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Introduction

With the price of energy declining, and the increased frequency and severity of illnesses, allergies, and chronic diseases, the focus on health and wellbeing of building occupants is becoming more and more mainstream. Dr. Michael Roizen, Chief Wellness Officer of the Wellness Institute of the Cleveland Clinic, stated that of all U.S. spending, healthcare spending as a percentage of Gross Domestic Product (GDP) is increasing significantly, while all other spending is going down. The growth rate of chronic diseases is likewise, trending upwards. Four factors cause 75% of chronic diseases – stress, physical inactivity, food choices, and tobacco. Chronic disease management represents 67% of health care costs for individuals under 65 years of age.

Officially released in October 2014 prior to Greenbuild, the WELL Building Standard® is the first of its kind with a focus on improving human health and wellbeing and reducing the health care costs associated with chronic diseases. The WELL Building Standard focuses on the environmental conditions within buildings that the typical American spends 90% of their time.

Ambient Energy is providing energy, commissioning, and/or sustainability consulting on several projects utilizing the WELL Building Standard. In an effort to learn more about WELL, I attended the inaugural WELL Building Symposium kickoff in New Orleans in October 2014. I was so intrigued by the content that in February of 2015, I attended the first WELL Building Standard training for future WELL Accredited Professionals (WELL APs) at the

Cleveland Clinic in Ohio. As an energy consultant for over 17 years, my first impression was that the WELL Building Standard sounds like a comprehensive and vigorous rating system, but "what is the true impact on energy and the environment?" **This report describes my interpretation of the energy usage and environmental impacts of select WELL Building Standard Preconditions and Optimizations in order to help design teams pursuing WELL maximum energy savings and minimize energy penalties. In addition, I have included strategies to save additional energy usage on many of the Preconditions and Optimizations.**

About WELL

The WELL Building Standard for New Construction is based on 102 Features, which are either Preconditions required for WELL Certification or Optimizations for designated levels of award. Required documentation includes specific design and construction information, letters of assurance and on-site verification of performance features. An Accredited WELL Assessor assigned by GBCI will evaluate each building, take air and water samples, light measurements, acoustical readings and provide a WELL Report. Recertification is required every three years to maintain the same high level of design, maintenance, and operations over time. A Wellness score of 5 indicates that all Precondition Features have been met, and is the minimum passing score. Scores of 5-6 earn Silver, 7-8 earn Gold and 9-10 earn Platinum, and the score is calculated based on Optimizations (similar to LEED credits) awarded out of the total Optimizations possible for the project. In addition to the overall Wellness score, each Concept (similar to LEED category) is awarded a score Silver to Platinum, so the building occupants can see how each Concept scores individually.

Example Energy and Productivity Case Study

To determine the effect that the WELL Building Standard has on energy usage, consider the particular type and usage of the building, its climate zone, and if the health benefits outweigh the energy cost of a particular Precondition or Optimization. For a typical office building for example, the cost of employees' salaries far outweigh the utility costs. Take a 250,000 ft^2 office building with 1,000 employees each earning on average $50,000 per year. Energy savings for high performance buildings range from 30-50% compared to a code compliant building. According to Jason McLennan, founder of the International Living Future Institute, temperature can cause a drop in productivity by up to 9%, poor air quality by 6-

9%, and noisy work places by up to 20%. On average productivity gains from healthy and buildings range from 1-20% compared to employee costs without a healthy building or wellness program. Assuming the low end of savings on both spectrums, 30% energy savings and 1% productivity gain, the annual cost savings from productivity are over 4 times that of energy cost savings (Table 1).

Table 1 Case Study of Productivity versus Energy Gain for a Typical Office Building

	Annual Costs	Savings	Annual Cost Savings
Energy Costs	$ 375,000	30%	$ 112,500
Staff Costs	$ 50,000,000	1%	$ 500,000

With the increasing severity and frequency of climate change occurrences, it's important to look at not only the direct economic impact of energy savings, but also the additional impact on global climate change, insurance premiums, risk of natural disasters, etc. Additionally, it is very difficult to quantify the productivity benefits of a WELL Certified™ building or a wellness program. At the Cleveland Clinic, and with many large organizations throughout the country, this is becoming more common. Employees are wearing "Fitbits" and other personal monitoring devices to monitor their health. If employees show increased improvements with their health that directly translates into lower health care premiums to the employee and their family.

Energy Impact

Of the 102 Preconditions and Optimizations, I have identified 5 Preconditions and 18 Optimizations that have energy impacts. Although a full 8,760 hour simulation of some of the impacts might better quantitatively describe the impact of WELL, the results would vary by building type and climate. Several of the Optimizations are the same or similar to LEED credits and other Optimizations are based on other references. Table 2 and Table 3 summarize the relative energy impact of credits unique to WELL for Preconditions and Optimizations.

I have not included the energy impact of the following credits that have the same impact as LEED: 03 Ventilation Effectiveness, 05 Air Filtration, 13 Air Flush, 15 Increase Ventilation, and 62 Daylight Modeling. Additionally, credits that are already in the ASHRAE 90.1-2013, Energy Standard for Buildings Except Low Rise Residential as requirements, such as 08

Healthy Entrance for vestibules or revolving doors and 12 Moisture Management for continuous air barriers are not considered (though note that vestibules or revolving doors are not required per Title 24-2013 Building Energy Efficiency Standards for Residential and Non-Residential Buildings in California).

The following summarizes each Precondition and Optimization and its impact on energy usage. More specifics on each Precondition and Optimization are available within the standard, which can be downloaded at ***www.wellcertified.com/standard.***

Preconditions Summary

Table 2 The Energy Impact of the WELL Building Standard – Preconditions

Concept	Precondition	Energy Impact
Air	**06 Microbe and Mold Control**	Savings
Light	**53 Visual Lighting Design**	Savings
	54 Circadian Lighting Design	Varies
	56 Solar Glare Control	Savings
Fitness	**64 Interior Fitness Circulation**	Savings

Preconditions Described

- ***06 Microbe and Mold Control.*** This Precondition requires Ultra Violet (UV) lamps on cooling coils and drain pans, at a UV radiation wavelength of 254 nm to provide the maximum germicidal effect. The goop that grows on HVAC evaporator coils, train pans, and ducts, called biofilm, gives off VOCs which cause watery eyes, headaches, allergies and asthma.
  Energy Savings. By applying ultraviolet (UV-C) radiation and reducing mold and biofilm, this thereby increases airflow and reduces pressure drop across the coil which ultimately saves energy. American Air and Water claim savings of 10-30% in energy usage of the system once full capacity is restored.
- ***53 Visual Lighting Design***. Ambient lighting at workstations is 20 foot-candles by electric lighting or daylighting. Lighting must be zoned in control banks larger than 500 ft^2 or 20% of open floor area of the room. Task lighting providing 28 to 46 foot-candles at the work surface should be available upon request.

Energy Savings. Low lighting with task lighting for those who need additional lighting helps to reduce energy usage by not providing high illumination for everyone in a work space environment. Illumination needs by person are a function of age, task, surrounding reflectance, and many other factors. Additional energy savings are achieved compared to LEED by only providing the additional task light to those who want it instead of for a percentage of work stations.

- ***54 Circadian Lighting Design Requirements***. To providing melanopic light intensity in work areas with 250 equivalent melanopic lux in 75% or more of workstations, 4 hours per day.

  Varies. The Equivalent Melanopic Lux is a measure of light's effects on the circadian cycle and determines how interior lighting can support the circadian function. Light sources with a higher blue component ("cooler" lights with an appearance closer to daylight) will produce more equivalent melanopic lux for a given visual lux output. Thus, the energy impact of this measure will depend on the particular lamp selected and should be compared to what typically would have been chosen as a baseline.
- ***56 Solar Glare Control***. For glazing less than 7 feet above the floor, provide interior window shading or blinds, external shading systems that are controllable by occupants or on a timer, and variable opacity glazing such as electro chromic glazing.

  Energy Savings. Interior or exterior shading and variable opacity glazing reduces glare as well as unwanted heat gain and cooling loads. However, with any occupant controlled device there is potential for misuse – the 'blinds down –lights on' scenario would increase energy use. Automated or timer-based controls are preferable. Energy savings will depend on orientation, glazing, building location and many other factors.
- ***64 Interior Fitness Circulation***. Promote the stairs, by making them accessible, easily located, wide enough, and aesthetically pleasing.

  Energy Savings. Having more people take the stairs, and less take the elevators can reduce energy consumption significantly. Elevators account for 2-5% of a buildings energy when idle and can be utilized much more during peak operational times in high rise office buildings such as beginning or close of business day or lunchtime.

Optimizations Summary

Table 3 The Energy Impact of the WELL Building Standard – Optimizations

Concept	Optimization	Energy Impact
Air	**14 Air Infiltration Management**	Savings
	16 Humidity Control	Slight Penalty
	19 Operable Windows	Savings
	20 Outside Air Systems	Savings
	21 Displacement Ventilation	Savings
	23 Advanced Air Purification	Penalty
	24 Combustion Minimization	Varies
Water	**36 Water Treatment**	Slight Penalty
Light	**60 Automated Shading and Dimming Controls**	Savings
	61 Right to Light	Savings
	63 Daylight Fenestration	Savings
Fitness	**70 Fitness Equipment**	Slight Penalty
	71 Active Furnishings	Slight Penalty
Comfort	**79 Sound Masking**	Slight Penalty
	82 Individual Thermal Comfort	Varies
	83 Radiant Thermal Comfort	Varies
Mind	**99 Beauty and Design II**	Varies
	100 Biophilia II Qualitative	Slight Penalty

Optimizations Described

- ***14 Air Infiltration Management.*** This optimization requires leakage testing after substantial completion through building envelope commissioning based on ASHRAE and NIBS Guidelines. Though not fully a code requirement everywhere, building envelope commissioning is becoming more common. U.S. Army Corps of Engineers was the first to adopt leakage requirements at 0.25 cfm/ ft^2. ASHRAE requires 0.40 cfm/ft^2.

  Energy Savings. Through design reviews, site inspections and infiltration testing on average approximately 10% to 40% reduction in air leakage can be achieved which translates to significant energy savings, although savings is very climate dependent.
- ***16 Humidity Control.*** Maintain relative humidity level from 30% to 50% for at least 95% of all business hours.

  Slight Energy Penalty. In climate zones that are within these humidity levels a high percentage of the year the energy impact will be minimal, however there will be an increase in HVAC energy use for humidification or dehumidification in climate zones outside of this range. Dehumidification is commonly used in high humidity climates to maintain comfort; however humidification is rarely added in dry climates.

- ***19 Operable Windows***. Every regularly occupied space requires an operable window that provides access to fresh air and daylight, with outdoor air measurement of ozone, PM10, temperature and humidity. Occupant software on computers, smart phones or indicator lights shall indicate to occupants to close windows based on outdoor conditions.

  Energy Savings. The use of the indicator lights or software to alert occupants to close the windows is a positive improvement to the random occupant usage of windows; however it does rely on humans to take action. One improvement upon this is for the HVAC system to shut off if the windows are open, and for the windows to close automatically based on outside conditions.

- ***20 Outside Air Systems***. Providing dedicated outdoor air systems (DOAS), achieving ASHRAE 55, and including a third party review of the mechanical design for thermal comfort, serviceability and system reliability meets the intent of this Optimization.

  Energy Savings. DOAS do save energy and improve air quality by decoupling sensible and latent loads, providing 100% of the required ventilation air, and eliminating recirculated air. Studies have found energy savings from dedicated outside air systems that vary across the US from 13% to 38%. The higher energy savings were achieved when DOAS were combined with radiant systems. See Optimization 83 for more information on radiant systems.

- ***21 Displacement Ventilation***. Utilizing underfloor air distribution systems (UFAD) or low side wall distribution systems for heating and/or cooling is one part of this Optimization.

  Energy Savings. Displacement ventilation provided by either UFAD systems or low side wall systems saves energy by providing air at the floor level or low to the ground at a higher temperature with reduced fan speed than air provided at the ceiling. Displacement ventilation systems can reduce cooling and ventilation air by 13% (Miami) to 45% (Seattle).

- ***23 Advanced Air Purification.*** There are many types of air purification systems to reduce VOCs and other contaminants in the airstream. Carbon filtration focuses on removing VOCs and ozone while UV germicidal irradiation and photocatayltic oxidation reduce the presence of mold spores, bacteria and viruses. Carbon filtration works by changing contaminants from a gaseous phase to a solid phase and have been used commercially in hospitals with MERV or HEPA filters. UV lamps placed in coils and drain pans of cooling systems remove micro-organisms from forming. Photocatalytic oxidation (PCO) is an emerging technology that involves photon and UV energy to activate a catalyst creating photo catalytic oxidation.

Energy Penalty. UV lights have the least effect on fan energy, though the energy impact of the light should be taken into account – lamp energy of approximately 7.5 W/ft^2 of coil surface area is recommended for a UV-C system. Savings are from restoring the coils to their optimal condition. Although carbon filtration has a lower pressure drop than the MERV 13 filters typically required of high performance buildings, both UV and Carbon filters are typically utilized as pre-filters, meaning the energy associated with them is in addition to a MERV rated filter.

- ***24 Combustion Minimization***. For this optimization appliance and heater combustion are banned in regularly occupied areas and engine exhaust is reduced.

  Varies. Gas cooktops, stoves, and ovens will have to be replaced with electric counterparts. Typically, electric stoves cost more to operate than their gas equivalents. However, if induction or convection appliances are selected, the energy usage is more comparable to naturalize. The indoor natural gas or wood fireplaces will also have to go which will save energy in the long run.
- ***36 Water Treatment***. For faucets, drinking fountains, showers and baths, provide an activated carbon filter, filter rated to remove suspended solids, ultraviolet germicidal irradiation (UVGI) water sanitation or NSF filter rated to remove microbial cysts to remove contaminants in water.

  Slight Energy Penalty. Water filter options such as activated carbon filters and others that water must pass through have a pressure drop associated with them, which leads to reduced flow rates. This pressure drop must be overcome by additional flow at the water distribution plant, which increases the energy used for pumping water. UVGI is a light source that does not have this pressure drop, however, suspended solids can still pass through, and there is an energy penalty associated with the UV light.

- ***60 Automated Shading and Dimming Controls.*** All windows greater than 6 ft^2 need to have shading devices that automatically engage when light sensors indicate that sunlight could cause glare at workstations. In addition, in workstations, lighting should be programmed into motion sensors to dim to 20 foot-candles or less or switch off when unoccupied and continuous dim in response to daylight.

  Energy Savings. Lighting on motion and daylight sensors in workstations and dimming or on off controls when workstations are unoccupied will save a significant amount on cooling energy.

- ***61 Right to Light.*** The distance between the exterior façade and the building core should be less less than 25 feet for 75% of regularly occupied spaces. Additionally, 75% of all desks are within 25 feet of an atrium or a window with views or 95% of all desks to be are within 41 feet of an atrium or window.

  Energy Savings. Providing a narrow building is the optimal way to provide a fully daylit building, and increases natural ventilation potential. As long as daylight sensors are optimally designed, installed and commissioned properly, the lighting reduction offsets the losses from additional building envelope skin. Net zero energy buildings often use this strategy to minimize energy usage.

- ***63 Daylight Fenestration***. This optimization includes visible light transmittance requirements above 7 feet (60%+VLT) and below 7 feet (50%+VLT), uniform color transmittance based on circadian lighting design, and window to wall ratio between 20% to 60%. If window to wall ratios are above 40%, exterior shading or intelligent glazing is required.

  Energy Savings. Visible light transmittance at relatively high levels, in combination with daylight dimming, can reduce electrical lighting energy significantly. Spectrally selective glazing should be selected at these high VLTs in order to select glazing with the lowest possible solar heat gain coefficient at a high VLT for daylight. Setting the window to wall ratio between 20% to 60% is best practice in the industry, however, the nearly all glass buildings will have to work a bit harder to be within the 60% goal. The window wall ratio should also be set per above grade façade, instead of average per building.

- ***70 Fitness Equipment.*** For 1% of occupants, provide low or high intensity fitness equipment such as treadmills, elliptical machines, rowing machines, bikes, bench presses, pull up bars, or squat racks.

Slight Energy Penalty. While some of this equipment uses power, some of it, like bench presses and pull up bars do not. See 71 for ways to offset energy.

- ***71 Active Furnishings***. Provide treadmill or bicycle desks for 5% of employees that are available for any employee to reserve.

  Slight Energy Penalty. The energy impact of a bicycle or treadmill desk is certainly going to be more than without one of these active desks, however, the more shared desks that can be used the better. Additionally, regenerative bicycles and treadmill desks produce electricity that can power your work station. The electrical consumption of treadmills, walking three hours a day five days a week can range from $0.10 to $0.36 per day, so it's important to select the most efficient ones, and to share them across the office.

- ***79 Sound Masking.*** Provide sound masking systems with a maximum sound masking limit for open and enclosed offices.

  Slight Energy Penalty. Sound masking systems have minimal impact on energy usage. For example, Quiet Technology, which is listed in GreenSpec, provides sound masking for 180,000 ft^2 for only 40 watts, which is the equivalent of an exit sign.

- ***82 Individual Thermal Comfort***. Provide a thermal gradient of 5◦F across open office spaces, between rooms, between floors. In addition, provide "free address" or "hotelling" across half of open office spaces of similar workstation so that people can move to their zone of most comfort. Personal comfort devices are allowed such as fans (excluding space heaters) for spaces with more than 10 occupants.

  Varies. Energy usage is dependent on selection of thermal gradient levels. Mechanical engineers can design systems to have minimal impact, though there may be a need for additional systems that can provide different temperatures in the spaces. Fans that are Energy Star labeled should be selected for personal comfort devices. Space heaters, though it is mentioned are excluded, should be banned as well.

- ***83 Radiant Thermal Comfort.*** Lobbies, common public spaces, and offices with hydronic heating and/or cooling or electric radiant floors.

  Varies. Hydronic heating and radiant systems are typically higher comfort systems due to the radiative heating effect. Gas fired hydronic heating typically has a lower energy impact than electric radiant floors, though it depends on the source of electricity. Energy can be further minimized by coupling radiant systems with solar thermal or condensing boilers.

- ***99 Beauty and Design II***. Requirements of this Optimization include having ceiling heights of at least 9 feet for rooms 30 feet wide and for those greater than 30 feet to have ceiling height of 9 feet plus 0.5 feet for every 10 feet over 30 feet.

  Varies. While room proportions and visually appealing spaces are important for occupant morale and mood, there is also an energy impact of spaces that have too high of ceiling height. Having a maximum, not only a minimum, ceiling height based on width of building would help to reduce the overall impact on energy usage. Additionally, mechanical systems such as UFAD or displacement ventilation could be required for high ceiling spaces above a certain height due to the benefits described in Optimization 21.
- ***100 Biophilia II Qualitative.*** Some of the strategies for biophilia include covering 1% of floor area per floor with indoor plantings and including a water feature for every 100,000 ft^2 that is about 6 feet in height.

  Slight Energy Penalty. Dependent on the particular water feature design, energy will likely be need for pumping to circulate water. Solar powered pumps as well as timers that only circulate water when the space is occupied can reduce or eliminate this energy consumption.

Conclusion

Of the five Preconditions with an energy impact, all have an overall energy savings which is beneficial. Design teams can then determine which Optimizations to select based on the health and energy impacts. Of the 18 Optimizations with energy impacts, seven have an energy penalty, seven save energy, and four will vary depending on option selected or particular building type or climate zone.

The goal of this report is to provide enough detail for the energy impact of each relevant Optimization to help WELL design teams select Optimizations that have minimal energy penalty and maximum energy savings. Also included are energy savings strategies to consider for many of the Preconditions and Optimizations. Overall, I believe the WELL Building Standard will significantly contribute to the quality of our buildings and improve the productivity, mental and physical health of employees.

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About Ambient Energy

Ambient Energy is a third-party consulting firm with offices in Denver and San Francisco, specializing in sustainability, energy, and commissioning consulting on new and existing buildings.

Endnotes

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