort, air renewal management).
- Meeting room management: pre-booking and last-minute booking of rooms via a Web interface.

Managing visitors or service providers
- Visitor identification, passport, or national identity card reader.
- Electronic logbook for service provider visits, preventive maintenance tracking.

Communal areas
- Management of flows relating to elevator management (elevator priority given to the higher floors).
- Management of the restaurant, number of meals for the catering staff to prepare, and real-time occupancy, thus enabling employees to find out via a Web interface when is the best time to have lunch.
- Management of preventive maintenance (management of equipment wear), especially for controlled-access corridors, turnstiles, elevators, etc.

Room cleaning
- Knowing the occupancy rate of rooms at the end of the day means cleaning teams can be organized efficiently.

2.7. Information and Communication in Order to Educate and Change Behaviour

For all optimization or improvement actions, all users of the building should be made aware of the role they can play in terms of maintaining the building's energy performance. Schneider Electric helps all users with this.

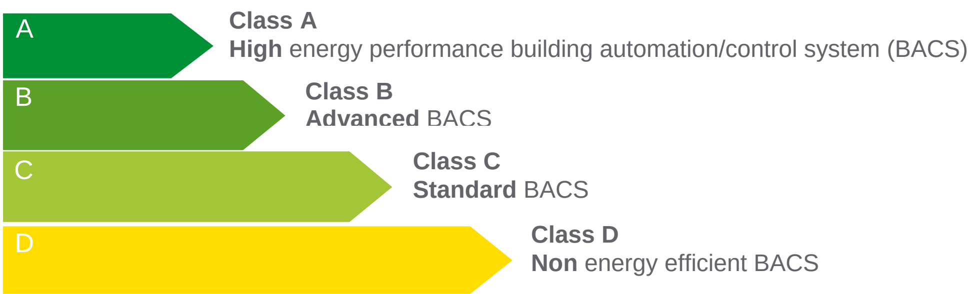
The user behavioural approach consists of various phases:
- Informing/explaining the desired improvement targets and challenges as far upstream as possible.
- Clarifying the effort to change in terms of the expected benefits at the level of the individual, teams, the company, and the environment in a wider sense and in terms of the compromises to be accepted.
- Instilling a desire to change using jointly designed approaches (membership of a group).
- Perpetuating the new behaviour on a daily basis by means of continuous information/correction/feedback sessions.

2.8. Compliance with Regulations, Obtaining Labels and Certificates

Energy management systems
Energy management systems are the new tools for calculating actual energy performance, which is required to comply with regulations and achieve certifications such as EN16001 and ISO 50001. Powerful measurement, metering, analysis, and display tools for real-time updating of these processes are used to attain the required performance.

Environmental certifications
The environmental quality certifications for construction/operation BREEAM®, LEED®, HQE®, NABERS®, etc. are awarded on the basis of an audit during the design, implementation, and operation phases. Technology can win points in the certification process. For example, systems that are eu.bac (European Building Automation Controls Association) certified or a certain EN15232 class can obtain a maximum number of points. *For more information, see appendix 1.*

EN15232
Specific technical standards govern the various systems and contribute to the above-mentioned certification targets (class A for EN 15232, eu.bac, etc.). Standard EN 15232 **characterizes the performance** of management control systems on the active energy efficiency of buildings. It specifies the **potential savings**, in heating and electricity, according to the type of building.



For more information, see appendix 1
For a high-performance system, Schneider Electric recommends aiming for class A.

The BMS system and energy metering and monitoring systems can link together the various building systems so as to provide an integrated overview. More efficient and unified building control is possible because of the powerful tools on each platform.

Building automation and control equipment and systems efficiently perform functions such as controlling equipment for heating, cooling ventilation, hot water production, lighting, etc. They result in higher operational yield and energy efficiency.

The system detects any anomalies, warns the operator, and automatically manages a return to normal. The BMS system supervises all the energies on site, making it possible to view and:
- Measure consumption in real time.
- Know the equipment status.
- Measure energy quality.
- Chart trends and forecasts.

The functions that have an impact on building energy performance, under European standard EN 15232, are:

Automatic control functions
- Heating control.
- Domestic hot water (DHW) control.

- Cooling control.
- Ventilation and air conditioning control.
- Lighting control.
- Blackout blind control.

Building automation functions: These are used to control a number of devices efficiently, and result in higher operational yield and energy efficiency. Complex, integrated energy performance functions are configured by taking the actual building use based on the actual needs of users so as to avoid unnecessary energy consumption and CO_2 emissions.

Building management system function: This provides information useful for operation, maintenance and management of buildings, in particular energy management (trend analysis, alarm activation, detection, and assistance with diagnosing faults) and unnecessary energy consumption. Energy management is a requirement relating to control, monitoring, optimization, and determination of the energy performance.

Functions must be at least class C, in other words they should correspond to standard BMS systems.

For low-energy buildings, in accordance with RT2012, Schneider Electric recommends at least class B (advanced systems).

For positive-energy buildings Schneider Electric recommends class A (high energy performance).

2.9. Performance Measurement and Verification plan conforming to the IPMVP

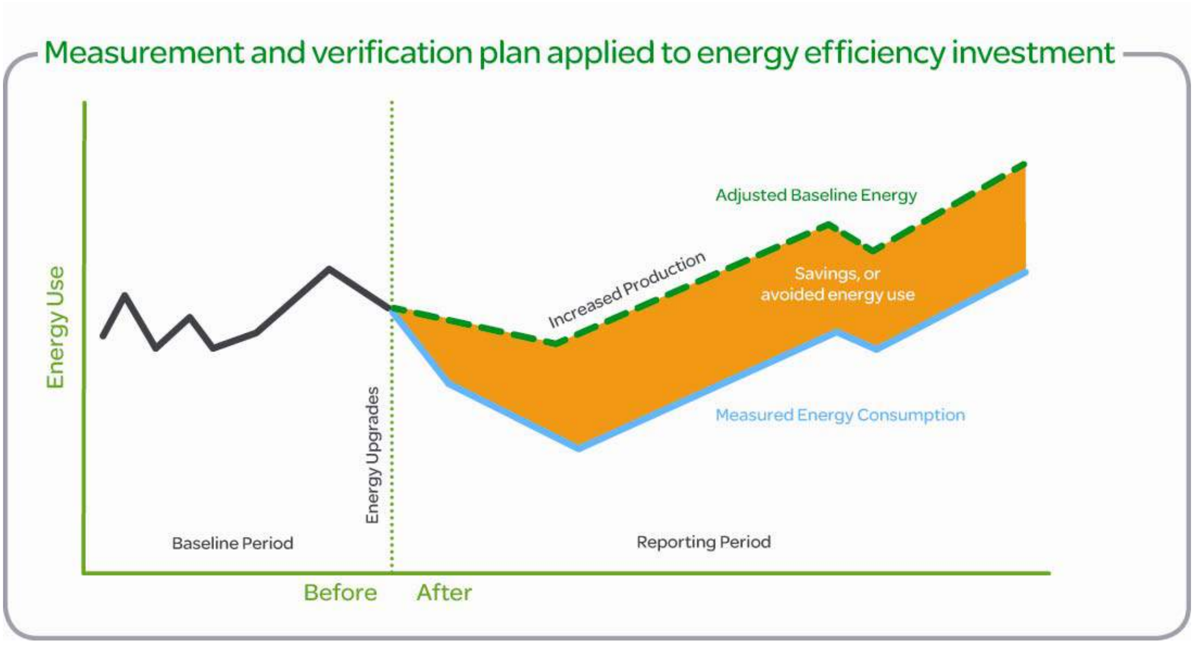
International Performance Measurement & Verification Protocol (IPMVP) is a protocol aimed at proving the energy savings achieved following the implementation of energy efficiency solutions. Developed by an American engineering association and validated by the Grenelle Environment Round Table, it is recommended by the French Agency for the Environment and Energy Management and the French Ministry for Ecology, Sustainable Development and the Sea. This protocol is therefore a mandatory measurement tool in the context of energy efficiency and its associated solutions.

The IPMVP is applied by Schneider Electric with all its customers, whether on industrial sites or commercial buildings, in order to quantify the savings made and verify that these correspond to the agreed figures stated at the outset of the project.

Method
This consists of, initially, understanding and integrating key parameters that can be used to analyze an annual graph of energy consumption. The aim is to determine the benchmark consumption level and be able to compare the results before and after the work is complete.

It is also a question of drawing up a “roadmap” that will act as a guide to the various participants by answering 13 specific points. For example: description of the energy efficiency actions implemented, identification of a scope and a monitoring period, specification of measurement points, etc.

Finally, the IPMVP provides the option of printing out performance criteria that can be distributed to the project participants, so they can see for themselves the results obtained by implementing energy efficiency solutions.



13 specific points requiring adherence:

1 Describe the Energy Efficiency Improvement Actions, and the expected result *(E.g.: changing a boiler with 20% energy savings expected).*

2 Identify and justify the choice of a methodology (A, B, C or D), then describe and assess the consequences, in terms of interactions.

3 Document the baseline situation and collect meaningful data from the site.
Create a baseline as soon as the building is put into use and set up a recalibration process every 6 months until the technical/energy reservations have been lifted and the nominal occupancy threshold is achieved. Usually the baseline is considered to have stabilized at the end of the second year of operation.

4 Identify the monitoring period, which varies in duration according to the chosen option and parameters *(e.g.: 5 years).*

5 Define the conditions for adjusting the energy consumption measurements *(e.g.: periodic variables = unified degree days; static variables = the volumes heated).*

6 Specify the data analysis method, algorithms and assumptions to be formulated for each savings report *(determine the main factors influencing the building's energy consumption).*

7 Specify the methods for calculating the financial savings *(e.g.: use of regulated tariffs).*

8 Specify the instrumentation used, and how to use and maintain it *(e.g.: heat meters, electricity meters)*.

9 Allocate responsibilities for M&V operations over the monitoring period *(designate the person responsible for Measurement and Verification).*

10 Specify the expected accuracy of results *(e.g.: 20% savings with accuracy of 10%).*

11 Define the budget associated with M&V operations and identify the resources dedicated to it *(we recommend that this budget is no more than 10% of the expected savings).*

12 Describe the templates and structures of the monitoring period reports *(to be attached to the contract).*

13 Indicate the Quality Control procedures followed in the M&V operations *(e.g.: company certified ISO 9000 or ISO 14001.*

Metering systems act as a basis for the measurement and verification protocol implemented to quantify energy savings.
This protocol is applied to the site in order to measure the savings made and verify that these correspond to the agreed results stated at the outset of the project. It is therefore a mandatory measurement tool in the context of energy efficiency and its associated solutions, the objective being to determine the baseline consumption level and be able to compare the results before and after the work is complete.

Finally, the protocol provides the option of printing out performance criteria that can be distributed to the project participants, so they can see for themselves the results obtained by implementing energy efficiency solutions.

Schneider Electric recommends that the IPMVP philosophy is adopted right from the design phase with the implementation of a baseline consumption database from the second year of operation (Target baseline to be attached to the chosen operator's contract).

3. Integration in the Smart Grid System

Key points

- Integration of the electric vehicle through Electrical Management System interaction – charging cluster controllers
- Integration of renewable energies and local storage capacities in tandem with the logic for balancing out the charge for each operator in the district
- Capacity of the building to fit into demand response scenarios by stimuli at D-1. For example, peak time from 8.00-10.00

The appearance of decentralized production equipment (photovoltaic panels, wind turbines, etc.), electric vehicles, and new ways of regulating the energy market (management of peak times, etc.) has necessitated the implementation of features that complement electrical flow management, thus dynamically adapting the offer to demand.

To design, build and operate a building equipped with a BMS system connected to the smart grid, it is essential that the following are defined as a matter of priority:

- The comfort specifications: heat, relative humidity, lighting, and air quality.
- Occupation of the space and flexibility of occupation.
- Allocation of spaces and flexibility of the type of rooms.
- Occupancy schedule for the rooms and flexibility of this schedule.

Hence, all interactions between the building and its occupants should be defined and the margins around these criteria should be flexible enough to allow energy optimization and demand response (DR) actions. Definition of the system, from the point of view of the objectives, affects the design of the energy and fluid systems.

Thus, at building level, the system takes account of all these elements in its local management while ensuring comfort is maintained.

These technological developments are encouraging energy suppliers to offer new supply contracts. The BMS takes account of these new tariffs so as to allow buildings to adapt their operation in an optimized manner that fits in with the tariffs, including the following functions:

- Validated load shedding.
- Acceptable load shedding.
- Price grid (information feedback to the BMS) for load shedding instruction.
- Optimization of off-peak/peak times.
- Automated demand response.
- Load curve.
- Demand.
- Anticipation.
- Etc.

The system takes account of:

- Management of decentralized production equipment connected to the building networks.
- Management of storage in tandem with the operator of the local loop.

The arrival of the electric vehicle in parking lots brings the need to control recharging and discharging them if necessary. The production capacity installed in the building, which is usually intermittent, is controlled. Optimization and control of these new flows involves interactivity and communication with the electricity grid, in order to determine at any time the optimal energy choice, including electricity load shedding if necessary.

These features involve more control systems, more interactions between the equipment and the grid, and advanced electrical flow management applications.

3.1. Demand Side Management

Introducing the concept of Demand Side Management (DSM)
DSM contributes to matching the offer (production + purchasing of energy) with the demand (consumption) and constitutes one of the main ways of resolving peak time problems or network congestion.

In most regions of the world, DSM basically concerns the problem of "peaks" and involves demand response, staggering consumption, etc. Peak electricity consumption is by definition the highest consumption. There are several electricity consumption peaks, since the concept of a peak depends above all on the period and the zone under consideration.

By way of example, the Nome law passed in France in June 2010 requires all power companies to have spare capacity available via production methods and demand response.

Three essential components are used to deal with peaks:
- Overall reduction in consumption.
- Smoothing of the load curve by controlling demand.
- Development of capacity so as to satisfy residual peaks.

Application to the building
The reduction of intrinsic actual consumption involves the establishment of a power engineering approach right from the design stage and implementation of active and passive energy efficiency technologies.

Smoothing the load ensures that the supervision system takes account of scenarios regulating consumption in each space according to the local weather (e.g. solar power received via the front of the building) and occupancy.

The BMS is designed to optimize demand on the grid in the district, depending on the pricing signals without adversely affecting comfort (of the distributor, of the energy supplier). A number of control scenarios allow users to benefit fully from the potential savings (total or partial curtailment of loads during the most expensive periods).

Main examples of Smart Grid use
- Managing demand to minimize costs.
- Managing local production and arbitration between on-site consumption and re-injection of electrical energy.
- Forecasting consumption according to the weather forecast.
- Use of internal heat sources (e.g.: computer rooms).
- Metering of consumption by family of occupants for cost allocation by services.
- Outlet load shedding (use of PC batteries), or load rotation on the heat emitters (e.g., 1 fan coil unit out of 3).
- Monitoring of intrinsic consumption of equipment serving the building (e.g.: IP computer network, active PoE equipment).
- Metering of real-time consumption, of costs and emissions for display.
- Metering of real-time consumption, of costs and emissions for comparisons with the other sites in the portfolio being managed.
- Metering of real-time consumption, of costs and emissions for comparisons with similar sites in the region.
- Managing penalties in the context of a green lease.
- Load forecasts for scheduling maintenance operations.
- Real-time identification of spare capacity available per network.
- Control of energy quality in order to implement improvement plans (e.g.: reactive energy).
- Managing penalties in the context of contracts with service quality commitments (availability and energy quality).

- Load curtailment inside commercial buildings on the instructions of the district management cockpit on the basis of exchanges with an ERDF[1] (*Electricité Réseau Distribution France*) upstream network manager (load peak, pricing signal, etc.).
- Interactions with the smart meter (e.g., Linky, an ERDF smart meter), especially for delivery of low voltage, such as yellow rate (below 250 kVA).

3.2. Electric Mobility

The transport sector, the main consumer of fossil fuel and producer of CO_2 emissions, is at the centre of the optimization campaigns being organized. In France, it represents 28% of energy consumption and 34% of CO_2 emissions.

Producing no CO_2 emissions or particle emissions and being silent, the electric vehicle is an effective concrete response to reducing the environmental impact of vehicle transport.

Energy should be managed in order to:

- Avoid recharging during consumption peak times when the energy is mostly of fossil origin.
  - By measuring the actual environmental impact of the electric vehicle.
  - By prioritizing use of renewable energies when they are available on the power grid.

Main examples of Smart Grid use:

- Managing electrical vehicle (EV) clusters on the road system.
  - According to instructions directly received from the grid at the point of delivery (network manager).
  - According to instructions received from the recharging infrastructure management centre in the zone or the district management cockpit on a signal from an ERDF upstream network manager.
- Managing EV clusters on a building internal network.
  - According to instructions received from the Building Management System on a signal from an ERDF upstream network manager.
  - According to instructions received from the district management cockpit independently of the ERDF upstream network manager, and according to the amount of kWh produced by the renewable energy (RnE) production systems (photo voltaic, etc.).
- Load shedding or capping the recharging power of individual charging stations (no clusters) by remote management via sending/receipt of data directly to the charging stations.
- EV partial charge scenario according to the user programming.
- Fast charge scenario in the middle of the night and CO2 balance measurement.
- Measuring the carbon balance of EVs from well to wheel.
- Building in island mode scenario to guarantee the level of load shedding in demand response mode.
- In the near future, implementation of Vehicle-to-Grid (V2G) or Vehicle-to-Home (V2H) scenarios[2]

Schneider Electric's innovation teams have developed smart recharging infrastructures to allow users new ways to access energy without compromising the safety of people and equipment.

Schneider Electric recommends Electric Vehicle recharging infrastructures in Mode 3, Type 3, 3-22 kW connected to the BMS with smart cluster controllers.

All Schneider Electric solutions comply with the recommendations of the *Livre Vert* official report, the French decree of 25 July 2011, with NFC15100, and Renault's Z.E. Ready standards, etc.

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[1] The Electricity Network Distribution France (ERDF) manages the public electricity distribution network for 95% of continental France

[2] In such scenarios, smart chargers will identify renewable energy source availability within the grid and use it to charge the electric vehicle. Additionally the EV battery can be useful as an energy source for the grid in an emergency or during peak consumption, as well as serving residential energy needs

3.3. Integration of Renewable Energies

Schneider Electric is an expert in the areas of electrical distribution and control and monitoring, and promises to support you through implementation of the project until delivery of turnkey installations, or even beyond delivery with a service contract.

High-efficiency equipment
In order to ensure maximum installation efficiency, technical solutions rely on optimized equipment. Such equipment – inverters, junction boxes, low-loss transformers, medium-voltage equipment – is at the heart of the energy conversion system.

Schneider Electric focuses on the project's profitability, taking all the parameters into account.

Schneider Electric is capable of taking contractual responsibility for the operation and maintenance of your site. This contract includes preventive and remedial maintenance operations, combined with a commitment to equipment availability.

Design studies can be executed to define very precisely the equipment best suited to your site. This approach can very effectively combat the direct impact and indirect effects of lightning, in particular:
- Surges from the grid.
- Surges generated in the loops by the magnetic field.
- Current flow generated by the electric field.
- Capacitive coupling.

The architectures and equipment used in the context of the solutions (field meshing, cabling, surge arresters, etc.) have been granted the *Qualifoudre* label[3] and of course comply with the recommendations of the French Agency for the Environment and Energy Management, for installations using renewable energies.

Video surveillance and access control systems can be used to monitor and protect installations 24 hours a day, 7 days a week.

At each stage of the project (feasibility study and design; equipment supply, installation and commissioning; operation; maintenance; and recycling), Schneider Electric offers the skills and expertise necessary to achieve the performance and availability targets.

Mastering the Four Cornerstones of Ensuring a High-Quality Installation
- Mastering safety.
  - Compliance with standards and technical specifications.
  - Determining the size of equipment and protection devices.
  - Ensuring the safety of people and equipment.

- Mastering the environment.
  - Visual impact study.
  - Assessment of means of access to the site.
  - Recommendation of sustainable technologies.
  - Mastering the installation end-of-life processes.

- Mastering longevity.
  - Selection of high-quality, reliable and sustainable manufacturers and equipment.
  - Design of service areas tailored to the equipment.
  - Establishment of a maintenance contract.

- Mastering profitability.

[3] This French label guarantees the quality of products and services related to prevention and protection against lightning. The label is administered by INERIS, a French public research body focused on the industrial and commercial sectors.

- Choice and positioning of installations.
- Determining the size of inverters.
- Optimization of the electrical wiring diagram.
- Assistance with control/operation.

Main examples of Smart Grid use:

- Storage and management of injection of RnE production onto the district grid, adhering to instructions from the district management cockpit, that are based on exchanges with an ERDF upstream network manager.
- Identifying the storage method and the injection device (inverter, etc.).
- Management of reactive power by controlling inverters.

4. The Durability of Actual Energy Performance

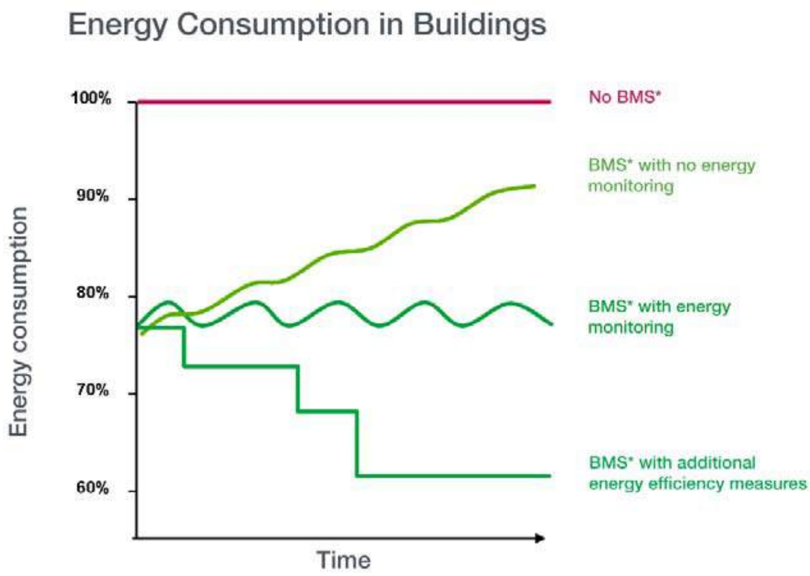
Key points

- Set-up and optimization from construction
- Surfaces that are not used do not consume
- Real-time monitoring of energy and uses
- An informed and committed owner
- Works action plan EE1, EE2, EE3
- Guaranteed cost-savings per contract, Green lease

4.1. Keeping the Building in Optimum Condition

If no action is taken to maintain the building's energy performance, this tends to decrease with time. It is therefore useful to follow a performance control procedure based on three phases:

- Understanding the site and analysis of its operation: Fine-tuning during the initial period and energy assessment.
- Maintenance of energy performance.
- Optimization of energy management.



Once the energy audits have been completed, the energy savings put in place, and the cost savings quantified, it is essential to ensure the stability of the performance over time.

This performance can only be maintained by a set of advanced services, energy assessment, space management, and other intellectual services.

Schneider Electric guarantees combined and advanced services such as:
- An energy audit.
- Analysis reports.
- Proposals for improvement and optimization.
- Assessment.

Energy performance commitments are guaranteed thanks to the application of the IPMVP protocol.

Fine-Tuning During the Initial Occupation Period
Schneider Electric conducts regular site visits to propose optimization of the systems installed during the initial period of the building's life cycle. These may include for example:

Modification of Setpoints
Savings consist of re-evaluating and/or making the setpoints more flexible. Differences can be achieved based on external conditions. For example, in the case of an air-conditioned building, the summer setpoint for cooling can be increased in proportion to a rise in the external temperature.

Occupancy

- **Modification of Time Programs**

The operation of the installations must be defined according to the time programs representing the building's activity.

As well as a permanent change, the ability to occasionally extend a time operation, or for a period of 0 to 30 minutes, in the event of an occasional change in occupancy, as would be the case for a late or unforeseen meeting, would allow modifications to the setpoints for this given period to then return to the normal occupancy mode.

- **Zoned Management**

Zoned management is applied for buildings with multiple occupancy modes so that these are only heated or air-conditioned when necessary. To optimize the potential savings, specific occupancy times, compensation, and optimization can be applied to each zone.

- **Modification of Schedule Plans and Holiday/Public Holiday Periods**

The installation allows the implementation of typical configurations for different schedule dates. This allows different programs to be configured a long time in advance and to be adapted to working habits. This option applies to zones where the occupancy rate constantly changes from one week to the next, such as exhibition halls or meeting rooms. Programming time is reduced since the configuration only has to be made once.
The "public holiday" programs can be used as required, in association with the time programs.

As a result of the "integrated systems" approach, a simple modification to the basic time or "public holiday" program is applied to all the integrated systems, including lighting, security, and access control. This allows the HVAC systems to operate based on the setpoint for actual occupancy, and therefore optimizes energy savings for the entire building while reducing operating costs.

- **Optimizers**

The BMS optimizes the start-up of the heating and cooling systems, ensuring that the system functions for a minimum time and generates energy savings.

The optimizer stores the settings and adapts to the building/zone using auto-adaptation to obtain the best settings. The configuration of the occupancy is determined by time programs for heating/cooling inside the building. If the program is interrupted by an external switch, it is important that the auto-adaptation is disabled during the manual interruptions as well as in the event of a failure.

The BMS can print out detailed reports on the activities of the optimizer. These reports are regularly examined to ensure maximum savings. The examination is conducted under different external temperature conditions and on different days of the week. The BMS optimizer includes "boost" functions (forced start) which are applied if the temperature has not reached the occupancy level in the previous 24 hours, for example on Monday morning. These functions, which are automatically activated, ensure that comfortable room temperature levels are achieved.

- **Interruptions**

In cases where the systems are subject to a manual interruption, a regular examination is required to ensure that the energy is not used unnecessarily.

- **Optimization of External Supplies**

In addition to temperature regulation systems, external conditions optimization systems can also be added. For example, automatic lowering of blinds when the facade is exposed to the sun.
Light graduation system for premises based on natural light.

- **Implementation of the Free-Cooling Function**

The fresh air handling units are equipped with a "free-cooling" system (natural cooling using external air). When the building requires cooling and the external temperature is lower than the temperature inside, the supply of fresh air is maximized.

- **Heat Recovery from Extracted Air**

The fresh air handling units are equipped with a heat recovery system for extracted air.
The temperature is taken for extracted air, fresh air, and supply air to optimize the energy consumption of the fresh air.

- **Air Handling Systems - Damper Economy Override Function**

An air quality sensor in the return air duct regulates the supply of fresh air. The variable air flow systems combine the control of fresh air flow with air quality management.

Electricity Savings

- **Speed Drives**

The information stored in the BMS, and the implementation of speed drives, optimize the rotation speed of the motors. For example: access control can supply information on the occupancy rate therefore facilitating the adaptation of the air flow.

- **Maximum Power**

The electrical loads at site level are cut off if the algorithm forecasts that the limit will be exceeded; they are restored once the dangerous period has ended.

The electrical loads are cut off in turn based on the priority level and a matrix allows the criticality of the load to be selected. Calculations allow continuous modification of the frequency at which the loads are cut off and restored.

The target demand is recalculated by the BMS if future reductions in energy consumption are required.

An indirect reduction in the maximum power is applied forcing the reduction of the maximum opening of a refrigerated water regulation gate.
This indirectly reduces the power required by the water cooling station and as a result the electricity consumption.

Remote Monitoring for Optimum Maintenance

Following optimization of the site and the implementation of the final precision adjustments, the energy consumption management and control system offers the following features:

- Consumption analysis.
- Monitoring of key parameters in the installation's operation.
- Triggering of alarms in the event of drifts noted or faults with the installation.
- Management of alarms and their processing by the site's maintenance teams.

- Monitoring of interventions and maintenance.

Alarms are produced based on a list in real-time for all systems (heating, air conditioning, ventilation, lighting, cold, water, etc.).

Schneider Electric supplies its energy expertise to define the limit values and the notification rules for each of them, allowing the generation of alarms.

Management rules based on predefined scenarios can be configured. These facilitate the automatic generation of "Intervention Orders" when certain critical values from the systems are reached or exceeded. For example, if the temperature in a computer room exceeds the critical value of 22°C, an e-mail, SMS, or telephone call is generated and sent to the designated people (on-call management).

The remote monitoring system for energy performance generates regular dashboards, ensures reporting to the owner, occupants, and site facilities' manager.

The dashboards offer the following functions:
- Monitoring of key management indicators.
- Analysis of management performance based on Key Management Indicators.
- Fault and alarm monitoring chart.
- Monitoring of interventions and maintenance.

The management of Interventions and Maintenance allows:
- Flexible and personalized management of remedial interventions and of preventive maintenance.
- Structured traceability and archiving of all types of interventions and the associated costs.
- Automatic generation of an assessment of the multi-annual works plans to be performed over a defined period.

4.2. Maintenance and Optimization of Energy Performance

The progress plan conducted by the Energy Manager on the site aims to reduce the intrinsic consumption of the m² occupied every day (kWh fe/m²/year).

Surfaces that are not used do not consume.

Energy optimization is first of all based on the optimization of the number of square metres occupied. For example, for a building that currently consumes 50 kWh/m², a drop from 10,000 m² to 9000 m² represents a saving of 10% on the energy bill (without counting the more global bill, which includes the rent, etc.).

Schneider Electric specifies the construction of GILIF® Ready buildings by integrating the construction of D5X STIBIL regulation systems. The implementation of the occupancy measurement is therefore easily performed by the occupant. The first reports to help with the decision are available within three months.

Real-time monitoring of energy and uses
Energy optimization is then achieved through real-time monitoring of energy and uses.
Expert services such as Energy Operation Energy Bureau allows the Energy Manager to organize Green Committees and action plans to improve usage, operation, and maintenance.

An informed and committed owner
Every time the operator changes, the Energy Manager organizes a process to bring the new equipment up to standard in relation to the target objectives:
- Manufacturer training for familiarization with the technical systems.
- Presentation of optimum consumption thresholds.
- Presentation of the maintenance plan.
- Presentation of the measurement plan.

- Presentation of possible deviations.
- Presentation of the systems supporting the decision-making (Vizélia portal).

Works Action Plan
Three levels of action may be applied during the building's lifetime:
- Action on user behaviour on the site (EE1).
- Action on the building's active systems (EE2).
- Action on the building's intrinsic qualities (EE3).

EE1: metering, reporting, analysis, consulting, and display to understand the weaknesses and promote good behaviour:
- Remote monitoring to collect information, archiving, reporting, and display.
- Instant analysis (recommendations for optimization) and continuous analysis (control actions).
- Collection of multi-fluid data based on "zoning" specific to the building (structure for the distribution of energy and the corresponding metering points).

EE2: Management systems and all services linked to their operation:
- BMS (multi-fluid energy, but also safety, surveillance): Installation, audit, and optimization, operational support (SMART online offer), maintenance.
- Optimized control of electrical appliances (lighting, roller shutters, etc.), monitoring.
- Safeguarding of the energy distribution.
- Optimization of the quality of the electrical energy.

EE3: comprehensive and inclusive actions for the building as a whole:
- Comprehensive energy audits (the entire building), optimization of the entire building, advanced regulation of heating and cooling systems.
- Integration of renewable energy.
- Modifications to the building (openings, insulation, geothermal, etc.).

Guaranteed cost-savings per contract, green lease
- Energy Performance Contracting (EPC).
- Simulation and means of proof via the IPMVP protocol.

In the event of site development, Schneider Electric is the reference agent for performing the modifications.
Schneider Electric's proposal for improvement includes:
- Engineering studies to quantify energy savings (in kWh) and the corresponding investment.
- Choice of partners for implementing the solutions.
- Monitoring of the action implementation.
- Verification and guarantee of the energy performance result via the application of the energy performance measurement and verification protocol: IPMVP.

Conclusion

Today's high-performance building should still be performing tomorrow and adapt to the developments in standards, regulations, and market conditions.

Taking into account targets concerning consumption actually paid for by the tenant from the programming phase requires the integration of energy engineering techniques very early on in the process.

Current property market logic often tends to downgrade integrated technology for buildings in favour of architectural choices or the energy performance of one single building.
This trend should be reversed in the future due to increases in energy prices, the green lease, and interactions with the smart electricity system in the area and/or town.

To promote performance requirements in construction, it would be useful to integrate, within an energy performance package, all of the services and supplies impacting energy consumption (engineering, supply of active technologies, start-up, optimization, and monitoring up to three years following the entry of the first tenant).

The implementation of Property Management and Environmental Performance Information Systems will facilitate monitoring, assessment, and transactions on property asset portfolios. These systems must provide the occupants with information on how to manage progress plans.

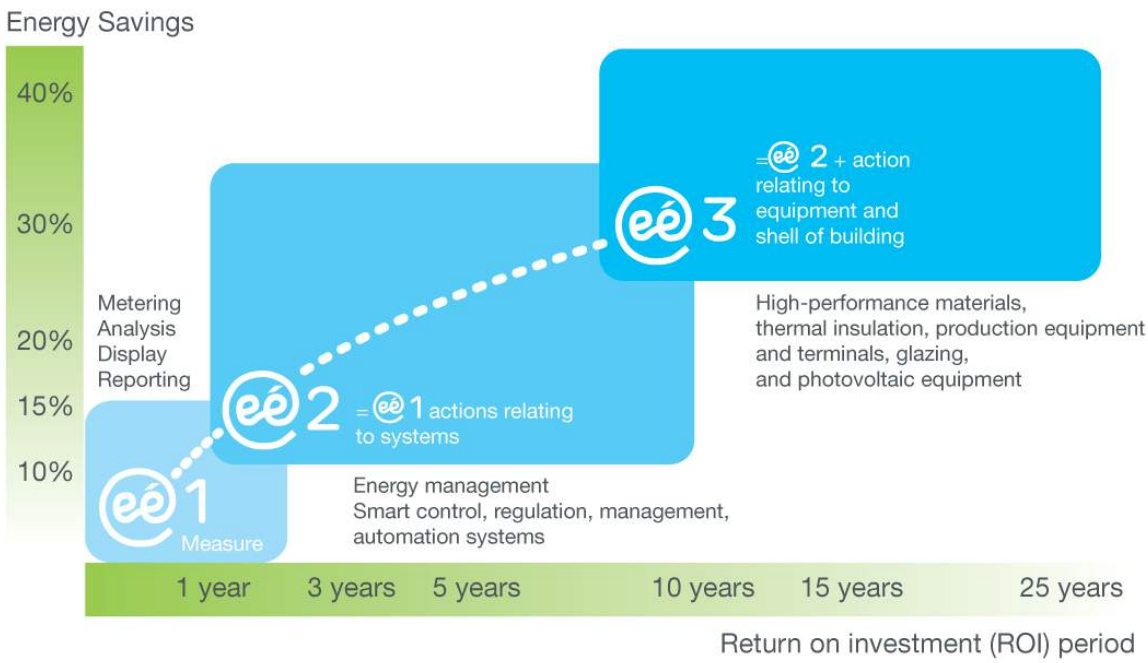
Definitions

Energy Efficiency Actions
Three different classes of energy efficiency action can be defined.

• Class EE1 (measurement type)
This class includes all actions relating to: metering, analysis, display, reporting.
The aim of these actions is to educate users and promote good behaviour to ensure that the improved performance is sustainable.

• Class EE2 (EE1 type along with actions relating to the systems in addition)
This class includes EE1 class actions and also actions for energy management, smart control systems, regulation, management, and automation.
The aim of these actions is to improve energy optimization by automating the building's functions and uses.

• Class EE3 (EE2 type with actions on the equipment and building shell in addition)
This class includes EE2 class actions with all actions relating to high-performance materials, thermal insulation, energy production equipment and appliances, glazing and renewable energies.
The aim of these actions is to act in all possible areas of energy efficiency.



Energy Efficiency
Energy performance of a process, appliance, or a building in relation to the energy supply is required for proper operation. Optimum energy efficiency is defined as lower energy consumption for the same service provided.

Active Building Management
A building with a high degree of active management is a highly energy-efficient building which integrates into its smart management the required energy-using equipment, production equipment, and storage equipment.

Performance Management:
Performance management uses all automated systems, the building's security applications, energy IT systems, and movement management to manage and achieve the global performance required

for the building. This performance impacts the building's energy efficiency, its environmental quality, and its integration into the sustainable district, for example. Performance management plays a major role in the building's ability to adapt and be upgraded.

Actual Energy Performance
Actual energy performance is defined as the difference on the bill in the intrinsic energy consumption (all fluids) of the occupied building.

IPMVP Protocol
The International Performance Measurement & Verification Protocol. IPMVP is a protocol aimed at proving the energy savings achieved following the implementation of energy efficiency solutions.

Smart Grid
The Smart Grid mainly covers two significant developments in electricity management:

- The first is the development of the power grid, the organization of which must be changed to adapt to the intermittent and decentralized production of renewable energy and respond to new consumption such as charging electrical vehicles.
- The second development corresponds to the grid users: it is hoped that they will become participants in the electrical system, allowing them to reduce energy consumption and control consumption peaks that generate heavy investments and greenhouse gas emissions.

Energy Management Information System (EMIS)
The energy management information system is a tool facilitating the integration and management of energy information so that a solid and coherent energy policy can be drafted based on said information.

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- Green Buildings Functional Design Brief - Schneider Electric, June 2011

[4] This white paper is available in English. Please send an email to kathleen.batcheller@schneider-electric.com to request a copy.

Appendices

<u>Appendix 1</u>

Standard EN 15232

The impact of energy efficiency on energy consumption is estimated as follows:

Offices	BMS efficiency classes			
	D	C	B	A
	Low energy efficiency	Normal (reference)	Improved	High energy efficiency
Energy for heating	**+44%**	**-**	**-21%**	**-30%**
Energy for cooling	**+57%**	**-**	**-20%**	**-43%**
Energy for the DHW	**+11%**	**-**	**-10%**	**-20%**
Electrical energy for lighting	**+10%**	**-**	**-15%**	**-28%**
Electrical energy for auxiliary equipment	**+15%**	**-**	**-14%**	**-28%**

Control function classes are defined in the table above. (Please note that the "Class C" reference is defined as the minimum class to be respected as defined by the RT 2012).

HQE Exploitation certificate

HQE Exploitation (High Environmental Quality in Operation) certification is based on:
- - A managerial tool: The Usage Management System (SMEx).
- - Two references:
  - Environmental Quality of Practice (QEP).
  - Environmental Quality of Buildings in Use (QEBE).

Environmental Quality of Buildings in Use (QEBE):
- The Intrinsic Environmental Quality of the Building (QEIB) (e.g.: acoustic, thermal performance, etc.).
- The Environmental Quality in Operation (QEE) (maintenance of equipment, upkeep of spaces, monitoring of consumption and comfort parameters, etc.).

Constitution of a profile, according to the 14 HQE targets, is based on three performance levels.

To obtain certification, the minimum QEBE profile is:
- Seven targets at the Basic level.
- Four targets at the Performing level.
- Three targets at the High Performing level.

The interest in obtaining HQE Exploitation certification is to make official a building's good environmental performance in terms of its impact on the environment, comfort, and the health of those occupying the building. The good environmental performance of a building rests upon:
- Environmental management.
- The technical solutions used.
- Behaviour.

The HQE Exploitation certification has a new approach in terms of HQE construction, since it takes into account the concept of continued improvement over time. The general structure of the reference differs from the traditional "construction" references. A managerial tool, the Usage Management System (SMEx), is used as the methodological framework for the approach. The major difference lies in the assessment of environmental quality. This is conducted using three different references:
- The Environmental Quality of Practice (QEP) covers best practice that can be implemented by the agents in the building. This is exclusively linked to the practices of the agents.
- The Intrinsic Environmental Quality (QEIB) of the building covers all of the concerns linked to the Intrinsic Environmental Quality of the work (acoustic, thermal performance, etc.).
- Environmental Quality in Operation (QEE) covers all the concerns linked to the management of the building and monitoring of the work (monitoring of consumption, equipment maintenance, upkeep, etc.), as well as the improvement of the Intrinsic Environmental Quality of the Building.

In the HQE certification approach, nine different targets are used to assess the BMS whose functions guarantee and maintain performance levels, as well as the comfort of the occupants:
- Target 4, Energy management.
- Target 7, Maintenance and monitoring of the performance of the
  - Ventilation (7.2).
  - Lighting (7.3).
  - Water management (7.4) systems (beyond the scope of EN15232).
- Target 8, hygrothermal comfort in winter and summer.
  - Temperature stabilized in spaces for intermittent use (8.2.2).
  - Air speed does not interfere with comfort (8.2.3).
  - Setpoint may be set per room (8.2.4).
  - Cooling air speed (8.4.2).
  - Setpoint may be set per room (8.4.4).
  - Relative humidity (8.4.5).
- Target 11, olfactory comfort.
  - Control of air flows (11.1.1).
- Target 13, air health quality.
  - Control of air flows optimized for the activity (13.1.1).

In the HQE Exploitation certification approach, the following targets can be achieved by using a BMS whose functions impact the energy performance of the building:

- QEIB 4, QI 4.4; Intrinsic Environmental Quality of the Building relating to Energy Management, Intrinsic Quality in Operation.
  - In the presence of a regulation system and in accordance with standard NF EN 15-232, list all the different functions covered by the regulation system and allocate the corresponding class to each function; determine the overall energy performance class of the regulation system and out of a total of 22 possible points for the [QEIB 4] if the performance achieved is:
    > Class C= 1 point in HP (High-performing).
    > Class B= 2 points in HP.
    > Class A= 5 points in HP.

For monitoring and maintaining performances on a total of 28 possible points:

- QEE 4, SM 4.1 Environmental Quality in Operation relating to Energy Management, Monitoring and Maintenance; determine the energy consumption over a 12 month period, and
  - SM 4.2. Overall energy consumption performance:
    > If there is a reduction of less than 10% in consumption = 3 points in HP.
    > If there is a reduction of at least 15% in consumption = 6 points in HP.
    > If a method that complies with directive 2006/32/EC (e.g. IPMVP) is used then add three points in HP.

For the monitoring of consumption and maintenance of performance levels:

- SM 4.3. Optimize the monitoring of energy consumption.
  - If the monitoring is conducted in real time via a BMS system:
    > Via sub-metering = 2 points in HP.
    > On all meters present = 4 points in HP.
    > If linked to an alert system, and corrective provisions then add three points in HP.
- SM 4.4. Regularly analyze energy consumption.
  - Take into account unified degree days for heating and occupancy scenarios.
  - Interpret the statements via sub-metering = 4 points in HP.
  - Analyze consumption at least twice a month and add one point.
- SM 4.5. Implement an energy efficiency service, for example an EPC to
  - 1 type of energy = 3 points in HP.
  - For all types of energy = 7 points in HP.

The HIGH PERFORMING level is achieved if the total is 12 POINTS, including 8 POINTS for the sub-target QEE.4 and 3 POINTS for recommendation SM.4.5.

In QEIB7 "Intrinsic Environmental Quality for the Building relating to maintenance, sustainability of environmental performances", QEE 7 "Environmental Quality in Use relating to maintenance, sustainability of environmental performances (HP level 7 points minimum)":

- QI 7.2. Put in place the means necessary to monitor energy consumption during the use of the work.
  - First and second level metering = 3 points.
  - And provisions taken to ensure the specific monitoring of energy consumption on certain energy-related items (ventilation, heating, cooling, lighting, DHW), in coherence with the metering tree put in place add two points.
- QI 7.3. Make available the means necessary to monitor water consumption during use of the work.
  - First and second level metering = 3 points.
  - And provisions taken to ensure the monitoring of water consumption on each tap add two points.
- QI 7.4. Make available the means necessary for the control of systems during use of the work having an impact on the comfort of the occupants (Heating/cooling, lighting, ventilation).
  - Provisions taken to program the comfort settings (temperatures, flows, etc.) and equipment operating times (timers) = PERFORMING level.
  - Provisions taken in suitable spaces (identify these beforehand) for control at an operating comfort setting that is outside the times requested in PERFORMING for at least two systems (out of three) = 2 points.
  - For three systems = 3 points.
- SM 7.5. Optimization of the monitoring of technical systems relating to the four systems: Heating/cooling, lighting, ventilation and DHW.

- Review the efficiency of the system in its entirety at least once a year; ensure consistency in:
  > The manufacturer data.
  > The use of the premises.
  > The planned maintenance contract(s) AND
  > Cross referencing these factors to check whether the systems are still well adapted to the use of the premises and the type of maintenance associated, AND corrective provisions taken if necessary.

- This process is implemented relatively:
  > To at least one system out of four = 2 points.
  > To at least two systems out of four = 4 points.
  > To at least three systems out of four = 6 points.
  > To all systems = 8 points.

- SM 7.6. Ensure the sustainability of the possible regulation system(s).
  - The regulation system(s) were checked at least twice a year = 2 points.

The HIGH PERFORMING level is achieved if the total is 13 POINTS, including 8 POINTS for the QEE.7 sub-target.

Other possibilities for obtaining points to achieve the HIGH PERFORMING target are included in:
- QEIB 8 Intrinsic Environmental Quality of the Building relating to hygrothermal comfort.
- QEIB 10 Intrinsic Environmental Quality of the Building relating to visual comfort and QEE 10 Environmental Quality in Operation relating to visual comfort.
- QEIB 11 Intrinsic Environmental Quality of the Building relating to olfactory comfort.
- QEIB 13 Intrinsic Environmental Quality of the Building relating to the health quality of the air.

In the HQE certification approach, nine different targets are used to assess the BMS whose functions guarantee and maintain performance levels, as well as the comfort of the occupants:

- Target 7, Maintenance and monitoring of the performance of the
  - Ventilation (7.2).
  - Lighting (7.3).
  - Water management (7.4) systems (beyond the scope of EN15232).
- Target 8, Hygrothermal comfort in winter and summer:
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- Target 11, Olfactory comfort.
  - Control of air flows (11.1.1).
- Target 13, Air health quality.
  - Control of air flows optimized for the activity (13.1.1).

LEED (Leadership in Energy and Environmental Design)

Leadership in Energy and Environmental Design (LEED) is an internationally recognised green building certification system developed by the U.S. Green Building Council (USGBC) (www.usgbc.org). It provides third-party verification that a building or community was designed and built using strategies aimed at improving building performance from a sustainability perspective. The most recent version of this system is LEED 2009. (The third public comment period for LEED 2012 opens on March 1, 2012, Balloting for LEED2012 will take place in June and is expected to launch in November.

The maximum amount of points that can be allocated is 110, distributed into six categories of criteria. The ultimate goal of the LEED certification program is to use methods, systems, and construction materials that will improve the health and well-being of the occupants, increase the economic performance of buildings while minimizing, as far as possible, the ecological footprint of these on their environment. It is based on these principles that the LEED certification combines the specifications of the healthy house.

The preliminary conditions and credits are classed into five broad categories.

Sustainable Sites	26 Points
Construction Activity Pollution Prevention	Required
Site selection	1
Development Density & Community Connectivity	5
Brownfield Redevelopment	1
Alternative transport	**12 max.**
Site Development	2 max.
Stormwater Design	2 max.
Heat Island Effect – Non-Roof & Roof	**1 each**
Light Pollution Reduction	**1**

Water Efficiency	10 Points
Water Use Reduction (20%)	**Required**
Water Efficient Landscaping	4 max.
Innovative Wastewater Technology	**2**
Water Use Reduction	**4 max.**

Energy & Atmosphere	35 Points
Fundamental Commissioning of the Building Energy Systems	**Required**
Minimum Energy Performance (EnergyStar60)	**Required**
Fundamental Refrigerant Management	**Required**
Optimization of Energy Performance	**19 max.**
On-Site Renewable Energy	**7 max.**
Enhanced Commissioning	**2**
Enhanced Refrigerant Management	**2**
Measurement & Verification	**3**
Green Power	**2**

Materials and Resources	14 Points
Storage & Collection of Recyclables	Required
Building Reuse	4 max.
Construction Waste Management	2 max.
Materials Reuse	2 max.
Recycled Content	2 max.
Regional Materials	2 max.
Rapidly Renewable Materials	1
Certified Wood	1

Indoor Environmental Quality	15 Points
Minimum IAQ Performance	**Required**
Environmental Tobacco Smoke (ETS) Control	Required
Outside Air Delivery Monitoring	**1**
Increased Ventilation	**1**
Construction IAQ Management Plan	2 max.
Low-Emitting Materials	4 max.
Indoor Chemical & Pollutant Source Control	1
Controllability of Systems – HVAC & Lighting	**1 each**
Thermal Comfort	**2 max.**
Daylight & Views	**2 max.**

Innovation & Design Process	6 Points
Innovation & design	**5 max.**
LEED accredited professionals	**1**

Regional Priority Credits	4 Points
Specific Credit	**4**