

KB HOME.
projekt

Where Tomorrow Lives.™



DEFINING HEALTH AND WELL-BEING AT HOME

hanleywood

builderonline.com/kbhomeprojekt

INTRODUCTION: WHY HEALTHY HOMES?

“Where Tomorrow Lives” is the guiding principle for the BUILDER KB Home Projekt Concept Innovation and Learning program that brings a future set of standard features and technologies for healthier-living single-family homes and communities within view of the present and within the means of a broader group of home buyers.

The BUILDER KB Home Projekt and the narrative surrounding it, including this white paper, create a story to motivate and inspire people to think differently about how their new homes and communities can and should live and work. As home buyers’ expectations build on the recent focus on the economy of energy, water, and materials performance as measures of value, the residential construction community will respond to a critical and potentially lucrative new emerging opportunity: to create value around technologies and designs for a homeowner’s health and well-being that align and harmonize with how sustainability and resilience function in a home.

Here are the tent-pole precepts of this analysis:

1. People now regard a home’s healthy design and futures as keys to their own health trajectories
2. Data and evidence show differing priorities around smart healthy features, varied by age and lifestage
3. People see a direct correlation between healthy home function and medical bills and personal finance
4. Emerging building technologies address indoor air, room comfort, water purity, noise, circadian light patterns, and factors related to sleep, rest, and a sense of serenity.

A new form of industry collaboration is bringing forward process innovation; re-evaluating and designing homes on the virtue of their quality of air, water, circadian lighting, noise reduction, resilience biophilic technologies, and conduciveness to sound sleep. This represents a fundamental shift in viewpoint, the evolution of a home not just as a basic commodity, but progressing beyond the typical duty of performing as shelter to becoming a source of protection and prosperity: toward a new role as a valuable asset in terms of the resident’s mental, physical, and emotional well-being. That innovative collaboration is a force behind the design and engineering of the BUILDER KB Home Projekt and will be represented throughout this paper.

GLOBAL WELLNESS ECONOMY: \$3.7 trillion in 2015



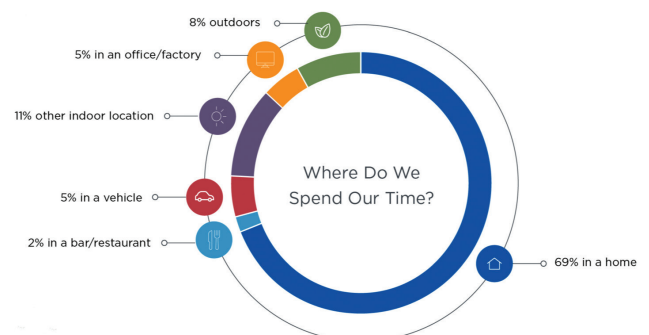
Source: Global Wellness Institute. Global Wellness Economy Monitor, January 2017



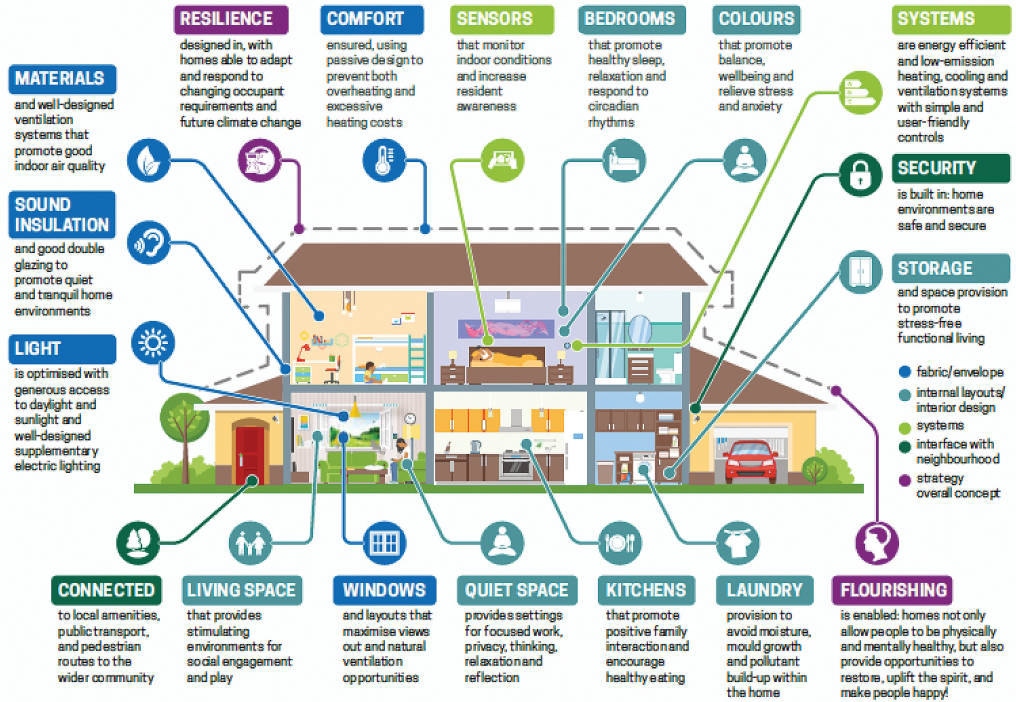
This relatively new industry of wellness is strong by the numbers and continues to grow, amounting to a roughly \$3.7 trillion industry worldwide. The focus on wellness encapsulates all aspects of home and work environments, including a category called Wellness Lifestyle Real Estate that was the fastest-growing sector from 2013 to 2015—growing 19%, to \$118.6 billion—and including everything in the built environment that incorporates wellness elements in its design, construction, amenities, and services.³³

And, with the use of technology, housing is also allowed to become a more active and interactive interface, adapting to each of its residents’ needs to heal, restore, and regenerate.

The focus on healthier homes is coming at a time when in the U.S., people spend approximately 70% of their time at home.¹



Source: Smart and Healthy Homes Industry insights presentation, January 2018, Delos



Spending time at home certainly shouldn't be seen as a negative; however, there are risk factors lurking in every aspect of our built environment. A healthy home has dozens of impact areas, each of which serves a specific purpose to enable healthy living. Here's a healthy-home outline from the UK Green Building Council's Health and Wellbeing at Home report.³

Even though, as a population, we tend to spend a lot of time inside our homes, only about one-third of home buyers feel their home is very healthy. The 2014 Houzz Healthy Home Trends Study revealed the following ratings.⁴

Specifically, 70% of buyers recognize comfort and minimizing exposure to chemicals as important to their

health, along with dozens of other factors that can be dramatically decreased with a thoughtful approach to home design, engineering, and construction.

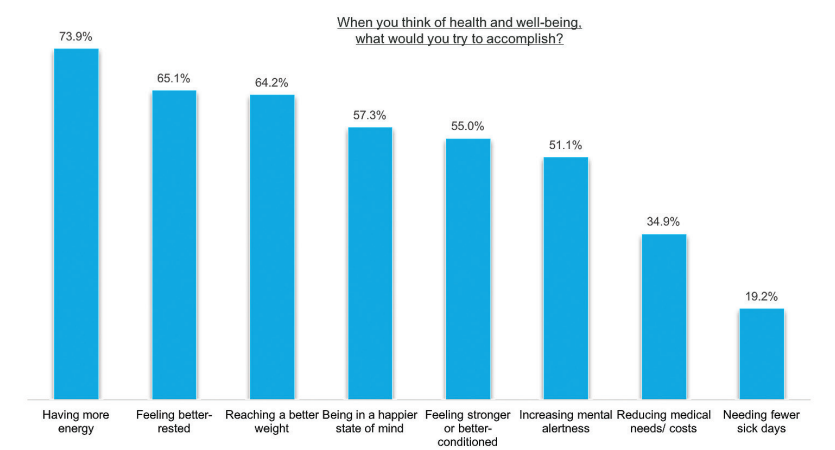
Similarly, more than 76% of the 13,000 U.S. occupants who participated in the Hayward Score online survey reported they believe their home is harming their health/their family's health at least somewhat.⁵

In support of the BUILDER KB Home ProjeKt, The Farnsworth Group fielded insights and responses from a sample of more than 300 home buyers aimed at understanding how they think about health and well-being in the home buying process and ownership experience. The sample included recent home buyers, along with those who are currently in the purchasing process.⁶

When asked their thoughts on the desired outcomes of health and well-being in the home, the survey respondents focused mostly on having more energy, feeling better-rested, and reaching a better weight.⁶

WHO IS THE BUYER?

While concerns related to health and well-being are growing, homeowners lack basic education about how their environment is affecting their health in both the long and short terms. According to Bill Hayward of Hayward Healthy Homes, half of the homes in the U.S. have an indoor air quality problem that places at least one family member's health at risk.



Although nearly all homeowners prioritize health and well-being as a key factor in the housing they purchase, attitudes, preferences, and values vary by age and generation as to how living quarters contribute—or don't—to health. The Houzz research found that more than 70% of millennials feel their homes are healthy, as opposed to less than 60% of baby boomers and Gen Xers.⁴

are going to force a shift in the housing market to deliver healthy places where they can age comfortably.

As Liddy Manson, director at The AgingWell Hub, part of Georgetown University's McDonough School of Business, points out, the population of 65-plus is expanding rapidly and will accelerate in the next 20 years. According to the U.S. Census Bureau, the boomer wave will fuel growth of the "old old" in 30 years. Individuals 85 and older will represent nearly twice the size of the 65-plus group by that point. By 2050, the number of centenarians is expected to increase 18 times. Although the proportion of people who live beyond the age of 100 is still very small, their numbers are growing rapidly. In 2000, there were an estimated 180,000 centenarians throughout the world; by 2050, they are projected to number 3.2 million.⁷

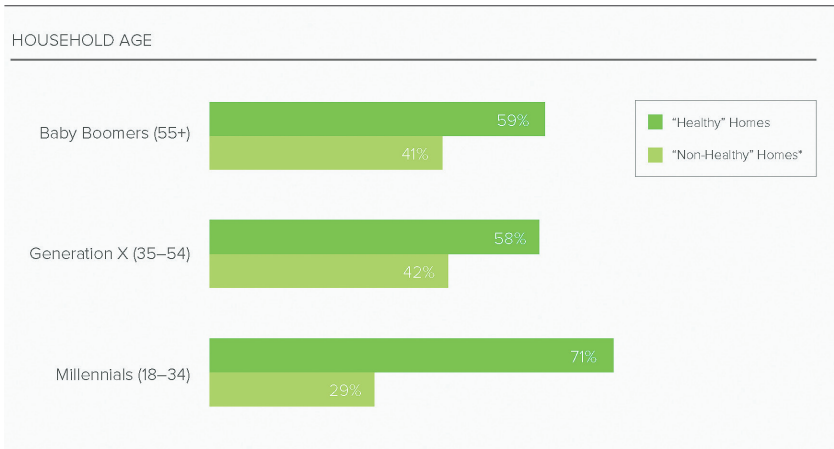
Manson has seen that informal caregivers currently play a critical role in making healthy living possible. Caregivers are instrumental in providing for certain daily living activities, such as transportation (83%); housework and grocery shopping (75%); meal preparation (65%); and financial management (64%).⁸

This group of boomers doesn't feel that current housing options meet their needs for aging comfortably in place. The AgingWell Hub's research shows that this group of boomers is considered by other generations to be fragile, incapable burdens with no future, while they consider themselves to be strong, independent business owners with possibilities.⁸

Much research shows that seniors would prefer to age and remain in communities they have lived in for many years, where they have already formed a community, a network of connections. And, because they are living longer, today's older adults desire and will likely have a different aging experience than that of their parents and grandparents. Manson shares this list of the new boomer's perspective. They:

- Don't want today's senior housing
- Intend to continue to be active in their communities
- Hope to remain in the paid or unpaid workforce
- Expect to be civically engaged and respected for their contributions.⁸

Based on these criteria, designers and builders can provide more livable solutions that include features



Delos, the pioneer of Wellness Real Estate™, is transforming our homes and other indoor environments by placing health and wellness at the center of design, engineering, and construction decisions. It offers perspective on the generational trends in living environments.

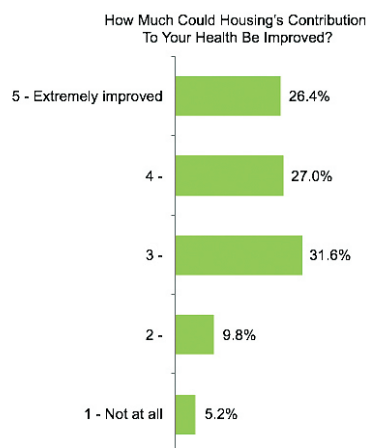
Delos data show that baby boomers are retiring at a rate of 10,000 per day and want to downsize, be part of a community, and incorporate children in their lives. The boomer generation also needs to consider how to receive care. Generation X, meanwhile, desires space for their children, access to child care, sustainable employment with minimal transportation, and the ability to spend time with friends. And millennials want to live in a place that provides access to people their own age, a short commute to work, a variety of entertainment, and other shared activities.²

As noted above, fewer boomers than millennials feel their living quarters are healthy. And there are more and more boomers entering the age when that is an incredibly important housing feature. As boomers reach the age when they have to start considering how their surroundings are going to support them in the future, their demands, in concert with their growing numbers,

such as accessible transportation and walkability; a focus on affordable living; civic engagement and social life; and access to goods and services.

WHY ACT NOW?

The moment to act on this growing business opportunity is now. Data are available to consumers on an immense scale, giving them the information they need at their fingertips to understand how their environment truly can impact their health and overall ability to perform daily tasks.



Source: The Farnsworth Group and Hanley Wood research.

Furthermore, the industry is waking up to this new opportunity. The green, sustainable building trend is leading to a larger consciousness of living well—not only treating the environment well, but treating ourselves well—and that design has a role and responsibility in meeting this objective.

One example of the new emphasis on this trend is the International WELL Building Institute, which has established and certifies buildings according to healthy-for-humans standards—just as LEED gave us healthy-for-the-environment standards. Another example is the Delos and Mayo Clinic's new Well Living Lab, which tests every aspect of the indoor environment (air, water, light, sleep quality, and so on) and how it affects, and can be reoptimized for, human health.

Other organizations, such as the Center for Active Design, which started the Fitwel standard and certification program, have centered considerable research and resources on this initiative as well. The

Center for Active Design is a global not-for-profit organization working to transform design and development practice to support health and ensure equitable access to vibrant public and private spaces that support optimal quality of life. As part of the Center's work, the Fitwel Certification System supports widespread adoption of health-promoting strategies through a user-friendly digital portal.

Other programs, such as the City Health Dashboard, are taking the health discussion to a broader scale by capturing metrics that shape healthy living. The Dashboard project captures metrics for more than 500 U.S. cities using 36 different measures of health, and therefore provides city leaders access to data that can support health-related decision making.

There also are programs such as Declare, the nutrition label for products, a platform and product database that is changing the materials marketplace so there is more transparency. Declare offers information to the consumer on the origin of a product, what it is made of, and where it goes at the end of its life, making it more transparent to end users and allowing them to make a more informed decision about what goes into their home.

Manufacturers and builders are also paying attention to the "Red List" materials, which are products that are worst in class and have many negative consequences when used in building materials, such as polluting the environment, bioaccumulating until they reach toxic levels, and harming those with exposure to them during the manufacturing or installation process. The Red List is available from the International Living Future Institute's website.⁹

In the shadow of the sustainability movement, legislators, local and national alike, will see the positive impact healthy living can have on a more robust economy and start enforcing building codes specific to healthier homes.

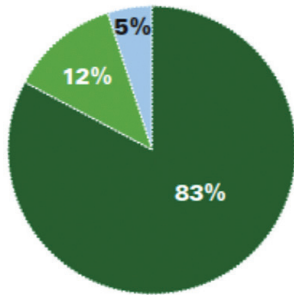
FINANCIAL FORCES

For years, the design, engineering, and construction of housing have focused on more-sustainable, more-energy efficient, and better-performing products. This evolution has been able to take place through a collaboration of building codes and builders that has sprung to action and focused business goals on related

Willingness of Home Buyers and Home Owners to Pay More for a Healthier Home (According to Home Builders and Remodelers)

Dodge Data & Analytics, 2015

- Willing to Pay More
- Not Willing to Pay More
- Don't Know



Willingness of Home Buyers/Owners to Pay More for a Healthier Home (According to Home Builders and Remodelers)

Dodge Data & Analytics, 2015

- Willing to Pay More for a Healthier Home
- Not Willing to Pay More for a Healthier Home
- Don't Know

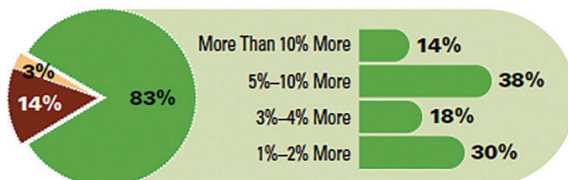
Age 18–35



Age 36–54



Age 55 or Older



Source: Dodge Data & Analytics. Green and Healthier Homes.

outcomes. Yet, it all comes down to the fine line of what consumers value, what is valuable enough to pay for, how much value it delivers to them, and, therefore, what makes sense for builders to consider.

Some real estate developers are putting pencil to paper, and their initial estimates indicate that a focus on wellness drives impressive returns, resulting in up to a 35% premium for wellness-branded single-family homes. Those developers also see a 7% to 10% premium for wellness rentals and a 15% to 30% average daily rate premium for wellness-branded hotels. Not only are there price benefits, the developers also reported that these homes that benefit well-being sell more quickly than the competition.¹⁰

Another survey, of 232 home builders and remodelers in the U.S. by Dodge Data and Analytics, shows an increasing awareness of healthy-home options and an increasing desire to pay for those benefits. The report shows that 83% of builders believe home buyers are willing to pay more for a healthier home.

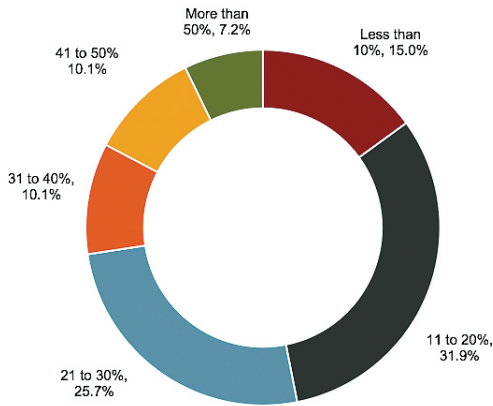
Taking it a step further, the same survey looked at how much more a home buyer might be willing to pay to get features that benefit their health and well-being. The survey showed that one-third of home buyers would be willing to pay at least 5% more, a figure that increases along with the age of the buyer, for those features.¹¹

Fortunately, we're in a time for healthy living. At any given age, as a U.S. population, we're healthier than we have been in the past. The incidence of diseases is in decline.

However, in the U.S., we continue to spend \$3.3 trillion in health care annually, showing that there's an incredible market for healthy living.²

Data from the BUILDER KB Home ProjeKt Farnsworth study show that 21% of respondents spend \$500 or more (up to \$5,000 or more) on "health and well-being" products, services, and activities on a monthly basis. More than 65% of the respondents spend more than \$100 a month to improve health and well-being in their lives, which to them means "having more energy," "feeling better-rested," "reaching a better weight," and "being in a happier state of mind," as opposed to spending less on medical costs.

How Much Could Medical Costs Be Reduced By the Right Housing?



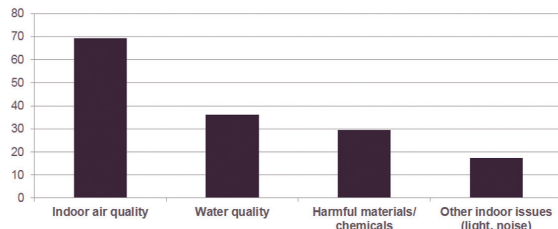
Source: The Farnsworth Group and Hanley Wood research.

People see tangible and measurable benefits derived from home features and functionality that promote health and well-being, with up to 67.7% of our respondents attributing healthy homes to savings on health care and medical costs ranging from an 11% to 40% reduction of out-of-pocket expenses in health care and medical expenses.⁶ This is critical in a country where out-of-pocket medical costs can be one of the leading factors driving people into debt, in fact becoming the number one source of personal bankruptcy filings in the U.S. last year, according to a CNBC report.¹²

In addition, 80% of construction litigation is due to moisture issues. And the EPA reports that 46% of homes, buildings, and schools have an indoor air quality problem due to moisture and mold, which jeopardizes people's health.¹³ Providing healthy, safe homes will put builders in a position to avoid costly litigation that may total millions of dollars.

Figure 2: Indoor Air Quality and Other Indoor Environmental Problems Drive Homeowner Interest in 'Healthy Housing'

Share of Homeowners Concerned about 'Healthy Housing' who Cited the Following Specific Issue(s) (Percent)



Source: United States Environmental Protection Agency: Moisture Control Guidance for Building Design, Construction and Maintenance.

So, through the rest of this paper, you will see how our research uncovers the opportunity for builders to approach and start to leverage the emerging trillion-dollar health and wellness movement, and to weave it into all dimensions of Americans' lives.

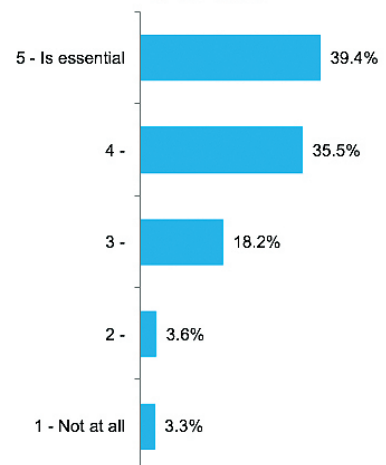
THE DATA ON HEALTHY LIVING DEMAND

In broad terms, the BUILDER Farnsworth research for the KB Home Projekt, Where Tomorrow Lives, shows that people want health and well-being to be a part of the value they get from their homes, but they are unclear, or unspecific, as to the particular functionality, design, and benefits of health and well-being elements in their homes.

In the survey, respondents ranked the nonnegotiable features of a home. The top priority, of course, was location, followed by square footage and responsive health and well-being features. The bottom three on the list were sustainable high-energy performance, smart-home features, and a spare room for potential income.⁵ And while location is number one on the list, could location start to be secondary to concerns of access to healthy water, air quality, and exposure to nature as fundamental elements to healthier living?

Far and away, the data show that three out of four people in our survey say housing is an essential contributor—at a high to extremely high level—to one's health, and more than half—53%—feel there's opportunity for significant to extreme improvement

How Much Does Housing Contribute to Your Health?



Source: The Farnsworth Group and Hanley Wood research.

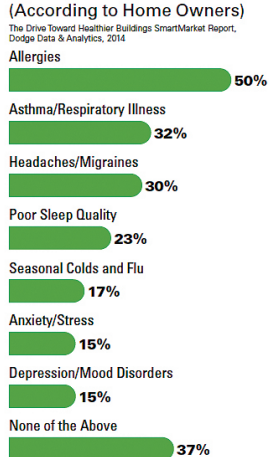
in how homes can contribute to improving occupant health.⁶ The statistics suggest that people think of their homes as playing a core role in what makes them be and feel healthy, and that in itself is a big opportunity for learning among home builders.⁸

Two of the most cited areas for improvement are indoor air quality and exposure to chemicals within the home. In a Harvard Joint Center for Housing Studies research effort, homeowners expressed concerned most about indoor air quality and water

A study by Lawrence Berkeley National Laboratory concluded that building dampness and mold raise by 30% to 50% the risk of a variety of respiratory and asthma-related health effects. A companion study by EPA and Berkeley Lab estimated that 4.6 million cases of asthma, 21% of the 21.8 million cases of asthma in the U.S., could be attributed to exposure to dampness and mold in homes.¹⁵

Based on reported data, the Hayward Score has collected information on health-related symptoms

Health Conditions Affected by Home Factors
(According to Home Owners)



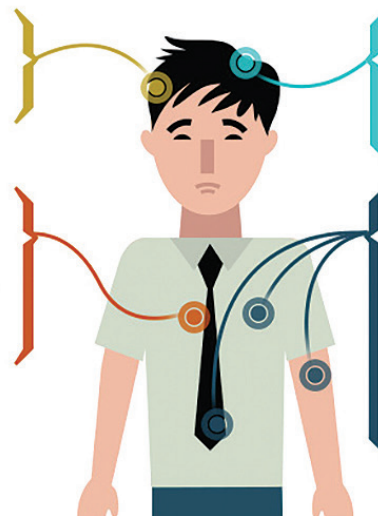
EMOTIONAL CHANGES

- Mood changes, feeling agitated or depressed.



RESPIRATORY CHANGES

- Sinus congestion.
- Coughing or shortness of breath.
- Need to increase use of asthma inhaler or other medications.



COGNITIVE CHANGES

- Frequent headaches.
- Foggy thinking, difficult to make decisions.
- Sleep disturbance (can't sleep, can't wake up).
- Short term memory loss.

OTHER PHYSICAL ISSUES

- Stomach discomfort.
- Muscles and joints hurt, making exercise difficult.
- Extreme fatigue, feel weak and lethargic.
- Always feeling sick (too many colds).
- Skin Rashes.
- Night Sweats.
- Heart racing or palpitations.

Source: Harvard T.H. Chan School of Public Health's Center for Health and the Global Environment (left); Hayward Healthy Home (right)

quality, followed by harmful materials/chemicals and other indoor issues such as lighting and noise levels.²⁸ The BUILDER Farnsworth study showed similar data—indoor air quality far outranks other features as a contributor to health and well-being, with natural lighting, home fitness areas, and outdoor recreational areas as secondary contributors.⁶

Dr. Joseph Allen, professor at Harvard's School of Public Health, posits that since the 1980s, when building requirements shifted to allow less airflow, there has been a dramatic, 80% decline in sufficient indoor air exchange (from 1 exchange of air per hour down to 0.2), leading to a dangerous increase in interior pollutants and carbon dioxide levels. Allen also reveals a doubling of cognitive function in people working in buildings with high levels of air ventilation.¹⁴

occupants experience at home. Research has shown that symptoms that are expressed by occupants when exposed to home conditions can be quite varied and can depend on the sensitivity of the person and the severity of the exposure.⁵

The BUILDER KB Home Projekt Farnsworth study shows that beds and sleeping areas far outweigh other home spaces and features as being linked to resident health and well-being. This could correlate with the role of sleep and security, one tangible and one less tangible health-related area. The data say that people associate health and well-being with the bedroom, which may include a focus on lighting, soundproofing, sleep, sonic experiences of music, and so on.⁶

In response to poor housing design that doesn't provide a healthy sleeping environment, homeowners have spent

an estimated \$41 billion on sleeping aids and remedies, an amount that's expected to grow to \$52 billion by 2020. This massive, exploding market includes sleeping pills, sleeping studies, sleep monitoring, and health coaches, according to a 2016 Consumer Reports study titled *Why Americans Can't Sleep*.²² In a Parks Associate survey, respondents identified the specific areas of their sleep issues, with the majority (24%) having trouble falling asleep, an issue that can be influenced by the design of one's environment.

Long-term sleep deprivation can increase one's risk of heart disease, stroke, obesity, diabetes and elevate depression and anxiety as well as decrease overall quality of life. Chronic insomnia makes someone 20 times more likely to develop an anxiety disorder and five times more likely to develop depression,²⁶ and increases the risk of coronary heart disease by 30%.²⁷

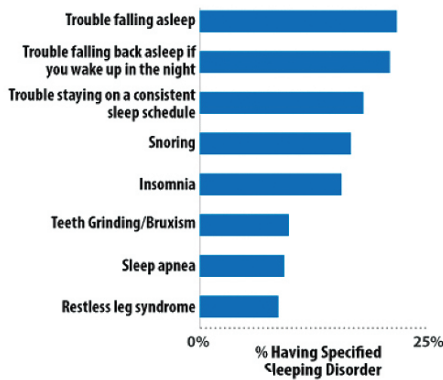
Interestingly, and perhaps related, a majority of respondents picked "noise reduction, insulating high-performance walls" over a "golf community," indicating they value the health performance of their walls higher than a golf community. Other choices—a grow/green

Asthma remains the most common chronic condition of childhood, affecting more than 9% of all U.S. children. More than 6 million children suffer from the condition, leading to 205,000 hospitalizations and 697,000 emergency-department visits each year. Exposure to allergens and irritants at home is a major factor in the development and complications of asthma. As many as 40% of asthma cases in minority children may be attributable to exposure to residential allergens, including moisture and dampness, poor ventilation, deteriorated carpeting, and structural deficits.¹⁵

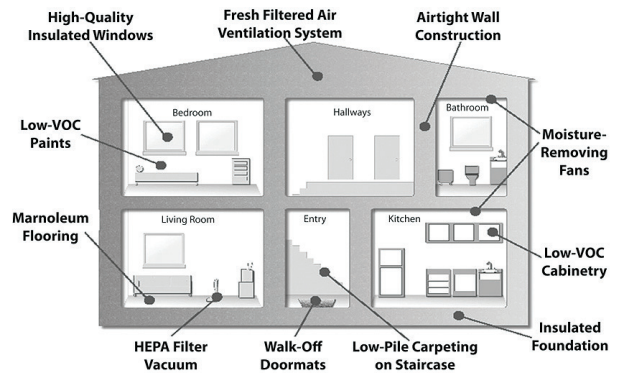
The Seattle Housing Authority explored the health consequences of better ventilation and moisture control in a home and has now adopted the model of the Breathe Easy Home Indoor Air Quality System. In homes certified as Breathe Easy Homes, exposure to mold, dampness, and rodents decreased dramatically. After a homeowner spent one year in a Breathe Easy Home-qualified residence, evidence of moisture was rare, rodents had been eliminated, and the combined trigger score measuring the average number of triggers per home was close to zero.

The costs for the features needed to comply with

Health Conditions - Sleeping Disorders
U.S. Broadband Households



Source: Park Associates: State of the Market



Note. VOC=volatile organic compound; HEPA=high efficiency particulate air.

FIGURE 1—Features of the Hight Point Breathe-Easy Homes.

Source: Breathe Easy Home

wall over granite countertops, net-zero energy versus a walk-in closet, and high-performance windows with a reflective coating versus an outdoor kitchen—show a growing awareness and favoring of health features over more conventional design trends.⁶

There are many conditions that could be solved through the right housing, dramatically reducing the level of spending on health care.

Breathe Easy Home qualifications were roughly \$5,000 to \$7,000 more than other high-quality homes in the same development, or about a 5% premium. The Breathe Easy Home study reported that these minimal costs were quickly recouped in the resulting health-care savings and the lack of missed work and school days.²³

Not only does one's housing affect one's physical well-being, it influences emotional and cognitive

well-being, as well. There's a new and growing emphasis on intentional communities for the purpose of relieving loneliness. According to a study by AARP, more than 40% of American adults suffer from loneliness, a condition that, Murthy warns, is as dangerous to physical health as smoking 15 cigarettes a day, increasing the risk of cardiovascular disease, diabetes, cancer, and more.²⁰ Worse, loneliness is a condition that attacks any and all age groups; it affects millennials just starting their careers, widowed boomers just ending theirs, empty-nesters, new divorcees, first-year college students far away from family and high school friends. And even though social media has the positive intention of drawing people closer, it may instead be causing more separation, creating virtual connections that have few of the benefits of actual connections.

Many studies have pointed to the health benefits of social interactions since the idea started trending in the early 1990s. Among people with cardiovascular disease, those with more social connections have a 2.4 times lower risk of death within an established period than those with poor social ties. Social connections lower the risk of cancer, speed recovery among people who do contract the disease, and reduce the risk of hypertension and other cardiovascular illnesses. Even wound-healing improves with social connections. Multiple studies suggest this may be a consequence of the psychological boost that meaningful relationships provide. People seemingly make better health choices, whether conscious or not, when they have a close-knit group of friends and family that depend on them.²¹

In a study conducted by Harvard, cognitive function scores improved in well-performing, sustainable built environments. And not just better, but substantially improved, in nine different areas, including crisis response, strategy, and focused activity level.

The green building design this study employed lowered energy use, improved ventilation, and lowered exposure to carbon dioxide and VOCs. The results showed that cognitive scores were 61% higher in green building conditions and 101% higher in enhanced green building conditions.¹⁴

HEALTH AND WELL-BEING OPPORTUNITY: HOW TO DEVELOP, DESIGN AND MARKET

The information presented in this paper points to a solid opportunity for the future of housing to improve

the design, development, and awareness of health and well-being in homes. Done well, the opportunity will not only be profitable for builders and consumers who will be able to reduce medical spend and lead more productive lives, but also for the overall economy, which will benefit from more-productive, connected communities.

The opportunity requires a high-level, integrated approach with involvement from all aspects of the housing community—suppliers, manufacturers, health experts, builders, designers—enabled by new technology. The AgingWell Hub's Manson also incorporates retail, home services, civic services, faith, financial services, insurance, retail, and transportation in the formula to reinvent healthy housing. She believes tech trends will support healthy and independent living, including mobile ubiquity, artificial intelligence, voice, the Internet of Things, the transportation revolution, e-commerce, and remote patient care.

Thoughtful community design can foster emotional and cognitive health, also providing security and safety or perceived safety. A few ways The AgingWell Hub suggests builders and developers can start incorporating community, health, and happiness into design are by focusing on:

- Cohousing
- Significant space-sharing inside and out
 - Purposeful, activity-focused
 - Communal food storage and preparation
 - Crafting, art and working spaces
 - Gathering and study areas
- Age blending (exchange of services, management of life event transitions, etc)
- Clusters of communities within communities
- Getting the right ratio of people : shared space
- Sports teams
- Group celebrations
- Child-watching¹²

Once you get into the individual home unit, there are many design aspects to consider that will deliver a healthier built environment. Bill Hayward breaks the solution into the Four Principles of Healthy Home Construction:

1. Continuous fresh air.
2. Properly sealed and insulated (air tight and no cold spots).
3. Less toxic materials.
4. Cleanable surfaces.

Hayward says a critical aspect is the need for the right ventilation with energy efficiency. “In our experience, energy efficiency without adequate ventilation typically degrades air quality in the house, along with the occupants’ health,” he says. “A healthy home will last longer than an unhealthy home. It will be more energy efficient. Its occupants will take better care of it.”

And, as he points out, sustainability and energy performance are shown to go hand in hand with

healthier living environments from other sources, as well. The U.S. DOE’s Home RX: The Health Benefits of Home Performance : A Review of the Current Evidence report shows that short-term, energy-efficiency measures can reduce symptoms of lower respiratory tract diseases such as asthma.

One portion of the study was performed on children with asthma, while another was directed at people with respiratory conditions, and the results showed that energy-efficient design can improve health outcomes while also reducing associated health-care expenses. Home occupants in the study showed decreased symptoms of asthma and fewer incidents requiring health care.¹⁵

The International Energy Agency report Capturing the Multiple Benefits of Energy Efficiency points to specific design considerations and their intended impact. With better insulation, air sealing, improved heating systems, improved cooking systems, and improved ventilation, residents were able to enjoy healthier living spaces.

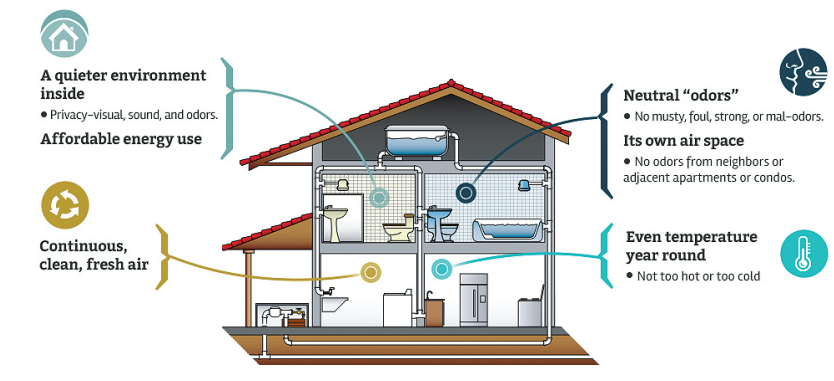


Table 1: Overview of impacts of improved energy efficiency on health and well-being

Energy Efficiency Measure	Primary Housing Effect	Secondary Housing Effect	Expected Health Outcomes
Insulation	Heating/cooling retained within dwelling	<ul style="list-style-type: none"> • Comfortable indoor temperatures • Lower indoor relative humidity • Reduced allergens 	<ul style="list-style-type: none"> • Reduced deaths due to temperature extremes • Reduced symptoms of respiratory disease
Air Sealing			
Improved Heating Systems	Heating provided to whole dwelling	<ul style="list-style-type: none"> • Comfortable indoor temperatures • Reduced gases and particulates • Increased usable living space 	<ul style="list-style-type: none"> • Reduced deaths due to cold • Reduced symptoms of respiratory disease • Reduced stress and infectious disease
	Cleaner burning heating systems		
Improved Cooking Systems	Combustion by-products properly vented to outdoors	<ul style="list-style-type: none"> • Reduced gases and particulates 	<ul style="list-style-type: none"> • Reduced symptoms of respiratory disease • Reduced risk of cancer
	Cleaner-burning cooking systems		
Improved Ventilation	Increased air flow within dwelling	<ul style="list-style-type: none"> • Reduced gases and particulates • Reduced dampness • Reduced mold 	<ul style="list-style-type: none"> • Reduced symptoms of respiratory disease • Reduced risk of cancer • Reduced symptoms of cardiovascular disease • Reduced arthritis • Reduced depression

Adapted from Table 4.1 of the International Energy Agency report: Capturing the Multiple Benefits of Energy Efficiency.

Indoor environmental conditions generally improved with enhanced ventilation, the report shows. Of the five studies that looked at indoor-air outcomes, four observed statistically significant improvements from enhanced ventilation. Pollutants that were reduced with ventilation included respiratory triggers such as formaldehyde and other VOCs, airborne mold and phthalates, and radon. One study observed reductions in carbon dioxide.

The installation of HRVs/ERVs is associated with fewer asthma/respiratory symptoms. The three studies that specifically looked at HRVs/ERVs on children with asthma or children at risk of respiratory illness found that their respiratory health was better than that of children living in homes without such ventilation installed. Improvements in skin allergies and general health were also observed.

In addition, the study showed that the better ventilation also led to less exposure to radon.¹⁵ Data from a supplemental analysis to the DOE's Evaluation of the Weatherization Assistance Program also found that installing whole-house exhaust-only ventilation led to lower levels of radon.

A simple design solution for cleaning indoor air could be allowing for the space and opportunity to include the right indoor plants to filter the air. The plants would need to be exposed to natural sunlight and be watered on a regular basis. Although there isn't enough substantial evidence that adding indoor plants to the home environment improves indoor air quality, adding plants can have other benefits.

Studies show, for example, that houseplants can reduce stress levels by calming the sympathetic nervous system and can also make the home occupants feel better and happier. Other studies have shown that access to nature helps a person's mood and energy levels.¹⁶

Consider offering a housewarming gift to new home buyers that promotes a focus on their health. Leave a houseplant that can improve indoor air, absorb carbon dioxide, and release oxygen. Some indoor plants are effective even at removing pollutants and dust particles released from stoves and furnaces. Some are particularly effective at purifying indoor air because

they absorb pollutants. These include lady palms, spider plants, dwarf date palms, bamboo palms, sword ferns, areca palms, blue daisies, American rubber plants, Boston ferns, and blue-eyed daisies.¹⁷

The Mariposa Healthy Living Toolkit compiled best practices from LEED, Healthy Community, Enterprise Green Communities, and SITES to suggest these additional design considerations for creating a healthy living environment:

- Provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the home.
- Access to open space and natural areas with outreach and education can increase the frequency of physical activity by 48%.
- Access to open space and natural resources improves quality of life and provides the opportunity to better understand the importance of the natural environment.
- Provide outdoor spaces for mental restoration and provide outdoor spaces for social interaction.
- Provide views of vegetation and quiet outdoor spaces for mental restoration: Develop and implement a plan to provide views of vegetation and access to quiet outdoor spaces on site to optimize mental health benefits of occupants.
- Locating a project within an existing neighborhood and in close proximity to infrastructure encourages more resource-efficient development of land, reduces development costs, conserves energy, and adds to the vitality of the overall community.
- Design and build the project to the density required for the location type.³²

Healthy homes need more than just ventilation enhancements. Below are recommended changes for the housing industry driven by the Hayward Healthy Home Principles and health symptoms reported from 13,000 homes that completed the Hayward Score survey.¹⁸

Design Implications to Achieve Healthy Home

1. Add balanced mechanical ventilation. Use high performance HRV or ERV. ASHRE recommends a ventilation rate of .3ACH. We disagree. System

should be designed to operate silently between .35 to .6ACH. A ventilation rate of .6 ACH is necessary for the first two years after construction to mitigate chemical off gassing from building materials and necessary to maintain healthy air under many normal living conditions. Exhaust ventilation only is not a healthy installation and won't mitigate your risk even though it meets code. Commissioning is the only way to know if it is performing correctly. Do not skip this step.

2. Eliminate open vented crawl spaces with dirt floor. Install barrier over dirt and mechanically ventilate with ERV. Traditional crawl spaces are "air quality degradation chambers."
3. Design houses to an air tightness of 1-2 ACH@ 50 Pascal to optimize indoor air quality, insulation performance and minimize airborne biological buildup in the wall cavities.
4. Aggressively seal the garage house connection. Unless the seal is close to 100% all the chemicals off gassing from all the things in your garage are ending up in your home and bedroom. Install mechanical ventilation as per 2019 code. (Don't put washer and dryer in the garage.)
5. Cleanable, non-course surfaces for interior finishes are critical for maintaining long term air quality. In addition, there should be a thorough preoccupancy dust cleanout. Construction dust holds the entire record of all the chemicals used during the construction process and lingers in the home for years after completion degrading air quality. Thoroughly remove all construction dust from all surfaces, which requires a HEPA vacuum and non-chlorinated damp cloth to do effectively. Clean all HVAC ducting.
6. Make sure that the electric plan doesn't include panels or major runs within six feet of the bed to avoid unnecessary exposure to electromagnetic fields.
7. Add a drainage plain between exterior cladding and water management layer.
8. Do not install wall-to-wall carpet.
9. Link the kitchen range hood to the range so it turns on automatically when cooking. Plus, add makeup air kits to the range hood and dryer, in addition to using induction or electric cooking ranges. Cooking effluent is now understood to be worse than second hand smoke. Install a good, quiet range hood and a makeup air kit to make sure it draws and exhausts effectively. Electric or induction cooking

produces much less aerosolized particulate.

10. Use plywood instead of OSB to reduce formaldehyde off-gassing and to improve permeability. If you use engineered lumber, seal with a no VOC sealant to encapsulate formaldehyde and other VOCs.
11. Manage electromagnetic radiation. Outline the location of beds on subfloor, favorite chairs, desks and couches. Tell the electrician not to put any major electrical runs or panels within six feet of those locations.

All of these recommendations are climate and geographic zone specific, with these recommendations exclusive to the central coast of Southern California. It is important to adapt these recommendations to the specific home location, for example, adding dehumidification for hot humid climates.

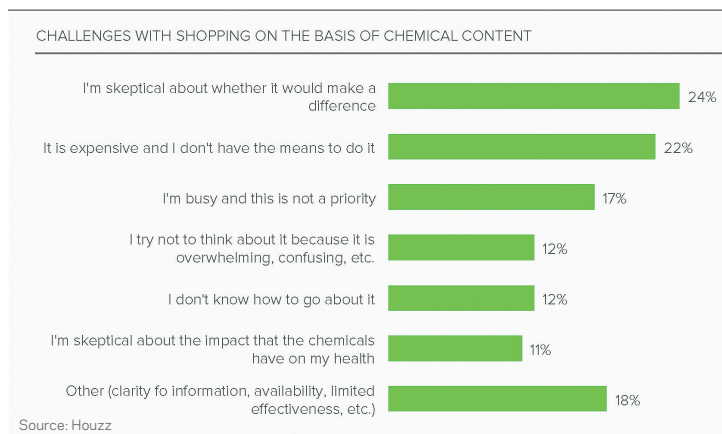
Hayward also says builders need to provide systems that can be managed long term for healthy living. He cautions that to avoid poor water management, builders should use only advanced waterproofing systems and test their airtightness with a blower door test, along with testing the waterproofing system. Next, avoid chemically laden building materials. A less toxic environment starts with looking at the products that are the source of the most VOCs, such as OSB, cabinetry, wood floors, foam insulation, and wall-to-wall carpets and pads, and finding the right manufacturers that offer lower-emitting or nontoxic items.

Hayward advises adding continuous balanced filtered ventilation to mitigate the nearly inevitable offgassing of new-home construction. Finally, he advises drying out all materials prior to final installation or close-in. Damp material trapped in wall cavities will make people sick. It actually takes two years for most wall cavities to dry out, and during routine temperature changes the cavity can reach more than 90% relative humidity, which aggravates the issue.

On average, one in five owners of healthy homes and one in three of nonhealthy homes is uncertain about the many risk factors inside their home—from dust mites to mold to drinking-water contaminants to formaldehyde. Nor are they aware of the outdoor irritants that might affect them indoors, such as toxins in the soil, air pollution, and allergens.⁴ This may

be overcome by a series of educational techniques based on information captured with sensors in the community that read off this information inside the home, before purchase and via online outlets, as well.

The most common place for home buyers and owners to ignore the chemical content or to be unaware of it is in carpet and furniture. Systems like the Declare labels will help mitigate that problem by offering new information and transparency, which your purchasing manager will need to consider and software systems will need to start considering.



The 2014 Houzz report shows that there is a large opportunity to improve residential ventilation systems. Plus, it reports that most homes have gas appliances and furnaces, but one-fifth of the homes lack carbon monoxide detectors and those that have detectors only have one. Only 50% of homes have a dehumidification system. Air purification systems are almost unknown. Only half of the homes surveyed had a water filtration system.⁴

Finally, indoor moisture control could be the most important aspect of creating healthier home environments. The EPA guide Moisture Control Guidance for Building Design, Construction and Maintenance provides the following three guidelines to avoid the health risks of moisture when building:

1. Design to control liquid water. Locate plumbing lines and components where they are easy to inspect and repair. Slope the grade. Maintain drainage plane water-tightness in roofs and walls.
2. Control condensation. People and their activities, especially cooking and washing of floors and

clothes, are usually the leading sources of humidity. In low rise buildings of all types, damp basements or crawlspaces may add as much water vapor to the air in a day as all the other internal sources combined. Design HVAC systems to manage air flow and control condensation.

3. Use moisture-tolerant materials¹⁹

Just as important as these system considerations are the design features that will offer a comfortable, healthy, safe environment for the growing aging population that wants to stay in their home for the remainder of their lives.

The AARP has created the HomeFit Guide to help identify safer, healthy ways to allow residents to age in place. The kit suggests design improvements that not only help the aging population but everyone else, as well, including:

- Step free entrances
- A bedroom, full bathroom and kitchen on the main level
- Work surfaces that can be used while seated
- Staircases with railings on both sides.
- Cabinets and shelves that are easy to reach
- Touch or sensor style faucets
- Shower with step free entry
- Grab bars in the shower and bathroom where there are slick surfaces
- Well-lit staircases, hallways and exterior entrances and walkways
- Wide doors (at least 36") or use of wing-clear hinges²⁸

In addition, as The AgingWell Hub suggests, the increasing numbers of the aging population will need and want space for caregivers, which means designing a discrete living area that the primary homeowner doesn't spend time in. It may mean a separate entrance and other features, such as an individual kitchen, laundry, and even temperature controls. Separate entrances will have zoning implications depending on the area of construction.

According to Parks Associates, 32% of consumers in broadband households currently care for an aging family member, or a family member with a health-related condition, or expect to in the next five years.²⁹

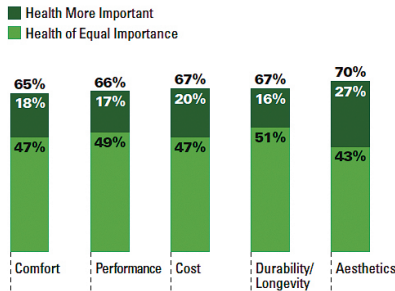
New technologies are making homes healthier as well, such as Darwin by Delos. The system ties into the built environment to control lighting, water purity, noise, temperature, and air quality for better overall health and comfort.

Consumer awareness of these issues is improving and therefore creating a foundation for builders to promote their home products. Programs like the aforementioned Declare label are increasing consumers' access to

information. In the Houzz survey, consumers identified the biggest issues with trying to incorporate healthier products into their purchase decisions, showing a lack of education about negative implications.⁴ Home builders could provide clear-cut infographics that show an overall picture of the products they choose, along with lower emissions, to make the process clear and simple for the buyer. Plus, builders could offer true price comparisons to show buyers real value, along with information on how the conditions contribute to lowering health-care expenses.

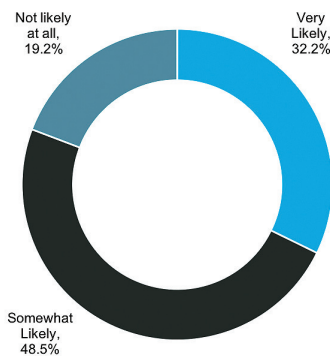
Importance of Health Impacts Versus Other Factors When Making Product Purchase Decisions (According to Home Owners)

The Drive Toward Healthier Buildings SmartMarket Report, Dodge Data & Analytics, 2014



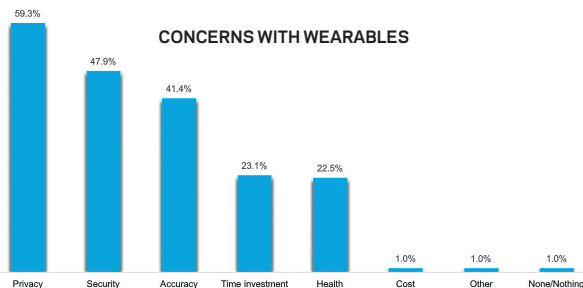
Source: Dodge Data & Analytics. Green and Healthier Homes.

Likelihood to purchase wearables to be more healthy at home



Source: The Farnsworth Group and Hanley Wood research.

CONCERNS WITH WEARABLES



Source: The Farnsworth Group and Hanley Wood research.

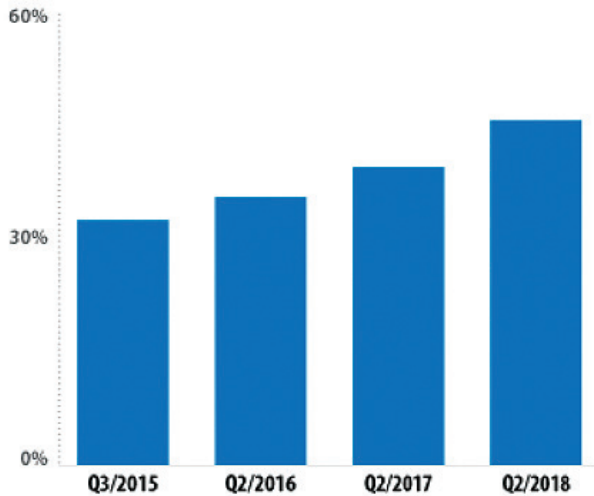
In the Dodge study, the results from homeowners showed that they are most likely to place health above the importance of aesthetics and least likely to place it above durability/longevity. More than two-thirds of respondents said health was equally important as or more important than cost when making a product purchase decision, which means they'd most likely pay more for a healthy home¹¹ and that builders can appeal to buyers first and foremost with a message about how healthy their homes are as opposed to their cost, performance, comfort, durability, or aesthetics.

Another aspect of healthy living is access to healthy food. Housing design will need to start capturing ways to incorporate features such as green walls, green roofs, and space to grow and harvest fresh vegetables. The Mariposa Healthy Living Toolkit suggests builders offer access to fresh, local foods along with the LEED ND NPdC1.3 recommendation for local food production. A healthy development should promote community-based food production, improve nutrition through increased access to fresh produce, and support local economic development that increases the economic value and production of farmland and community gardens.³²

There also are plenty of opportunities to learn more in ways that will inform better solutions. In the Farnsworth BUILDER KB Home ProjeKt research, survey respondents reported they aren't ready to use wearables in their home as part of the technology solution, with only 32% saying they're very likely to purchase wearables. However, as these technologies evolve and become more accepted, more data and information about the way people live in their homes and what their needs are will be available to shape future solutions.

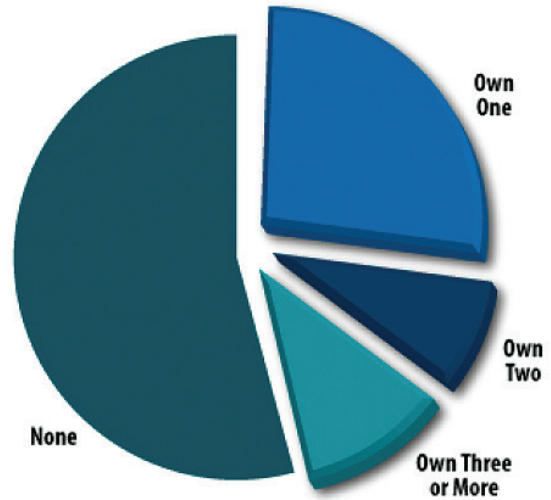
For now, we need to solve for the concerns regarding wearable devices. In the survey, respondents said the biggest barriers are privacy (59%) and security (48%).⁶

Overall Adoption of Connected Health Devices U.S. Broadband Households



Source: Parks Associates. State of the Market.

Connected Health Device Ownership U.S. Broadband Households



Source: Parks Associates. State of the Market.

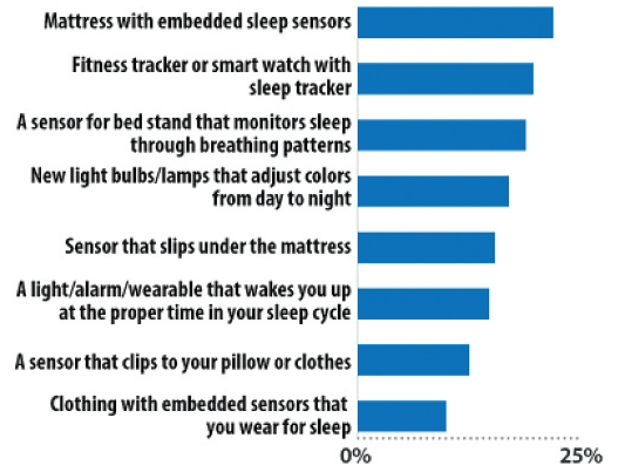
A Parks Associates survey shows that overall adoption of connected health devices has increased year over year from 2015. The same survey shows that 45% of homes currently own a connected health device. About 25% own one device, about 10% own two, and another 10% own three or more, which include wrist-worn devices, exercise equipment, pedometers, blood pressure monitors, and digital scales.

The same Parks Associates research shows the top products that homeowners would consider purchasing to address sleep issues, with most starting to breach the in-home wearable devices market.

The data also show that 40% of U.S. broadband households would pay for at least one home-living service for themselves, including those with features such as alerts if a family member is in an emergency, alerts to the consumer about dangers in the home, and concierge services offering advice on retirement and healthy-home living.

And although the data still don't suggest a full focus on integrated smart-home health systems, those who choose to go in that direction need to pay attention to associated security companies, based on data from Parks Associates. Buyers interested in smart-home

Willingness to Buy Sleep Tech Products U.S. Broadband Households

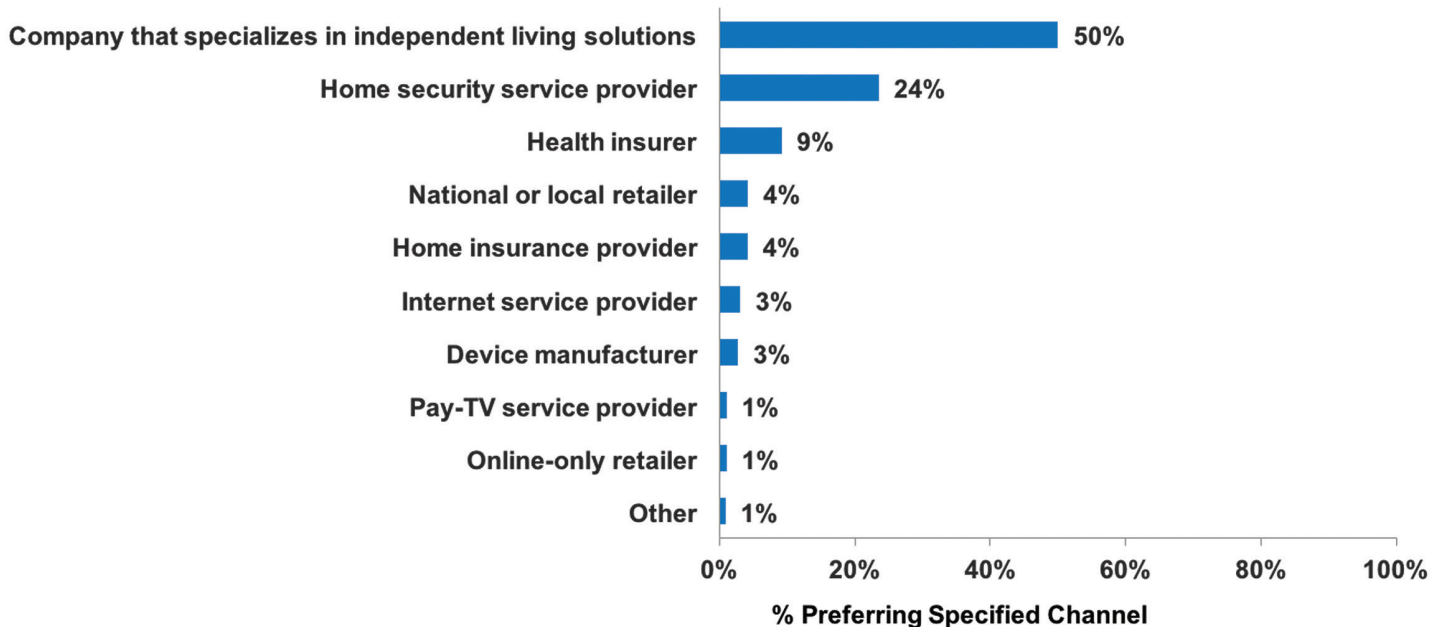


Source: Parks Associates. State of the Market.

technology systems are more comfortable purchasing from companies that specialize in home security. Almost one-third of seniors who own a security system and subscribe to professional monitoring services would prefer to buy an independent-living solution from a security service provider.³¹

Preferred Sources to Purchase Independent Living Systems (Q2/18)

Among the 17% of U.S. BB HHs Willing to Purchase an Independent Living System, n = 868, ±3.33%



"H4334d. From which type of company would you most like to purchase a system that would help you live independently as you age?" | Asked of Subgroup of 5,026 U.S. BB HHs | Source: American Broadband Households and Their Technologies Q2 2018 | N=10,024, ±0.98% | © 2018 Parks Associates

Builders should be cautious about adding technology to their homes and regard data interoperability, as opposed to hardware interoperability, as the priority to slow the rate of obsolescence. Be careful to select products that share data and “speak to each other” effectively, then build a hardware infrastructure that can be easily upgraded or replaced.

CONCLUSION

While there always seem to be new health and wellness crazes, and the trends seem to ebb and flow and contradict what was popular a decade earlier or even just last week, the landscape is changing, not only in the residential space but from a macroeconomic level.

As consumers demand more and builders deliver more through their homes, the equation is changing. A home delivers sustainability features, energy efficiency, comfort, security, health, and well-being. A home now

contributes to a homeowner’s bottom line, as well, reducing utilities and medical expenses, revising the decades-old formula of spending 30% of household income on housing, issued by the government in 1981.

That culture shift that welcomes opportunities for housing to take a bigger role and responsibility in the occupant’s life could be the catalyst to new technologies and innovations. Just as the evolution of green features and standards has occurred, health and well-being standards have similar potential. There’s opportunity for codes and standards to be developed and to become common building practices within the next decade and beyond.

Architects, engineers, and builders will need to include wellness and well-being as standard virtues that their structures must promise and deliver—durability, usefulness, and beauty—along with attainability for a scalable marketplace. ■

Appendix: Sources and Resources

1. Federal Healthy Homes Work Group. Advancing Healthy Housing A Strategy for Action citing Lepeis NE, Nelson WC, Ott WR, et al. The National Human Activity Pattern Survey (NHAPS): A resource for assessing exposure to environmental pollutants. *J Expo Anal Environ Epidemiol.* 2001;11(3):231-252.
2. Smart and Healthy Homes Industry insights presentation, January 2018, Delos. Slide 8.
3. UK Green Building Council Health and Wellbeing at Home, July 2016. Infographic developed for UK GBC by PRP: 7. <https://www.ukgbc.org/ukgbc-work/health-wellbeing-homes/>
4. Houzz. Healthy Home Trends Study. 2014. 808 residents in the United States. <https://www.houzz.com/ideabooks/93684873/list/2014-us-houzz-healthy-home-trends-study>
5. Hayward Score www.haywardhealthyhome.com <https://www.haywardscore.com/how-people-experience-an-unhealthy-house/>
6. The Farnsworth Group and Hanley Wood research. June 2018. 300 home buyers and home owners.
7. United States Census Bureau. Decennial Census of Population and Housing. April 1, 2010. <https://www.census.gov/programs-surveys/decennial-census/decade.2010.html>
8. Liddy Manson, AgingWell Hub, Georgetown University McDonough School of Business, presentation for HIVE Design Conference, September 2018.
9. Living Future Declare Product Red List <https://living-future.org/declare/declare-about/red-list/>
10. 2015 Summit Wrap Up Global Wellness Summit Identifies Top 10 Future Shifts in Wellness <https://www.globalwellnesssummit.com/images/stories/gsws2015/pdf/summit-wrap-up-2015-mexico-final.pdf> 2015 by Global Wellness Summit: 9.
11. Dodge Data & Analytics. Green and Healthier Homes. 2015. 232 home builders and remodelers in the US. <https://www.construction.com/toolkit/reports/green-healthier-homes-sustainable-living>
12. CNBC report, Medical Bills Are the Biggest Cause of US Bankruptcies: Study, Dan Mangan. July 2013. <https://www.cnbc.com/id/100840148>
13. United States Environmental Protection Agency: Moisture Control Guidance for Building Design, Construction and Maintenance, December 2013, EPA 402-F-13053. www.epa.gov/iaq/moisture
14. Harvard T.H. Chan School of Public Health's Center for Health and the Global Environment, Joseph G. Allen, DSc, MPH, Principal Investigator, Assistant Professor of Exposure Assessment Science; John D. Spengler, Ph.D., Co-Principal Investigator; Akira Yamaguchi Professor of Environmental Health and Human Habitation; Piers MacNaughton, MS Project Manager, Doctoral Candidate, Syracuse University Center of Excellence—The Total Indoor Environmental Quality Laboratory (TIEQ); Suresh Santanam, ScD, PE, Co-Investigator, Deputy Executive Director, Syracuse CoE; SUNY Upstate Medical School; Usha Satish, PhD, Director, Strategic Management Simulations Institute for Human Performance <https://green.harvard.edu/tools-resources/research-highlight/impact-green-buildings-cognitive-function>
15. US Department of Energy, Home RX: The Health Benefits of Home Performance – A Review of the Current Evidence <https://www.energy.gov/sites/prod/files/2016/12/f34/Home%20Rx%20The%20Health%20Benefits%20of%20Home%20Performance%20-%20A%20Review%20of%20the%20Current%20Evidence.pdf>
16. You Asked: Can Indoor Plants Really Purify the Air? TIME <http://time.com/5105027/indoor-plants-air-quality/> and Interaction with indoor plants may reduce psychological and physiological stress by suppressing autonomic nervous system activity in young adults: a randomized crossover study *J Physiol Anthropol.* 2015; 34(1): 21. Published online 2015 Apr 28. doi: 10.1186/s40101-015-0060-8 Min-sun Lee, Juyoung Lee, Bum-Jin Park, and Yoshifumi Miyazaki
17. Caelus Green Room. 7 Tips to Green your Houseplants. February 24, 2017. <https://www.caelusgreenroom.com/2017/02/24/7-tips-green-houseplants/>
18. Hayward Score Data & Hayward Healthy Home Principles with recommended changes to the building industry, September 2018 - Specific to California Central Coast Climate.
19. United States Environmental Protection Agency: Moisture Control Guidance for Building Design, Construction and Maintenance, December 2013, EPA 402-F-13053. www.epa.gov/iaq/moisture

Appendix: Sources and Resources (continued)

20. Knowledge Networks and Insight Policy Research. AARP. Loneliness Among Older Adults: A National Survey of Adults 45+. September 2010. https://assets.aarp.org/rgcenter/general/loneliness_2010.pdf
21. Gerteis J, Izrael D, Deitz D, LeRoy L, Ricciardi R, Miller T, Basu J. Multiple Chronic Conditions Chartbook. AHRQ Publications No,Q14-0038. Rockville, MD: Agency for Healthcare Research and Quality. April 2014
22. 2016 Consumer Reports, Why Americans Can't Sleep. <https://www.consumerreports.org/sleep/why-americans-cant-sleep/>
23. The Breathe-Easy Home: the impact of asthma-friendly home construction on clinical outcomes and trigger exposure. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3000722/> Am J Public Health. 2011 Jan;101(1):55-62. doi: 10.2105/AJPH.2010.300008.
24. Everyone Needs Someone: Why Americans of All Ages Are Coming together in Intentional Communities, TIME, by Jeffrey Kluger <http://time.com/intentional-communities/>
25. Harvard Joint Center for Housing Studies. Challenges and Opportunities in Creating Healthy Homes: Helping Consumers Make Informed Decisions. Survey. 2016. 529 US homeowners.
26. Neckelmann D, Mykletun A, Dahl AA. Chronic insomnia as a risk factor for developing anxiety and depression. Sleep. 2007. <https://www.ncbi.nlm.nih.gov/pubmed/17682658>
27. Lao XQ, Liu X, Deng HB, Chan TC, Ho KF, Wang F, Vermeulen R, Tam T, Wong MC, Tse LA, Chang LY, Yeoh EK. Sleep quality, sleep duration, and the risk of coronary heart disease: a prospective cohort study with 60,586 adults. J Clin Sleep Med. 2018. <https://www.ncbi.nlm.nih.gov/pubmed/29198294>
28. American Association of Retired Persons (AARP) Home Fit Guide. 2015. <https://www.aarp.org/content/dam/aarp/livable-communities/documents-2015/HomeFit2015/AARP%20HomeFit%20Guide%202015.pdf>
29. Parks Associates. State of the Market: Smart Home & Connected Entertainment, p 33-38. 2018.
30. "H4-335. Are you a caregiver for an aging family member or a family member with a health-related condition?" Source: Multiple Surveys: American Broadband Households and Their Technologies | © 2018 Parks Associates
31. "H4-334d. From which type of company would you most like to purchase a system that would help you live independently as you age?" | Asked of Subgroup of 5,026 U.S. BB HHs | Source: American Broadband Households and Their Technologies Q2 2018 | N=10,024, ±0.98% | © 2018 Parks Associates
32. Mariposa Healthy Living Institute, Denver Housing Authority, Mithun, Inc. Mariposa Healthy Living Toolkit. Positive Health Outcomes in Community Redevelopment. 2012. <http://www.denverhousing.org/development/Mariposa/Documents/Mariposa%20HLI%20Toolkit%202012.pdf>
33. Lizzie O'Leary and Paulina Velasco, Marketplace. The industry of wellness, by the numbers. January 2018. <https://www.marketplace.org/2018/01/04/world/wellness-craze-numbers>. Based on the research from the Global Wellness Institute <https://globalwellnessinstitute.org/press-room/press-releases/wellness-now-a-372-trillion-global-industry/>.

PROJECT PARTNERS

Builder



andersonbaron



Architecture + Planning