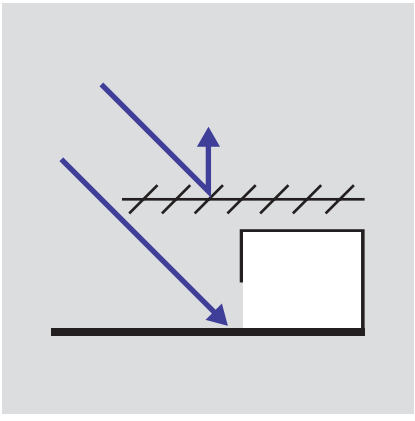

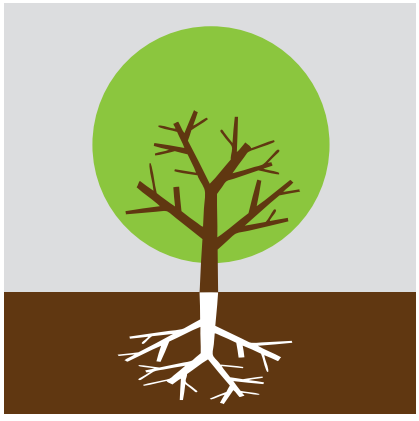

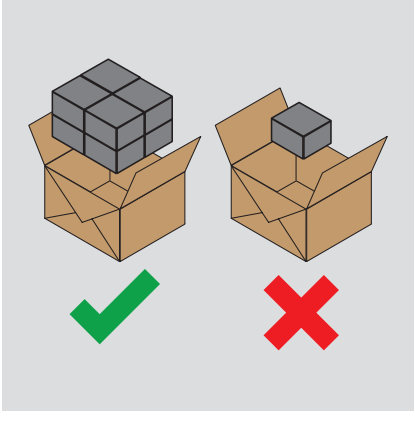

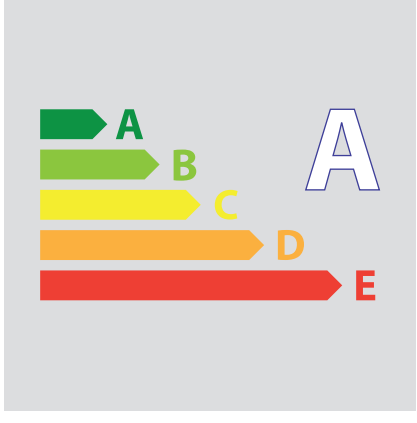

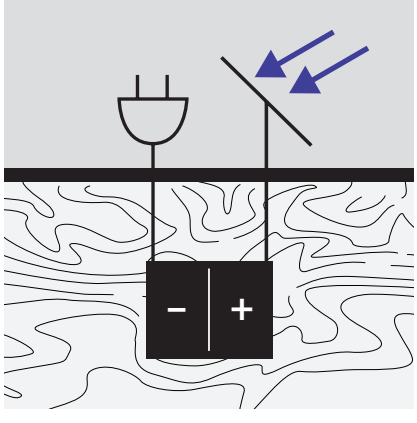

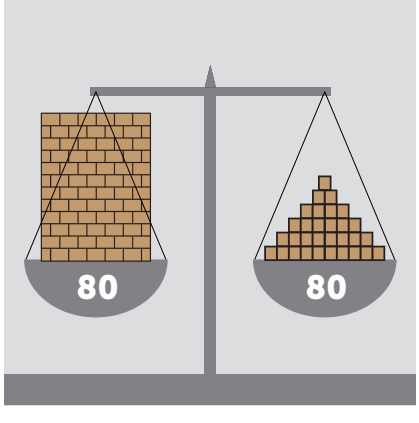

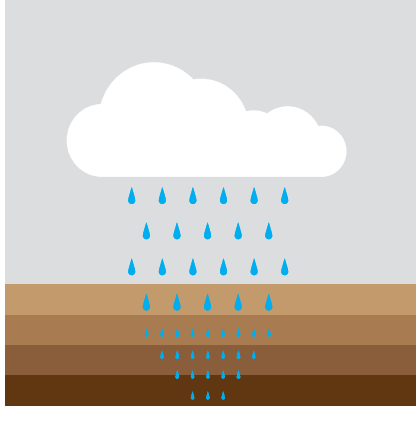

EXPO MILANO 2015

GUIDELINES
SUSTAINABLE SOLUTIONS
Design, Construction, Dismantling and Reuse

In collaboration with:

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INTRODUCTION

We are in global ecological overshoot

According to the Global Footprint Network, today we are in global ecological overshoot. This means that humans are using more resources than the Earth can provide.

Moderate UN scenarios suggest that if current consumption trends continue, by the 2030s, we will need the equivalent of two Earths to support human development and provide food and water to the population.

In this context how can we foster sustainable human development within the means of 1 planet?

Sustainable buildings as part of the solution

Rapidly growing, especially in developing countries, the building sector offers the largest, most cost-effective opportunities for resource efficiency, with considerable co-benefits.

Today the building sector accounts for 30 to 40 percent of the world's energy consumption, it uses raw materials, water, land and generates waste, contributing to current world CO2 emissions for 25 to 35 percent.

Building owners, designers, and builders face a unique challenge to meet demands for new and renovated way of planning that establishes a deep connection with the climate, the culture and the natural environment of a place.

This becomes much more important for a temporary pavilion which may have even a higher environmental impact comparing to a permanent building, if properly sustainable solutions are not adopted.

"Guidelines Sustainable Solutions" as a design tool for the Participants

According to Special Regulations and International Participants Guide, Theme Guide and Self-Built Exhibition Space Official Participants Guide, the present document provides suggestions and references to Participants with the aim to improve the performance of temporary buildings and Exhibition Spaces in Expo Milano 2015. The contents of the Guidelines are not mandatory. Each Participant may adopt voluntary one or more solutions, depending on its strategy for the exhibition plan.

The purpose is to share knowledge on best solutions and practices and to provide references to designers with the aim to improve the performance of temporary buildings and Exhibition Spaces in Expo Milano 2015 by reducing the consumption of energy, water and materials, and by preventing potential environmental impacts. Each Participant may adopt voluntary one or more solutions, depending on its strategy for the exhibition plan since the contents of the Guidelines are not mandatory. Obviously, more green strategies are adopted, much closer is the goal of sustainable human development as well as it is higher the opportunity to improve Participants' green credentials.

As shown in the previous official documents, Expo Milano 2015 introduces a new model for Universal Expositions in the 21st century through an innovative thematic approach that pervades every aspect of Expo, including the Exhibition Spaces. Its success will depend on the engagement of all the Participants and their willingness to share their contributions to create a benchmark for future Universal Expositions.

The architecture itself must communicate to the public, then we invite Participants to showcase the sustainable solutions adopted in order to inform visitors and increase their awareness.

Expo Milano 2015, within the Expo Awards, will promote communication and visibility on the best practices voluntary adopted by each Participant.

METHODOLOGY

This document is divided in three chapters which reflect the life cycle thinking approach: **Design, Construction, Dismantling** and **Reuse**.

For the Set Up phase it is suggested to adopt those strategies described in the Self-Built Exhibition Space Official Participants Guide.

The structure of the document is meant to mirror the methodological steps of the Life Cycle Thinking Approach. In addition, it enables to clearly identify the environmental strategies available to Participants in the design, construction and dismantling phases of the self-built structures.

Each section introduces the environmental themes (energy, materials, construction technology, waste, water, soil, air quality) through a page that summarizes the applicable strategies. In order to facilitate the consultation of the document, these strategies are illustrated both by narrative and graphic explanations. The narrative parts are meant to clarify proposed solutions and to provide, whenever possible, some parameters for implementation.

"Warning" boxes are used either to highlight strategies that can be in conflict with other environmental objectives; or simply to remind Participants of technical norms or recommendations included in different parts of the document.

The environmental strategies outlined in this document have been selected on the basis of their applicability to the context of Lombardia Region. Because of that, this document does not have the ambition of being exhaustive. According to the key role of Universal Expositions, the Participants are also invited to show other innovative solutions which ensure the minimization of the environmental impact of their own Exhibition Space.

With the aim of facilitating the adoption of strategies as "site specific" as possible, some sections provide Participants with "input data", meant to help achieve the environmental objectives and reduce the impact of the building.

DISCLAIMER

The Organizer, Fondazione Lombardia per l'Ambiente and Bulding Green Futures accept no responsibility or liability for any damages or costs of any type arising out of or in any way connected with the use of the Guidelines. Data and information are provided for information purposes only, and are not intended for trading purposes.

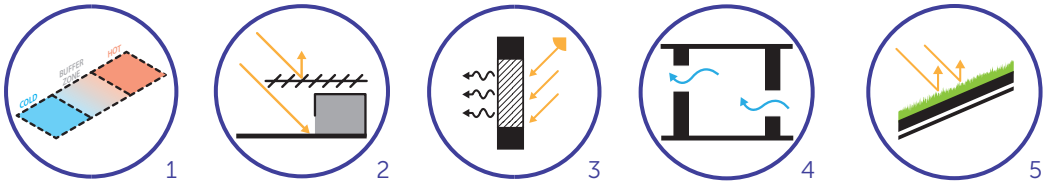
PHASE 1 / DESIGN / ENERGY

The main objective of climatic design is to provide comfortable living conditions with a minimum and meaningful input of artificial energy.

GOALS & IMPLEMENTATION STRATEGIES

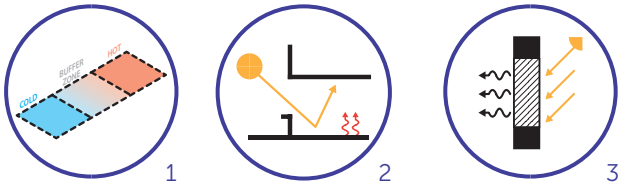
A. MINIMIZE THE ENERGY DEMAND FOR COOLING

1. Optimize functional layout
2. Minimize direct solar heat gains using shading devices
3. Increase thermal mass of the building to provide inertia
4. Promote natural ventilation to take off internal loads and optimize the indoor climate
5. Reduce overheating of the interiors and the heat island effect



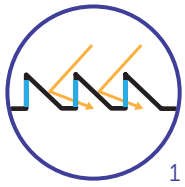
B. MINIMIZE THE ENERGY DEMAND FOR HEATING

1. Optimize functional layout
2. Increase direct solar heat gains
3. Increase thermal mass of the building to provide thermal storage



C. MINIMIZE THE ENERGY DEMAND FOR LIGHTING

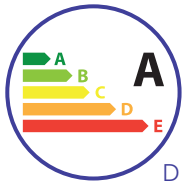
1. Improve daylighting



1

D. MAXIMIZE EFFICIENCY

1. Apply an appropriate ventilation strategy
2. Select efficient chillers
3. Design an efficient artificial lighting system
4. Select energy efficient electrical appliances
5. Select efficient cooking facilities
6. Recover excess heat
7. Use a smart control system to manage building operation



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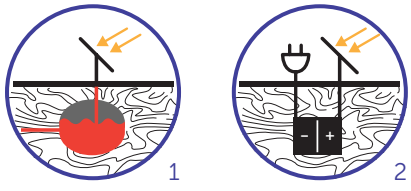
E. MAXIMIZE THE USE OF RENEWABLES

1. Use solar thermal for cooling and cooking purposes
2. Use solar electric to power appliances



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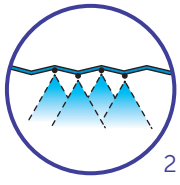
F. MAXIMIZE THE USE OF ALTERNATIVES

1. Use fuel cell to store energy
2. Use evaporative cooling instead of mechanical cooling



2

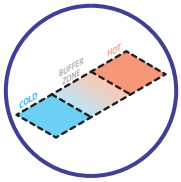
A. MINIMIZE ENERGY DEMAND FOR COOLING

INPUT DATA
In June, July and August the average daily maximum temperature is above the comfort zone.

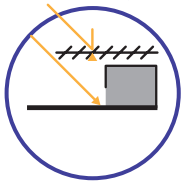
MAIN STRATEGY
Cooling the building without any mechanical plant.

REMEMBER THAT
Under the adaptive thermal comfort method, in a free running building, the allowable internal temperature range depends on the outdoor climate rather than being fixed. In this situation occupants tolerate a larger range of temperatures than in air-conditioned buildings.

Layout



Shading



1. OPTIMIZE FUNCTIONAL LAYOUT

- **Place the storage room in the cooler area of the building**
- **Separate functions at cooler temperatures from those at higher ones (technical rooms, kitchen...)**

2. MINIMIZE DIRECT SOLAR HEAT GAINS USING SHADING DEVICES

Except for North facade, all glazed surfaces should be screened between 10:00 and 16:00 as the opaque surfaces, if these are not massive. The variety of shading methods is large and the designer has the choice of many options.

Parameters: choose the position and shape of all shading devices according to sun path (altitude and azimuth angles).

Warning: when selecting the type of shading device, apart from shading, other factors should also be considered; the airflow through the openings should be reduced the least possible, never stopped completely. The view should not be obstructed. Daylight should not be reduced too much.

- **Shading by building shape: adopt forms which cause overshadowing during hot months**
- **Place screenings on the outside of the building**

  Parameters: beside the sun's path various factors have to be considered. The shading effect depends not only on the geometrical shape and orientation of the fixtures, but also on the material used and on the surface treatment and color.

  Materials with a low thermal capacity should be used near openings, thus ensuring that they cool quickly after sunset.

Horizontal screenings are very efficient high midday sun, especially on South facade. They can take the form of a roof overhang, a slab projection and verandahs, or with fixed or adjustable louvers.

Vertical screenings are best against low sun, thus on East and West facades. Optimal efficiency can be obtained with movable elements. A simple form of vertical screening can also be achieved with a deep window frames.

A combination of vertical and horizontal elements may be required on East to Southeast and on West to Southwest oriented surfaces.

- **Shading with trees or large shrubs selecting the appropriate size and type of plant**

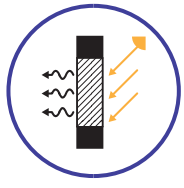
When measuring the radiation intensity in the shade of a tree compared to unshaded conditions the efficiency of different species varies.

Parameters: the shading efficiency is influenced by the spreading canopy and leaf density, therefore by the age, rate of growth and method of propagation of the plant.

Warning 1: a tree or large shrub planted close to the building, even with the crown covering the roof, provides the best protection from the intense midday sun, but allows access to the sun in evening hours, when in certain situations this is welcome. A tree or large shrub planted within a certain distance of a building provides shade only during evening or morning hours, but not at midday, the hottest time. **Warning 2**: specifications on atmospheric discharge protection are provided in the Guidelines – Technical System Requirements.

3. INCREASE THERMAL MASS OF THE BUILDING TO PROVIDE INERTIA

Thermal mass



Optimize the building structure and/or envelope with high heat storage capacity in order to keep building cool in daytime.

Parameters: thermal inertia is directly proportional to the heat capacity value of the materials and inversely proportional to the thermal conductivity and temperature gap between interiors and exteriors.

Materials commonly used: water, concrete, clay brick, adobe bricks, mudbricks, rammed earth, natural rock and stone, logs.

Warning 1: when the outdoor night temperature does not fall below comfort level, the heat released by the building mass has to be expelled by ventilation. **Warning 2**: natural materials should be composed of renewable resources, logs should be certified, concrete and clay bricks should contain recycled content and should be reusable or recyclable. Go to **MATERIALS AND CONSTRUCTION TECHNOLOGY,** and to **WASTE SHEET** for more information.

Natural ventilation

4. PROMOTE NATURAL VENTILATION TO TAKE OFF INTERNAL LOADS AND OPTIMIZE THE INDOOR CLIMATE

- **Ample ventilation at night**

  When the stored heat is to be dissipated at night, ample ventilation is necessary. The cold night air should be directed so that it passes the hottest inside surfaces. The placement of openings, louvers etc. should be designed accordingly.

- **Cross ventilation through openings on vertical walls induced by external winds**

  Parameters: natural ventilation is influenced by:
  - the pattern of existing winds (speed, direction, temperature);
  - the change in wind direction during the course of the day and with the seasons;
  - the change in air movements for building shape, external obstructions, location, net area of the openings and pressure difference between openings. This difference is higher when the inlet is on the windward side, and the outlet is leeward side, the openings are on opposite walls and the incidence angle of the wind is between 30° and 90°.

  Warning 1: the wind direction often does not coincide with the best orientation according to the sun. Here a compromise should be found. **Warning 2**: in summer, before entering the building, wind should not pass over external hot surfaces. **Warning 3:** for planning purposes, it is important to distinguish between regular wind patterns and winds that occur only occasionally.

- **Convective cooling through transitional spaces**

  Parameters: when regular winds do not exist, natural ventilation can be promoted taking advantage of diurnal temperature fluctuations and by using exposed and shaded multiple courtyards, patios and loggias.

- **Stack ventilation**

  Parameters: stack effect is obtained by vertical pressure differences developed by thermal buoyancy.

  When breeze is not sufficient, stack effect can be used to increase ventilation through the use of passive systems (solar chimneys, roof openings and roof shape) and mechanical devices mounted on the roof powered by solar energy.

  Solar chimneys make use of solar heat to reinforce natural air convection.

A black coated metal pipe chimney is heated by the sun's radiation. The inside air rises taking the interior air up and out. This system is self-regulating, the hotter the day, the faster the air motion. A variation is the "glazed solar chimney". Such chimneys, when facing West, are favorable for ventilation during the hot afternoon. If a thermal storage mass is added behind the glazing, the system will store heat and keep on expelling air after sunset.

The height and shape of the building interiors can facilitate the air stratification and internal air movements. In this case, roof or top openings can remove hot air and facilitate entry of cool air from the lower openings.

- **Regulate internal air movement**

Where there is little or no breeze, mounted electric ceiling or other types of fans (punkah fans) powered by solar energy may be used. The increased air flows can remove excess heat from the human body and the structures but not induce the exchange of air.

Place all partitions parallel to the airflow. These elements may divide this stream, but do not reduce the velocity. As an alternative, provide partition openings in order to have a reliable air circulation.

5. REDUCE OVERHEATING OF THE INTERIORS AND THE HEAT ISLAND EFFECT

- **Use a ventilated façade**

Ventilated facades, by covering the exterior walls with a ventilated air gap, can reduce the amount of heat that buildings absorb in hot weather conditions due to partial reflection of solar radiation.

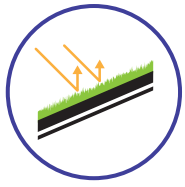
Warning: the walls behind the ventilated facades should be massive in order to reduce the solar radiant heat gain.

- **Choosing materials with high albedo for pavements (SRI>30) and roofing (SRI>80) to limit solar absorption and reradiation of solar heat**

Solar reflectance, or albedo, refers to a material's ability to reflect the visible, infrared, and ultraviolet wavelengths of sunlight. The Solar Reflectance Index (SRI) combines albedo and emittance (a material's ability to release absorbed heat) into a single value expressed as a fraction (0.0 to 1.0) or percentage. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100.

Warning: white concrete and high-albedo surfaces can cause glare that may be uncomfortable to pedestrians and even potentially limiting to visibility.

Solar reflectance



- **For open spaces maximize green areas and use trees, pergolas, awnings, canopies for shading**

- **Use facade greenery (for shading with trees see strategy number 2) to shade the walls surface and reduce the solar radiant heat gain**

  Two possible approaches: climbers growing in the natural ground (but this takes time!) or in planters or other similar systems hung onto the facades.

  Warning 1: go to **WATER SHEET** for saving water strategies for irrigation. **Warning 2:** do not use plants with aggressive roots, as they may harm the structure. **Warning 3:** Participants have to adopt all protective measures required by Italian legislation and EU directives (2000/29/EC) against the introduction and spread into European and Italian territory of organisms harmful to plants or plant products. More specifications will be provided in the **Guidelines - Import of plants and plant products, for Construction and Set-up of Exhibition Space**.

- **Use green roof**

  The greening rate of roofs shall not be lower than 50%.

  Green roof has a strong regulating effect on the indoor temperature due to the heavy earth coverage and the shading effect; it reduces the thermal stress on the structure because the temperature remains stable and it absorbs dust.

  Warning 1: go to **WATER** for saving water strategies for irrigation. Green roofs absorb rain water. This results in less amount of harvested rainwater. **Warning 2:** climatic conditions on a rooftop are extreme, choose carefully planting material. **Warning 3:** do not use plants with aggressive roots, as they may harm the structure.

- **Ventilated roof**

  Use a double roof to shades the ceiling. To avoid overheating, it is important to have an open roof space in order to remove the heat from the air gap and thus reducing the temperature of the ceiling.

- **Roof shape**

  The designer can adapt the building shape according to the overshadowing need (and so to the sun path).

  Parameters: a roof shape absorbs less solar radiation then a planar surface and there is always a surface temperature difference between shaded and exposed part of the dome that encourages internal air movements.

Moreover, the bigger surface of a dome, compared to a flat roof of the same building, allow to have a lower surface temperature/square meter and to have a higher heat loss capacity during nighttime. Depending on the overshadowing needs and site context, much more complex shapes may be more appropriate to reduce overheating risk.

B. MINIMIZE ENERGY DEMAND FOR HEATING

INPUT DATA
In May, September and October the average daily minimum temperature is below the comfort zone.

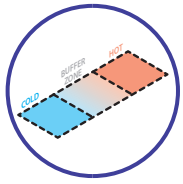
MAIN STRATEGY
Heating the building without any mechanical plant.

REMEMBER THAT
According to local Milan regulations, during the Expo timeframe use of heating systems is not allowed, except from the 15th of October.

1. OPTIMIZE FUNCTIONAL LAYOUT

- **Separate functions at higher temperatures from those at lower temperatures**

Layout

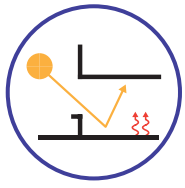


2. INCREASE DIRECT SOLAR HEAT GAINS

Parameters: orient and size transparent surfaces according to the sun path (altitude and azimuth angles) and to the internal and external obstruction.

Warning: in summer and during the hottest hours in spring, note that eastern and western transparent surfaces may cause overheating if not properly shaded. As an alternative, keep these walls as small as possible and place as few and small openings as possible.

Solar gains

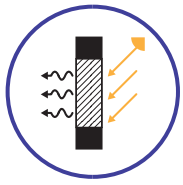


3. INCREASE THERMAL MASS OF THE BUILDING TO PROVIDE THERMAL STORAGE

Parameters: thermal inertia is directly proportional to the heat capacity value of the materials and inversely proportional to the thermal conductivity and temperature gap between interiors and exteriors.

For areas exposed to direct solar radiation (primary mass) the thermal storage capacity is related to the first 15-25 cm and for areas not exposed to direct solar radiation (secondary mass) this is 8-10 cm. The primary mass is much more effective than the secondary mass with regard to active heat storage capacity. Materials commonly used: water, concrete, clay brick, adobe bricks, mudbricks, rammed earth, natural rock and stone, logs.

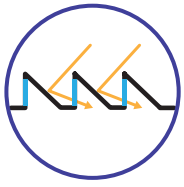
Thermal mass



Warning 1: to prevent overheating in summer, use the cold night air to cool down the structure of the building so that it can absorb heat gains in the daytime (night ventilation). **Warning 2**: natural materials should be composed of renewable resources, logs should be certified, concrete and clay bricks should contain recycled content and should be reusable or recyclable. Go to **MATERIALS AND CONSTRUCTION TECHNOLOGY,** and to **WASTE SHEET** for more information.

C. MINIMIZE ENERGY DEMAND FOR LIGHTING

Daylighting



1. IMPROVE DAYLIGHTING

Parameters: aperture orientation, location and size; reflectance of room surfaces; glazing materials; daylighting systems and redirection devices; distance between buildings and reflectance of external surfaces.

- **Aperture orientation**

  Maximizes South and North exposures, and minimizes East and West exposures for best solar access and ease of control.

  Warning: except for North facade, all glazed surfaces should be screened between 10:00 and 16:00.

- **Aperture location and size**

  The daylight distribution is influenced by two rules:
  - illumination is inversely proportional to the square of the distance between the light source and the surface. As a general rule of thumb, the depth of daylight penetration is about two and one-half times the distance between the top of a window and the sill. Moreover, the higher the window head height, the deeper into the space the daylight can penetrate. A floor depth of no more than 15-18 mt from South to North has been shown to be viable for daylighting;
  - effective illumination is proportional to the cosine of the angle of incidence of the light on the surface (angle between the direction of the light and the perpendicular to the surface). Vertical windows and roof skylights cause different daylight distribution.

  Warning 1: the illumination does not increase proportionally when increasing window size. **Warning 2:** for daylighting applications, high visible transmission values (VLT) are important to deliver as much daylight as possible, but may provide glare unless the glazing is above normal viewing angles, shaded by an exterior overhang, or shielded by interior louvers or a lightshelf. Balancing these contradictory needs frequently dictates the use of two different windows - an upper daylight

glazing (with high visible transmission, greater than 50% VLT) and a lower view glazing (with exterior shading or lower visible transmission less than 40%VLT). **Warning 3:** the window area needs to be a careful balance between admission of daylight and thermal issues such as summertime heat gain.

- **Reflectance of room surfaces**

It will significantly impact daylight performance and should be kept as high as possible. It is desirable to keep ceiling reflectance over 80%, walls over 50%, and floors around 20%. Of the various room surfaces, floor reflectance has the least impact on daylighting penetration.

! **Warning:** consider furniture design reflectance and interior walls placement during daylighting design.

- **Glazing materials**

Solar heat gain coefficient and visible transmittance are two glass characteristics that influence daylighting. For daylighting in large buildings, consider the use of glass with a moderate-to-low solar heat gain coefficient and relatively high visible transmittance. This is typically achieved through spectrally-selective films.

- **Daylighting systems and redirection devices**

In large and high buildings is useful to employ skylights for top lighting, or admitting daylight from above.

Saw-tooth apertures are a top-lighting technique formed from a vertical glass element and a sloping roof. The light distribution element can be light-colored baffles or the sloping ceiling itself. Roof Monitor has two opposing vertical glazed elements raised above the general roof line. The distribution system too can be light-coloured baffles or the ceiling of the monitor. The atrium, or light well, is a core lighting technique. The outside perimeter is lit with windows whilst the centre receives diffuse light from the atrium.

Active skylights have a mirror system that increases the performance of the element by channeling the sunlight down into the skylight well. Some of these systems also attempt to reduce the daylight ingress in the summer months, balancing daylighting with cooling loads.

Tubular daylight devices employ a highly reflective film on the interior of a tube to channel light from a lens at the roof, to a lens at the ceiling plane.

Daylight redirection devices, often called lightshelves, are generally a large horizontal element, or louvered systems. They allow to direct some of the light up onto the ceiling where it will diffuse deeper into the space.

Warning 1: except for North facade, all glazed surfaces should be screened between 10:00 and 16:00. **Warning 2:** to avoid overheating and horizontal shading, it is preferably to orient saw-tooth apertures to the North side. **Warning 3:** the ratio of height to width of the light well should not be greater than 2:1 in most circumstances. If this ratio cannot be achieved, then it is also possible to use reflectors or diffusers suspended within the atrium space to bounce light sideways and therefore deeper into adjacent internal spaces.

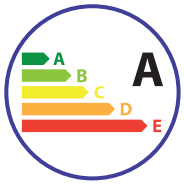
- **Distance between buildings and reflectance of external surfaces**

Warning: white concrete and high-albedo surfaces (as water ponds) can cause glare that may be uncomfortable to pedestrians and even potentially limiting to visibility.

D. MAXIMIZE EFFICIENCY

REMEMBER THAT
The efficiency of all systems should be selected according to the energy demand and the characteristics of the fuel (renewable, not renewable) and energy vector (thermal/electrical) used.

Efficiency



Warning: the efficiency of appliances and plants is not enough to minimize the energy consumption in a building. As a rule of thumb, a lower energy demand, higher efficiency and use of renewable energies are the key actions to reduce the carbon emissions.

1. APPLY AN APPROPRIATE VENTILATION STRATEGY

- **Hybrid ventilation combines mechanical ventilation with natural ventilation (e.g. by automatic openable windows) according to outdoor and indoor conditions**

In this case a smart control is essential to switch and/or combine different ventilation strategies. Furthermore it is possible to take advantage of high infiltration rates due to visitor accesses by regulating air pressure into the building to promote air flows (a slight pressurization promotes air extraction, depressurization allows air intake).

Warning 1: the mechanical (or artificial) ventilation requires an air tight envelope (by closing all windows and doors) to avoid any air infiltration. Due to the high pedestrian fluxes (and subsequent air leaks on the building accesses) this solution is not recommended. **Warning 2:** excessive cold air speed can lead to thermal discomfort and can cause discomfort.

- **Use demand controlled ventilation systems for spaces where occupancy is quite variable to modify the air flows according to the number of users and CO_2 levels**

2. SELECT EFFICIENT CHILLERS

Following thermal analysis, if cooling is still required, select chiller systems with a higher COP (Coefficient of Performance=ratio of heating or cooling provided over the electrical energy consumed) and systems that maintain high efficiency also with variable workloads (full/partial) which are strictly related to visitors affluence.

Heat pumps are one of the most energy efficient technologies used to provide both heating and cooling. These systems transfer thermal energy from a heat source to a heat sink (like air, ground or water), thus providing heating or cooling.

Warning: to reduce energy demand from Expo grid, power these systems with renewable energy (e.g. solar energy, as described in detail in MAXIMIZE THE USE OF RENEWABLES).

3. DESIGN AN EFFICIENT ARTIFICIAL LIGHTING SYSTEM

- **Optimize daylight levels**

  As described in MINIMIZE THE ENERGY DEMAND FOR LIGHTING.

- **Design the artificial lighting system according to daylight availability and lighting requirements**

  Environmental analysis tools can support the design process.

- **Optimize the distribution of lighting appliances according to the user's presence and the spatial layout**

- **Select energy efficient lamps**

  According to EU energy label, the energy efficiency ranges from category A to G. In this context LED and CFL (Compact Fluorescent Lamps) are strongly suggested.

- **Adopt dimmer and presence sensor to regulate artificial lighting according to daylight levels and user proximity**

  Warning: white concrete and high-albedo surfaces can cause glare that may be uncomfortable to pedestrians and even potentially limiting to visibility.

4. SELECT ENERGY EFFICIENT ELECTRICAL APPLIANCES

Select the most appropriate appliances with a EU label certification. Prefer appliances that have the ability to be automatically turned-off after a certain time.

Warning: the contemporary use of more appliances can lead to a large peak power demand. See how to avoid the overload on the energy grid on "Use a smart control system to manage building operation" and chapter MAXIMIZE THE USE OF RENEWABLES.

5. SELECT EFFICIENT COOKING FACILITIES

Cooking facilities has to be powered with electricity. Select systems with a high electricity to heat efficiency conversion and high level of insulation (the latter for ovens). Evaluate the nominal peak power to assess its potential energy consumption. If possible, verify the EU label energy certification.

Warning: to reduce energy demand from Expo grid, power these systems with renewable energy (e.g. solar energy, as described in detail in MAXIMIZE THE USE OF RENEWABLES).

6. RECOVER EXCESS HEAT

Instead of rely on mechanical heating and increase insulation levels, use heat recovery from internal heat gains in assembly areas (due to people, lighting and appliances) and from excess heat in technical rooms (e.g. from the kitchen).

7. USE A SMART CONTROL SYSTEM TO MANAGE BUILDING OPERATION

The adoption of a smart control system to manage heating, ventilation and air conditioning, and other systems (like lighting, water management and irrigation, home appliances, etc.) can optimize building operation during the day thus reducing resource consumption and peak demand. Moreover it can provide useful information to further optimize building operation and communicate to visitors the building performance.

E. MAXIMIZE THE USE OF RENEWABLES

REMEMBER THAT

The Organizer provides a limited energy supply to the Self-Built Exhibition Spaces. In this context, renewable energies can supply extra power, reduce peak power demand and carbon emissions. Today a wide range of renewable systems are available and/or in development.

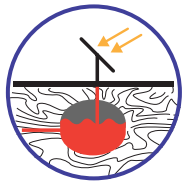
The following description is non exhaustive and related only to the more conventional systems available on the market and suitable for Milano weather condition. New generation

and innovative solutions like piezoelectrics that capture vibration energy, algae and other biochemical systems that produce hydrogen, solar concentration systems, etc., are available and Participants are encouraged to propose their innovative solutions in their designs.

It is strongly recommended to integrate renewable technologies within the building in order to reduce its visual impact and structural elements.

1. USE SOLAR THERMAL FOR COOLING AND COOKING PURPOSES

Solar thermal

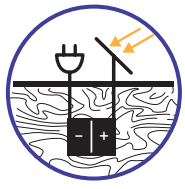


This system is widely used in Italy to produce hot water, especially for personal hygiene purposes, but can be implemented also to provide cooling or power a kitchen. These technologies depend exclusively on solar energy, therefore it is essential to provide heat storages and external generation systems to supplement heat production during cloudy days and nighttime. By using solar concentrators is possible to collect heat at higher temperatures allowing for major energy efficiency.

Parameters: to maximize solar harvesting, the panels should be oriented towards South (up to ±30° azimuth range is acceptable in terms of productivity). For Expo Milano 2015 timeframe, the optimum slope range is 15-25°. To avoid mutual overshadowing between panels, layout and orientation has to be optimized through shadow analysis, taking in account surrounding buildings, vegetation and obstructions.

2. USE SOLAR ELECTRIC TO POWER APPLIANCES

Solar electric



Solar photovoltaics convert sunlight directly into solar electricity. Considering the opening hours of Expo Milano 2015, mainly during daytime, this solutions can satisfy directly the diurnal energy demand, without recurring on other energy sources.

Photovoltaic energy surplus generated during daytime can be sold to the grid or stored in batteries for later use (e.g. during night time or cloudy days with low solar resource).

Use of automatic tracking systems to follow the sun across the sky can increase significantly photovoltaic production by 30% if compared to fixed panels. There are many tools to evaluate solar productivity for both fixed and tracking systems (e.g. PVgis http://re.jrc.ec.europa.eu/pvgis/, a free and user friendly tool developed by EU Joint Research Centre).

Parameters: to maximize solar harvesting, the panels should be oriented towards South (up to ±30° azimuth range is acceptable in terms of productivity). For Expo Milano 2015 timeframe, the optimum slope range is 15-25°. To avoid mutual overshadowing between panels, the layout must be designed according to shadow analysis.

Warning: the use of conventional batteries is not recommended due to the use of hazardous chemical substances. Lithium batteries have been considered promising candidates of next generation energy storage devices. Brown Liquor Batteries continue to be a subject of study of some researchers to provide cheap, renewable solar energy storage.

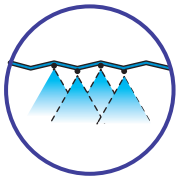
F. MAXIMIZE THE USE OF ALTERNATIVES

1. USE FUEL CELL TO STORE ENERGY

Electricity is used to decompose water in hydrogen and oxygen. When reacted with oxygen, hydrogen combusts to produce water vapour and electricity. The process is reversible and this system can be used as an alternative energy. These systems have good efficiency if compared to conventional batteries and are reliable.

Warning 1: hydrogen is not an energy source but it is an energy vector, useful to store energy! **Warning 2:** fuel cells are still in research and development. It is strongly recommended to be supported by external expertise to implement these systems in regard to technical feasibility, costs and efficiency.

Evaporative cooling



2. USE EVAPORATIVE COOLING INSTEAD OF MECHANICAL COOLING

It is a natural cooling technique developed in the past centuries in hot and arid climates, like in the Middle East. The basic principle is to lower air temperature trough the evaporation of a little amount of water. Air absorbs water, increasing its humidity. According to external conditions, especially during the hottest hours of the summer days when air is dry, this technique can be used to cool external air for both interiors and open air areas without using fans and electrical powered heat pumps.

Warning 1: design of evaporative cooling systems can affect building shape and layout, therefore it is essential to work in close collaboration with energy consultants in order to develop integrated design solutions and verify the technical feasibility. **Warning 2:** in humid days it can be necessary to supplement evaporative systems with cooling machines.

PHASE 1 / DESIGN / MATERIALS AND CONSTRUCTION TECHNOLOGY

GOALS & IMPLEMENTATION STRATEGIES

A. REDUCE THE ENVIRONMENTAL AND HEALTH IMPACT OF THE BUILDING

1. Choose green materials
2. Choose environmental construction techniques

1

A. REDUCE THE ENVIRONMENTAL AND HEALTH IMPACT OF THE BUILDING

REMEMBER THAT

The raw resource extraction, manufacturing, transportation, construction, usage and end-of-life stages of building products each generate significant GHG emissions, consume energy, produce pollution and waste and cause habitat destruction and resource depletion. This Guidelines does not preclude Participants from purchasing other materials or construction technologies. It simply recommends that Participants purchase green materials, when these items meet applicable specifications and performance requirements, using the criteria that follows.

- **Recycled Content**

  Products with identifiable recycled content, including postindustrial content with a preference for postconsumer content.

- **Natural, plentiful or renewable**

  Materials harvested from sustainably managed sources and preferably have an independent certification (e.g. certified wood) and are certified by an independent third party.

- **Resource efficient manufacturing process**

  Products manufactured with resource-efficient processes including reducing energy consumption, minimizing water consumption, waste (recycled, recyclable and or source reduced product packaging), and greenhouse gases and using green energy during production.

- **Locally available**

  Building materials, components, and systems found locally or regionally saving energy and resources in transportation to the Exhibition Site.

- **Salvaged, refurbished, or remanufactured**

  Includes saving a material from disposal and renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality, or value of a product. Specifying materials with high recycled content not only reduces the amount of new material, energy and pollution in their production, it reduces the need for landfills, and possible pollution from incineration.

- **Reusable or recyclable**

  Select materials that can be easily dismantled and reused or recycled at

the end of their useful life. Recycled or recyclable product packaging: products enclosed in recycled content or recyclable packaging.

- **Durable**

  Materials that are longer lasting or are comparable to conventional products with long life expectancies.

- **Non-toxic**

  Materials which are not carcinogenic, do not emit reproductive toxicants, or irritants as demonstrated by the manufacturer through appropriate testing.

- **Minimal chemical emissions**

  Products that have minimal emissions of Volatile Organic Compounds (VOCs). Products that also maximize resource and energy efficiency while reducing chemical emissions.

- **Low-VOC assembly**

  Materials installed with minimal VOC-producing compounds, or no-VOC mechanical attachment methods and minimal hazards.

- **Moisture resistant**

  Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.

- **Healthfully maintained**

  Materials, components, and systems that require only simple, non-toxic, or low-VOC methods of cleaning.

- **Systems or equipment**

  Products that promote healthy IAQ by identifying indoor air pollutants or enhancing the air quality.

Warning 1: when there is a cost premium or a life cycle implication, it can be helpful to have some method of quantifying the comparative environmental benefits of the alternatives (like embodied energy/embodied CO_2, environmental profiling and eco-footprinting) in order to make an informed decision. **Warning 2**: materials and products used must bear the CE marking (for products included in the CPD/CPR). The Construction Products Regulation (CPR-305/2011) has been adopted by the European Commission and replaces the Construction Products Directive (CPD). CE marking is mandatory in Italy.

According to such regulation, the requirement for CE marking will apply to: "any product or kit which is produced and placed on the market for incorporation in a permanent manner in construction works or parts thereof and the performance of which has an effect on the performance of the construction works with respect to the basic requirements for construction works." In particular, materials and products for built structures must be identified and characterized under the responsibility of the producer and verified by the Participant's Technical Supervisor. Whereas for Structural Products without CE marking (due to lasck of harmonization) an ad hoc certification must be obtained by Italian authorities. For all the CE marked construction products refers to: http://ec.europa.eu/enterprise/newapproach/nando/index.cfm?fuseaction=directive.annex. **Warning 3**: wood is a renewable resource yet the improper cultivation and harvesting of it can damage the environment. Look for certification of wood forms such as the FSC (Forest Stewardship Council) and PEFC (Programme for Endorsement of Forest Certification schemes).

1. CHOOSE GREEN MATERIALS

SITE CONSTRUCTION

Porous paving products

Compost

Mulch

- **Porous paving products**

  Porous asphalt, made with reclaimed asphalt pavements or recycled rubber, and pervious concrete, made with recycled aggregates, are manufactured without "fine" materials, and incorporate void spaces to allow infiltration. Grid paver systems are concrete interlocking paving blocks or recycled plastic paving forms with open areas designed to allow grass to grow within the void areas. Alternatively, loose fill permeable surfacing includes: gravel, cobbles, wood, mulch, brick, and natural stone.

  Warning 1: to reduce heat island effect choose high albedo materials for pavements (SRI>30). As an alternative, use materials that promote absorption of CO_2. **Warning 2:** porous paving products used in pedestrian areas need to be fully accessible according to the Universal Design approach and principles enshrined in the United Nations "Convention on the Rights of Person with Disabilities" and the applicable Italian laws and regulations.

- **Compost**

  The recovered organic materials from which compost and fertilizer are made include, but are not limited to, yard waste, food waste, manure and biosolids.

- **Mulch**

  Hydraulic mulch is comprised of small pieces of cellulose fibers, which

can be made completely from wood waste or recovered paper. Through hydroseeding, a mixture of water, seeds, and hydraulic mulch is sprayed over bare soil to quickly promote plant growth.

- **Lawn and edging**

Lawn edging can be manufactured with recovered plastic or rubber.

Lawn and edging

MASONRY

- **Clay masonry**

Clay bricks are a high thermal mass and durable material.

To avoid the improper mining of raw materials it is suggested to select reused bricks and stones which make efficient use of existing materials. Fired clay blocks and bricks with recycled materials are available. They can be reusable if used with lime mortar. Manufacturing waste is typically recycled in new units while industrial waste by-products can be used for aggregate in concrete blocks.

As an alternative there are the calcium silicate bricks which are reusable if used with lime mortar. Old calcium silicate bricks can be crushed and recycled into new bricks without loss of quality.

Clay masonry

ALTERNATIVES TO TRADITIONAL MASONRY

- **Wood Blocks**

Large hollow softwood blocks made from glued board offcuts of softwood is a dry precision construction system, that means that no other means of fixing is needed. The interlocking blocks stack quickly, secured with vertical dowels. It is possible to upgrade thermal performance by stuffing loose natural insulation or adding insulation to the exterior surface of the block.

Wood Blocks

- **Recycled Wood Pallet Masonry Blocks**

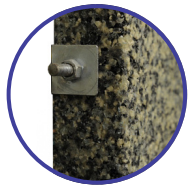
This is a reinforced wall frame system which uses PFA (pulverized fuel ash) and recycled wood material (usually wood pallet waste) to produce walls with high thermal, acoustic and fire protection properties.

Recycled Wood Pallet

- **Panels or blocks made with pre-selected waste**

They are elements made with selected waste products that have been diverted from landfill. This pre selected waste is recycled then size reduced, after which it is mixed with a Resin and the TPR Polymers. The result is a moldable liquid compound that is poured like concrete.

Pre-selected waste



CONCRETE

Concrete is a material with a high thermal mass, it is fire resistance and has long-term performance but the production of cement is a significant contributor to global warming. In addition to optimizing the energy efficiency of Portland cement production plants, the amount of cement used in concrete mixes can be reduced by using cement substitutes or recycled aggregated and use preparations that results in reduced amounts of concrete needed.

Precast concrete

- **Precast concrete (concrete blocks, concrete panels)**

  To avoid the improper mining of raw materials it is possible to use supplementary cementitious materials like natural pozzolans and recycled products from other industries. Natural pozzolans include: diatomaceous earths, volcanic ash, and pumicites. Recycled supplementary cementitious content materials include, among others: coal fly ash, ground granulated blast furnace slag, silica fume.

  In addition to cement substitutes, it is possible to use recycle aggregated materials such as fiberglass waste materials, discarded glass, granulated plastics, wood products, old tires, waste paper, rubble crusher. It is even possible to use preparations that results in reduced amounts of concrete needed such as: foam crete is a lighter, aerated, foam-based concrete that requires less energy to produce; ceramicrete and glass fiber reinforced concrete are twice as strong as traditional concrete, so builders use less of it.

Warning 1: due to variations in cement, strength requirements, costs, and construction practices, it is important to evaluate with a technician the recovered materials content levels for cement or concrete containing recycled supplementary cementitious content or recycled aggregates.
Warning 2: the density of the aggregate is generally proportional to the loss of thermal mass and improved thermal insulation.

Reinforced concrete

- **Reinforced concrete**

  Steel reinforcing bar, commonly known as rebar, serves as the unseen support structure in concrete construction projects. The vast majority of rebar is produced from recycled metal and rebar itself is completely recyclable. The use of steel scrap keeps millions of tons of ferrous scrap from landfills.

- **Cast in place concrete**

  Resource efficient options for permanent formwork include textile forms and insulated forms, panels or blocks made from expanded polystyrene (beads or extruded), known as insulated concrete forms. Temporary forms (metal pan forms, wood forms, modular plastic forms, corrugated

paper forms) are generally reusable and easily recyclable. This means that it is possible to find reclaimed formworks. Most typically contain recycled content.

Moreover, in order to obtain considerable material savings in steel, cement and aggregate it is possible to use:

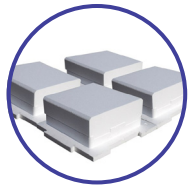
- pre-stressed concrete hollowcore floor slabs;
- bubble deck, precast floor system that comprises large plastic balls inserted into a steel lattice into which concrete is poured;
- modular framework in recycled polypropylene, polystyrene, hollow blocks for slabs that are cast on site or semi-prefabricated.

Warning: the Expanded Polystyrene (EPS) used in insulating concrete forms are not typically made from recycled material. However, the plastic webs and connectors may be made from recycled material.

Pre-stressed hollowcore

Bubble deck

Modular framework



METALS

Steel can be recycled repeatedly without any degradation in terms of properties or performance in quality. Any waste generated during manufacture is recycled. It is a durable and low maintenance material. Much of the components are pre-fabricated and pre-assembled in the factory. This reduces the amount of site work and waste generation at the site and increases the quality and precision of the installation works. Steel products include among others: structural steel (steel beams and columns), light steel-framing (structural and non-structural wall frames and roof trusses manufactured from cold-formed galvanized or ZincAlum structural steel sections), steel roofing and decking.

Warning 1: steel manufacturing processes vary significantly in their environmental impacts. Prefer steel products manufactured with resource-efficient processes. **Warning 2:** steel framed building has insufficient thermal mass. This should be added within the frame or to the interiors.

Structural steel

WOOD

- **Engineered wood products (EWP)**

Engineered wood products use trees more efficiently than traditional wood products and help reduce demand for virgin timber. They use wood chips, resins, smaller wood members, and ingenious engineering to create strong building materials. Engineered wood components include: plywood, oriented strand board (OSB), composite wood panels, glue laminated beams, structural composite lumber. Finger-jointed lumber, which is interchangeable with solid sawn lumber, is also considered an EWP. Engineered wood products are typically prefabricated, not site fabricated.

Engineered wood products

Warning 1: the adhesives used in some EWP products may be toxic. Search for products with low formaldehyde resins (this information is usually available from the manufacturer website). **Warning 2:** engineered wood products might be more difficult to recycle than standard, solid sawn lumber due to the binders used in the manufacture of the engineered wood product. They may require more primary energy for their manufacture than solid lumber.

Wood Plastic Composite

Solid lumber

Bamboo

Cardboard

Pultruded glass reinforced plastic

- **Wood Plastic Composite (WPC)**

  Wood Plastic Composite is a material manufactured by blending natural wood fibers with plastic. It is a combination of highly refined wood fibers and virgin polymer resins (plastic) wherein the wood fibers are aligned and encapsulated in plastic. One advantage over wood is the ability of the material to be molded to meet almost any desired shape. They can be made using recycled plastics and the waste products of the wood industry. Moreover they can be recycled easily in a new wood-plastic composite.

- **Solid lumber**

  To disallow the use of new solid sawn lumber, it is preferred to select salvaged reclaimed lumber, since it performs comparably to new lumber if properly graded. Instead of old growth timber it is preferred to select wood created from younger, fast-growing farmed trees.

ALTERNATIVES TO WOOD OR METAL FRAME

- **Bamboo**

  Bamboo is one of the strongest plant-based building materials, it thrives in diverse climates, is natural and rapidly renewable material. The connections are the difficult structures in bamboo constructions. There are several examples of different kind of connections, modern least-tech connection, which can be produced very cheap and assembled by unskilled workers, and high tech connection with industrial standard elements like steel plates, nuts and bolts.

- **Cardboard**

  It is a cheap material, based on renewable resources and recyclable. It is a strong material considering its light weight. As per bamboo elements, it is very important to detail the connection of cardboard structures with stiffer and stronger materials like steel or timber.

- **Pultruded glass reinforced plastic**

  GFRP - Glass Fiber Reinforced Polymer, known also as FRP-Fiber

Reinforced Polymer composites are structural alternatives to traditional building materials like steel, aluminum and concrete. While FRP can be recycled, it is not usually economically feasible currently. However, production of virgin FRP parts actually consumes less energy and produces less greenhouse effect than recycling of steel and aluminum. FRP composite products have high resistance to rot and corrosion, a longer and more economical service life and require less frequent energy-intensive maintenance and replacement.

IN-SITU COMPOSITES

It is a type of construction that uses a mix of materials (straw bales, hemp blocks, hemp walls, rammed earth etc..) together with a structural frame (steel, wood, bamboo...).

- **Straw bales**

Densely bound straw bales are either fitted non load-bearing within a structural post and beam system or taking loads themselves on a ring beam fitted round what is in effect a block wall. Straw is an agricultural waste product, it is easy to handle and it is renewable. Straw bale construction also has excellent insulation qualities and is extremely cheap.

Straw bales

- **Hemp blocks**

The blocks are supplied in either load-bearing or non-load-bearing formats. Hemp blocs are a mixture of water, lime and hemp shives. The blocks are light weight and easy to handle. By bricking the blocks together a solid wall is created with a high insulation value that can be finished with a natural loam render on the interior and a lime render or wooden cladding on the exterior side. The entire wall is permeable to damp and has a high heath storage capacity which ensures a healthy and comfortable interior climate.

Hemp blocks

- **Solid hemp walls and pre fabricated hemp elements**

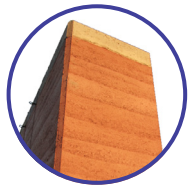
The mixture of water, lime and hemp shives can be used in situ and assembled in formworks. It is also possible to spray the mixture on to the construction. Another possibility is to have prefabricated panels made by a wooden construction filled with the hemp-lime mixture at the factory. On site, the building can be quickly assembled. Piping and electrics can be pre-assimilated in the factory.

Solid hemp walls

- **Rammed earth**

Rammed earth walls (also known as pise) are constructed by the compacting (ramming) of moistened subsoil into place between temporary formwork panels. When dried, the result is a dense, hard monolithic wall.

Rammed earth



It is a natural and readily available material with a high thermal mass and a traditional form of construction. It can be applied in internal load-bearing unstabilized walls (in this case the material is reusable post-demolition) o in external load-bearing walls with the addition of a stabilizer (the most common is cement).

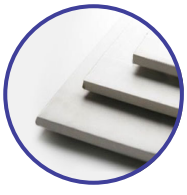
Warning 1: adding cement stabilization can compromise environmental credentials. **Warning 2:** to reduce construction period it is possible to use prefab composites elements. **Warning 3:** not all soil types are appropriate.

Recycled wood pallets

Unfired clay brick

Clayboard

Fibre reinforced gypsum board



Wood and particle boards

OTHER ALTERNATIVES FOR WALLS CONSTRUCTION

Recycled wood pallets, plastic boxes, containers, scaffolding elements are just some of other construction elements that can form the pavilion. For massive walls an alternative to traditional masonry and concrete construction are the earth-filled tires, earth bags walls, monolithic walls with incorporated bottles.

FINISHES, CLADDING AND PARTITION

- **Unfired clay brick**

  Unfired clay bricks suitable for most internal non load-bearing applications. Unfired clay bricks have excellent sustainability credentials - low energy input, very low waste and high recyclability. When incorporated into a building they give thermal mass and acoustic insulation, inhibit condensation and regulate the relative humidity of the atmosphere.

- **Clayboard**

  Clay boards are 100% natural made with clay, reed and hessian. Clay boards have outstanding thermal and vapour diffusion properties. The boards can regulate temperature, are able to absorb moisture, and at other times gently give it off again.

- **Fibre reinforced gypsum board**

  Gypsum, cellulose fibres and water are combined to form a homogenous mass, which is then formed into a dense sheet material for wall, ceiling and floor lining. It is a recyclable material and it uses post and pre-consumer newspaper and gypsum recovered from desulphurisation plants.

- **Wood and particle boards**

  There are many eco-friendly panels and boards with no formaldehyde added to the fibres. Among others: Medium density fibreboard (MDF) made with wood chip is a reusable and recyclable material with recycled content. As an alternative to wood MDF product it is possible to select

wheatboards or hemp panels. Sorghum stalks or bamboo are other natural materials for strong, lightweight, durable and environmentally friendly boards.

- **Honeycomb cardboard**

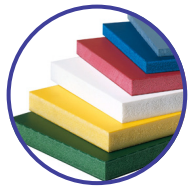
  It can be used for non structural partition made with 100% post consumer paper fiber.

Honeycomb cardboard

- **Plastic sheets and boards**

  Recycled plastic can be used as panels in high density Polyethylene (HDPE) and Polypropylene (PP) or as decorative sheets. By adding small amounts of aluminum foil and glass fibre it is possible to have a solid alternative to traditional wood, metal, and plastic layers used in sandwich panel constructions.

Plastic sheets and boards



- **Laminates**

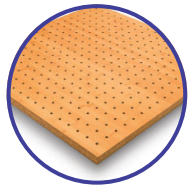
  Laminates derived from wood pulp with an eco-friendly water-based adhesive are biodegradable and recyclable materials.

Laminates

- **Ceiling tiles**

  Acoustic ceiling tiles manufactured from recycled cellulose or reclaimed wood chip are available; generally the recycled cellulose and wood chip are pre-consumer, industry waste. Ceiling tile manufactured from slag wool, which is a pre-consumer recycled material, is also available. Just some of other materials are: bio-soluble mineral wool, MDF panels reusable and with recycled content, synthetic gypsum boards made with materials that would otherwise be disposed of in landfills.

Ceiling tiles



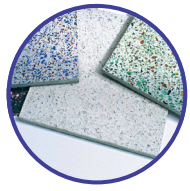
- **Stone, Ceramic, Concrete, Glass tiles or boards**

  Salvage rocks and stones are available on the market. Tiles and boards can be made with recycled natural stone aggregates, recycled glass mixed with fly ash. As an alternative it is possible to use reconstituted stone walling using reclaimed aggregates.

  Ceramic tiles with recycled glass and recycled porcelain content are available as concrete tiles made with recycled aggregate (like cellulose).

  Recycled glass can be used for tiles, paviours and panels. These products are also recyclable.

Tiles

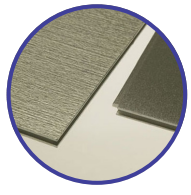


- **Metal coverings**

  Copper is a natural material that has an infinite recyclable life.

  Copper, by itself or in any of its alloys, such as brass or bronze, is used

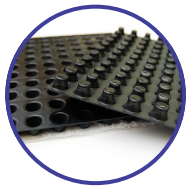
Metal coverings



over and over again. Copper's recycling value is so great that premium-grade scrap normally has at least 95% of the value of the primary metal from newly mined ore.

Recyclable aluminum tiles and panels made from 100% post-consumer recycled aluminum or aluminum foam are available.

Green roof

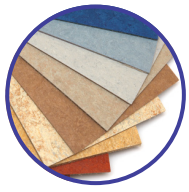


- **Green roof**

Many of the materials used in green roof construction are manufactured from recycled building materials, plastics and rubber reducing landfill disposal.

Warning 1: climatic conditions on a rooftop are extreme, choose carefully planting material. The ability of plants to survive on a green roof is directly proportional to the amount of maintenance time and budget allocated to the project. It is vital to know where if the previous growing conditions were comparable to the ones on the roof. **Warning 2:** Participants have to adopt all protective measures required by Italian legislation and EU directives (2000/29/EC) against the introduction and spread into European and Italian territory of organisms harmful to plants or plant products. More specifications will be provided in the **Guidelines - Import of plants and plant products, for Construction and Set-up of Exhibition Space**.

Resilient flooring



- **Resilient flooring**

Post consumer and total recycle content rubber decreases demand for non-renewable resources while creating a market for recycled rubber. Natural Linoleum is made from linseed oil and pine resin, which are natural, renewable resources. It is a durable and biodegradable product.

Warning: sealants, if used, can produce harmful VOCs. Choose products that can be laid without adhesive or with low chemical emission adhesive.

Paint

- **Paint**

Green paint are all non-toxic and have low volatile organic compounds (VOC). Natural or "Eco" Paints are made from renewable and biodegradable ingredients. They are low VOC and contain no ozone-depleting chemicals. Milk (Casein) Paint usually comes in a powder form and is mixed with water at the site. It is considered permanent but not waterproof. When dry, it is odorless, nontoxic, durable, zero VOC and biodegradable. Typical ingredients are mineral pigments, casein (milk) powder, and sometimes, chalk, clay or lime for opacity.

Silicate Paints may be applied on paper-faced drywall. They create a coating that is breathable and resistant to weathering. As with the other

mineral based paints, it is odorless, nontoxic, durable, zero VOC and biodegradable.

Paints which contain post-consumer recycled content (PCRC) are recovered waste paint that are mixed with virgin materials, such as resins and colorants, and tested. Reprocessed paint is postconsumer latex paint available in various colors and is suitable for both interior and exterior applications. Reblended (consolidated) paint is recovered paint that is screened, re-mixed, tested and packaged for distribution. Virgin raw materials such as resins and colorants may be added in small quantities. Consolidated paint is typically used for exterior applications or as an undercoat.

Warning: it is important to investigate carefully the components of the product to avoid allergies and high ventilation rates when used in interior spaces.

ACCESS, BARRIER & CIRCULATION PRODUCTS

- **Exterior glass and glazing**

  Post consumer and total recycle content glass decrease demand for virgin materials and require less energy in production than a virgin product. Creates market for materials typically disposed.

- **Doors and frames**

  Post consumer and total recycle content metal doors and frames reduce demand for virgin non-renewable resources. Timber frames or doors from certified forest are available.

Doors and frames

2. CHOOSE ENVIRONMENTAL CONSTRUCTION TECHNIQUES

PRINCIPLES

- Design for salvaging materials and reconstruction
- Design for future durability and adaptability
- Use fewer materials to realize a design
- Reduce off-cutting on site

- **Design for reconstruction by using dry construction technology with mechanical or chemical-mechanical fixing systems**

  Use fewer adhesives and sealants, making it easier for construction professionals to salvage useful items and valuable building materials.

- **Choose light structures using a minimum amount of materials**

Warning: lightweight construction require mechanical equipment or a deliberate inclusion of thermal mass to provide inertia.

- **Design optimization**

  Reduce number of different components, in order to increase efficiency in manufacturing process, and use of standardized construction component sizes.

- **Prefabricated elements**

  Use factory-assembled or off-site construction components which are then just craned into the place on site. Prefabricated elements can allow tighter on-site assembly tolerances and can greatly reduce off-cutting on site.

- **Prefer materials with a good workability in order to reduce construction time and materials used**

- **Reuse construction elements (like scaffolding) as building components**

  Reusing building components is (almost) always the greenest option.

- **Adopt the preparatory services offered by the Organizer**

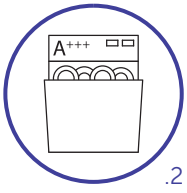
PHASE 1 / DESIGN / WATER

GOALS & IMPLEMENTATION STRATEGIES

A. SAVING WATER FOR INDOOR USE

1. Use water-efficient plumbing fixtures
2. Use water-efficient appliances
3. Use alternative on-site sources of water


.1



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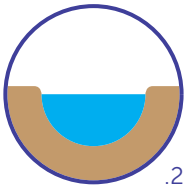
B. SAVING WATER FOR IRRIGATION

1. Use native/adapted plants that require minimal or no irrigation
2. Adopt a landscape design and materials that facilitate water retention
3. Use high-efficiency equipment and/or climate-based controllers for irrigation
4. Use hydroponics or aquaponics systems


.1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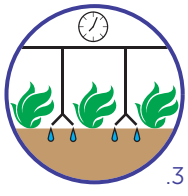
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INPUT DATA
Normally in Milano the height of the rainfall from Maj to October is around 500-550 mm.

A. SAVING WATER FOR INDOOR USE

Efficient Plumbing

1. USE WATER-EFFICIENT PLUMBING FIXTURES

- **Ultra low flush toilet (ULF), high efficiency toilets (HET), dual flush high efficiency toilets**

  An Ultra Low Flush ULF toilet flushes at a maximum of 1.6 gallons (6 liters) per flush. A HET toilet flushes at maximum of 1.3 gallons (5 liters) per flush. Dual-Flush toilets are a type of HET with a full flush and a half flush capability. The average flush volume of a modern dual flush toilet is 1.1 gallons (4 liters) or less.

- **Ultra low flush (ULF) urinals, High-efficiency urinals (HEU)**

  An Ultra low flush (ULF) urinals use 1.0 gpf or less. An HEU flush with 0.5 gpf or less. The mechanism for flushing, the flushometer valve, is the same as for conventional and ULF urinals, but requires a higher pressure and higher velocity for the supply water and a smaller orifice in the diaphragm of the flush valve.

- **Waterless urinals**

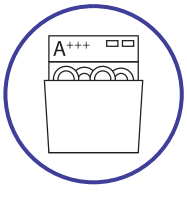
  Waterless urinals work without using any water other than for routine cleaning.

  These products normally use a special trap with lightweight biodegradable oil that lets urine and water pass through, but prevents odor from escaping into the restroom. There are no valves to fail and no flooding. Other products use a cartridge technology to improve performance and hygiene.

- **High efficiency faucets and showerheads**

  High efficiency faucets and showerheads control flow rate either through flow restriction or flow regulation (e.g. aerators, laminar flow devices). They can be automatic with electric sensor or with a timer and a thermostatic mixing valve.

Efficient Appliances



2. USE WATER EFFICIENT APPLIANCES

Dishwashers with an improved technology that save water, energy and thus money during their functioning are available. EU energy labels help consumers choosing water efficient appliances.

3. USE ALTERNATIVE ON-SITE SOURCES OF WATER

- **Rainwater harvesting**

Normally rainwater harvesting is the immediate collection of rainwater running off surfaces upon which it has fallen directly. These Guidelines promote the reuse of rainwater for internal use; therefore they encourage rainwater collection from roofs and facades, where the contamination risk by natural means or man-made activities is lower than on the ground.

This system operates through a staged process – transporting rainwater through pipes or drains, filtration, storage in tanks and contamination treatment for reuse.

Parameters: water harvesting potential is proportional to the height of the rainfall, the collecting area, to the runoff coefficient and the first-flush wastage. Indeed, collection results can be improved by using a big collector surface and placing extra care in the selection of materials for the catchment surfaces.

Warning: water jars/containers have to be constructed in such a way that it avoids algal growth and invasion by insects, lizards and rodents.

- **Recycled gray water**

Graywater is wastewater generated from internal activities such as dishwashing and bathing. The combined use of septic tank, green plants and associated microorganisms can remove and/or reduce the concentration of pollutants in grey wastewater. This can then be recycled on-site for uses such as toilet flushing, floor washing and garden or land irrigation.

Parameters: the treatment efficiency is related to the type of soil and plants used, the area and geometry of the planter bad, typology of the septic tanks. The economic feasibility of this solution is related to the amount of gray water produced.

Warning 1: Participants have to adopt all protective measures in order to reduce the risk of dissemination of organisms. **Warning 2**: recycled graywater is never safe to drink. Do not use the treated graywater for the vegetable garden and food production.

- **Air conditioning condensate**

With central air-conditioning, the cold refrigerant passes through the heat exchanger coil inside the building. As the air passes through the coil, water vapor in the air turns to liquid when it comes in contact to the cold coils. This condensate water must be removed to prevent water damage to the equipment and the building structure. Depending on

the location of the central AC A-coils, this water can be easily captured, stored and utilized.

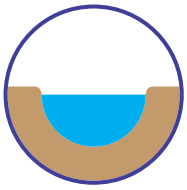
B. SAVING WATER FOR IRRIGATION

Native/adaptive plants

1. USE NATIVE/ADAPTED PLANTS THAT REQUIRE MINIMAL OR NO IRRIGATION

Warning: plants that are national symbol are accepted but participants have to adopt all protective measures required by Italian legislation and EU directives (2000/29/EC) against the introduction and spread into European and Italian territory of organisms harmful to plants or plant products. More specifications will be provided in the **Guidelines - Import of plants and plants products, for Construction and Set-up of Exhibition Space**.

Landscape design

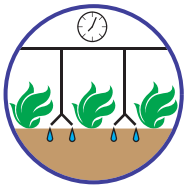


2. ADOPT A LANDSCAPE DESIGN AND MATERIALS THAT FACILITATE WATER RETENTION

Traditional methods of water harvesting are still used in many countries (dry walls, barrows and stone arrangement, rainwater harvesting in pits). Those systems enable to collect water for irrigation purposes without using water from waterworks.

Dig up soil, remove weeds, plant foods and soil conditioners help soil retain water and hold on to its moisture.

Climate-based Controllers



3. USE HIGH-EFFICIENCY EQUIPMENT AND/OR CLIMATE-BASED CONTROLLERS FOR IRRIGATION

With proper installation, programming, and maintenance it is possible to better match plants' water needs according to the local weather and landscape conditions.

4. USE HYDROPONICS OR AQUAPONICS SYSTEMS

- **Hydroponics is a subset of hydroculture and is a method of growing plants using mineral nutrient solutions, in water, without soil**

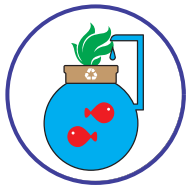
Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in a substrate (typically an inert medium) where roots can be anchored, such as perlite, gravel, mineral wool, expanded clay or coconut huts, thus adsorbing nutrients through water flows.

There are two chief merits of the soil-less cultivation of plants. First, hydroponics may potentially produce much higher crop yields. Also, hydroponics can be used in places where in-ground agriculture or gardening are not possible. Moreover the water stays in the system and

can be reused, thus minimizing water consumption and bills. Hydroponic systems are good for the cultivation of vegetables and flowers.

- **Aquaponic system combines fish breeding and a vegetable hydroponic garden**

Aquaponics

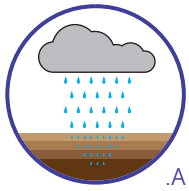


No soil or land is needed because all the plants are cultivated with hydroponic system. It is a nearly-closed loop ecological system.

The water with fish waste is sent to the hydroponic system where it is filtered by microorganisms and plant's roots as vital nutrients. The cleansed water is then sent to the fish basin creating oxygenation.

An aquaponic system utilizes nitrogen from fish waste to feed plants. No chemical or other fertilizers are needed. It adsorb a low quantity of energy, almost no manual work is needed.

PHASE 1 / DESIGN / SOIL & SITE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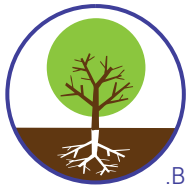
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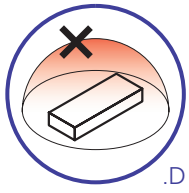
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GOALS & IMPLEMENTATION STRATEGIES

A. REDUCE STORM WATER RUNOFF AND INCREASE INFILTRATION RATES

1. Maximize the use of natural surfaces
2. Use porous artificial surfaces or open-grid pavement system

B. PREVENT SOIL EROSION AND POLLUTION, PREVENT LOSS OF SOIL

1. Design landscape considering the waterways
2. Ensuring that material excavated on the site is reused on site

C. REDUCE THE AMOUNT OF LANDFILL WASTE

1. Provide waste collection area where waste generated during the use of the building can be separated

D. MINIMIZE THE HEAT ISLAND EFFECT

1. Maximize the use of plants and green area
2. Improve external shading
3. Use the cooling effect of water (water spray systems, fountain, pools)
4. Choose materials with high albedo for pavements (SRI>30) and roofing (SRI>80). As an alternative, use materials that promote absorption of CO_2

E. PREVENT LIGHT POLLUTION

1. Use high performance optical systems to prevent upward light distribution and save energy
2. Use low reflectance surfaces
3. Install efficient lighting control systems (smart, motion-sensing lighting system, daylight sensors...)
4. Install and operate lighting only where it responds to a demonstrated need or requirement

F. PREVENT RADON FROM ENTERING IN THE BUILDING

1. Active Subslab suction
2. Radon resistant barrier
3. Other Types of Radon Reduction Methods

G. PREVENT EXTERNAL NOISE POLLUTION

1. Place all noisy plants far away from crowded areas
2. Use noise barrier or enclosure for noisy plants
3. Use landscape to reduce noise and absorb sound and vibration

A. REDUCE STORM WATER RUNOFF AND INCREASE INFILTRATION RATES

INPUT DATA

The territory is slightly sloping to the South-Southeast, and presents a series of mild depressions riverbed that generally develop in NNW-SSE direction, while maintaining alignment with the existing surface drainage network. The area reaches its maximum altitude, 140m above sea level, in proximity of the Fiera Rho-Pero parking (north western part of the Exhibition Site). The catchment area is characterized by the presence of a strong development with natural waterways and artificial different matter. In general terms, hydrography has a generally North-South direction, in agreement with the morphology of the central plains of Lombardy, characterized by a surface slightly inclined towards the South of about 0.3%. The trend piezometric stood at depths between 5 and 10 meters from the ground level, and flow direction oriented North-West and South-East.

1. MAXIMIZE THE USE OF NATURAL SURFACES

Increase infiltration rates

A minimum of 30% of each lot must be dedicated to open areas and greenery. Excluding lot setbacks the Open-Air Exhibition Space represents around 50% of each lot, where it is possible to build structures used for plants ensuring soil permeability (e.g. trellises, pergolas, garden structures, planters) and landscaping structures (e.g. structures used to retain soil or other materials, pools, exhibition structures, art works).

2. USE POROUS ARTIFICIAL SURFACES OR OPEN-GRID PAVEMENT SYSTEM

See **MATERIALS AND CONSTRUCTION TECHNOLOGY** and **WASTE SHEET** for choosing porous paving products.

B. PREVENT SOIL EROSION & POLLUTION, PREVENT LOSS OF SOIL

Prevent soil erosion

1. DESIGN LANDSCAPE CONSIDERING THE WATERWAYS

Design the external areas in order to protects receiving stream channels from excessive erosion. Decrease the volume of storm water runoff by promoting infiltration (e.g. using pervious pavement, grid pavers, disconnection of imperviousness, rainwater recycling, constructed wetlands, vegetated filters and open channels).

2. ENSURING THAT MATERIAL EXCAVATED ON THE SITE IS REUSED ON SITE

Some of the suggested uses are, among others: road base and verge construction, garden beds, landscaping, suds, noise barriers, construction materials such as in concrete or hardcore.

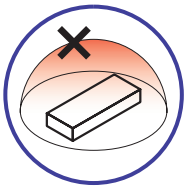
C. REDUCE THE AMOUNT OF LANDFILL WASTE

1. PROVIDE WASTE COLLECTION AREA WHERE WASTE GENERATED DURING THE USE OF THE BUILDING CAN BE SEPARATED

Warning: the waste collection facility must be designed to accommodate organic waste divide by: 1) gardening waste, kitchen waste, organic fraction of municipal waste generated by staff and visitors; 2) miscellaneous waste generated by exposition or commercial activities and personnel, partially separable into different categories following the establishment of source-separation waste collection systems (e.g. paper and cardboard, glass, wood, plastic, steel, aluminum, electrical/electronic devices, other waste).

D. MINIMIZE THE HEAT ISLAND EFFECT

Minimize heat island



1. MAXIMIZE THE USE OF PLANTS AND GREEN AREAS

Plants absorb water through their roots and emit it through their leaves. This movement of water is called "transpiration." Evaporation, the conversion of water from a liquid to a gas, also occurs from the soil around vegetation and from trees and vegetation as they intercept rainfall on leaves and other surfaces. Together, these processes are referred to as evapotranspiration, which lowers temperatures by using heat from the air to evaporate water.

Warning 1: Participants have to adopt all protective measures required by Italian legislation and EU directives (2000/29/EC) against the introduction and spread into European and Italian territory of organisms harmful to plants or plant products. More specifications will be provided in the Guidelines - Import of plants and plant products, for Construction and Set-up of Exhibition Space. **Warning 2:** use native/adapted and mature plants that require minimal or no irrigation and do not require active maintenance such as mowing or chemical inputs such as fertilizers, pesticides or herbicides.

2. IMPROVE EXTERNAL SHADING

See: MINIMIZE DIRECT SOLAR HEAT GAINS USING SHADING DEVICES, in **ENERGY SHEET**

3. USE THE COOLING EFFECT OF WATER (WATER SPRAY SYSTEMS, FOUNTAIN, POOLS)

Urban water bodies not only serve as places for recreation and leisure activities, but also contribute to mitigate urban heat island effect in hot summer. Water body's area, geometry, built-up proportion and location towards the external winds influence the cooling results.

Warning: high-albedo materials, including water surfaces, can cause glare that may be uncomfortable to pedestrians and even potentially limiting to visibility.

4. **CHOOSE MATERIALS WITH HIGH ALBEDO FOR PAVEMENTS (SRI>30) AND ROOFING (SRI>80). AS AN ALTERNATIVE, USE MATERIALS THAT PROMOTE ABSORPTION OF CO_2**

Solar reflectance, or albedo, refers to a material's ability to reflect the visible, infrared, and ultraviolet wavelengths of sunlight. The Solar Reflectance Index (SRI) combines albedo and emittance (a material's ability to release absorbed heat) into a single value expressed as a fraction (0.0 to 1.0) or percentage. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100.

Warning 1: white concrete and high-albedo surfaces can cause glare that may be uncomfortable to pedestrians and even potentially limiting to visibility. **Warning 2:** white concrete and high-albedo surfaces can also result in increased light pollution if fixtures are aimed directly at the high reflectance pavements.

E. PREVENT LIGHT POLLUTION

For Expo by Night activities can be necessary to have an outdoor lighting system to guarantee safety levels. At the same time it is prohibited to set up light beams facing upwards and it is strongly suggested to maximize energy savings following these criteria:

1. **USE HIGH PERFORMANCE OPTICAL SYSTEMS TO PREVENT UPWARD LIGHT DISTRIBUTION AND SAVE ENERGY**

2. **USE LOW REFLECTANCE SURFACES**

3. **INSTALL EFFICIENT LIGHTING CONTROL SYSTEMS (SMART, MOTION SENSING LIGHTING SYSTEM, DAYLIGHT SENSORS...)**

4. **INSTALL AND OPERATE LIGHTING ONLY WHERE IT RESPONDS TO A DEMONSTRATED NEED OR REQUIREMENT**

Warning: it is prohibited to set up light beams facing upwards also for advertising purposes

Prevent light pollution

F. PREVENT RADON FROM ENTERING IN THE BUILDING

Participants are requested to take into account the preventive measures indicated by the "Regione Lombardia Decreto n. 12678 del 21/12/2011 – Linee guida per

Prevent radiation

la prevenzione delle esposizioni al gas radon in ambienti indoor". Here follow some of the suggested strategies:

1. **ACTIVE SUBSLAB SUCTION**

   Also called subslab depressurization, it is the most common and usually the most reliable radon reduction method. One or more suction pipes are inserted through the floor slab into the crushed rock or soil underneath. They also may be inserted below the concrete slab from outside the building. The number and location of suction pipes that are needed depends on how easily air can move in the crushed rock or soil under the slab and on the strength of the radon source. Passive subslab suction is the same as active subslab suction except it relies on natural pressure differentials and air currents instead of a fan to draw radon up from below the slab.

   Warning: it is extremely important that the gas pipe outlet is placed far away from other openings or air inlets of the building.

2. **RADON RESISTANT BARRIER**

   These membranes are used to cover vertical and horizontal elements of the building that are in contact with the ground. They are normally made of a special elastoplastomeric compound based on bitumen, plastomers and elastomers. Barrier continuity can be obtained by torch-welding membrane overlaps or they can be sealed with other radon barrier materials.

   Warning 1: the radon resistant barrier normally is not sufficient if an airvent is not used to draw the radon from under the slab or wall and vent it to the outdoors. **Warning 2**: radon gas enters the building via cracks and joints within the structure and the gas barrier membranes selected must be capable of accommodating that movement without rupturing.

3. **OTHER TYPES OF RADON REDUCTION METHODS**

   Other radon reduction techniques that can be used in any type of building include: submembrane suction, sealing, building or room pressurization, heat recovery ventilation and natural ventilation.

Prevent external noise

G. PREVENT EXTERNAL NOISE POLLUTION

1. **PLACE ALL NOISY PLANTS FAR AWAY FROM CROWDED AREAS**
2. **USE NOISE BARRIER OR ENCLOSURE FOR NOISY PLANTS**
3. **USE LANDSCAPE TO REDUCE NOISE AND ABSORB SOUND AND VIBRATION**

PHASE 2 / CONSTRUCTION / AIR QUALITY

GOALS & IMPLEMENTATION STRATEGIES

A. REDUCE GHG ARISING FROM TRANSPORT AND CONSTRUCTION VEHICLES

1. Optimize journeys to and from the site
2. Shift transportation from truck to railway when possible
3. Use low-emitting/fuel-efficient vehicles
4. Avoid exceptional large loads
5. Provide first the renewable or alternative energy systems
6. Allow convenient access for the storage area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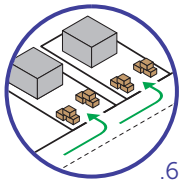
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B. REDUCE DUST POLLUTION

1. Designate truck and vehicles wheels cleaning area
2. Secure excavation ground and dry materials from wind
3. Capture and reuse site water for dust control without importing water from off site
4. Minimize the production of dust when cutting frames to size

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A. REDUCE GHG ARISING FROM TRANSPORT AND CONSTRUCTION VEHICLES

1. OPTIMIZE JOURNEYS TO AND FROM THE SITE

Optimize truck journeys

- **Reducing the amount of excavation ground to be removed from site**

  Ensure that the greenfield top soil and subsoil is reused on site. Some of the suggested uses are, among others: road base and verge construction, garden beds, landscaping, suds, noise barriers, construction materials such as in concrete or hardcore.

Warning: backfilling quarries, stockpiling on third party sites or outside the site boundary are not allowed. More specification are provided in the **Official Participants Guide – Self-Built Exhibition Spaces**.

- **Minimizing the amount of waste generated on site**

  Go to **WASTE SHEET** for more information.

- **Ordering the correct type and amount of materials to make sure that nothing will be brought back**

Shift to railway

- **Improving vehicle load: optimize transport packaging and the stacking pattern, height, and location of materials into the truck**

- **Avoiding empty return trips of trucks by planning work and delivery schedules**

- **Prefer the adoption of the Construction Support Services offered by the Organizer**

Low emission vehicles

2. SHIFT TRANSPORTATION FROM TRUCK TO RAILWAY WHEN POSSIBLE

3. USE LOW-EMITTING/FUEL-EFFICIENT VEHICLES

Excavation equipment, landscaping equipment, earthmovers and material lifts can be electric powered or using fuel cell or hybrid technology.

Avoid large loads

4. AVOID EXCEPTIONAL LARGE LOADS

Heavy transport equipment is used to move extremely large, bulky, or heavy items and materials from one point to another. When such a machine is in operation, guide vehicles are usually required to escort it from one point to another and this increases the pollutant emissions and risk of congested roads.

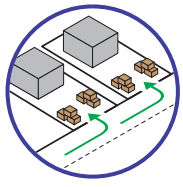
5. **PROVIDE FIRST THE RENEWABLE OR ALTERNATIVE ENERGY SYSTEMS**

It is suggested to provide first the renewable or alternative energy systems (if used in the project) as vehicle charges solutions during construction.

6. **ALLOW CONVENIENT ACCESS FOR THE STORAGE AREA**

Locate the storage area near the streets and site boundaries.

Accessible storage area



B.REDUCE DUST POLLUTION

1. **DESIGNATE TRUCK AND VEHICLES WHEELS CLEANING AREA**

In order to solve the environmental and storm water problems caused by tire track-out of dirt and sediment onto external roads, it is suggested to pace a wheel wash system next to the entrance of the site area. Closed loop water recycling technology and electronic vehicle sensor are available.

Parameters: the selection of the most appropriate model is related to the wheel, tire or chassis typology and the traffic volume.

Concrete cleaning area

2. **SECURE EXCAVATION GROUND AND DRY MATERIALS FROM WIND**

Secure excavation ground

3. **CAPTURE AND REUSE SITE WATER FOR DUST CONTROL WITHOUT IMPORTING WATER FROM OFF SITE**

Water tanks can be used during construction to capture rain water to reuse on site.

Capture and reuse water

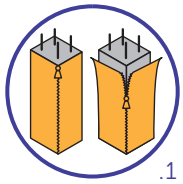
4. **MINIMIZE THE PRODUCTION OF DUST WHEN CUTTING FRAMES TO SIZE**

PHASE 2 / CONSTRUCTION / WASTE

GOALS & IMPLEMENTATION STRATEGIES

A. REDUCE WASTE PRODUCTION

1. Minimize formwork waste (recycle formworks, or use alternative technologies)
2. Minimize packaging waste
3. Avoid rework as it costs money and wastes time and materials
4. Minimize the amounts of damaged materials
5. Minimize the amounts of unused material
6. Reduce landfill waste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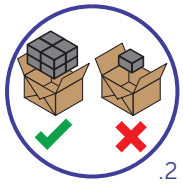
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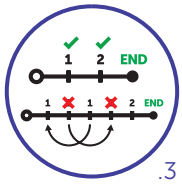

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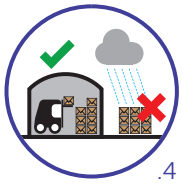
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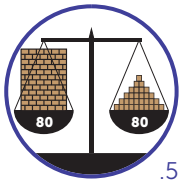

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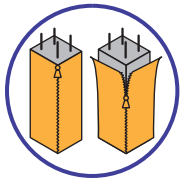
A. REDUCE WASTE PRODUCTION

1. MINIMIZE FORMWORK WASTE (RECYCLE FORMWORKS, OR USE ALTERNATIVE TECHNOLOGIES)

Resource efficient options for permanent formwork include textile forms and insulated forms, panels or blocks made from expanded polystyrene (beads or extruded), known as insulated concrete forms.

Temporary forms (metal pan forms, wood forms, modular plastic forms, corrugated paper forms) are generally reusable and easily recyclable. This means that it is possible to find reclaimed formworks. Most typically contain recycled content.

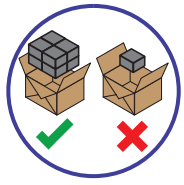
Reuse formworks



2. MINIMIZE PACKAGING WASTE

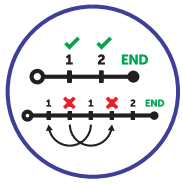
Prefer building materials with optimized packaging solutions. Recyclable packaging materials are available; the optimization can be obtained by reducing the amounts of material needed. As an alternative work with suppliers to take back and reuse packaging.

Optimize packaging



3. AVOID REWORK AS IT COSTS MONEY AND WASTES TIME AND MATERIALS

Avoid rework



- **Use the correct materials for the job to avoid poor workmanship, which can lead to rework**

- **Collaboration between designers and manufacturers enables both sides to check for manufacturability before the site construction starts**

  If the products are not manufacturable, they end up as scrap or something that needs to be reworked.

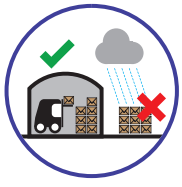
- **Use a Building Information Modeling (BIM) and Virtual Design and Construction (VDC)**

  It aids in trade coordination and eliminates conflicting construction sequences, both of which cause rework. This reduces cost and helps deliver the constructed facility on time.

- **Take photographs or make a video diary in order to record the location of service trenches, such as drains, before they are filled in**

  This will facilitate the maintenance operations without damaging large area of construction. Moreover this will facilitate the demolition phase.

Minimize materials damage



4. MINIMIZE THE AMOUNTS OF DAMAGED MATERIALS

- **Storage properly the materials**

  - organize lay down materials in order of use;
  - cover them from weather;
  - identify environmental methods of cleanup;
  - do not storage directly on the ground, causing dampness, or on uneven surfaces, causing warping, or in areas that doesn't allow for sweating and escape of moisture;
  - do not use the materials as a storage or work platform.

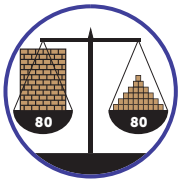
- **Install materials according to manufacturers' instruction**

- **Avoid keeping materials in storage for too long as this may lead to damage and spoilage**

  Plan the timing of your purchases so that delivery is just-in-time for the required building stage.

- **Keep your site tidy and organized in order to reduce accidents which may damage materials**

Minimize unused materials



5. MINIMIZE THE AMOUNTS OF UNUSED MATERIAL

- **Double-check the correct amount of building materials that would be needed**

- **If you require a small amount of a material which is only available in bulk, use a materials exchange scheme or plan to use the material for future jobs**

6. REDUCE LANDFILL WASTE

- **Ensure that the greenfield top soil and subsoil, if available, is reused on site**

  Some of the suggested uses are, among others: road base and verge construction, garden beds, landscaping, suds, noise barriers, construction materials such as in concrete or hardcore.

  ! **Warning**: backfilling quarries, stockpiling on third party sites or outside the site boundary are not allowed.

- **Return unused materials and off-cuts to vendor, explore salvage markets or exchange schemes**

- **Including the recycle of scrap during construction**

- **Look for authorized construction and demolition waste service providers or authorized local waste collection and recycling services in order to separate accordingly the materials waste generated on site**

  Allow convenient access for the waste collection area where waste can be separated.

- **During the design phase, specify green materials**

  Go to **MATERIALS AND CONSTRUCTION TECHNOLOGY,** and to **WASTE SHEET** in the Design Phase for more information.

PHASE 2 / CONSTRUCTION / SOIL & SUBSOIL

GOALS & IMPLEMENTATION STRATEGIES

A. PREVENT SOIL EROSION AND POLLUTION, PREVENT LOSS OF SOIL

1. Complete grading as soon as possible after it is begun
2. Control sedimentation and drainage by stabilization, structural strategies or with temporary matting
3. Ensuring that material excavated on the site is reused on site
4. Revegetate the slope as work progresses
5. Minimize contact with natural soil during construction
6. Avoid water contamination in case concrete deliveries are planned on site
7. Adopt groundwater protection strategies if refueling station for construction equipment is located in the lot area

A. PREVENT SOIL EROSION AND POLLUTION, PREVENT LOSS OF SOIL

INPUT DATA

The territory is slightly sloping to the South-Southeast, and presents a series of mild depressions riverbed that generally develop in NNW-SSE direction, while maintaining alignment with the existing surface drainage network. The area reaches its maximum altitude, 140m above sea level, in proximity of the Fiera Rho-Pero parking (North Western part of Expo Milano 2015 Exhibition Site).

The catchment area is characterized by the presence of a strong development with natural waterways and artificial different matter. In general terms, hydrography has a generally North-South direction, in agreement with the morphology of the central plains of Lombardy, characterized by a surface slightly inclined towards the South of about 0.3%. The trend piezometric stood at depths between 5 and 10 meters from the ground level, and flow direction oriented North-West and South-East.

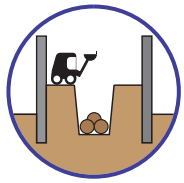
1. COMPLETE GRADING AS SOON AS POSSIBLE AFTER IT IS BEGUN

Fast grading

2. CONTROL SEDIMENTATION AND DRAINAGE BY STABILIZATION, STRUCTURAL STRATEGIES OR WITH TEMPORARY MATTING

To effectively stabilize disturbed soil areas on construction sites, proper planning, selection, and implementation of temporary soil stabilization strategies are required. Temporary soil stabilization alternatives include: mulch, hydroseeding, soil binders, rolled erosion control products. The following structural strategies are, among others, additional measures: earth dikes, drainage swales, lined ditches, silt fences, sediment traps, storm drain inlet protection.

Control sedimentation



3. ENSURING THAT MATERIAL EXCAVATED ON THE SITE IS REUSED ON SITE

Ensure that the greenfield top soil and subsoil, if available, is reused on site. Some of the suggested uses are, among others: road base and verge construction, garden beds, landscaping, suds, noise barriers, construction materials such as in concrete or hardcore.

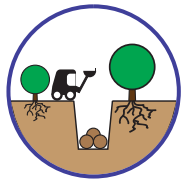
Reuse on site

! **Warning**: backfilling quarries, stockpiling on third party sites or outside the site boundary are not allowed.

4. REVEGETATE THE SLOPE AS WORK PROGRESSES

By hydroseeding or adopting correct planting procedures.

Revegetate



Parameters: the planting techniques is related to how the plant was grown in the nursery, the plant's drainage requirements, the soil type and drainage characteristics, and the availability of irrigation water and sun exposure.

It is suggested to prepare the soil in advance for planting by amending the beds with a sandy-loam topsoil and aerifying the soil as deep as possible. During transport always protect the roots, stems and foliage during transport and store the plants in a site construction area protected from the wind and sun. For an "instant" landscape look it is suggested to select large, landscape-size trees or shrubs. With large mechanical digging equipment, 15 to 20 cm diameter trees or shrubs can be moved.

Warning 1: Participants have to adopt all protective measures required by Italian legislation and EU directives (2000/29/EC) against the introduction and spread into European and Italian territory of organisms harmful to plants or plant products. More specification will be provided in the **Guidelines – Import of plants and plant products, for Construction and Set-up of Exhibition Space. Warning 2**: use native/adapted and mature plants that require minimal or no irrigation and do not require active maintenance such as mowing or chemical inputs such as fertilizers, pesticides or herbicides. **Warning 3**: a properly planted tree or shrub will be more tolerant of adverse conditions and require much less management than one planted incorrectly.

Minimize soil contact

5. MINIMIZE CONTACT WITH NATURAL SOIL DURING CONSTRUCTION

Use the constructed ground slab itself to support construction equipment.

6. AVOID WATER CONTAMINATION IN CASE CONCRETE DELIVERIES ARE PLANNED ON SITE

The wash water can be returned with each concrete truck for disposal at the concrete batch plant by using onboard self-cleaning systems. Water can be separated by waste concrete, pumping it back into the water tank for reuse as washout water. As an alternative, it is possible to place an on-site concrete washout area around and under the concrete truck to catch any spills. This can be a prefabricated or self-installed. It is suggested to allow convenient access for concrete trucks, preferably near the area where the concrete is being used.

Ensure tyres are clean before leaving construction site.

Warning 1: the concrete washout area should not be placed near to storm drains, open ditches, or water bodies. **Warning 2**: vacuum and dispose of the waste material in an approved manner. It is suggested to reuse the hardened concrete onsite or haul it away for disposal or recycling.

7. ADOPT GROUNDWATER PROTECTION STRATEGIES IF REFUELING STATION FOR CONSTRUCTION EQUIPMENT IS LOCATED IN THE LOT AREA

Parameters: general site location, geology, hydrogeology, proposed site layout, storm water runoff strategy, and equipment requirements.

Clean the fueling areas with dry methods, using rags or absorbents. Fueling areas should never be washed down unless the water is collected and disposed of properly.

PHASE 3 / DISMANTLING AND REUSE / WASTE

GOALS & IMPLEMENTATION STRATEGIES

A. REDUCE THE AMOUNT OF LANDFILL WASTE AND MINIMIZE THE NEED FOR VIRGIN RESOURCES BY REDUCING

1. During the design phase, choose green materials and design for deconstruction
2. During the construction phase, adopt solutions that facilitate the building deconstruction
3. During the dismantling phase minimize the amounts of damaged materials

B. REDUCE THE AMOUNT OF LANDFILL WASTE AND MINIMIZE THE NEED FOR VIRGIN RESOURCES BY REUSING

1. Inspect and evaluate for reuse the entire exhibition facility (or part of it) in your country
2. Identify components to be salvaged for reuse

C. REDUCE THE AMOUNT OF LANDFILL WASTE AND MINIMIZE THE NEED FOR VIRGIN RESOURCES BY RECYCLING

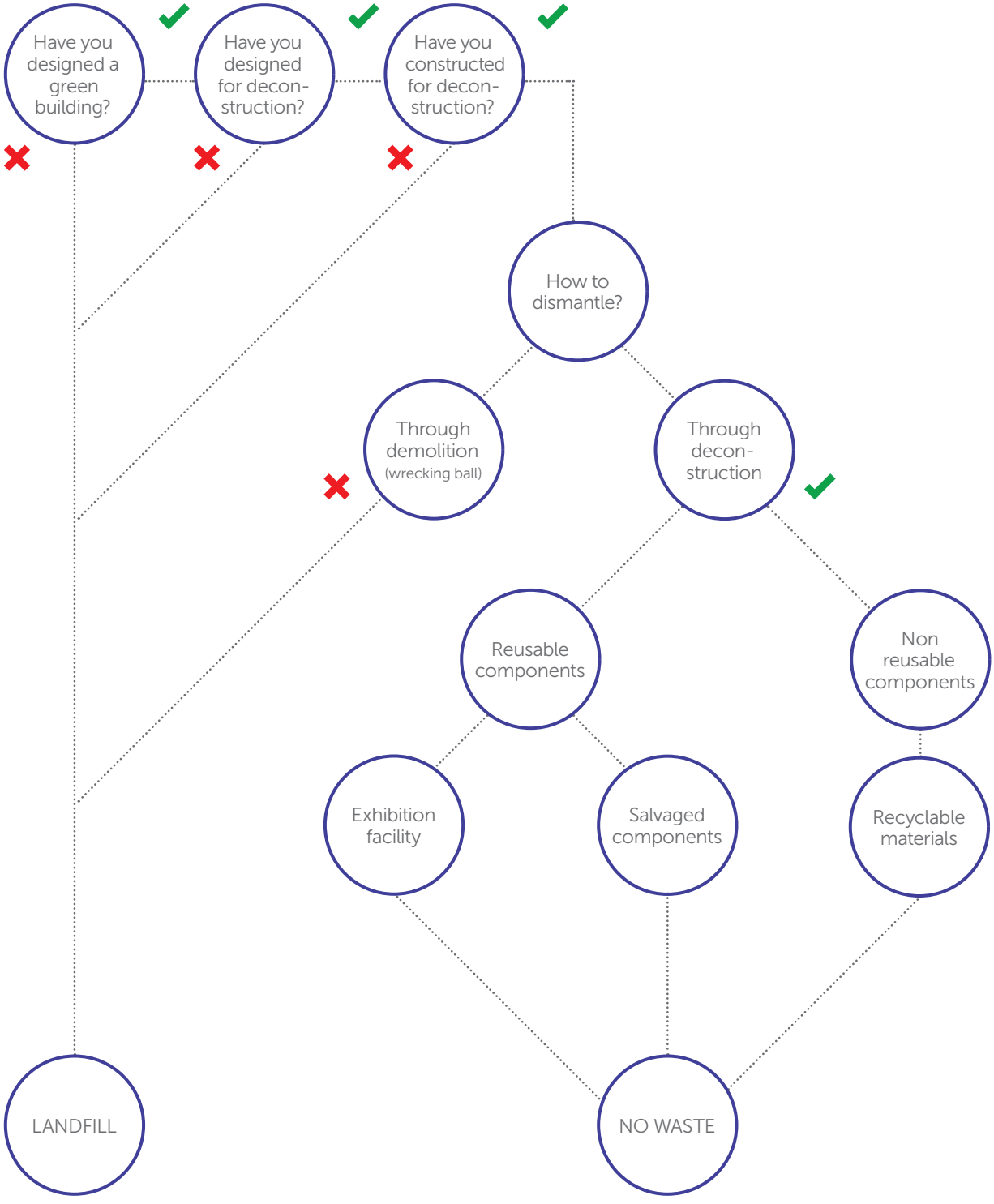
1. Identify materials which can be recycled and transformed into a new product

REMEMBER THAT

The Organizer has prepared a list of "Construction Support Services" for the Participants in order to simplify the dismantling phase. Participants are encouraged to follow the implementation strategies of this chapter in order to reduce the environmental impact of the building during the dismantling phase.

Warning: Participants are encouraged to adopt an Environmental Management System (in accordance with ISO 14001/EMAS or equivalent) in the dismantling phase. In any case Participants should require their suppliers (or general contractor) to develop and adopt an Environmental Manual for Sitework Management.

How to reduce waste?



A. REDUCE THE AMOUNT OF LANDFILL WASTE AND MINIMIZE THE NEED FOR VIRGIN RESOURCES BY REDUCING

REMEMBER THAT

Landfill waste production is the main environmental risk associated to this phase which can increase the environmental impact of the Exhibition facility and invalidate the good practices adopted in the previous steps. For this reason, it is strongly suggested to:

- Follow a process-based "Life Cycle Thinking" from the design phase in order to be sure that the Exhibition Spaces are designed for dismantling at the end of the Event and the original site can be restored (ground surface and subsurface) with the minimum amount of demolition waste;
- Select the properly waste minimization strategy according to the "waste hierarchy approach" which includes the following 3R options (lowest on the list are least desirable because they require a higher resource and energy consumption): Reduce, Reuse, Recycle.

1. DURING THE DESIGN PHASE, CHOOSE GREEN MATERIALS AND DESIGN FOR DECONSTRUCTION

Go to **MATERIALS AND CONSTRUCTION TECHNOLOGY,** and to **WASTE SHEET** in the Design Phase for more information.

- **Select construction materials based on their capacity to be reused and recycled after the building has served its purpose**

  Avoid hazardous materials altogether as they are detrimental to the natural environment and are non-reusable.

- **Prefer dry construction technology in order to make components within systems easily separable**

  Allowing physical access to the fasteners is another needed aspect of this design.

- **Design by components which can be easily removed without dismantling all building layers**

  The bigger size of components, the better since they can accelerate the dismantling phase. Modular building design can also facilitate the reuse of single units arranged in various combinations in other context.

! **Warning**: Avoid exceptional large loads. Go to **AIR QUALITY SHEET** in the Construction Phase for more information.

2. **DURING THE CONSTRUCTION PHASE, ADOPT SOLUTIONS THAT FACILITATE THE BUILDING DECONSTRUCTION**

   - **Avoid or use fewer adhesives and sealants**
   - **Install materials according to manufacturers' instruction in order to facilitate their dismantling**
   - **Where it is not possible to make all layers of the building visible, it is suggested to take photographs or make a video diary in order to record the location of service trenches, such as drains, before they are filled in**

3. **DURING THE DISMANTLING PHASE MINIMIZE THE AMOUNTS OF DAMAGED MATERIALS**

   - **Avoid building implosions or 'wrecking-ball' style demolitions since they create substantial amounts of rubble which is difficult to reuse and separate to be recycled**

     Use a "softer" demolition technique, called "deconstruction" in which materials can be removed intact (e.g. windows and frames, plumbing fixtures, floor or ceiling tiles) or in large pieces (e.g. lumber).

   - **Use photographs or videos made during the construction phase to identify the location of trenches**

     Use construction drawings in order to indentify all components.

   - **Remove materials following manufacturers' instruction in "reverse"**

Warning: deconstruction is typically more labor intensive than demolition but thoughtful and considered disassembly represents the best way to salvage items scheduled to be reused.

B. REDUCE THE AMOUNT OF LANDFILL WASTE AND MINIMIZE THE NEED FOR VIRGIN RESOURCES BY REUSING

1. **INSPECT AND EVALUATE FOR REUSE THE ENTIRE EXHIBITION FACILITY (OR PART OF IT) IN YOUR COUNTRY**

   Locally or in other countries for the same purposes (temporary or permanent exhibition facilities) or preferably for social purposes (e.g. emergency centers, community centers, urban design and others).

Warning 1: to reuse the entire exhibition facility (or part of it) it is important to design for adaptability and for deconstruction during the planning phase taking into account the future functional programs and needs. **Warning 2**: to reuse the entire exhibition facility (or part of it) Participants have to take into consideration the article 10, paragraph 8 of the Agreement between the Italian Republic and the Bureau International des Expositions on Measures necessary to facilitate participation in Universal Exposition 2015 in Milan (Law 14 January 2013, n. 3 –done in Rome on July 11, 2011)

2. IDENTIFY COMPONENTS TO BE SALVAGED FOR REUSE

In your country, or locally typical materials suitable for reuse include plumbing fixtures, doors, windows, brick, light fixtures, ceiling and floor tiles, wood, HVAC equipment and others.

- **Look into donation programs or reuse stores**

  Community centers, thrift stores, schools, and nonprofit organizations may accept a variety of used building materials and unneeded furniture.

- **Link a deconstruction project with a current construction or renovation project to facilitate reuse of salvaged materials**

- **Explore manufacturer take-back and/or buy-back services**

- **Identify online websites where people can advertise the need for materials and used industrial equipment**

Warning 1: deconstruction is typically more labor intensive than demolition but thoughtful and considered disassembly represents the best way to salvage items scheduled to be reused. **Warning 2**: instead of creating a pile of mixed items, separate them according to their final destination in order to salvage useful products. Allow convenient access for the waste collection area.

C. REDUCE THE AMOUNT OF LANDFILL WASTE AND MINIMIZE THE NEED FOR VIRGIN RESOURCES BY RECYCLING

1. IDENTIFY MATERIALS WHICH CAN BE RECYCLED AND TRANSFORMED INTO A NEW PRODUCT

Some of the typical materials which can be recycled from building sites, rather than being disposed of and managed as waste, include metal, lumber, tiles, concrete, roofing materials, corrugated cardboard and wallboard, rubble (go to **MATERIALS AND CONSTRUCTION TECHNOLOGY,** and to

WASTE SHEET in the Design Phase for more information on materials with recycle content).

These materials are used in place of virgin inputs in the manufacturing process which transforms them into either the same product or a secondary product.

- **Identify authorized construction and demolition waste service providers and associated recycling industries**
- **Explore manufacturer take-back and/or buy-back services**

Warning: instead of creating a pile of mixed items, separate them according to the local construction waste management. Allow convenient access for the waste collection area.

PHASE 3 / DISMANTLING AND REUSE / AIR QUALITY

GOALS & IMPLEMENTATION STRATEGIES

A. REDUCE GHG ARISING FROM TRANSPORT AND CONSTRUCTION VEHICLES

Go to **AIR QUALITY SHEET** in the Construction Phase to see the implementation strategies.

B. REDUCE DUST POLLUTION

Go to **AIR QUALITY SHEET** in the Construction Phase to see the implementation strategies.

REMEMBER THAT

Deconstruction has also been defined as "construction in reverse". This is the reason why it is suggested to adopt the same strategies described in **AIR QUALITY SHEET** in the Construction Phase in order to reduce the GHG arising from transport and construction vehicles and reduce dust pollution during the dismantling phase.

PHASE 3 / DISMANTLING AND REUSE / SOIL AND SUBSOIL

GOALS & IMPLEMENTATION STRATEGIES

A. PREVENT SOIL EROSION AND POLLUTION, PREVENT LOSS OF SOIL

Go to **SOIL AND SUBSOIL SHEET** in the Construction Phase to see the implementation strategies.

REMEMBER THAT

Deconstruction has also been defined as "construction in reverse". This is the reason why it is suggested to adopt the same strategies described in **SOIL AND SUBSOIL SHEET** in the Construction Phase in order to reduce the GHG arising from transport and construction vehicles and reduce dust pollution during the dismantling phase.

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