

Studies of Photovoltaic Roofing Systems at Wind Engineering and Fluids Laboratory at Colorado State University

Rising prices of crude oil and natural gas have led to renewed societal interest in application of photovoltaic technology to generate electricity. Various innovative systems incorporating photovoltaic panels have been developed over the past decades. Prominent among them are photovoltaic roofing systems, installed on roofs of new and existing buildings in loose-laid arrangements or attached to supporting structures. A representative example of such systems adapted for installation on flat roofs is shown in Figure 1. The depicted system has been developed by SunPower Systems (formerly PowerLight Inc.), a wholly owned subsidiary of SunPower Corporation – a leading US provider of a variety of photovoltaic systems installed worldwide.

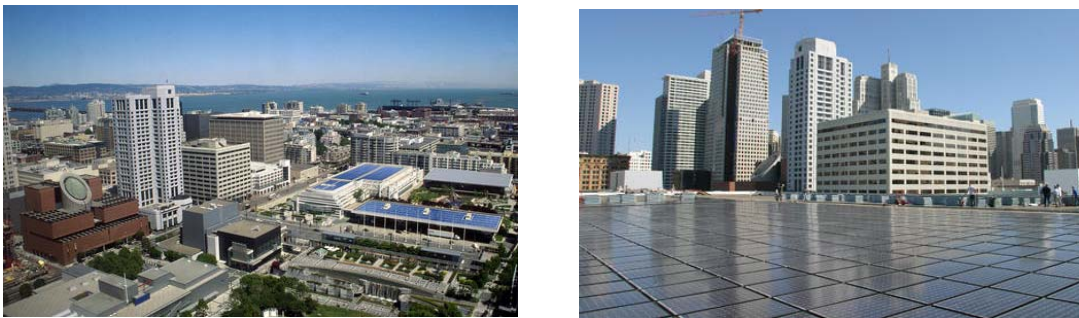


Fig. 1. Representative Photovoltaic Roofing System (Courtesy of SunPower Corp.)

Development of economically viable photovoltaic systems of high performance and operational reliability involves addressing a number of technical aspects. Wind resistance of the system is one of the critical issues considered in this process.

Over several decades, researchers affiliated with Wind Engineering and Fluids Laboratory (WEFL) at Colorado State University (CSU, www.windlab.colostate.edu) have been involved in investigations of wind effects on buildings and other structures, and their components. The results of fundamental and applied wind engineering research performed at WEFL have been utilized by architects, structural engineers, as well as developers of innovative building systems, including roofing photovoltaic systems.

The WELF's involvement in wind engineering studies of roofing systems offered by SunPower Systems was initiated shortly after a first meeting (held at CSU in 1994) involving Tom Dinwoodie, currently the CEO of SunPower Systems and Bogusz Bienkiewicz, currently Prof. & Dir. of WEFL. The exploratory wind resistance study at WEFL of the original concept proposed by Tom Dinwoodie was followed by a number of refined wind tunnel investigations and analyses carried out by the staff of WEFL. These efforts led to establishment of the aerodynamically optimized configurations which served as the basis for photovoltaic systems subsequently further refined and installed worldwide by SunPower Systems.

Reflecting on the above investigations at WEFL, Tom Dinwoodie recently observed: “Without the validation provided by CSU in the early days, PowerLight (now SunPower), would not have become what it is today. It was a necessary and critical leap to evolve from heavy-ballasted and structure-mounted photovoltaics to the lightweight, low-cost, penetration-free system that we developed with Dr. Bienkiewicz. These innovations enabled rapid development of the solar power market. As a result of our technology lead, SunPower is today a global leader in the market for solar power.”



In addition to SunPower Systems, over the years, Dr. Bienkiewicz and his team at WEFL have assisted other companies and inventors in development of various loose-laid and attached roofing systems involving photovoltaic components. Although the wind tunnel testing procedure (implemented at WEFL) has been only slightly modified over that time, see Fig. 2, data analysis and its adaptation for specific roofing products have been significantly improved.

Fig. 2. Representative Wind Tunnel Configuration for Testing of Models of Photovoltaic Roofing Systems, at Wind Engineering and Fluids Laboratory, Colorado State University