Executive Summary

This report is intended to explain the results of several investigations into the proposed alternatives systems for the Integrated Sciences Building as a part of the Penn State Architectural Engineering program. The Integrated Sciences Building is an urban University facility that will be home to several scientific research departments in addition to becoming the first LEED Gold certified building at one of the most prestigious education institutions in the northeastern United States.

The original mechanical system uses primarily Variable Air Volume (VAV) systems with terminal to meet the thermal loads of the office, educational, and research spaces within the building, with Constant Volume air systems serving the 240-seat auditorium and atrium. The laboratory VAV systems supply 100% Outside Air to guarantee acceptable air quality and to purge the building of any contaminants generated during experiments. Two 620-ton centrifugal chillers provide chilled water to meet cooling demands and a district steam system provides heating capacity of up to 20,000 pounds per hour.

The proposed alternatives include a Variable Primary Flow (VPF) chilled water pumping system in place of the existing Primary/Secondary system. After performing parametric energy analysis on a number of different pumping configurations, it was determined that the VPF system has the potential to save over 32,000 kWh annually, which translates to 3.97% of the total chilled water plant energy consumption. Over the 30-year life cycle, this comes to a net benefit of over $40,000.

The next alternative study performed was Thermal Energy Storage (TES) system which was designed to flatten the cooling load profile of the Integrates Sciences Building in attempts to reduce the monthly billable electrical demand. Calculations showed that annual electrical demand charges would be reduced by over $10,500 annually, but the penalty of ice production for thermal storage resulted in an annual increase in electrical consumption bills by over $9,000 annually. In the end, due to the capital cost and reduced annual maintenance estimates, the life cycle costs showed that a TES system would produce a 30-year net benefit of over $450,000.

A solar photovoltaic energy production system was also designed to take advantage of the renewable energy production capabilities. The system, sized at 80kW is projected to produce over 99,000kWh of electricity per year. With state and government financial grants and incentives, the payback period on the system comes to only five years.

Finally, a Construction and Logistics study was performed to estimate the effect the thermal storage system construction would have on the project schedule. Using RSMeans scheduling data, it was determined that the thermal storage system could be installed concurrently with other construction tanks, minimally effecting the overall schedule. An extra 375 man hours would be added to the schedule and the entire thermal storage tank and piping system could optimistically be installed in little over four weeks.