SYNOPSIS

# KEY POINT SUMMARY

## OBJECTIVES

The purpose of this research was to evaluate the similarities and differences between eight hospitals, four located in Scandinavia and four in the Pacific Northwest, in their energy profiles and design attributes.

# Comparative Analysis of Hospital Energy Use: Pacific Northwest and Scandinavian

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## Key Concepts/Context

Today, operational hospitals in the United States consume an enormous amount of energy. This study is an outgrowth of previous research evaluating high-quality, low-energy hospitals that serve as examples for new high-performance hospital design, construction, and operation. Through extensive interviews, numerous site visits, development of case studies, and data collection this team established thorough qualitative and quantitative analyses to compare several contemporary Scandinavian hospitals against several Pacific Northwest hospitals. This report seeks to illustrate examples of qualitative attributes that lead to higher indoor environmental quality. This report also includes case studies of four Scandinavian hospitals.

## Methods

The four Pacific Northwest and four Scandinavian hospitals were chosen for their energy performance, age, size, and indication of relevance in current hospital design. The Pacific Northwest was chosen as a specific study area because its climate most closely matches that of Scandinavia's climate.

The eight hospitals are compared based on energy performance, as determined by the U.S. Environmental Protection Agency's Portfolio Manager. Portfolio Manager is the tool most widely used by building owners and operators to track building energy performance. This product tracks energy based on source energy use (the amount of energy that must be produced to serve the building) and accounts for the impact of weather as well as key physical and operational attributes of the building. It collects relevant information about a building including square footage, occupancy, electrical energy use, gas energy use, and water consumption, and through a series of regression analyses provides an ENERGY STAR rating. The ENERGY STAR rating ranks the building's performance in comparison to other similar buildings to create a percentile-based "score," where 100 means that it is the top-performing building of its type and size. In order to better understand the Portfolio Manager tool, the research team attended a half-day training workshop.

In order to characterize a building's ENERGY STAR rating, Portfolio Manager uses a database of existing operational buildings and performs a regression analysis that includes rankings for building type, location (climate), size, and other building operational and physical characteristics. For hospitals, the dataset that Portfolio Manager accesses was updated in 2011 by the EPA in collaboration with the American Society for Healthcare Engineering (ASHE) and the American Hospital Association (AHA). The dataset includes 191 operational hospitals nationally. From this dataset, it was determined that size, number of patient beds, number of full-time employees, number of MRIs, and number of cooling-degree days were significant in determining the energy intensity of hospitals. These attributes do not determine the energy intensity of hospitals, but they are indicative of a hospital's relative energy intensity.

Data for this report were collected through interviews, site visits, and e-mail correspondence. The empirical data for the Scandinavian examples were gathered in an effort to match the information needed for imputing the data into Portfolio Manager. Due to differences in units, post-processing of the data was necessary in order to enter U.S. equivalent values for area, energy, etc. For all hospitals, the data analyzed is for 2011, except as noted for Rikshospitalet, where data from 2011 was unavailable, thus data from 2010 are reported.

## Findings

This report shows a side-by-side comparison of Scandinavian and Pacific Northwest hospitals evaluating site EUI, source EUI, and ENERGY STAR scores. As hypothesized, Scandinavian hospitals use less energy at a site level compared to their Pacific Northwest counterparts, and they generally rank much higher in ENERGY STAR score, due to both total site energy consumption and source energy type. It is clear that a hospital's site energy utilization, as well as the fuels used to supply that energy, significantly impact the ENERGY STAR ranking.

These results show that the Pacific Northwest hospitals use more energy on site, on a square-foot basis, than their Scandinavian counterparts using between 157-226 kBtu/SF Year with an average of 198 kBtu/SF Year. These Pacific Northwest examples represent well-operated facilities that are relatively efficient compared to their counterparts, highlighted by the fact that each hospital is below the median Energy Use Intensity (EUI) for the Pacific. [EUI is normally reported in units of kBtu/SF Year in the U.S. and in KWh/SM Year in Europe. This measure is similar to using a miles-per-gallon rating for cars and it enables a side-by-side comparison of buildings' energy use footprints.

Based on the data collected and analyzed in this report, the hypothesis stands true that Scandinavian hospitals consume significantly less energy than Pacific Northwest hospitals.

As institutions whose missions are to "first do no harm," reducing the environmental and health burden of energy consumption and providing high-quality healthcare environments should be fundamental priorities for healthcare organizations. These Scandinavian hospitals provide evidence for professionals in design, construction, and operation of U.S. hospitals showing that it is possible to achieve significantly reduced energy footprints and increased indoor environmental quality in healthcare facilities.

## Design Implications

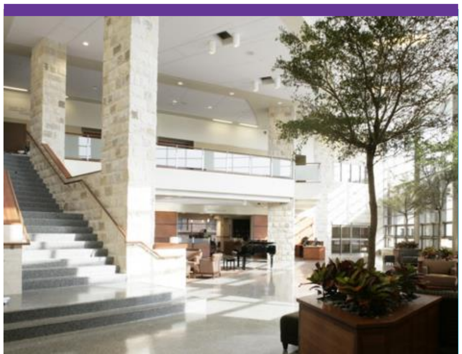
Specific architectural, building mechanical, and plant systems make these hospitals efficient, but more importantly, the integration of strategies leads to synergistic savings that enable the level of energy use that the authors see exemplified in the Scandinavian hospitals.

### ARCHITECTURAL STRATEGIES

- Shading, reducing solar heat gain in order to reduce the total load on spaces so that the cooling load can be accommodated with water-based systems, the Scandinavian examples use a combination of exterior shading devises, most commonly exterior dynamic shading that automatically deploys with the movement of the sun.
- Improved thermal envelope
- Operable windows with some natural ventilation
- Reformulation of the building massing to create greater exterior connection
- Day lighting throughout with electric lighting reductions

### BUILDING MECHANICAL STRATEGIES

- De-coupled ventilation and thermal tempering, virtually eliminating re-heat
- One of the biggest departures from traditional U.S. hospital design that has the biggest energy impact is the virtual elimination of re-heat. Re-heat represents at least 40% of a typical U.S. hospital's energy use. In the Scandinavian examples, the systems for delivering fresh air and thermal tempering are commonly separated, where fresh air is delivered with a modest amount of conditioning and supplemental heating and cooling are provided through water-based systems. Typically, heating is delivered through radiators under the window and cooling is delivered (when supplemental cooling is even needed) in radiant cooling panels or fan coil units in spaces that have greater cooling requirements. This approach of de-coupling heating and cooling from ventilation dramatically reduces re-heat.



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Air delivery systems also vary and include ceiling diffusers, conventional sidewall grills, and displacement ventilation through supply grills low in the volume of the space (including in patient rooms).

- Control strategies that turn spaces "off" when not in use, including operating rooms
- Heat recovery at every possible opportunity

CENTRAL PLANT STRATEGIES

- Efficient, centralized energy production with district heating and cooling
- Cooling from direct sources such as lakes and rivers
- Ground source heat pump plants

If district energy is not available, most hospitals use heat pumping in some form for heating and/or cooling, including the extensive use of large closed-loop, ground-coupled heat pump plants.

The results are compiled as a complement to online tools that the team is simultaneously developing, aimed at guiding practice for achieving radical energy reductions in hospitals. These online tools can be viewed at idlseattle.com/t100.

## Limitations

Reviewers' note: Without evaluation of all the data from a content expert it is hard to understand all the nuances of the data translation and comparisons, especially when converting outputs between countries.