

**A Quantum Leap in Energy Efficiency**  
**The Development of Icephobic Coatings for Air Source Heat Pumps**

**Paul Oppenheim, Ph.D., P.E.**  
**Rinker School of Construction Management**

Heat pumps are a very energy efficient way to provide heating and cooling. Approximately, 3.5 million of Florida's 7.3 million households use these systems. The majority of the balance use electric resistance heating along with straight cooling air conditioning systems which are far less efficient than a heat pump. However, in South Florida, with minimal heating loads, electric resistance heating systems prevail.

While heating, a heat pump uses the outdoor air as the source of heat and transfers thermal energy to the conditioned space. However, when the outdoor air is cold and humid, frost will develop on the heat pump's outdoor coil. This frost on the coil surface blocks air flow and reduces the heat pump's efficiency. To restore the unit's heating capacity, a defrost cycle is needed to remove the accumulated frost developed on the coil. To remove frost, heat pumps reverse the refrigerant cycle to heat the outdoor coil and melt the frost. This approach has the undesirable consequence of cooling the indoor space intended to be heated, such that backup heaters are used to provide temporary heating during the defrost period. This practice also results in spikes in electricity demand. Many electric utilities in Florida have their peak electric load due to this phenomena. While defrosting restores heat pump efficiency, this period of operation results in an energy penalty and increased consumption. A heat pump system capable of eliminating or minimizing defrost, therefore, would benefit the consumer by decreasing their electricity consumption and would benefit the utility by minimizing demand spikes due to defrost.

Icephobic coatings have been developed to prevent the formation of ice on surfaces where icing can be problematic. Applications to date include: roads, bridges, power lines and aircraft. Successful application of an icephobic coating to the outdoor coil of a heat pump would prevent ice formation and negate the need for defrost.