Living Wall Systems Potential in the Nearly Zero Emissions Building assessing

Roberto GIORDANO

International Conference on Living Wall Systems and Ecosystem
6-8 July, 2015
ABOUT US – START-UPPERS

Silvia Tedesco
Partner Co-Founder and CEO, Architect Ph.D in Innovation Technology for Built Environment

Elena Montacchini
Partner Co-Founder and research manager, Architect Ph.D, Assistant Professor, Politecnico di Torino, DAD

Roberto GIORDANO
Partner Co-Founder and research manager, Architect Ph.D, Associate Professor, Politecnico di Torino, DAD
GREEN_SOLUTIONS

GRE_EN_Solutions are LWS developed as:
1) Hydropic systems
2) Modular box systems

A modular box is essentially made up by a recycled metal container:
1) filled with rigid plastic geogrid and growing medium
2) covered by double felts coupled
GREEN_SOLUTIONS

1. GRE_EN_SKin
Thin vegetated cladding devised for the technological integration on new and existing wall

2. GRE_ENvelope_System
Self standing and quick assembling LWS

3. GRE_EN_Suitcase
Vegetated modular and transportable building totally equipped

A Nearly zero-energy building is defined as “a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources”

According to scientific literature within such definition some issues needed to tackled
TOWARD NZEB

The energy demands - over the building life cycle – is often matched to carbon emissions as highlighted by the:

International Energy Agency
Annex 52, Task 40

International Energy Agency
Annex 57
Some indicators should be included in the building energy & environmental analysis, such as:

**EMBODIED ENERGY AND EMBODIED CARBON**

Embodied Energy: embedded energy in construction materials over the building life cycle

Embodied Carbon: CO₂ equivalent due to EE accounting and to CO₂ sequestration/credit potential ascribed to some materials and to vegetation (if assumed as part of a building system)
The study was aimed at characterizing the carbon dioxide equivalent emissions and the carbon storage potential of a LWS – initial Embodied Carbon taking into account the manufacturing processes and the on-site assembling over a defined period.

The study was based on a Life Cycle Assessment carried out according to ISO 14040:2006 standard.
LWS: CO$_2$ eq ACCOUNTING

**Functional Units:** one square meter ($1m^2$) of GRE_EN_Skin

Four modular boxes make one square meter

Six pockets are hand-cut on the outer layer of every modular box

Potting soil, vegetation planted (Lonicera Nitida) materials required to product system were taken into account
LWS: CO₂ eq ACCOUNTING

**Boundary in time**: carbon dioxide emissions and credits were accounted on 100 years target

**Boundary towards geography**: Italy electric energy mix

**Boundary in the life cycle**: raw material extraction, raw material refining, components manufacturing and building-system assembly

**Boundary towards nature**: the carbon dioxide credits were accounted by including the CO₂ credits content in shrub biomass and in cellulose based fibers
LWS: CO$_2$ eq ACCOUNTING

The carbon dioxide calculation (Lonicera nitida) was implemented estimating the shrubs biomass from basal stem diameter (Ohmann et. Al. 1976)

\[ Y = a \cdot X^b \]

\( Y = \text{dry weight} \)
\( X = \text{stem diameter} \)
\( a \) and \( b \) = variables based on stem diameter

The stem diameter (cm) was measured at 0.25 cm above the soil. The Lonicera stem diameter was 1.5 cm (mean value for the measured plants). The \( a \) and \( b \) values – for substituting in allometric equation - were respectively 2.371 and 0.7265. The values refer to current-year's twigs (Lonicera was planted on potted soil in 2012) excluding leaves size (individual leaf area and mass).
The carbon dioxide calculation concerning the vegetation was carried out on a reference building – test cell - in 2013 (may) four month after the construction and in 2015 (may) after three pruning.
### LWS: CO₂ eq ACCOUNTING

<table>
<thead>
<tr>
<th>Shrub specie</th>
<th>Mean stem diameter [cm]</th>
<th>Values for biomass predictions based on current year's twig</th>
<th>Biomass [grams]</th>
<th>Number of stem per pocket</th>
<th>Number of pocket</th>
<th>Total stems per modular box</th>
<th>Total biomass per modular box</th>
<th>Estimated Carbon contents dried wood</th>
<th>Estimated CO₂ equivalent contents dried wood</th>
<th>Total CO₂ equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lonicera Nitida Honey suckle</td>
<td>1.3</td>
<td>5,147</td>
<td>1,184</td>
<td>7.02</td>
<td>18</td>
<td>6</td>
<td>108</td>
<td>1643.16</td>
<td>1,643</td>
<td>0.435</td>
</tr>
</tbody>
</table>

#### 2013: CO₂ credits for modular box

<table>
<thead>
<tr>
<th>Shrub specie</th>
<th>Mean stem diameter [cm]</th>
<th>Values for biomass predictions based on current year's twig</th>
<th>Biomass [grams]</th>
<th>Number of stem per pocket</th>
<th>Number of pocket</th>
<th>Total stems per modular box</th>
<th>Total biomass per modular box</th>
<th>Estimated Carbon contents dried wood</th>
<th>Estimated CO₂ equivalent contents dried wood</th>
<th>Total CO₂ equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lonicera Nitida Honey suckle</td>
<td>1.5</td>
<td>5,147</td>
<td>1,184</td>
<td>8.32</td>
<td>40</td>
<td>6</td>
<td>240</td>
<td>1996.45</td>
<td>1,996</td>
<td>0.435</td>
</tr>
</tbody>
</table>

#### 2015: CO₂ credits for modular box
LWS: CO$_2$ eq ACCOUNTING

Toward a “nearly” zero CO$_2$ emissions LWS

[2015 scenario]
CONCLUSIONS and OUTLOOKS

Vegetation plays a strategic role in the NZEB approach

The equivalent carbon dioxide - Embodied Carbon - changes over the building life cycle due to the vegetation growth

An expected vegetation life span should be considered as well as some end-of-life scenarios
The Leaf Area Index (LAI) and root biomass might be considered in order to get an extensive evaluation of CO₂ equivalent
Life Cycle Approach to designing, manufacturing and assessing a Living Wall System

Roberto Giordano, Elena Montacchini, Silvia Tedesco

Abstract

In recent times Life Cycle Approach in building design and construction was set up by means technical standards (e.g. CEN/TC 350) as well as comprehensive impact assessment methods (e.g. LEED® and ITACA). Although standards and methods may be considered as accurate and exhaustive, product and system design needs a further organisation and systematisation of those environmental requirements tricky to take into account in preliminary design. It stands to reason such trickiness becomes more important in industrial research projects.

Starting with the assumption that there is an urgent need to overcome the gap between design and production, the paper deals with the outcomes of a research project focused on detailed designing, manufacturing and monitoring of a Living Wall System (LWS) aimed at carrying into action a Life Cycle Approach.

http://www.fupress.net/index.php/techne/article/view/12820
CONTACTS

Growing Green s.r.l.
sede legale: via Alfonso Lamarmora 16 - 10128 Torino (TO)
C.F./P.Iva 11237690018  REA TO - 1198081

info@growinggreen.it
+39 0141/476910

www.facebook.com/greens2013
@groingre