Green façade is often used for architectural and ecological purposes. Despite aesthetic functions, few designers use their primary function, being to take over the solar energy coming to the building wall to moderate the heat flow penetrating the wall and to improve the building energy balance.

When properly designed, the insulation properties of a building wall may be improved significantly and the demand for ventilation and air-conditioning can be reduced.

The TRNSYS software is a simple and low-cost simulation tool to determine the building’s thermal and energy balance. However, it didn’t include a module to calculate the heat of a green façade, therefore, within CommONEnergy, CIM-mes developed a dedicated TRNSYS vertical façade component, the VFC (Vertical Foliage Component).

To make it useful for engineering purpose, an open database of plants physiological parameters relevant to heat conduction issues is also included, taking into account seasons and geographical location.

Note: the VFC module is designed to allow calculations for a vertical green façade fixed on wiring.
The vertical green façade sub-model programmed in the VFC component of TRNSYS aims at calculating the building energy balance, for new and existing buildings. Its integral element is the plant database, where their thermal properties such as solar radiation absorption / attenuation, thermal conductivity of the leaves and their dimensions, stomatal properties, seasonal variations and more are included. The mathematical model programmed in the VFC has been verified in a laboratory environment for summer and autumn.

The green solution is limited to vertical foliage fixed with wiring being anchored on a wall; particularly well applicable on a building due to its low cost, easy fixing and maintenance, together with short ROI time. The mathematical model saved in VFC is a general-purpose model. It may be used for any building: new and retrofitted, residential as well as public or commercial. It is well suited for fast and low-cost improvement of retrofitted public buildings with walls’ high U-value.

When considering only the heat transfer across a façade, a climbing plant can decrease the annual heat transfer by an average of 35%. When in lower latitude areas, where the vegetation season is longer, the savings can even reach 80%.

The VFC design tool is well-suited for architectural and engineering offices working on new building development and building retrofitting preparatory works. It can also serve as a tool to forecast the building operation energy costs for real-estate developers and managers.

**How It Works**

The VFC component stores the mathematical model of climbing plants. It has been tested in laboratory for a climbing plant fixed on the wall with wiring. In the TRNSYS VFC environment, it is an add-on to the regular wall model and corrects the solar radiation acting on the wall surface.

\[
C = c_p g_{	ext{rh}} (T_u - T_L) \\
E = \lambda g_h \frac{0.611 (h_r - 1)}{p_a} e^{\frac{13.72 T_L}{T_r - T_L}} \\
XR = \frac{\varepsilon_L \varepsilon_g \sigma (T_u - T_L)}{\varepsilon_L + \varepsilon_g - \varepsilon_L \varepsilon_g} (T_u - T_L) \\
LR_g = \varepsilon_L \varepsilon_g \sigma (T_g - T_L)
\]

**Innovative Potential**

The mathematical model for the VFC is a unique building energy design tool, taking into consideration both the exploitation of the green wall functionalities and adjusting the proper impact on the building’s energetic balance.

When considering the building design process, the use of VFC is the one step forward from the aesthetic functionality of a green façade to its thermal functionality.
Possibility to evaluate the influence of the green façade on the energy balance of the building
Ability to develop a strategy for the automation of the air conditioning systems
Exploitation of the time shift between the solar heating of the bare wall and the wall protected by foliage to enable an enhanced strategy for the HVAC control
Typical insulation of a building can be replaced with a low cost, ecological installation of a wired green façade. Such a strategy significantly reduces the investment cost; however, it requires in each case a detailed analysis carried out by specialists
The green façade improves the water management of the building (accumulation of rain water): plants are used as natural water storage system so water sewage run-off may be decreased

BENEFITS

The VFC module is an add-on for the TRNSYS / TRNBUILD simulation environment. TRNSYS users can extend the existing building’s thermal calculation capabilities by installing the green façade component.

COMPATIBILITY WITH OTHER TECHNOLOGIES

The mathematical model programmed in the VFC module and the variable geolocation and seasons parameters are intended for use in the TRNSYS simulation environment.

The VFC module and related climbing plants database are software-codes-customized for TRNSYS simulation environment.

Installation of the VFC module is straightforward especially for engineers using TRNSYS; it consists in copying a module into a DLL.

No specific training is necessary to use the VFC module, for people skilled in TRNSYS. When analysing the building as a whole, the TRNBUILD application should be used.

The VFC automatically retrieves the weather data from the "meteonorm" database available in TRNSYS, however for plants characterization across different geographical locations and related seasons impact, plant data is retrieved from the attached open database. It may be updated by users.
The project CommONEnergy (2013-2017) focuses on transforming shopping centres into energy efficient buildings, by developing smart renovation strategies and solutions to support their implementation as well as assess their environmental and social impact.

- 3 demo cases, 8 reference buildings & 23 partners from across Europe
- 25 technologies developed and installed in 4 years
- Up to 75% reduction of energy demand, leading to costs reduction
- A payback time of maximum 7 years

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