ENVIRONMENTAL RECOMMENDATIONS
FOR SUSTAINABLE BUILDINGS
BY LUX-DEVELOPMENT

OBJECTIVES AND TARGETS

When building, LuxDev's environmental recommendations aim to achieve a balance between the internal and external environment, eco-management and social development in terms of the measures and resources applied in creating and using a building, from its design to the end of its life. A building should, if possible be straightforward, solid and suitable means, protect the environment (external environment), ensure the occupants' comfort and good health (internal environment), enable operational and maintenance costs to be reduced, reduce energy and resource consumption as well as the production of greenhouse gases, waste and various types of pollution.

SD	4 OBJECTIVES	10 TARGETS
I. ENVIRONMENT	1. EXTERNAL ENVIRONMENT AND ECO-CONSTRUCTION CONTROLLING THE IMPACT OF THE BUILDING ON THE EXTERNAL ENVIRONMENT	Target 1 - Promote the harmonious integration of the building into its environment
		Target 2 - Choose environmentally-compliant materials and procedures and promote clean technology
		Target 3 - Create "clean" construction sites and promote waste management during the operation of the buildings
	2. INTERNAL ENVIRONMENT, COMFORT AND HEALTH CREATING A HEALTHY, COMFORTABLE INTERNAL ENVIRONMENT	Target 4 - Improve the quality of buildings' internal environment
		Target 5 - Guarantee that building users have an internal environment with the best sanitary conditions
II. ECONOMY	3. ECO-MANAGEMENT AND ECO-FACILITIES REDUCING THE IMPACTS OF BUILDINGS DURING OPERATIONS	Target 6 - Reduce the building's overall energy demand and promote renewable energy sources
		Target 7 - Manage water consumption in the building and reduce potable water consumption
		Target 8 - Develop sustainable maintenance practices (life cycle cost approach)
III. SOCIAL	4. SOCIAL DEVELOPMENT AND FAIRNESS PROMOTING FAIRNESS, GENDER EQUALITY, COHESION AND SOCIAL SOLIDARITY	Target 9 - Place significant emphasis on consultation with the building's users, especially women, and make the users aware of environmental protection and climate change
		Target 10 - Promote accessibility for persons with special needs

GENERAL RECOMMENDATIONS

These recommendations are intended to set out the arrangements required in order to achieve the level of quality expected by LuxDev and the local contracting authority while complying with the economic framework, budgets and timeframes. Under no circumstances do they substitute the applicable national standards, regulations or recommendations.

This document is supplied to all candidates participating in tenders for the procurement of architectural and engineering services: it sets out all the general environmental rules regarding the objectives and work principles agreed between LuxDev and projects' local contracting authority.

These rules are applied to all construction operations co-financed by the contributions of the Government of the Grand Duchy of Luxembourg and implemented by LuxDev as part of its procurement procedure regarding environmentally-compliant construction.

These rules may give rise to partial derogation, depending on the context and scope of the contract; under those circumstances they must be justified and approved by LuxDev and the contracting authority.

These recommendations may be complemented by specifications or a programming document that establishes requirements which are more precise or appropriate to the local context, depending on the targets jointly aimed at or agreed on by the counterpart and LuxDev, especially in the event of delegation of management.

Environmental management system (EMS)

The achievement of a high level of environmental quality requires environmental management of projects, to ensure that the final performance corresponds to the initial objectives set by the client.

Therefore, it is strongly advised that the project is efficiently and rigorously organised in line with international or local standards that include a specification of environmental management arrangements and methods.

1. EXTERNAL ENVIRONMENT AND ECO-CONSTRUCTION

CONTROLLING THE IMPACT OF THE BUILDING ON THE EXTERNAL ENVIRONMENT

TARGET 1 - PROMOTE THE HARMONIOUS INTEGRATION OF THE BUILDING INTO ITS ENVIRONMENT

A study should be carried out on the orientation of the premises to achieve the best technical performance (reduction of internal heating and solar gain in summer in order to reduce the air-conditioning requirements, and vice versa in winter) and simply to ensure visual comfort for the occupants (apertures with interesting views and daylight management).

Additional solar shading with a high quality of architectural integration and low maintenance can also help to manage solar gain and provide visual comfort (roof extensions, masking, vegetation, etc.).

Likewise, a simple, compact building shape is desirable in order to reduce areas of thermal loss and areas which cannot be used.

The organisation of spaces must take into account pedestrian flows, the auditory environment and natural lighting.

The impact of the completed building on the environment (integration into the landscape and architectural context, noise pollution, circulation of people, access to sunlight and daylight, pollution, protection of the ecosystem, etc.) must be studied in order to reduce any negative effects, especially for noisy premises.

The processing and organisation of spaces must also take into account the impact of the building on the wider environment (noise, soil and air pollution, climatic conditions, site topography, etc.).

Biodiversity: Existing plants must be preserved as far as possible. The presence of notable animal species - bats, birds, reptiles, … - must be considered in the design and work phases.

Integration into the urban fabric, the use of urban land and transport systems

Designers must comply with the local planning requirements. In the absence of rules or other planning provisions, designers must propose the best possible integration of the building, taking into account a justifiable occupation of urban land at optimal density.

The building must fit into the urban landscape and underscore any historic value of the built area.

Landscaping and biodiversity

The external spaces, in terms of their image and relationship with the building and its environment, must be directly representative of the environmental quality of the operation. They must be a genuine recreational area for users which is as imposing as the interior of the building. General consideration must go into integrating the various traffic flows.

Landscaping and planting must be systematically integrated into the operation to a significant degree. These aspects must be paid the same attention as the building and must be the subject of a clearly defined "landscape group" which integrates their various purposes (reception, recreation, presentation of environmental quality, education, etc.).

In general, the vegetation must be chosen from local species and require minimal watering and maintenance (e.g. preferably meadows rather than lawns), but this should be complemented in various ways such that the potential of the site and roles assigned to the planted areas can be expressed:

- **aesthetic:** spatial organisation, landscaping, ease of orientation on the site, effects of materials, colour, light, marking or softening of edges, etc.;
- **biological:** enhancement of the environment, biodiversity, support for development of animal life, capacity to set ecological dynamics in motion, etc.;
- **climatic:** creation of microclimates, protection against wind, change to water systems, planting of deciduous trees for façades exposed to sunlight, etc.;
- **educational:** support for experimental observation, illustration capacity, etc.

Planted areas are essential to create a new landscape for the project. The choice of species and vegetation structure, as well as their maintenance regime must be set out precisely, giving reasons for the choices and the expected effects on the perception of the site, the development of the environment, impact on living conditions and the modification of climatic factors.

Soil permeability

In order to limit water run-off from the soil, open ditches and installations to retain water and allow it to soak away will contribute to an enhancement of the open spaces.

Apart from for surfaces which can generate permanent or accidental pollution (carparks, electricity generators, etc.), as a priority the water must be retained and then allowed to soak into the soil. Allowing water to run into the sewage system must only be done as a last resort, when it is not possible to let the water immediately soak away (water catchment protection area, ground not permeable enough). At no time must the water table be put at risk by leaching.

Watering network

Rainwater recovery to water the external areas must be systematically included in the design, with the installation of an integrated watering network connected to a storage network, thus ensuring the lasting quality of the landscaped areas.

Means of transport

All transport flows must be taken into consideration and the environmental system must promote less polluting transport, in this order of importance :

- pedestrians;
- bicycles;
- school buses and public buses;
- mopeds and motorcycles;

and finally

- individual vehicles.

This order of priority must be expressed in the landscaping for each type of traffic.

TARGET 2 - CHOOSE ENVIRONMENTALLY-COMPLIANT MATERIALS AND PROCEDURES AND PROMOTE CLEAN TECHNOLOGY

Special attention must be paid to multiple criteria in the choice of materials and products. Three groups of criteria must be offered to teams and must be considered when adjudicating on proposals and in the design process:

- **Technical and architectural criteria**: technical performance, operational performance, architectural quality, sustainability and ease of maintenance;
- **Economic criteria**: investment costs, deferred costs (maintenance, renewal);
- **Environmental criteria**: related energy savings and impact on the environment and health throughout the building's lifecycle.

The priorities for choices of techniques, products and materials are:

1- The technical and architectural criteria traditionally used by designers are non-negotiable: the component, product or material must **comply with architectural, technical and environmental requirements** in these fields;

2- The second set, economic criteria, must be taken into account not on a product-by-product basis but on a general basis, to ensure that the operation **remains in line with the planned investment cost targets and total cost targets**. There may be compensating factors from one product to another;

3- In most cases, this leaves a margin of choice for the consideration of the third set, environmental criteria. **The total lifecycle** begins with the extraction of raw materials for the manufacture of the product and ends with the final disposal of the waste after the building is demolished. The order of priority of these phases is: (i) the operational phase of the occupied building; (ii) the upstream phases of manufacture and implementation of materials; and (iii) the decommissioning, alteration phase.

In the absence of lifecycle analyses (LCAs), materials with low environmental impact should be found: **products with very little embodied energy** (low primary energy consumption and a preference for regional materials), use of recycled and renewable materials which themselves must be reusable or recyclable[3]. In particular, ISO 14001 certified production sites must be the preferred option.

Synthetic resources must be used with protection and materials used which contain critical, problematic or toxic components must be avoided (solvents, volatile organic compounds, halogenated or mutagen substances, biocides, plastifiers, formaldehydes, substances which damage the ozone layer, etc.). International environmental agreements banning certain toxic or harmful materials or substances must be strictly complied with when the contracts are performed (Montreal Protocol[4], POPs[5], CITES[6], CDB[7], Declaration of Helsinki[8], Stockholm Convention on POPs[9], WHO Class 1 Pesticides[10], etc.).

Due to its low ecological footprint, the use of wood must be supported to the extent that it is selected in accordance with the abovementioned criteria and priorities. In this respect, certification must be produced of the **sustainable management of the forests** from which the wood involved in the work on the site originates (FSC [11] or PEFC[12] label, or another system of certification of sustainable management of forests, if it is equivalent). Local species, limiting transport and sustainably managed, must be preferred, where they are not protected or do not fall under the CITES Convention[6].

The preferred option must be to use species which can be used without processing / treatment for a set purpose. Where processing is necessary, priority must be given either to processes not involving the addition of chemical processing products or to non-harmful products. As a last resort, where wood has to be primed, products not containing chrome and arsenic must be used.

Construction products must not be pollution sources. Wherever possible, products must carry a recognised label (e.g. European labels: NF-Environnement mark[13], EU Ecolabel[14], etc.).

The materials selected must be **easy to maintain** and must not require cleaning products which are sources of pollution; the range of materials must be limited.

Designers may be requested to produce materials declarations giving environmental data on the materials to be used. This will especially be the case where the environmental certification or energy efficiency of materials or products are important for achieving the desired performance of the building. This data must be sent to the enterprises responsible for the works.

TARGET 3 - CREATE "CLEAN"CONSTRUCTION SITES AND PROMOTE WASTE MANAGEMENT DURING THE OPERATION OF THE BUILDINGS

An environmentally-compliant site should be a natural extension of the environmental quality steps implemented in designing a building. Any construction site places stress on the immediate environment: the challenge for a "clean" site is to restrict any damage - this will benefit possible occupants of the site, local residents, employees and the environment.

For this purpose, **the LuxDev "Clean building site specifications"** must be appended to the technical specifications for consultation by the enterprises concerned. The Clean-building-site specifications must be adapted by the design team from the model supplied by LuxDev and made available to the enterprises and persons involved in the operation, and must be included in their contractual documents.

Waste management

In order to encourage waste management during the operation of the building, designers must propose a system of selective waste collection. The following must be provided:

- containers nearby for the collection of each type of waste and sites for the consolidation of sorted waste;
- a location for storage, with the option of packaging and disposing sorted waste;
- appropriate signage.

The size, arrangement and layout of the storage premises, as well as the organisation of the internal collection inside buildings must enable the selective collection of the various waste types: (i) paper and cardboard; (ii) metal (aluminium cans, other cans), glass; (iii) plastic; (iv) food waste, some of which may be refrigerated, toxic waste; and (v) green waste[15].

Achieving this target may involve the client inviting the enterprise responsible for the works to appoint an officer to implement the environmental requirements during the construction phase.

2. INTERNAL ENVIRONMENT, COMFORT AND HEALTH

Creating a healthy, comfortable internal environment

TARGET 4 - IMPROVE THE QUALITY OF THE BUILDINGS' INTERNAL ENVIRONMENT

Designers' choices must ensure that the users of the building are comfortable, while attempting to reduce the energy required for this purpose. The levels of hygrothermal, visual and acoustic comfort must be achieved following the abovementioned recommendations.

Hygrothermal comfort

Designers must attempt to achieve the best level of thermal comfort inside the buildings, with a view to reducing or not using the air-conditioning and/or heating, i.e. by preferring "passive" technologies.

(a) Zones with a thermal comfort problem in summer

Apart from certain premises to which legislation applies, **neither air-conditioning nor cooling must be used**. As a general rule, the internal temperature in summer in various premises must always be calculated using the international standards for comfort established on the basis of laboratory studies[16] and the standards drawn up for each purpose. However, designers must check on the availability of surveys and research in the regions concerned regarding the behaviour of the users of the buildings and its "adaptability"[17,18] to internal comfort conditions. These surveys will enable the refinement of internal temperatures to be used as a basis for the studies, especially to reduce the need for air-conditioning.

Thermal comfort in summer must be achieved through the good design of premises, with the appropriate architectural provisions and techniques (solar protection, good insulation of walls, thermal inertia, apertures, possibility of assisted nocturnal ventilation, etc.).

Some **external solar protection** must be considered, depending on the orientation, for any vertical, glazed surface (horizontal and vertical shading, external blinds, sunshades, etc.). Systems suited to each orientation must be chosen: preference must be given to those systems that obstruct direct rays of sunlight but also allow natural light (through reflection or otherwise). Internal solar protection is to be avoided.

Attention must also be paid to **insulation**, especially roof insulation. The ventilation system in summer mode must be designed to cool the building when it overheats - in general, passive cooling systems and natural ventilation must be used.

When the building is occupied, the air speeds in the areas occupied must not affect users' comfort, especially when windows are open or during periods of cooling.

Attention must be paid to the following points:

- the choice of orientation of premises leading to the strong risk of discomfort in summer (occupation or facilities);
- the external solar protection implemented for each orientation;
- the reduction of internal loads, especially loads due to office use, lighting and cooking appliances;
- the inertia of the building must be sufficient to offset the peaks of overheating and to release during the day part of the coolness stored during the night;
- for well-insulated buildings, the system must enable nocturnal cooling.

(b) Zones with a thermal comfort problem in winter

The internal temperature of the building when occupied must comply with the regulatory requirements, professional recommendations and international standards of comfort[19,20].

An adequate temperature level in the various premises when occupied, taking their purpose into consideration, must be maintained through good regulation and the management of intermittent usage. In corridors, comfort requirements are less rigorous than in the other premises and all or part of the corridors may be heated or not.

Other factors must be under control, such as the air speed, uniformity of temperature in the room, the difference in temperature between different body areas, glazed surfaces, the absence of cold walls, etc. The effect of cold walls must be mitigated by the use of highly-insulated glazed walls (double-glazing with low emissivity).

For well-insulated buildings, the premises at risk of overheating must be positioned strategically.

The choice of emitters and their position must be optimised according to the type of premises, such that the atmosphere is made as comfortable as possible.

Visual comfort

Natural lighting must be the preferred option and sources of artificial lighting must allow energy consumption and comfort to be controlled.

The use of natural light must be preferred for its visual comfort (excellent light production, excellent colour production, etc.), for psychological aspects (combating fatigue) and its energy efficiency.

Designers must try to optimise natural lighting through avoiding the risk of glare and ensuring comfort in summer and winter.

For users' comfort, views of the outside environment should be provided. Depending on their purpose, the premises (including the edges of corridors) must be orientated such that clear and agreeable views of the outside environment are enabled. Glazed apertures at visible height giving external views will allow users to relax and recuperate their energy.

The well-being of the occupants of the establishment must be part of the environmental quality of the operation and it will be important to choose colours that create an agreeable, harmonious environment and promote distribution of the light (natural and artificial light). These colours may also be used to direct traffic in large premises, to signpost specific areas, to promote orientation in the space and to comply with security objectives.

The layout of the glazed apertures in relation to the work stations must be studied carefully, as well as the equipment (curtains, solar protection, etc.).

With regard to glare, the risk of visual discomfort must be reduced by balancing out the brightness in the visual field. Matt surfaces should be preferred in the visual field. Lighting must be suitable for the type of work, and avoid the light being reflected into the user's eyes. The more arduous the visual task, the more glare has to be controlled.

Contrasts of colours and between light and shade can give character and create different ambiances, thus assisting users to find their way around the building easily.

The choice of lamps and lights must take into account the requirements of visual comfort, lifecycle and energy-efficiency (for artificial lighting, see Principle 6).

Acoustic comfort

The work, materials and facilities must be designed, chosen and implemented such that the transmission of the noise of equipment, the noise of impact, internal and external airborne noise is limited.

Designers must comply with provisions imposed locally and with the applicable rules on the acoustics of the premises which include an environmental quality system.

Soundproofing must be addressed as part of this system. The following should be taken into account: insulation of façades and walls, acoustic weak spots of windows, the consistency between the level of acoustic insulation in relation to the external environment and the sound level of the facilities on the premises.

In general, the volume of the rooms and the configuration of the premises must be planned to address possible internal and external noise pollution.

With regard to internal arrangements, premises where silent activities are carried out must be far removed horizontally as well as vertically from premises where simultaneous noisy activities is taking place and any technical premises containing noisy equipment. Where this is not possible, the acoustic insulation of the walls must be increased and direct communication between these premises must be avoided.

Soundproofing will limit the risk of nuisance between inside and out, between the various locations and in rooms where quiet is required. Additional solutions to acoustic insulation may be used if required (buffer zones, absorbent materials such as wood, felt, flocking, etc.).

In particular, premises containing equipment generating noise pollution (workshops, music rooms, auditoria, technical rooms, etc.), must be equipped with absorbent panels or any process which avoids resonance phenomena.

Special attention must be paid to restricting any noise emanating from the external walls of technical rooms, during the day and night.

Materials and equipment must be chosen for their acoustic characteristics (partitions, doors, flooring, apertures, etc.).

The air speed in ventilation conduits must be controlled in order to limit noise pollution.

Olfactory comfort

The air quality described in Target 5 and olfactory comfort require very similar action, especially effective ventilation and control over pollution at its source. This depends on the **natural or mechanical ventilation** installed in the building to evacuate speedily any sources of olfactory nuisance (from the WC or kitchen) and avoid, as far as possible, nuisance being produced internally or allowed in from outside.

Designers must attempt to improve the olfactory quality of the buildings by considering:

- the construction products (materials, flooring, insulation, etc.),
- the facilities (furniture, energy systems, hot water production system, etc.),
- the activities performed inside the building (maintenance, works, etc.), the environment surrounding the building (soil, external air, etc.)
- the users (their activities and behaviour),

The ventilation systems installed must enable the entry of fresh air free of direct pollution and the evacuation of polluted air without any risk of its re-entry into the building.

To prevent internal pollution, each product family must be researched to determine its emissions of odours and harmful chemicals (volatile organic compounds (VOCs), CRMs - substances which are carcinogenic, mutagenic and toxic for reproduction, formaldehydes), its capacity to promote fungal growth (moulds), bacterial growth and its natural radioactive emissions.

TARGET 5 - GUARANTEE THAT BUILDING USERS HAVE AN INTERNAL ENVIRONMENT WITH IMPROVED SANITARY CONDITIONS

Designers must ensure the best health conditions inside the building for its users. This especially concerns aspects connected with air and water quality, but also aspects linked to the safety and protection of staff.

Air quality

The greatest care must be taken in designing air distribution systems in order to avoid: bacterial developments and excessive maintenance; noise pollution; feelings of discomfort caused by draughts of cold air coming directly onto the occupants.

The environmental quality of the projects must be improved by choosing:

(i) reliable installations that are easy to maintain and installations which are economical in their electricity usage;

(ii) installations which economise on cooling and heating of the premises.

Water quality

Water quality must also be taken very seriously by designers.

Water management within the building which guarantees water quality while also conserving resources is the desired outcome. In addition, the design of systems to store and distribute water must enable health risks to be minimised.

The issue of water management is also addressed in Target 7.

Safety and protection of staff

Designers must ensure, in the design of the buildings and their construction, that any maintenance and repair operations and subsequent work done on the building can be carried out under easy, economical conditions and in complete safety for users and for the employees performing this work.

The layout of the premises, construction techniques, materials and equipment used must be designed to avoid any physical injury to users:

- slippery floors must be avoided;
- protrusions and overhangs in the shell must be avoided;
- the weight of parts of false ceilings must be limited;
- security glass must be used for any glazing located less than one metre above floor level;
- the opening range of casements must be restricted and windows

must only be allowed to open to a minimum aperture.

Stairs must be equipped with a non-slip nosing which is solidly fixed. Guard-rails of staircases, corridors, mezzanines, etc. must be at least 1.10 m high.

Roofs and terraces must be generally inaccessible, apart from service gangways with regulation equipment. However, where this obligatory inaccessibility cannot be complied with or circumstances allow for access, protective measures must be applied.

All the protective or safety work connected with water, electricity or heating networks must be made inaccessible to the building's users and to visitors.

The window breasts and panes throughout the building must resist shocks and must either not present any danger in the event of breakage or must be protected.

In general, sharp edges and protrusions of equipment and internal facilities (locks and handles, coat-stands, etc.) are forbidden.

Fire safety

Designers must refer to the existing national legislation. In the absence of local rules, they must comply with internationally accepted rules in this field. They must use constructive provisions which ensure the maximum degree of "passive safety", limiting the subsequent use of complicated, costly measures.

All materials liable to release toxic fumes during a fire (e.g. PVC) must be limited and labelled accordingly.

Contractors are liable for supplying extinguishers. Designers must gauge their number and location in accordance with local standards. Extinguishers using halon gases are forbidden.

Designers must supply safety plans and signage for fires, emergencies and gas.

3. ECO-MANAGEMENT AND ECO-EQUIPMENT

Reducing the impact of buildings during operation

TARGET 6 - REDUCE THE BUILDING'S OVERALL ENERGY DEMAND AND PROMOTE RENEWABLE ENERGY SOURCES

Designers must ensure the building is well-designed in architectural and technical terms in order to **avoid using air-conditioning** in hot climates during summer **and restricting heat loss and heating usage** in cold climates in winter (orientation, building inertia, night-time cooling, premises at risk of overheating should be north-facing if possible, etc.).

Designers must integrate the following objectives, especially with a view to reducing the building's energy needs:

- The building envelope, the characteristics of the air-conditioning, heating and electricity equipment must enable improvements to be made over the conventional consumption of a similar building.
- The insulation of the building must be high-performing (treatment of thermal bridges, insulated windows with low emissivity, humidity-controlled vents, etc.), especially in areas which present comfort problems in winter.

Choosing **high-performance equipment with low energy consumption** (adequate sizing and regulation of heaters, effective ventilation i.e. heat recovery, low-energy bulbs with separate electronic ballast, systems which economise on lighting, etc.). Designers may request a minimum performance of the equipment based on existing classifications for low-energy equipment.

Natural lighting must be optimised in order to minimise electricity consumption. This optimisation must be linked with good technical management of the installation of artificial lighting.

Designers must attempt to improve the efficiency of energy equipment (control systems, ventilation systems, hot water heating systems and energy-saving appliance systems, zone-heating, very good insulation of distribution networks and optimisation of piping, recovery of heat losses in kitchens, consumption displays, etc.). They must promote the use of solid, robust equipment which can be repaired and maintained easily in line with the local conditions for repair and after-sales service.

The choice of equipment must be made using the same philosophy as in the choice of materials: (i) technical criteria (performance, sustainability, etc.) (ii) economic criteria (lifecycle cost approach) and (iii) environmental criteria (small ecological footprint, low embodied energy, etc.)

Artificial lighting

The choice of bulbs and lighting fixtures must take into account visual comfort and energy-saving requirements. Lighting fixtures must in general cater for the installation of high output fluorescent tubes.

The lighting for all the premises must be functional (function must take priority over aesthetics). Lighting devices must be mainly equipped with fluorescent tubes or low-energy bulbs.

Bulbs must be of a type with reduced levels of mercury.

Lighting in series or zoned lighting must be installed where possible.

Lighting of corridors, courtyards, entry halls and toilet blocks must be mainly controlled by motion detectors. The circuits must be connected to timers (with a "switch-off" warning in stairwells).

For external lighting (signage of external traffic flows, carparks, bicycle parks, green spaces, etc.), all or part of it may be provided using photovoltaic systems.

On the façades of buildings, in general, low-energy spotlights must be installed, connected to motion detectors.

Use of renewable energy

Once the maximum effort has been made to reduce energy needs, the residual needs must be covered by systems and energy types which must meet the following three objectives in the most efficient way: (i) the cost of energy consumption must be reduced; (ii) the building's contribution to the consumption of non-renewable energy resources must be limited, and (iii) the building's contribution to environmental degradation on a local, regional or global scale must be limited;

The use of renewable energy systems must be a requirement, with the implementation of reasonable technical and economic methods that are suited to the climatic conditions and uses of the building. To that end, the payback calculations for the technologies proposed must be systematically set out. Renewable energy options must be prioritised as follows:

- **Solar hot water**: depending on needs of the main premises involved (boarding school, accommodation/housing, gyms, kitchens) as well as for any staff accommodation;
- **Solar photovoltaic**: to be considered for external lighting and for electricity generation projects with or without grid connection;
- **Wind power**: to be considered

without grid connection, depending on the site (distance versus noise), on the wind power potential and/or a possible local or regional grouping;

- **Biomass heating** (i.e. micro-Combined Heat and Power): when replacing (high-output) fuel oil, coal or gas boilers, including propane, and for new-builds;
- **Micro-hydroelectric:** where there are watercourses available near the site.

The means of energy production and the correlation between energy consumption and production must be specified following examination of the energy consumption in kWh/m2/year, in line with the profile of the building's seasonal occupation, users' priorities and the equipment installed.

TARGET 7 - MANAGE WATER CONSUMPTION IN THE BUILDING AND REDUCE POTABLE WATER CONSUMPTION

Consumption of potable water must be reduced through the use of water-saving appliances and equipment such as flow reducers, pressure reducers, taps with timers, dual flushes, good quality ceramic seals, etc.

Toilet cisterns must be systematically replaced with low- flow automatic shut-off valves. Dual flush cisterns may also be proposed.

Taps with timers must be the preferred option.

Hot water

The preferred option for hot water production must be solar appliances.

If it is impossible to install solar systems, the appliances must be chosen on the basis of their energy rating.

Rainwater recovery

The recovery and storage of rainwater must be systematically applied for watering and possible uses such as flushing toilets and urinals, even floor maintenance or some specific needs.

This rainwater recovery must not entail too much electricity consumption (i.e. pumps) and its installation must be economically viable.

For the installation of a parallel network, designers must manage the risks connected with non-potable water networks, e.g.:

- colouring the rainwater recovered for uses inside the buildings;
- identifying the networks using a different paint and durable signs and including a stopcock.

Sanitation

A "separator" network must be included in the design, such that the collection of wastewater and rainwater is done in different networks, for cleanliness' sake. The wastewater is transported to waste water treatment centres for purification or into the septic tank, while unrecovered rainwater is fed back into the natural environment without treatment.

Ideally, water treatment installations should be planned for water run-off in carparks (oil and petrol filter, etc.).

Trees must not be planted near sewers. For existing trees, a system of protection against the roots must be implemented.

Innovative independent sanitation systems may also be considered :

- Lagooning and/or treatment using microphytes (algae) or plants;
- Mini treatment centres, especially for industrial polluted water that has been evacuated separately.

TARGET 8 - DEVELOP SUSTAINABLE MAINTENANCE PRACTICES

The Grand Duchy of Luxembourg supplies infrastructure which create major costs for local partners for **the operation and maintenance of buildings**.

Therefore, systematic consideration must be given to construction systems, materials and technical installations that are simple, strong, reliable, have a long lifecycle, require low-level, easy maintenance and preferably have automated operation (self-cleaning surfaces, motion detectors, timers, etc.).

From the design phase onward, maintenance and technical operation concerns, with a view to improving the subsequent operational conditions and limiting future maintenance and technical operation expenditure on the building, must be taken into consideration.

Designers must aim for a good level of service quality to be maintained that is compatible with an often limited operational budget.

Identification of maintenance needs and costs: lifecycle cost approach

The future maintenance and technical operation costs of the building will come from three main areas:

(i) **technical operation** (energy and water bills, cleaning, maintenance of green spaces);

(ii) **ongoing maintenance** (the cost and time spent in running and inspecting installations and in maintenance operations and the cost of maintenance contracts granted to external enterprises);

(iii) **major maintenance work** (the direct and indirect costs of corrective maintenance (breakdowns and repairs) and the costs of major maintenance works connected with the capital repairs and renewal of a building's components).

In this context, designers must systematically take into account initial investment and deferred costs (consumption, maintenance, renewal), i.e. overall cost.

Designers must attempt to minimise the operating costs of construction and installation (sustainability, ease of repair of fittings, minimisation of energy costs, centralisation of main controls, anti-theft protection, use of durable materials that require little maintenance, façades and roofs not needing major repairs during the payback period, etc.).

Designers must consider the cost of services proposed over a period of at least 30 years and justify their calculations accordingly (estimates of water and energy consumption of various positions, maintenance and operating costs).

Careful consideration must be given to **the volume of the body of the building: too great a complexity must be avoided** which cannot be controlled - reflex angles, junctions between inclined roofs, vertical walls and horizontal terraces, etc.

The construction principles (structure, façades, sealing returns or seal plugs, valleys) on the architectural side must be simple, tested and reliable.

Preference must be given to **standard materials and techniques which require no or little maintenance** (coverings of floors, walls, façades, external woodwork) or do not require the services of an external supplier.

Technical and architectural designs must limit dirt and mess: choice of colours, anti-graffiti coatings, treatment of skirting boards and bases, etc.

Furthermore, making the premises and the technical installations simple and sized appropriately for the users' needs is the primary way to make savings. This reduces ongoing maintenance, the cost of maintenance contracts and risks of the installations' breaking down or malfunctioning; this also limits the numerous resulting indirect costs.

The various components of the building and their details must be chosen for their **sustainability**, which sets the context for, on the one hand, how frequently equipment is available and the costs of dealing with breakdowns and, on the other hand, how frequently subsequent major maintenance operations are required.

The lifecycle requirements must enable the sustainability of each piece of work to be adapted to the inevitable developments over time: from 15 to 20 years, for internal walls, heating or lighting equipment, floor and wall coverings intimately connected with the internal design of the premises and the development of teaching methods, to several dozen years for structural elements.

Adaptability and flexibility

Designers must locate their design within a strategy that guarantees both the flexibility and adaptability of the installations and buildings, even if, initially, the activities proposed during the consultation must be able to be carried out under perfect conditions.

The construction systems and technical choices must provide for the greatest degree of flexibility and modularity, with a view to accommodating any internal (and external) developments:

- The structure of the buildings must be designed using a regular framework which will enable premises with different surface areas to be dropped in;
- Shafts (vertical openings) will be constructed at regular intervals for facilitating the installation or upgrading of future supply systems (HVAC ducts, electricity wiring, potable and used water, ...)
- Large loads must be supported on the same plate;
- The ease of removing partitions;
- Shafts will be designed at regular intervals to facilitate the installation of vertical networks (waste water pipes, various wiring) to be installed subsequently if required;
- Central distribution of utilities must be planned, with the possibility of connections on the different premises;
- Ducts and switchboards must be of an appropriate size to be used for any increase in power or network scope;
- In office areas, there must be no break in the flooring between the areas, likewise on the false ceilings, in order to facilitate as much as possible the removal of partitions;
- The design of the buildings to be built must allow for later, more or less major modifications, ranging from internal partitions to extension.
- In general, the technical premises and facilities must be designed such that subsequent alterations will not be prevented.

Protection against intrusion and vandalism

The buildings and facilities must be protected against intrusion and vandalism.

The protection systems must be simple, effective and easy to maintain (apertures which are shock-resistant and resist break-in attempts). These provisions may possibly be replaced, if the shape of the building allows it, by perimeter sensors.

Doors must be fitted with simple and comfortable systems which avoid any additional operational or maintenance.

Internal facilities and fittings must be solid and resist deterioration of any kind.

Documents required for operation and maintenance

Contractors must be instructed by designers to supply operating documents such as plans and diagrams which provide users with a genuine knowledge of the buildings and technical installations and allow them significant autonomy in operational and maintenance terms.

One of these documents must be a maintenance and repair guide advising on the quality, frequency and nature of the minimal maintenance operations for each piece of equipment. This guide must enable users to recognise the installations; to recognise the advance warning signs of a fault; to make, on the basis of a set schedule, checks, adjustments, replacements of small items and to understand operational arrangements and precautions to be taken; to know the brand, supplier and any required features in order to order spare parts; to monitor energy and water consumption and to highlight problems (excessive consumption, failure to comply with operational contracts, etc.).

4. SOCIAL DEVELOPMENT AND FAIRNESS

LOCATING THE PROJECT WITHIN A TREND TOWARDS FAIRNESS PROMOTING GENDER EQUALITY, COHESION AND SOCIAL SOLIDARITY

TARGET 9 - CONSULTATION WITH THE BUILDING'S USERS, ESPECIALLY WOMEN, AND AWARENESS RAISING CONCERNING ENVIRONMENTAL PROTECTION AND CLIMATE CHANGE

Sustainable development can only be achieved with the participation of all stakeholders. In terms of buildings, this occurs through the consultation of users from the feasibility and pre-programming phase.

In this way, when designers come to perfect or complement the programming, they will pay special attention to the consultation with users, as well as to the users' needs, in accordance with the legal provisions in this field and in the spirit of the Aarhus Convention[21], which is based on citizens' right to information on any activity likely to affect the environment.

Designers must make themselves available to clients with a view to integrating users in the design process through meetings or public consultations.

Exemplar buildings and the ecological footprint

Buildings constructed in accordance with these environmental recommendations must be systematically highlighted as exemplars of environmental solutions in the country concerned.

To this end, educational measures which highlight the systems used to reduce the environmental impact of the buildings must be proposed. This also involves establishing systems to display the consumption of resources and energy - the ecological footprint of the building.

Designers must draw up accounts (energy, CO_2, ecological footprint, etc.) or acquire environmental labels at the end of the works, even if they do not participate in this phase.

Gender equality

The consultation process carried out by designers trained using this document must contribute to creating a social environment which is more favourable for gender equality.

This means a programming phase in consultation with future users which promotes more integration of women in the specification of needs and constraints to be considered in the building's design.

This kind of phase would also enable improved access for women to information and education on environmental issues.

Furthermore, contractors could be asked to cooperate on considering the needs and priorities of female employees in the construction sector and to support inclusion in the works contracts of clauses regarding female employees in the sector.

TARGET 10 - PROMOTE ACCESSIBILITY FOR PERSONS WITH SPECIAL NEEDS

Over and above the legislative aspect, accessible buildings must be designed for all users, ideally for all disabled persons, especially those with motor, sensory and cognitive disabilities.

In the absence of local legislation on this issue, designers may refer to all the international rules and standards.

General qualities of the building

The operational areas and corridors must be considered in the light of enabling access by disabled persons (furniture, width of passageways, floors, visual comfort, contrasting colours, directional lines, signage of stairways, height of switches and doorhandles, etc.).

Accessible sanitation facilities must be fitted for persons with reduced mobility and their spaces and furniture must be carefully considered (door, protection rod, basin, mirror, etc.).

Where applicable, lifts must be judiciously distributed inside the buildings such that they are quickly and easily accessible.

External routes and parking

An accessible route must lead to the entrance to the building(s) from the grounds and accessible routes must be signposted appropriately.

Each internal or external carpark, whether for the use of occupants or visitors, must include a percentage of spaces suitable for parking vehicles owned by persons with special needs or vehicles transporting disabled persons. These spaces must be close to the hall of the building or the lift and connected to either one via accessible routes.

Access to the premises and internal access

A disabled person must be able to locate, reach and use any measure that is intended to allow or restrict access to the building or to attract an occupant's attention.

Internal routes up and down must be accessible and danger-free for disabled persons.

Users with special needs must be able to access all the common-use areas (bicycle park, rubbish bins) as well as cellars and basements.

Floor coverings, doors and screens

Floor coverings and equipment located on the floor of routes in common areas must be safe and suitable for the abilities of persons with a motor deficiency and not create any visual or acoustic nuisance for persons with a sensory deficiency.

As far as possible, corridors must enable disabled persons to pass though them and persons with reduced mobility to negotiate them.

Air locks must enable disabled persons to pass through and negotiate doors (dimensions must exceed the clearance of both doors, there must be easy access to handles, avoidance of creating spaces which cause anxiety, etc.).

Internal and external equipment, furniture

Persons with special needs must be able to locate, reach and use the control and display equipment and devices in corridors and common areas.

Designers must ensure that the furniture proposed complements the works to improve access for disabled persons.

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