This research explored the use of vegetation in building facades as a potential solution to the problems of urban ecology and the excessive energy consumption in buildings. Vegetated facades substantially reduce building energy use, reduce the urban heat island effect, improve air quality, and increase the biodiversity of plants and animals in cities.

The goal of this research was to evaluate the effects of plants on building thermal performance and energy consumption by developing a thermal model of a building facade covered with a layer of plants. The developed mathematical model accounts for thermal physical processes in a vegetated exterior wall including solar radiation, infrared radiative exchange between the facade and sky, the facade and ground, the facade and vegetation layer, convection to and from the facade, evapotranspiration from the plant layer, heat storage in the facade material, and heat conduction through the facade. The model calculates vegetated facade surface temperature and heat flux through the facade for multiple weather conditions, plant physiological characteristics, and facade parameters inputs. The model was validated with the results of a week long experiment
measuring the thermal properties of bare and vegetated facades of a building on the Illinois Institute of Technology campus.

The experiment and subsequent sensitivity analysis demonstrated that a plant layer can effectively reduce the facade exterior surface temperature, daily temperature fluctuations, exterior wall temperature gradient, and, as a result, provide as much additional thermal insulation to the facade as a 2.5 cm layer of expanded polystyrene insulation. The vegetated facade model was also used to analyze the reduction in energy consumption in generic office and residential thermal zones for multiple parameters. The simulations showed that energy reduction could be as high as 6.2% of annual total energy use and 34.6% of cooling energy use in residential thermal zones.

Overall, the model provided new tools for evaluating the impact of plant layers on facade thermal performance in existing buildings retrofitted with green walls and for designing green walls for optimal energy efficiency in new construction.