



enable

Your home for today,
and tomorrow

Market Potential Narrative D8 Submission

August 10, 2017

HOUSE

by Northwestern

Northwestern University

U.S. Department of Energy
Solar Decathlon 2017



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**market potential
narrative**

INTRODUCTION

Enable by House by Northwestern is Northwestern University's first entry to the Department of Energy Solar Decathlon. Designed for active Baby Boomers living in Chicago's North Shore who are looking to downsize and buy their home for life, *Enable* delivers an **EN**ergized (energy-efficient and active lifestyle) and Adapt**ABLE** (the house meets residents' changing needs) experience for its target users. *Enable* is more than a house. It's a home for today, and tomorrow.

MARKET POTENTIAL

We are pleased to report that as of August 2017, **contract preparations** are taking place between a potential local buyer in our target demographic and the University. The potential buyer is willing to pay market value for *Enable*, and additionally is willing to vacate the property for two years after Solar Decathlon 2017 in order to give public access to the house for educational outreach, sustainability awareness, and workforce training programs. The public programs prior to *Enable* becoming a private residence are currently being developed in close collaboration with leaders of the City of Evanston, including the mayor and city council members. The potential buyer has no affiliations with the university and discovered our team organically through HBN's community outreach efforts. We believe this is a strong testament to our prototype house's success in not only demonstrating appeal for the target client but also addressing a critical market need.

From the start, we have closely integrated our team with our target customer demographic and practitioners of construction and energy technologies, as well as architecture

and design. This is our framework to innovating and producing a desirable product: by taking a user-centric approach to listen to the **voice of the customer** and marry the ingenuity and creativity of our student team members with the discipline and know-how of industrial leaders.

TARGET CLIENTS: BABY BOOMERS

Enable increases adoption of residential renewable energy by fulfilling key housing needs and requirements of an aging and massive Baby Boomer market – particularly in the Chicago North Shore area – and capitalizing on favorable solar and construction industry trends.

“MICHAEL & LISA”

Our target customers are Baby Boomer couples aged 55-70 years old who plan to live in the Chicago North Shore area, which includes Evanston. These individuals are generally still working at least part-time, are recent empty-nesters, and are looking to downsize from larger homes they own. The HBN team has created target client personas of “Michael and Lisa,” which are referenced frequently in our materials, to encompass HBN market research data and represent that common voice of the active Baby Boomer living in Chicago's North Shore. In their personas, Michael is 55 and Lisa is 53, and both would like to stay in Evanston, IL as they age, as it is the city where they have been for their entire married life. They have two children: one is in college, and the other lives with his fiancé in St. Louis. Michael works as a banking firm as a Senior Quantitative Analyst in Chicago and commutes downtown every day. Lisa is a graphic designer and generally works from home. They both expect to retire in 10 to 15 years. Based on Glassdoor averaged salary data, we arrived at a **household income of \$148,270** (\$100,685 for Senior Quantitative Analyst¹ and \$47,585 for Graphic Designer²). This household income is at the 85% percentile in Evanston³ and is in line with our target North Shore demographic.

At 55-70 years old, Boomers in this segment have relatively active



lifestyles: they may enjoy socializing at home several times a year, host holiday family gatherings, and engage in a range of hobbies including traveling, golf, and gardening. This segment is interested in living in their own homes as they grow older.

We believe *Enable* exceeds the expectations of our target customers by delivering a highly livable home with sustainable features that are also healthy, comfortable, high-performing, and easy to maintain over time. In the next sections, we describe these features in more detail and a through market analysis of the Baby Boomer housing market can be found in the section “Market Analysis & Client Preferences.”

AGING-IN-PLACE & UNMET HOUSING NEEDS FOR BABY BOOMERS

In the city of Evanston, IL, home to Northwestern University and part of Chicago’s North Shore, 20% of the population is projected to be 65 and older by 2020⁴. A community that takes pride in its age-friendliness, Evanston is one of 284 cities in the world and 45 cities in the United States approved to enter the World Health Organization (WHO) Network of Age-Friendly Cities⁵. Being a part of this network requires that a city adapt its structure and services

— including housing — “to be accessible to and inclusive of older people with varying needs and capacities”⁶.



Recent Boomer homebuyers aged between 52-61 project they will live in their homes for at least 20 years⁷ and approximately 90 percent of those over age 65 report wanting to stay in their homes as long as possible⁸. This desire to **age-in-place** means that Boomers’ houses will become important places for long-term care as residents deal with disabilities and other aging-related health challenges. However, the Joint Center for Housing Studies of Harvard University estimates that **only 1 percent of the current housing stock contains the key features required to support aging-in-place**, such as zero-step entrances, single-floor living, wide hallways and doorways, wheelchair-accessible light switches, and lever-style door handles and faucets⁹.

It is with this housing shortage and Evanston’s interest in

improving its current structures and services to create a culture of age-friendliness in mind that the Solar Decathlon team at Northwestern University set about designing a highly energy-efficient, yet fully-accessible home for a rapidly aging Baby Boomer demographic.

IDENTIFYING LOCAL CLIENT NEEDS THROUGH RESEARCH

The House by Northwestern (HBN) team took a user-centric approach to the design of *Enable*. In other words, community members weighed in at every step of the design process about how *Enable* could best meet their needs. The buyer personas of “Michael and Lisa,” which are referenced frequently in our materials, encompass HBN market research data and represent that common voice of the active Baby Boomer living in Chicago’s North Shore.

Based on primary research from HBN User and Market Research Teams¹⁰, our target market ranked the following housing features in order of importance to them: **comfort and livability, high-performance with functionality, easy home maintenance, sustainability, and affordability**. The crux of HBN’s design efforts was to create a home that balances the needs of the market with our team’s desire to create a sustainable, environmentally-friendly home. By packaging energy efficient and sustainable features into a comfortable, beautiful, accessible, and easy-to-maintain home, *Enable* offers sustainability without compromise.

During fall of 2016, HBN collaborated with the Osher Lifelong Learning Institute (OLLI), which is a continuing education program that serves older adults in the greater Chicago area. Throughout 14 weekly sessions that were two-hours each, HBN team members co-lead discussions on topics related to our project, which included “What is the Solar Decathlon?” “Sustainable Architecture” and “Interior Design.” Not only did the discussions reveal users’ attitudes towards sustainability, many of the ‘students’ participated in user interviews and observations, and even invited their friends to as well.

From the user interviews and observations, the team extracted “key insights”, one-line quotes that illustrated the relationship between user and home, and coded

them in two different ways: themes and nouns. Themes were the intangible things users valued, like functionality. Nouns were the tangible things users valued, like their kitchens. As a result, the team produced a list of themes and nouns ranked in order of importance, as well as a set of recommendations to fulfill these values in the House. With these recommendations in mind, the House by Northwestern team prioritized the real-life values of our target demographic when designing *Enable* (see Figure B1, Appendix B).

Following the fall class, many of the OLLI members chose to continue their involvement in the project. Between November and June, HBN members held 5 focus groups and 20+ shopping trips in order to expand the scope of their user research. Since June, we also held 3 on-site reviews to solicit feedback from members as the house took shape. Throughout this duration of time, the originally-small group has expanded as OLLI participants introduced House by Northwestern to other prospective users.

In order to test these recommendations as they were being generated, HBN's User Research Team conducted dimensioning sessions, created design matrices and drew storyboards. The dimensioning sessions gave HBN members and users a sense of the space constraints in which they had to work, and allowed for easy testing of hypothetical furniture configurations. The design matrices provided a way to quantitatively compare solutions by of the number of requirements they fulfilled (See Image B1, Appendix B). Users prioritized some requirements more than others, and thus were weighted more heavily. The storyboards (or journey maps) visually described the course of a user's experience with a product or a space. They allowed the team to identify micro-requirements, and depict how a brainstormed solution would fulfill those needs.

IMPACT ON U.S. RESIDENTIAL CONSTRUCTION & RENEWABLE ENERGY

Enable utilizes a newly developed **roof-integrated solar panel system** as an alternative to rack-mounted ones. The result is an economical, low-profile solar system that's directly integrated into the house's roofing system for better

aesthetics and longer performance value. Since the solar panels are not elevated on racks above the house's shingles but surrounded with a perimeter protection system, the risk of animal infestation and leaks are greatly reduced. The roof-integrated design of the solar panels also removes the headaches for future re-roofing issues associated with traditional roofs and reduces long-term material waste as the solar panels are covered by a 25-year warranty that is significantly longer than shingles. By utilizing installation methods and parts standard to traditional residential roofs, as designed by GAF, the solar system can be installed by trained roofing contractors (Image 1).



Image 1. GAF Roof-integrated solar panel installation. Source: GAF.

Integrating solar installation with roof construction results in a more streamlined procedure that not only lower costs but also protects the integrity of the roof. Given that 79% of Americans in 2015 said the country should put more emphasis on solar in a Gallup poll¹¹, we believe that innovations in changing the installers and finance models of roof-top solar can speak to consumers more easily and thus capture more value and increase adoption in a rapidly growing market.

The abovementioned solar array (6.5 kw) is DC-coupled to a 25 kWh AGM battery bank designed specifically for solar applications. The inclusion of battery storage enables us to increase our self-consumption fraction significantly over standard net-metered homes. Rather than selling solar energy back to the grid during the day, that excess energy is

stored in the battery bank and used in the evening, allowing solar energy to power the home 24 hours a day.

The DC-coupled system configuration provides a resilient system which allows the solar panels to continue to power the home and charge the battery bank in the event of a power loss (Image 2). All lighting, outlets, HVAC components, and appliances except for the range are backed up by this panel. Depending on energy consumption within the home and solar power production, *Enable* could operate off-grid indefinitely. This is a notable and unique benefit to our home, as AC-coupled or non-storage systems cannot use solar panels without a grid connection, thus requiring a fossil fuel generator if backup power is ever needed. Based on feedback from our target demographic and potential buyer, these are significant features that made a positive contribution to the marketability of *Enable*.

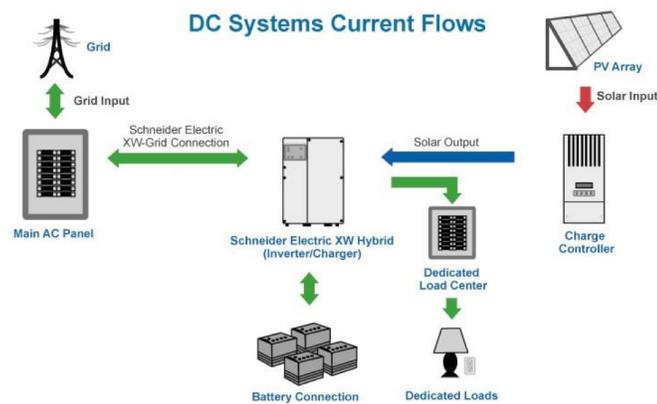


Image 2. Conceptual diagram of a DC-coupled solar system¹².

LIVABILITY

Enable's interior was designed with energy efficiency and the constraints and preferences of our users in mind. In order to understand what users value in a home and how their home influences their lifestyle, HBN's User Research Team conducted a thorough user-research process that involved both qualitative interview and observation strategies, as well as quantitative data-coding methodology. Three examples in lighting, smart home controls, and aging-in-place features are given below to demonstrate HBN's meticulous attention to details.

Often, weakened eyesight is a consequence of aging. Therefore proper levels of lighting are critical for users to

navigate the home safely and perform tasks, such as reading. Task lights are located next to dedicated reading spots, like the desk and sofa bed in the second bedroom. Luna Light nightlights self-illuminate the path from the master bedroom to bathroom. In the bathroom, the lighted medicine cabinets provide the right amount of light for users to check their appearance. In the kitchen, undercabinet and pendant lighting ensure users can fully utilize their counter space. According to our user research, lighting also makes a house a home. The clerestory windows provide ambient natural light, which is important to mental health. There is plenty of accent lighting: the uplighting above the cabinets, the chandelier, floor lamp, and solar-powered string lights in the main room set an elegant yet comfortable mood. *Enable* features LED lighting exclusively. The lighting system was created using photometric design tools (Image 3). This enabled us to confirm our light levels meet and exceed both competition requirements and recommended lighting levels for our target clients in each space within the home prior to construction.

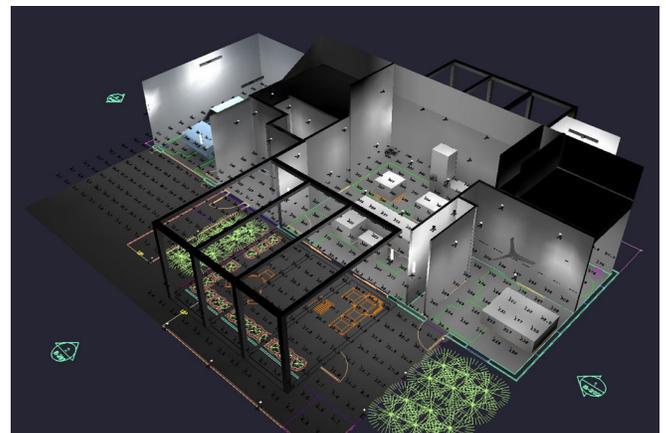


Image 3. Screenshot from photometric modeling design tool used to develop an effective lighting plan for *Enable*. Source: Paramount-EO & Kelso-Burnett.

Enable includes a host of user-friendly smart home systems, intended to make the operation of the home simpler and more intuitive. All light fixtures are controlled by the **Lutron Caseta** system, which allows occupants to dim all light fixtures, schedule when they are turned on, and create custom lighting scenes and programs. All of this can be done from within the home, or within the Caseta App anywhere with an internet connection. The Caseta system is also integrated with the **Nest Protect smoke and carbon monoxide detectors**, the **Nest Learning Thermostat**, and **Amazon Alexa**. Through the smart-bridge, all of these components can be linked together through one App, preventing users from needing to

switch applications frequently to use different features of the home. To help *Enable's* occupants monitor their energy usage, our home features the **Wiser Energy Center from Schneider Electric**, a fully integrated OEM electrical monitoring system that monitors every circuit within the home (Image 4). It is the only fully UL-certified residential smart panel available today which provides a clear, visionable, and actionable view of home energy consumption. The end user interface is simple to use and cleanly displays energy consumption for each circuit or load type, removing unnecessary clutter and overly technical information from common monitoring system graphs. These more detailed data points are still usable and can be analyzed both internally to the Wiser energy interface and externally through data exports.

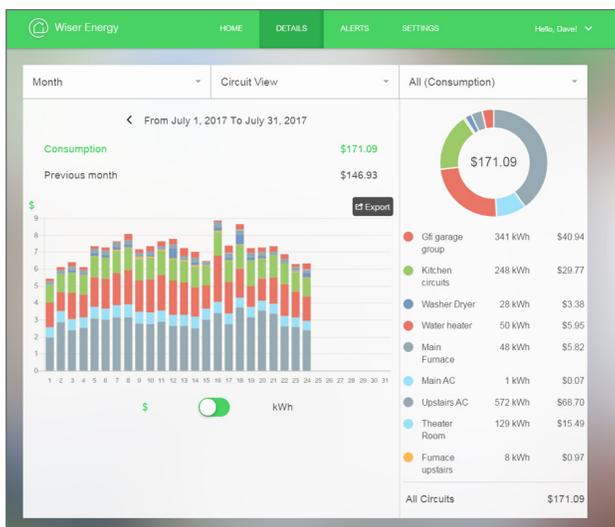


Image 4. Wiser Energy Center user interface¹³

To support a safe, functional, convenient, comfortable, and enjoyable dwelling place for our target clients to age in place and welcome their visitors, the flooring throughout *Enable's* interior and deck spaces is all on the same plane and **all spaces in *Enable* will be Americans with Disabilities Act (ADA) compliant.** An ADA-accessible layout allows for current or future space needs, including wheelchair space. An ADA-accessible guest bathroom offers both comfort (added privacy of having more than one bathroom) and the continued ability for residents to use either bathroom should they become disabled. If necessary, the guest bedroom and bathroom could function together as a caregiver space. The garage is also ADA-accessible and provides both residents and their automobiles protection from harsh Chicago winters. In addition, the house's circulatory spaces contain no sharp curves, and all its furniture and fixtures have no sharp corners. These design

decisions make *Enable* both easily accessible by wheelchair and safe for crawling grandchildren (no pressure from Michael and Lisa yet) to navigate at will. It also allows for clarity of layout, ensuring that *Enable's* spaces are free of nooks and crannies that can be difficult to access.

A unique aspect of *Enable* is the **modular interior wall system where the basic building blocks are the same**—the vertical posts, the way the frames of adjacent sections connect, the way panels are attached to the frame, etc. When all the parts are parametric, they can be standardized in the method they fit together but each part can be altered in size, material, or color, making them highly customizable and “future-proof.” With standardized connections and parts, new systems can be introduced with no compatibility issues: the same way that our parents' LEGO bricks still work with ours today despite different themes. In addition, when new technologies are introduced (e.g. flat panel TVs in the last decade), the walls can adopt to accommodate them.

The majority of the interior walls of *Enable* is manufactured by the Canadian company DIRT, an innovator in applying technology to construction. DIRT's connectors are extruded aluminum tracks designed to ensure close fit and strength but slide easily to allow for simple installation and removal. By using pre-engineered, pre-manufactured wall frames and panels, the interior space and rooms of *Enable* can be reconfigured to adjust and used over the owner's different stages of life (including adding medical gases). **Any required maintenance behind the walls will only require disassembly and not demolition.**

MARKET ANALYSIS & CLIENT PREFERENCES

Baby Boomers generally are very important to the U.S. housing industry given their sheer numbers. They were born between 1946-1964 and age between 52-70 years old as of 2016. According to the Census Bureau, **there will be 79 million people aged 65-and-over by 2035, an increase of more than 30 million people with 50% of that growth happening over the next 10 years.** People aged 80-and-over will reach 24 million by 2035 - double the number in 2015. Most of this growth will take place between 2025-2035. In terms of

households, the Joint Center for Housing Studies of Harvard University estimates this level of population growth will result in 49.6 million older households in 2035, up over 65% or nearly 20 million from 2015. Boomers aged 65 or older who head up owner households will reach 32 million by 2025 and 38 million ten years later. In the City of Evanston, home to Northwestern University, 20% of the population is projected to be 65 and older by 2020, up from 15% in 2014¹⁴.

Baby Boomers also command significant buying power. The National Association of Realtors Research Department estimates **30% of recent homebuyers to be between the ages of 52-70**¹⁵. Applying this estimate to recent Census Bureau home sales data¹⁶, we estimate Baby Boomers purchased over \$60 billion in new, single family homes in 2016 alone. Younger Boomers between the ages of 52-61 made up more than \$30 billion of this total.

Primary research from HBN User and Market Research Teams tells us that when considering housing features, our target customers value comfort and livability, high-performance with functionality, and easy home maintenance. Sustainability and affordability are also important but relatively less so than the aforementioned features. The sentiments of residential homebuilders on the attractiveness of sustainable homes to older buyers are more bullish. **81% of homebuilders and remodelers considered energy efficiency as being influential to homebuyers 55 and older** according to a study by Dodge Data & Analytics¹⁷. The study also showed that **83% of homebuilders and remodelers believed homebuyers and homeowners were willing to pay more for healthier homes**. These insights suggest the importance of emphasizing the healthier aspects as well as livability and practical functionality of sustainable features when designing a home for our target customers.

Marketers describe Baby Boomers as individualists and optimists who value self-expression and living in the present¹⁸. Regarding work, Boomers define themselves by their careers and prefer working to retiring. Many have “re-engineered” their lives in order to keep working and have thus entered into an “active retirement” phase of life. Being healthy and taking care of oneself are important personal goals. Family values and responsibilities are also held highly. They are a sandwich generation, having taken care of aging parents and their own children before becoming empty nesters. Many are wealthy

grandparents with disposable incomes to lavish on their grandchildren. Compared to previous generations, Boomers are more tech savvy and open to new technologies.

In terms of purchase behavior, Boomers prefer flexibility and option value. **They want instant value from easy-to-implement solutions that do not require complex, future changes**. They are sensitive to price, but less so if they believe they are getting good value from high quality products and services. Boomers seek to understand. Marketing collateral and customer interactions will be more effective if information is given openly and directly and questions are answered comprehensively. With respect to home buying, Boomers are influenced by home performance features such as sustainable technologies more so than younger buyers because many Boomers are experienced homebuyers and understand the connection between performance features and healthy living (based on findings from Dodge Data & Analytics).

Enable's marketing and communications are informed by these insights. Specific focus is placed on the target customers themselves, their families, and education around high-performance features that create healthier living spaces. For example, as Boomers age, they become more self-focused and seek to live carefree lives. Our messaging focuses on a home designed for their immediate needs as well as future needs that come with aging. Because Boomers may have adult children and grandchildren, these family members also become stakeholders or key decision makers. Our messaging highlights features that appeal to them as well. Finally, our messaging around performance features educate as well as inspire. The focus is on how sustainable technologies improve healthier living and how these innovations can achieve cost-effectiveness.

POSITIVE TRENDS IN THE US RESIDENTIAL SOLAR MARKET

Powerful policy and market forces impacting the solar industry are driving higher consumption of solar energy in the U.S. residential market. Lower costs, subsidies at various government levels, grid parity and new business models have created a favorable environment for the development and sale of solar-powered homes such as *Enable*.

U.S. residential distributed solar energy consumption was 98 trillion Btu in 2016, up nearly 40X from ten years prior .

Since 2007, distributed solar power consumption has been exponentially growing at a 50% compounded annual growth rate (CAGR). A confluence of factors are driving this rapid growth; primarily, declining photovoltaic (PV) modules and balance-of-system (BOS) costs which include costs for inverters, hardware for racking and installation, labor for design and installation, and regulatory and financing costs.

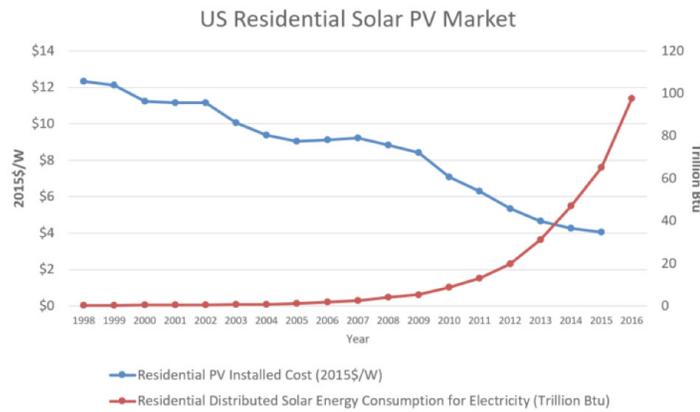


Figure 1. Increased residential solar consumption and declining installation costs. Source: US Energy Information Administration; Lawrence Berkeley National Laboratory; HBN Research

VALUE TO TARGET CLIENT

HBN’s vision is to deliver a home that promotes sustainable living without compromise. As evidenced by the published market survey findings from Dodge Data & Analytics above, an overwhelming majority (>80%) of homebuyers are willing to pay more for healthier indoor living environments, and Baby Boomers lead the other age groups in valuing energy efficiency and health. Through our own research, we discovered that North Shore older adults value comfort and livability, high-performance with functionality, and easy home maintenance the most. As such to align with market needs and expectations, we purposely placed emphasis (and cost) on interior construction and finishes but were still able to deliver a prototype house that has an enhanced market value due to the integration of sustainability and health features. The total cost of construction materials and labor on all permanent furnishings is \$386K (\$404K with a 5% contingency). A cost summary is provided in Table 1 and a detailed view can be found in the Cost Estimate Excel spreadsheet.

While we are pleased that contract preparations are currently taking place between a potential local buyer and the

DESCRIPTION	TOTAL \$	\$/SF (GSF = 992SF)	% TOTAL
INTERIOR CONSTRUCTION	\$100K	\$100	25%
ELECTRICAL	\$65K	\$65	16%
EXTERIOR CLOSURE	\$65K	\$66	16%
PLUMBING/ MECHANICAL/ FIRE	\$40K	\$40	10%
SPECIAL CONSTRUCTION	\$30K	\$30	7%
ROOFING	\$23K	\$23	6%
SUPERSTRUCTURE	\$21K	\$21	5%
INTERIOR FINISHES	\$15K	\$15	4%
TRUCKING, CRANE TIME, LULL/ FORKLIFT	\$13K	\$13	3%
EQUIPMENT	\$9K	\$9	2%
FOUNDATIONS	\$3K	\$3	1%
CONTINGENCY	\$18K	--	--
TOTAL PROJECT COST	\$404K	\$407	100%

Table 1. Construction Cost Summary (Note: Column totals may not sum due to rounding).

university, fully demonstrating *Enable’s* appeal to our target client, we have performed thorough market analysis on the Evanston real estate market. By interviewing local realtors, architects, builders, and potential homebuyers, we were able to compile representative costs for land, new construction, and monthly utilities.

The new construction cost of \$260 per sq. ft in Evanston was obtained by interviewing a current homeowner who had scoped out work to tear down his existing house and construct a new one¹⁹. In that cost per sq. ft, economizing measures included recycling/reusing many parts of the existing house: hardwood floors, doors, moldings, cabinets/countertops and appliances - even asphalt roof shingles. However, that cost does not include many of the sustainability features of *Enable*, such as high-performance windows and insulation, energy recovery ventilation, photovoltaics, residential battery, and heat pump.

DESCRIPTION	COST
LAND FOR TEARDOWNS	\$53.65/SF
NEW CONSTRUCTION	~\$260/SF
ELECTRICITY*	\$69/MONTH
NATURAL GAS*	\$52/MONTH

Table 2. Representative costs in Evanston (2017). *Actual electricity and natural gas data from 08-2016 to 07-2017 for an existing 96 year-old, 1200-sqft single family house in Evanston with insulation upgrades in 2008.

Enable targets clients who are looking to build a home that uniquely fits their needs and desires; a home that fits their monthly budget while promoting sustainability without compromise. An important marketing and messaging strategy to Baby Boomers for HBN has been communicating the performance features of *Enable*, and thus it is important to focus on the monthly savings from *Enable* when comparing to the costs of owning and operating a conventional house. *Enable* is designed to produce 110% of its energy needs over the course of a year in Evanston, including a 25-mile daily commute in an electric vehicle. Assuming that the non-*Enable* option for a similarly sized house has a monthly utility cost of \$121 (actual electricity and natural gas data from 08-2016 to 07-2017 for an existing 96 year-old, 1200-sqft single family house in Evanston) and transportation fuel cost of \$121 (750 miles in a representative 2010 BMW Series 3 at 23 mpg and gas price of \$2.80 per gallon), the combined savings from both for *Enable* translate to a \$51,000 increase in mortgage loan amount (30 year, 4% interest) while keeping monthly costs identical. Online calculator tools to estimate monthly payments found on popular websites such as Realtor.com are among the most popular features of those sites, but utility costs are to date not factored in, leaving one of the biggest benefits of a high-performing house like *Enable* hidden from potential homebuyers.

A 1000-sq. ft conventional house would cost roughly \$260K to construct in Evanston, and adding the \$51K increase in “mortgage loan amount,” the cost of building and operating *Enable* is competitive, albeit translating to a 30% or \$93K premium on conventional construction cost with energy-

saving features. We strongly believe that this premium is justified and within our target clients’ willingness to pay because of their demonstrated desire for high-end finishes (gourmet kitchen and elegant bathrooms), performance (water-efficient fixtures, smart home controls, adaptable interior wall system) and healthy indoor living environment (aging-in-place features, self-cleaning photocatalytic surfaces that remove air pollutants, and ventilation system).

BORROWING FROM TESLA'S SUCCESS

Enable’s vision is to **promote sustainable living without compromise**. We identified Baby Boomers as our target clients not only because there are unmet housing needs in our city and around the country for this demographic, but also because it gave us an opportunity to change the narrative of sustainable living from “barebones” (e.g. turning thermostat down in cold winters) to “highly desirable, and high-performance.” This approach is not unique to HBN.



Image 5. Tesla’s roadmap from Model S to the Powerwall to the Model 3. Source: Tesla.

Tesla Motors in introducing the luxury sportscars the Roadster and Model S in 2012 opened the door to the “affordable” and wildly popular Model 3 today in 2017 (not to mention driving down lithium-ion battery costs for renewable energy storage in homes and at scale). Tesla founder Elon Musk blogged in 2006: “...the overarching purpose of Tesla Motors (and the reason I am funding the company) is to help expedite the move from a mine-and-burn hydrocarbon economy towards a solar electric economy... **Critical to making that happen is an electric car without compromises**, which is why the Tesla Roadster is designed to beat a gasoline sports car like a Porsche or Ferrari in a head to head showdown.”²⁰ Musk goes on to say “The strategy of Tesla is to enter at the high end of the market, where customers are prepared to pay a premium, and then drive down market as fast as possible to higher unit volume and lower prices with each successive model.” It is a similar masterplan that HBN is pursuing: starting with a highly desirable product that is simply better (not cheaper) than the “conventional” alternatives through technology, design excellence, and customer value capture will lead to positive industry effects in technology and sociocultural perceptions. One example of HBN’s execution of our masterplan is our employing an innovative marketing strategy by associating residential energy-efficiency and smart home technologies with a luxury car brand. HBN has partnered with BMW for a regional sweepstakes (sponsored by BMW) in September 2017 to raise awareness of Solar Decathlon and high-performance homes in a different market segment. Rules for the sweepstakes are included in Appendix C.

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CONCLUSION

We believe **value-based pricing** and messaging are keys to drive uptake of homes like **Enable**: by clearly pointing out what the offering is worth to the customer via actual energy and maintenance savings and how the offering delivers towards the customers’ value perceptions, without compromise. The House By Northwestern team designed **Enable** specifically to our unique target site on Chicago’s North Shore, discerning target client of Baby Boomers, and harsh climate of Chicago. We are proud that we already have a potential buyer for **Enable** identified, as that speaks to the value of our prototype house and the validity of our marketing/messaging hypothesis.

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18. Journal of Behavioral Studies in Business. *Marketing to the Generations*. https://www.researchgate.net/publication/242760064_Marketing_to_the_Generations
19. Private communication with Gerald Brennan (August 2017)
20. <https://www.tesla.com/blog/secret-tesla-motors-master-plan-just-between-you-and-me>



APPENDICES

APPENDIX A. RENDERINGS



Image A1. Overhead exterior view from the southeast, Summer



Image A2. Exterior view from the southeast, Winter



Image A3. Exterior view from the southeast.



Image A4. Exterior view from the southwest.



Image A5. Interior view from front door, looking into the living room, dining room, and kitchen.



Image A6. Interior view from door to the convertible room, looking into the living room and out to the sunroom.



Image A7. Interior view of the master bedroom; door to the right exits to the sunroom.

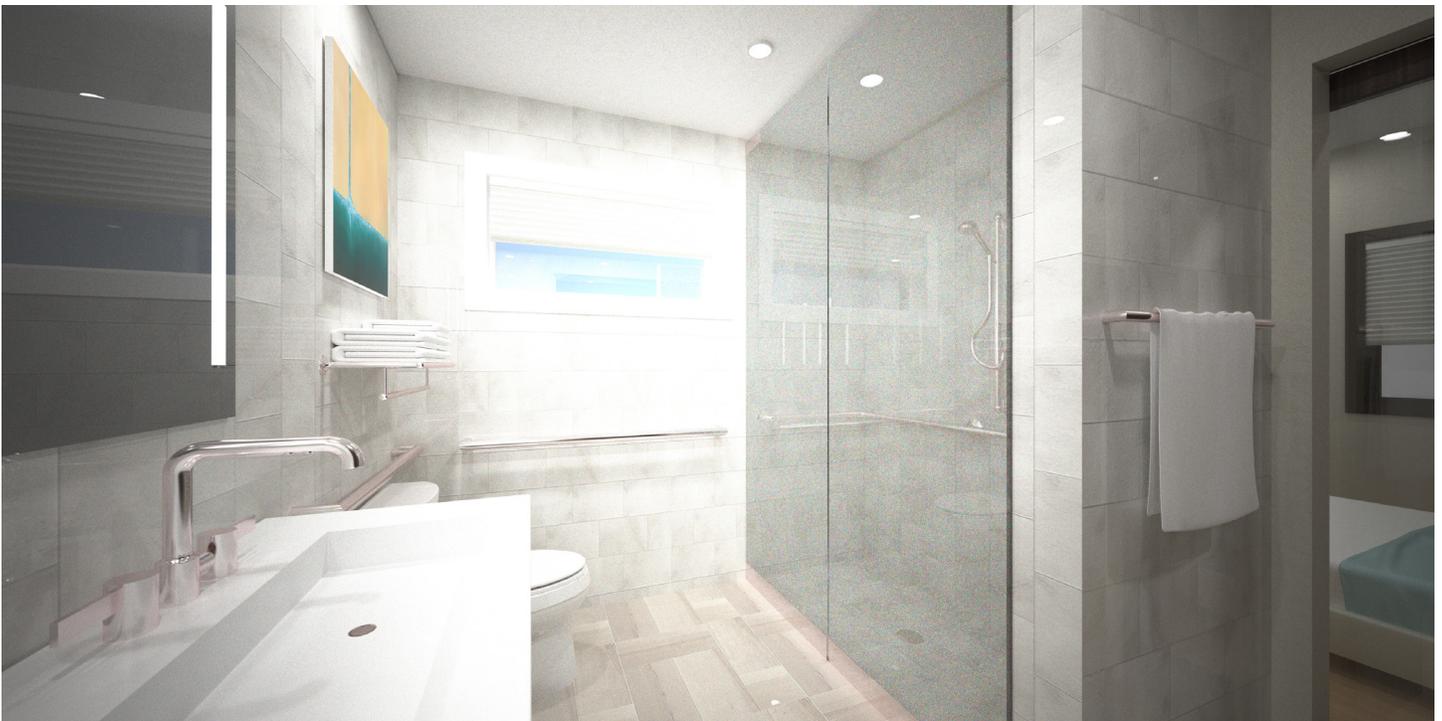


Image A8. Interior view of the master bathroom.

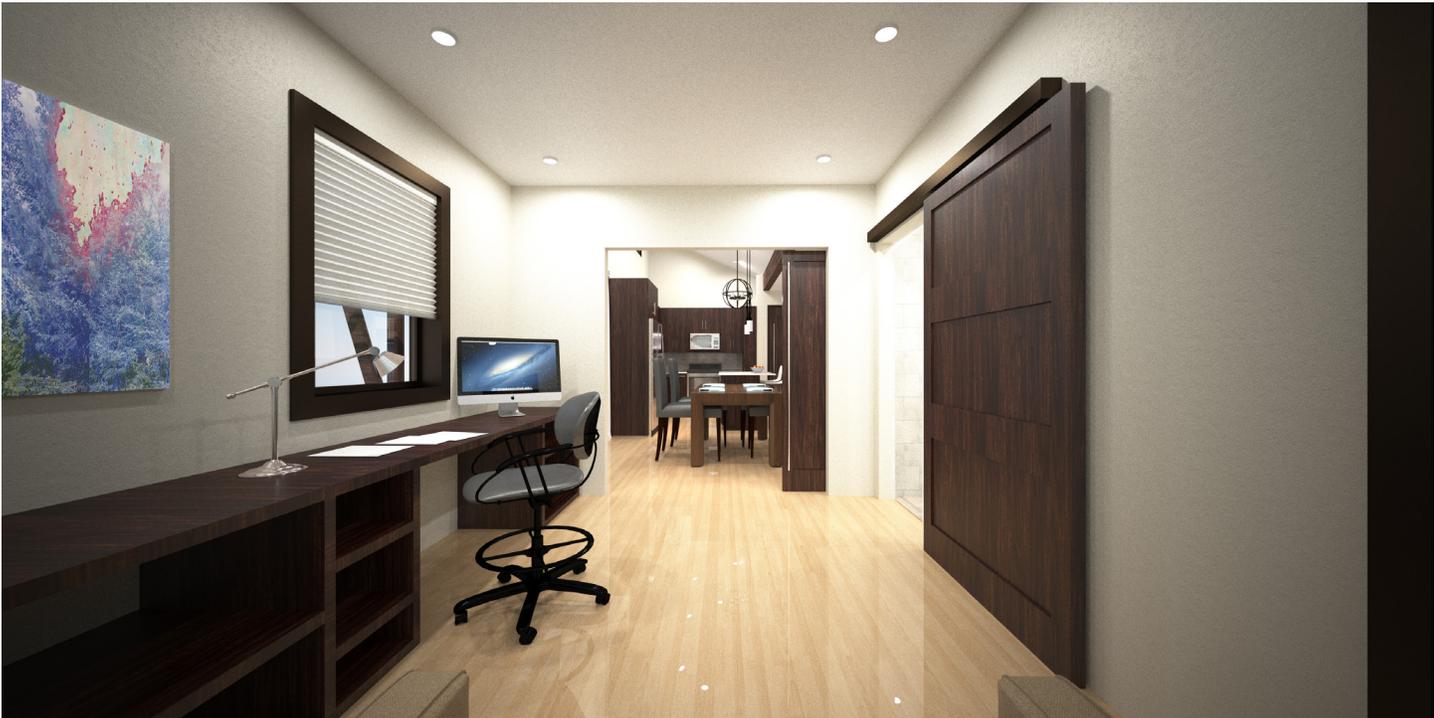


Image A9. Interior view of the convertible room, looking out to the dining room and kitchen.

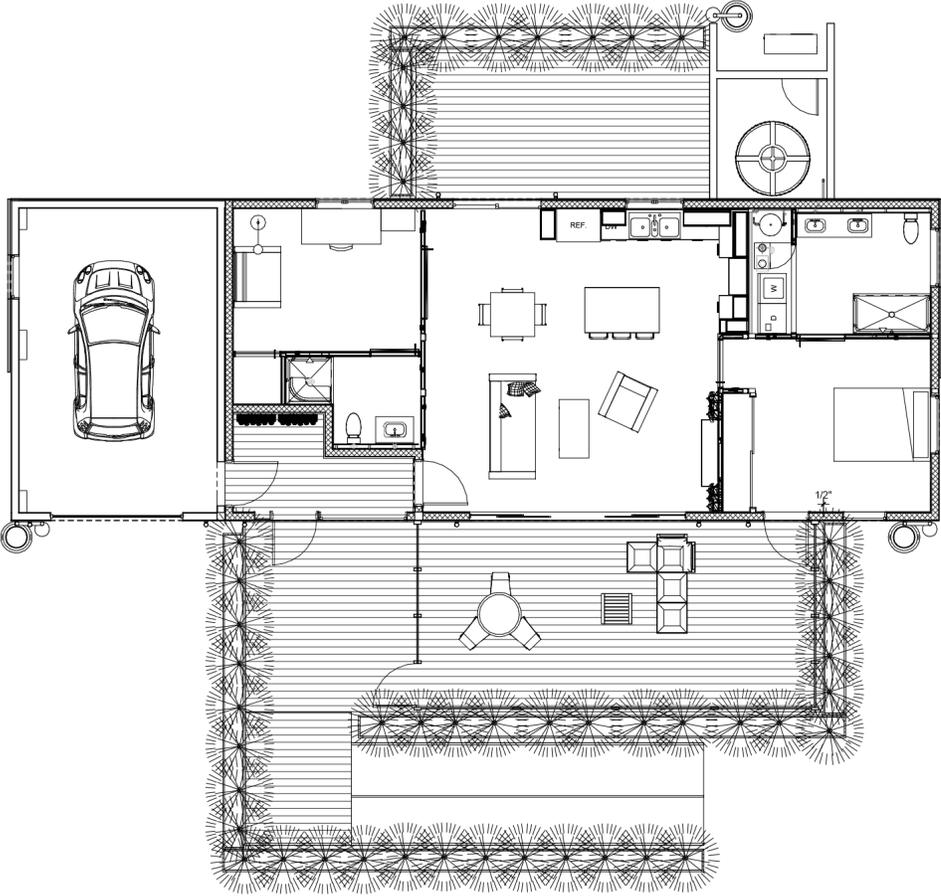


Image A10. Floor plan

APPENDIX B. USER RESEARCH DATA

View the video we made about our user research process here: https://www.facebook.com/pg/HouseByNorthwestern/videos/?ref=page_internal

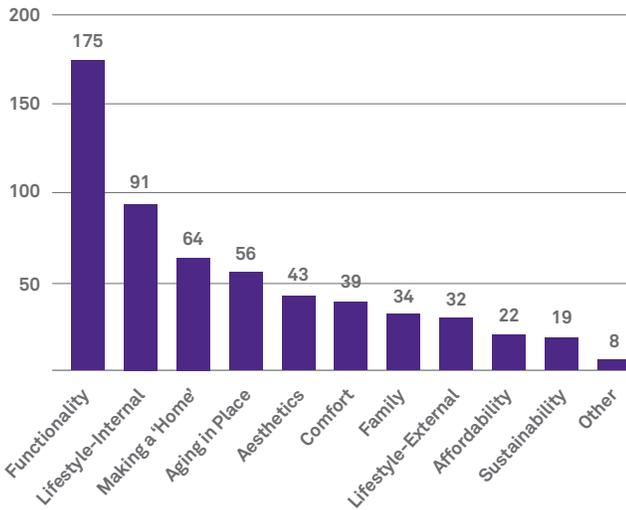


Figure B1. Target demographic housing priorities (ranked in order of importance). Source: House by Northwestern User Research Team ([bit.ly/2hgkw1k](https://www.facebook.com/pg/HouseByNorthwestern/videos/?ref=page_internal))

Requirements (Counter Stool)	Folio Top-Grain	Lowe Smoke Cc	Rouka Grey Up	Phoenix Ivory 2	Curran Crema Counter Stool
	\$499	\$279	\$349	\$149	\$369
Has a back for support, can grab on when getting in and out	1	1	1	1	1
Footrest to step on and off stool	1	1	1	1	1
No armrests so users can slide in and out	1	1	0	1	1
Feels sturdy, wide footprint by feet	1	1	1	1	1
Skinny enough to fit two in center island	1	1	1	1	1
User appeal (material, quality, design)	1	1	1	1	1
Comfortable to sit in (curve, upholstered)	1	1	1	2	1
Does not swivel	1	1	1	1	1
Design matches our aesthetic (grey=0.5, not grey = 1)	0.5	0.5	0.5	1	0.5
Price (ranked)	-1	2	1	3	0
TOTAL:	8.5	8.5	7.5	10	8.5

Requirements (Dining Chair)	Lowe Smoke Le	Curran Quilted	Sava Dining Ch	Monterey Charcoal Dining Chair
	\$199	\$349	\$249	\$199
Comfort	1	1	1	2
Customer reviews (durability, ease of cleaning)	-1	1	1	1
Aesthetic	1	1	1	2
Price	2	0	1	2
Lead time				
Seat depth no deeper than 17"	1	1		1
Width no larger than 19"	1	0		1
Seat height (29"-12") = 17"	0	0.5		1
TOTAL:	5	4.5	4	10

Figure B2. User Research Team design matrix used to determine most suitable counter stools and dining chairs. Requirements gathered from interviews, home observations, and focus groups with target demographic.

Requirements	Loveseat + swivel	2-seat sofa + armchair	Armless loveseat + swivel	L-shape	Right-arm + swivel
Can see 55" TV	2	-1		2	2
Looks out sunroom	-1	1		-1	-1
Comfortable armrests for lying down	1	1		-1	1
Easy to get in and out of	1	1		-1	-1
Correct firmness	1	1		1	1
Correct height	1	1		1	1
Sturdy	1	1		1	1
User appeal	1	1		0	1
ADA compliance + four route	1	1		1	-1
Total:	8	7		3	6
Armchair Requirements:					
	Elyse Swivel	Elyse Swivel Glider			
Arms match sofa	1	1			
Swivels to face conversation or outside	1	1			
Does not rock to allow users to get up	1	0			
Proper seat dimensions	1	1			
Fits in space	1	1			
Total:	5	4			
Fabric Requirements:					
	Duet - Natural	Diamond - Flax			
Interesting read	1	1			
Nice hand	1	1			
Matches color scheme	1	1			
Easy to clean	1	1			
Wrinkle resistant	0	1			
Total:	4	6			

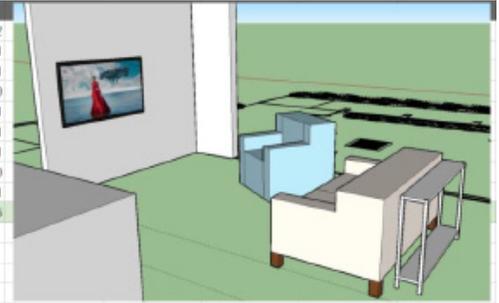


Figure B3. User Research Team design matrix used to determine most suitable living room layout. Requirements gathered from interviews, home observations, and focus groups with target demographic.

APPENDIX C. BMW SWEEPSTAKES RULES

OFFICIAL RULES THE BMW ULTIMATE SMART HOME SWEEPSTAKES

NO PURCHASE NECESSARY TO ENTER OR WIN. A PURCHASE WILL NOT INCREASE YOUR CHANCES OF WINNING. OPEN ONLY TO **LEGAL US RESIDENTS**, WHO RESIDE WITHIN 100 MILES OF CHICAGO, IL AND WHO ARE AT LEAST 21 YEARS OF AGE BY SEPTEMBER 1, 2017. Employees (and their immediate families (parent, child, spouse or sibling and their respective spouses, regardless of where they reside) and those living in their same households, whether or not related) of the BMW of North America, LLC, The Central Region Advertising Council Inc. (“Sponsor”), BMW dealers located within the geographic parameters of Sponsor,, Octagon, Inc., Northwestern University and their respective parents, affiliates, subsidiaries and advertising and promotion agencies are not eligible to enter or win. By participating, entrants agree to be bound by these Official Rules and the decisions of the Sponsor, which are binding and final on matters relating to this promotion. Promotion is subject to all applicable federal, state and local laws.

SWEEPSTAKES PERIOD: The sweepstakes begins on at 12:00 a.m. Eastern Time (“ET”) on September 1st, 2017 and ends at 11:59 p.m. ET on September 30th, 2017(the “Sweepstakes Period”).

TO ENTER: During the Sweepstakes Period, visit www.bmwhousebynusweeps.com to complete and submit the online entry form. Limit one (1) entry per person for the duration of the Sweepstakes Period. Multiple entries received beyond the stated limitations will be void.

DRAWINGS:

Grand Prize Drawings: A grand prize drawing will be conducted on or around Wednesday, October 4th by Sponsor to determine the potential grand prize winner from among all eligible entries received for the duration of the promotion.

Potential winner will be notified by mail, phone, and/or e-mail and may be required to execute and return an affidavit of eligibility, a liability release and, where lawful, a publicity release within a specific time frame as determined in the sole discretion of the Sponsor. If such documents are not returned within the specified time period, prize notification is returned as undeliverable, potential winner is not reached on first attempt or potential winner is not in compliance with these rules, prize will be forfeited and, at Sponsor’s discretion, a runner-up may be notified. Sponsor reserves the right in its sole discretion to conduct a background check on potential winner and disqualify any individual who has been charged or convicted of a crime or, if Sponsor determines in its sole discretion that awarding a prize to such individual may reflect unfavorably on the Sweepstakes or Sponsor. Sponsors’ decisions are final and binding on all matters relating to this Sweepstakes. The odds of winning are contingent upon the number of entries.

PRIZES:

Grand Prizes: One (1) grand prize winner will be awarded a one-month extended test drive of a BMW i3, plus a Smart Home package, including: Lutron Caseta Wireless Smart Lighting Starter Kit (\$88), Nest Protect Smoke & Carbon Monoxide Alarm (\$119), Awair – Air Quality Monitor (\$199) and Amazon Echo Dot (\$49.99).

The Approximate Retail Value (“ARV”) of the Grand Prize is \$455.99. The total ARV of all prizes awarded is \$455.99.

Grand Prize dates and times are determined in the sole discretion of the Sponsor. Winner is solely responsible for all expenses, costs or fees associated with acceptance and/or use of the prize not specified herein as being awarded. Prize is awarded “as is” with no warranty or guarantee, either express or implied by Sponsor. Winner may not substitute, assign or transfer

prize or redeem prize for cash, but Sponsor reserves the right, at its sole discretion, to substitute prize (or portion thereof) with one of comparable or greater value. Winner is responsible for all applicable federal, state and local taxes, if any, as well as any other costs and expenses associated with prize acceptance and use not specified herein as being provided. All prize details are at Sponsor's sole discretion and subject to availability. The winner shall be required to provide a social security or tax identification number.

GENERAL CONDITIONS: Released Parties (as defined below) are not responsible for lost, late, incomplete, inaccurate, stolen, misdirected, undelivered, garbled, illegible or postage-due mail, entries or email; or for lost, interrupted or unavailable network, server, Internet Service Provider (ISP), website, or other connections, availability or accessibility or miscommunications or failed computer, satellite, telephone or cable transmissions, lines, or technical failure or jumbled, scrambled, delayed, or misdirected transmissions or computer hardware or software malfunctions, failures or difficulties, or other errors or difficulties of any kind whether human, mechanical, electronic, computer, network, typographical, printing or otherwise relating to or in connection with the promotion, including, without limitation, errors or difficulties which may occur in connection with the administration of the promotion, the processing of entries, the announcement of the prizes or in any promotion-related materials. Released Parties are also not responsible for any incorrect or inaccurate information, whether caused by site users, tampering, hacking, or by any equipment or programming associated with or utilized in the promotion. Released Parties are not responsible for injury or damage to participants' or to any other person's computer related to or resulting from participating in this promotion or downloading materials from or use of the web site. Persons who tamper with or abuse any aspect of the promotion or website or who are in violation of these Official Rules, as solely determined by Sponsor, will be disqualified and all associated entries will be void. Should any portion of the promotion be, in Sponsor's sole opinion, compromised by virus, worms, bugs, non-authorized human intervention or other causes which, in the sole opinion of the Sponsor, corrupt or impair the administration, security, fairness or proper play, or submission of entries, Sponsor reserves the right at its sole discretion to suspend, modify or terminate the promotion and, if terminated, at its discretion, select the potential winners from all eligible, non-suspect entries or from non-suspect entries who have provided Sponsor with the required tax identification information received prior to action taken or as otherwise deemed fair and appropriate by Sponsor. Entrants, by participating, agree that Sponsor, Octagon, Inc., Northwestern University and their respective parents, affiliates, subsidiaries and advertising and promotion agencies and all of their respective officers, directors, employees, representatives and agents (collectively, "Released Parties") will have no liability whatsoever for, and shall be held harmless by entrants against, any liability, for any injuries, losses or damages of any kind, including death, to persons, or property resulting in whole or in part, directly or indirectly, from acceptance, possession, misuse or use of any prize or participation in this promotion. Except where legally prohibited, entry into this Sweepstakes and/or winner's acceptance of prize constitutes permission for Sponsor and its designees to use his/her name, address (city and state), photograph, voice and/or other likeness and prize information for advertising, trade and promotional purposes without further compensation, in all media now known or hereafter discovered, worldwide in perpetuity, without notice or review or approval. In the event of a dispute regarding entries received from multiple users having the same e-mail account, the authorized subscriber of the e-mail account at the time of entry will be deemed to be the entrant and must comply with these rules. Authorized account subscriber is the natural person who is assigned the e-mail address by the Internet Service Provider (ISP), on-line service provider, or other organization responsible for assigning e-mail addresses.

WINNERS LIST: For the names of the winners, send a self-addressed stamped envelope to: The BMW Ultimate Smart Home Sweepstakes Winners List, c/o Octagon, Inc., 875 N. Michigan Ave, Suite 2700, Chicago, IL 60611 by November 30, 2017.

SPONSOR: The Central Region Advertising Council Inc., c/o BMW of North America 498 Commerce Dr, Schaumburg, IL 60173.