ERASE**40**.org

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A PLAN TO REDUCE CO2 EMISSIONS BY NEARLY 40%

Erase40's mission is to develop market-based initiatives that result in the widespread adoption of a low carbon building technology called Passive House. Buildings are responsible for approximately 40% of all carbon emissions in the U.S. and globally, but a switch to this low carbon building technology can reduce this number drastically. Widespread adoption of this technology would also reduce people's exposure to air pollutants and lower their monthly energy and repair costs.

Erase40 is a fiscally sponsored project of the Social Good Fund a 5-1(c)(3) organization.

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Here is an opportunity to get people to take steps to reduce emissions and **be part of the fight against climate change** even if they are not otherwise invested in the issue.

AN EFFECTIVE WAY TO REDUCE EMISSIONS

Adopting the Passive House building technology and standard may be one of the easiest and least costly ways to greatly reduce carbon emissions around the world. Buildings are responsible for about 40% of all carbon emissions in the U.S. and globally but a switch to Passive House buildings (hereafter referred to as passive buildings) can reduce this number drastically.

The reduction of emissions would result from a reduction in energy demand as opposed to the conversion to a different energy source. This is significant because a reduction in total global energy demand, as opposed to only a conversion to a renewable energy sources, is necessary to reduce emissions to acceptable levels. The reduction in emissions from each passive building also lasts for life of that building which can be a hundred years or more.

Furthermore, unlike many other methods to address climate change and reduce emissions, this technology is not years away. It exists now and is being used in all regions in the U.S. (as well as in Canada, Europe, Japan and China) and with all major building types. Unlike the transportation, energy and agricultural sectors, this technology can be adopted without massive investments in infrastructure or changes to the economy. In fact, it is relatively inexpensive—with the construction cost of the buildings comparable to ones using conventional methods.

Finally, the adoption of this technology doesn't require a shift in the public's beliefs about climate change or appreciation of it as a danger. The buyers of homes and buildings do not need to be motivated by concerns about climate change because the other benefits (including health and financial benefits) make them superior to conventional buildings even when the environmental benefits are discounted. This makes it possible to sidestep politically contentious arguments about the environment when discussing the technology.

In other words, most emissions from buildings are now avoidable.

So what is necessary for large-scale adoption of Passive House technology? What needs to occur for it to replace conventional construction as the standard method of construction? With $1.2 trillion of new construction each year in the U.S. alone, and with each new conventional building locking us into a future reliance on fossil fuels, these are urgent questions.

Of course, it's not difficult to conceive of large policy initiatives or aggressive financial incentives that would push buyers in a number of market segments toward the adoption of passive building. However, the purpose here is not to devise a wish list of such policy initiatives and financial incentives. Nor is it to wait for resources and support that is neither currently available nor easy to secure.

Our purpose is to find ways to rapidly expand the market for passive buildings without such resources and support—so that widespread adoption of this technology can occur now.

Seven Reasons

This Technology Is A Good Way To Reduce Emissions

1. Technology exists now, not years away
2. The technology is performance based and inexpensive
3. No shift in the public's attitudes about climate change required
4. No large investments in infrastructure required
5. No major changes to the economy required
6. Applicable to all regions and all building types
7. Capable of reducing a major contributor of emissions to nearly zero

WHY THIS BUILDING STANDARD AND NOT SOME OTHER ONE?

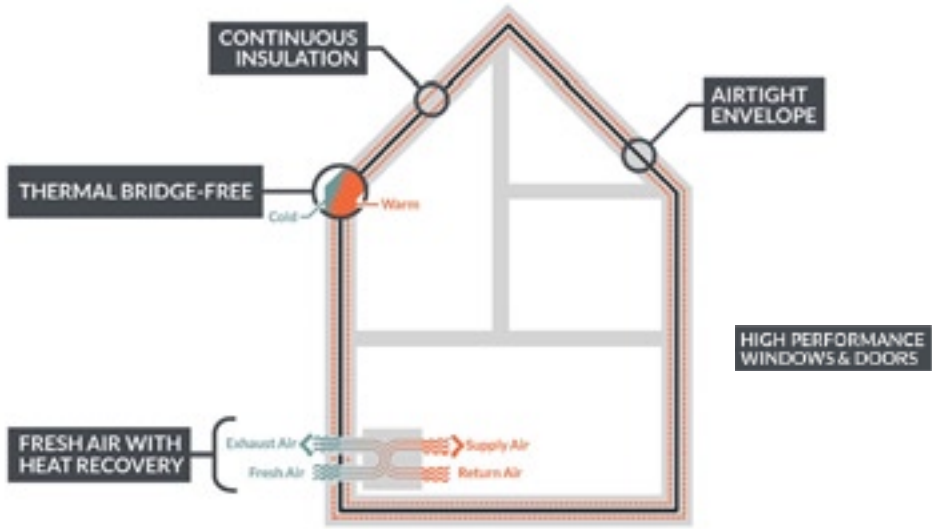
What is Passive House technology? It's a rigorous, performance-based building method that reduces the energy needs of a building and increases the amount of fresh air circulating inside that building. The buildings use an air-tight building envelope, high performance windows and a heat recovery air exchanger to produce buildings with a superior environment and significantly lower energy requirements. The buildings also incorporate regional weather data in the design phase so that they are built to withstand conditions specific to that area. The result is buildings that are more resilient and less costly to own.

This building standard is superior to others for a number of reasons.

- The technology is established and proven to be effective.
- It's rigorous, performance-based and supported by science.
- It allows for ongoing evaluation and third party validation.
- The buildings are designed using climate data specific to the region.
- The United Nations is currently developing global building guidelines and is basing those guidelines on Passive House principles. (See Appendix A)
- It is endorsed by building scientists and the U.S. Department Of Energy
- Organizations in China, Canada, Europe and Japan have adopted the standard and are advocating for it within those countries.

Passive House Principles

Illustration by
Hammer and Hand



RATE OF ADOPTION

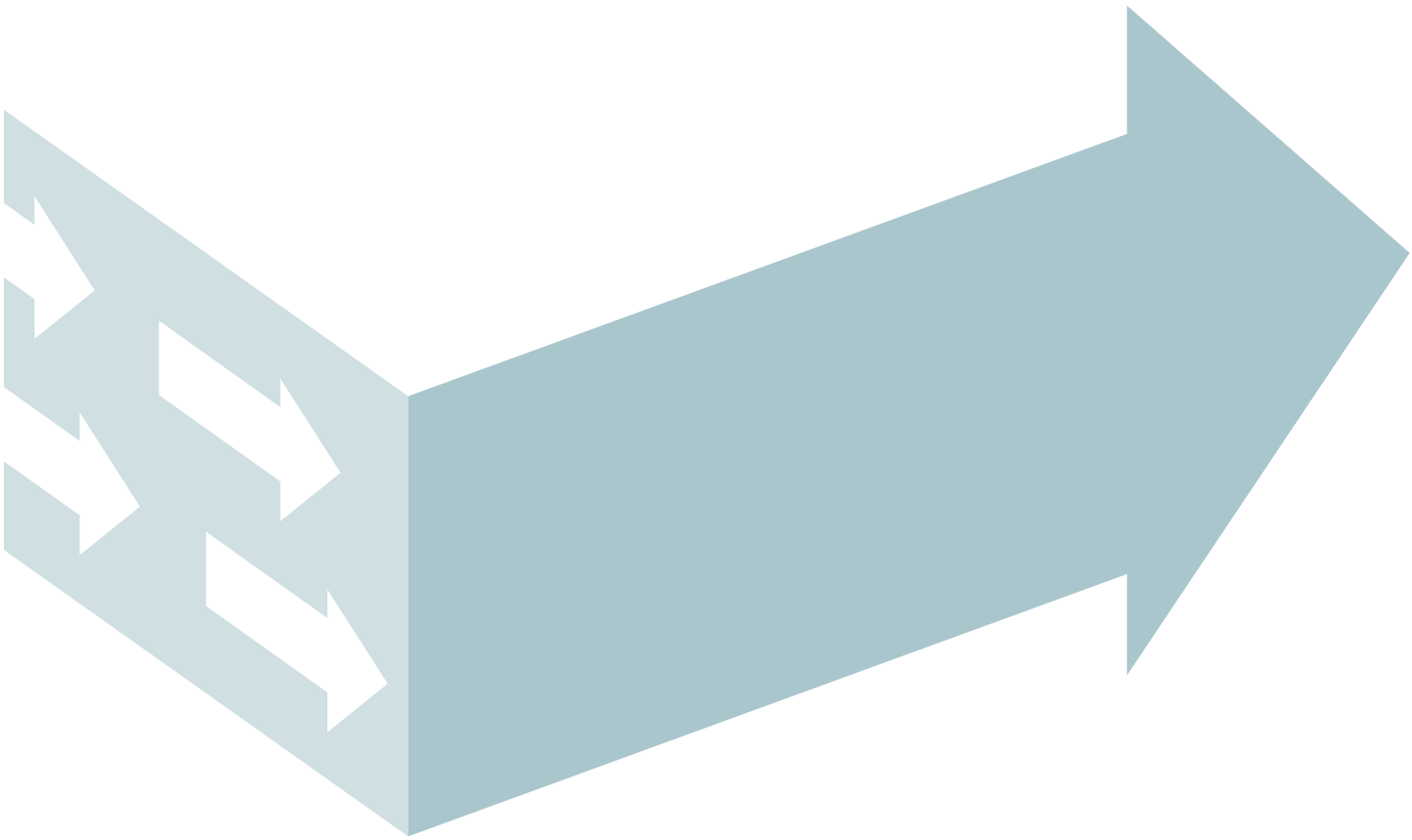
There's some enthusiasm for the passive house standard among policy makers but the rate of adoption among home buyers and developers (residential and commercial) is very slow. Right now there are only about 400 passive buildings in the U.S. and passive buildings constitute less than 0.1% of the market.

To understand why demand for these buildings was so low (and rate of adoption so slow) we conducted an analysis of the market. We also studied the client decision-making process in order to find clues as to how to increase the size of the market. We examined the behavior of market participants and used behavioral models and research to find the barriers to adoption. We relied on peer-reviewed behavioral research, surveys, interviews, financial analysis, industry reports and an analysis of the terms of competition within the industry and conversations. We also spoke with builders, architects, developers, home buyers, realtors and policy makers.

What we found was that a limited number of perceptions and behaviors influence the way buyers, funders and end users measure value and serve as barriers to widespread adoption of passive buildings. However, the removal of these barriers can result in a more robust demand for this technology.

What is required is a coordinated response to the barriers to adoption of this technology. Unfortunately, because of industry fragmentation, the building industry isn't capable to mounting a coordinated or effective response to these barriers (See Appendix B).

What's needed is for there to be an entity to solve the industry's coordination problem and drive the necessary change.



ERASE40

Erase40's programs will reduce the barriers to widespread adoption by increasing the perceived costs of conventional construction and increasing the perceived value of the attributes of passive buildings.

We'll speed the rate of adoption of the technology through the development of targeted market-based initiatives.

BEHAVIOR CHANGE PROGRAMS

CONSUMER EDUCATION

ADVOCACY, ADVERTISING AND MEDIA CAMPAIGNS

PARTNERSHIPS AND COMMUNITY OUTREACH

The aim is to cause a rapid reduction in CO2 emissions from buildings in the U.S. and abroad as well as a decrease of the reliance of buildings on fossil fuels.

Many social issues are ongoing and allow for no resolution. For example, programs that help people with diabetes offer care year after year without a way to rid the world or even the person of the condition. Such efforts are effective in reducing the suffering but cannot hope to bring an end to the problem. This is an effort of a different type. It's a problem that can largely disappear with a one time switch to zero energy buildings.

LEVERS FOR CHANGE

Despite the adoption of solar energy and pledges by countries to cut emissions, emission levels grow every year.

So how do we work our way to zero emissions by 2050?

There are a number of individual and social costs associated with the purchase, rental and occupancy of conventional buildings. These costs (three of them are listed below) can be used to drive change in the market. Our brains may be designed in a way that makes it difficult for us to think about or respond to climate change but we're strongly motivated to guard against threats to our health and to potential financial losses.

These costs to occupants and owners can serve as levers to change the behavior of a number of parties in the building ecosystem: buyers, funders, occupants, builders (developers, carpenters, architects) and building permit entities.

Is it important why a person does the right thing? Public attitudes towards climate change are an enormous obstacle to responding effectively to the threat. These attitudes must change. However, until they do, here is an opportunity to get the public to take steps to reduce emissions and be part of the fight against climate change even if they are not otherwise invested in the issue.

1 **Chronic exposure to indoor air pollutants**
Roughly 90% of our time is spent indoors and 60% of our time is spent in our homes. The negative outcomes of radon, TVOCs and particulate matter in the air indoors include higher risk of respiratory and cardiac conditions, cognitive impairment and aggravation of symptoms for those that already have respiratory conditions. According to the EPA, the air quality in homes is, on average, two to five times worse than outdoor air and can be as much as a hundred times worse than outdoor air. This can be particularly harmful to children under the age of five.

2 **Reduced savings, loss of opportunity and financial distress**
Energy costs, anticipated repair costs and unexpected repair costs impact populations differently. The negative outcomes vary from loss of opportunities to financial distress and low savings rates for individuals and budgetary obligations for government. Currently millions of households receive energy assistance each year but funding for this program is being reduced over time and so the eligible for assistance far exceeds the number of people to received this assistance.

3 **Regular sleep interruption**
Exterior noise is a frequently cited cause of interruption of sleep and conventional buildings usually fail to significantly reduce the volume of exterior noise. Exterior noise has also been found in a number of studies to significantly reduce a child's ability to focus and process information.

CHANGING WHAT PEOPLE EXPECT FROM A BUILDING

A limited number of behaviors and perceptions are complicit in the acceptance of the risks and costs associated with conventional buildings. Erase40's initiatives will target these behaviors and lower the barriers to adoption of passive technology. These initiatives will decrease the tolerance of owners, occupants and funders for the costs and risks associated with conventional buildings—and, in so doing, increase the perceived value of the attributes of passive buildings.

It's common to imagine ourselves and others to be fully rational beings capable of doing an effective cost benefit analysis when making important decisions. However, such people exist only in our imaginations. So when thinking about buying and rental decisions it's important that we think of people as they are (with limited capacities and pushed this way and that by a number of known biases) and closely examine the process by which they make decisions.

	Conventional Home	Passive House
TYPICAL MONTHLY ENERGY COSTS	**$250** month	**$40** month
TYPICAL TVOC LEVELS This is preliminary data of an ongoing study.	**432** parts per billion	**269** parts per billion

The current market is rife with irrational behavior. As a result of this behavior many parties bear otherwise avoidable costs. Individuals end up with inferior quality of life and lower financial and health outcomes. Companies face higher operating costs and lower employee performance. Governments face increased spending needs to support those on energy assistance and to pay certain health costs. Real estate investors face higher operating costs and lower asset value. Lenders face higher default risk and lower collateral values.

Option 1	Option 2
• High energy costs • High emissions from buildings • Growing inventory of fossil dependent buildings and points of combustion • Pollution and respiratory illnesses • Poor individual outcomes • Financial stress, defaults and high costs for home owners • No quality control in construction	• Reduced pollution • Reduced CO2 emissions • Better individual outcomes • Reduce dependence on fossil fuel • More green jobs and a more robust green economy • Reduced financial stress on vulnerable populations

USING AN ALREADY ESTABLISHED PROCESS

We as a society examined what occurs when a person picks up a cigarette. We looked at the negative health outcomes and social costs and, when we as a society decided that these costs were too high, we found a way to respond to the issue: target the behavior. Social scientists used behavioral models and research to design a number of interventions that prevented a person from picking up cigarettes in the first place and they developed interventions that helped people quit smoking. Social scientists in public health looked at related behaviors—how they get introduced to the idea, where they go, when they get the urge to try it, which people model the behavior—and they developed programs that interrupted the cycle.

This process that is evidence-based, uses peer-reviewed research and models and is shown to be effective across a number of domains. It can be used to see what is behind a behavior as well as to develop mechanisms to change behavior.

Erase40 will apply this same logic and this same process to behaviors relevant to the adoption of passive house technology. We've identified a number of behaviors that are making the choice for zero energy buildings less likely. Our programs will reduce the incidence of these behaviors and cause there to be more climate safe buildings.

One reason the process developed by social scientists is so effective is its focus on behavior and not on knowledge or the mere dissemination of information. Behavior is malleable and subject to change but knowledge alone is insufficient to drive behavior. So when expecting a person to engage in a particular behavior it's not enough to give them general information about, for instance, the topic. We see examples of this reality everywhere. Here's one such example: Eighty percent of smokers know that smoking causes heart and lung disease and yet continue to smoke. This is why efforts guided by a process other than the one we're describing here will inevitably fail to produce the necessary change.

Below we can see the difference in performance between a typical communications effort (the information only group) and behavior change program (the intervention group).

Behavior	Information Only Group	Intervention Group	Difference in Impact
Hospital hand washing	9%	90%	**10X**
Testicular self exam	23%	42%	**2X**
Smoking cessation	5%	15%	**3X**

HOW EFFECTIVE WILL OUR EFFORTS BE?

There are three ways to influence a decision: policy change, financial incentives and behavior change. Although circumstances call for the deployment of all three, policy on a large scale is too slow and financial incentives on a large scale are too expensive to shift the entire market. Only behavior change can do what is necessary in the current environment and with existing resources.

Our programs will be designed using in evidence-based social science and proven behavioral models. They will effectively target specific behaviors and barriers to adoption and be validated through surveys and pilot programs. Finally, each will be designed for ease of use and a high impact to cost ratio.

Currently, occupants, buyers and funders are not connecting attributes of a building—such as air quality—to outcomes. Nor are they effectively pricing the costs of certain outcomes in their rental, purchase, funding and building decisions. By assigning a value to certain attributes of passive buildings and connecting these attributes to long-term outcomes for occupants, funders and owners Erase40's programs will dramatically increase the perceived value of these attributes.

Attributes	Long Term Outcomes
• High air quality (no radon, lower VOCs, lower CO2) • Reduced exterior noise • Sharply reduced energy needs • Rigorous quality control and building durability • Resistant to water and moisture infiltration	• Reduced incidence of respiratory illness and reduced aggravation of existing conditions • Reduced sleep interruption and its consequences • Reduced financial obligations and increased savings • Reduced risk of unanticipated costs, higher savings, higher asset values • Reduced likelihood of mold growth and costs associated with mold remediation; reduced repair costs

Each program will be designed for ease of use and a high impact to cost ratio.

PARTNERSHIPS

Partnerships will also amplify our impact. There are many organizations and foundations whose missions and mandates will be served by the widespread adoption of passive buildings. These organizations and foundations are obvious allies to Erase40 and its programs.

Every year organizations dedicated to reducing the number of people with respiratory conditions or dedicated to reducing CO2 emissions spend billions to address these issues. Erase40 will seek out partnerships with these organizations and will provide evidence that its programs are resulting in direct and measurable impact on these issues.

Three Impact Metrics

1. **Increase** in the Number of Climate Safe Buildings
2. **Reduction** in Annual CO2 Emissions from Buildings
3. **Change In Number** of Building Occupants with Lower Exposure to VOCs

Checklist

These criteria will be used to evaluate our efforts and will be the standard we'll use to warrant the confidence and support of our donors and partners.

- [ ] **Worthy:** This is one of the best ways to massively reduce emissions.
- [ ] **Scale & Reach:** We can scale our programs via technology and outreach efforts.
- [ ] **Lasting impact:** This an opportunity to make an impact that is large and lasting—once the market is converted the benefits are ongoing and self-sustaining.
- [ ] **Cost efficient:** This is a low cost, high return effort (behavior change is less expensive than financial incentives).
- [ ] **Measurable:** Erase40's programs will be evidence-based and measurable with multiple validation stages to assess effectiveness.
- [ ] **Ease Of Use:** Our programs will be designed to be easy to use and implement.
- [ ] **Aggressive:** We plan to be as focused and as aggressive as possible.
- [ ] **Target Setting:** We're going to set goals about the rates of adoption and do everything we can to achieve them.

A LOOK AT ONE PROGRAM

Looking at one of our programs will show how Erase40 will isolate and target behaviors that play a large role in shaping the market.

The program, the Affordability Methodology Intervention, addresses the process most home buyer's currently use to determine affordability.

Home buyers often focus exclusively on the price of a home and fail to consider the cost of ownership (fuel costs, repairs, electricity). This can result in home buyers who face unexpected costs. This initiative will give people a more effective way of determining affordability, thereby reducing the likelihood that they unwittingly make a risky financial decision.

Furthermore, energy savings from fuel efficient homes often bear little or no influence on their purchase decision because certain biases (such as hyperbolic discounting) often interfere with a person's ability to appropriately value the energy savings of a passive home.

For example, a home buyer might see a $350,000 passive house as being more expensive than a $300,000 conventional house even though the 30 year energy and repair costs for the passive house may be $100,000 (or more) less than those for the conventional house. This tendency to underestimate the value of energy savings undercuts the appeal of home with lower energy requirement.

Target Behaviors and Biases

- The tendency to **discount future energy costs** and their impact
- The tendency to use **price as a proxy for affordability**
- The **failure to limit out of pocket costs** or follow a reliable procedure to estimate energy and repair costs
- The **failure to make use of available information** and resources

Intervention. A behavioral intervention that targets the biases that cause people to underestimate the value of energy savings and in the process increases the perceived value of those savings. This intervention is designed to change behaviors, attitudes and perceptions that increase the weight buyers give to energy savings in their purchase decision. A variation on this intervention, to be released subsequent to this one, can be used to target behaviors involved in rental decisions.

Rationale. This intervention employs four different methods to change behavior. First, it addresses primary beliefs behind the current behaviors as well as those toward the desired behaviors. Second, it also frames energy costs as a loss in order to elicit feelings of loss aversion. Because the loss is significant this can be expected to have a strong impact on the behaviors. Third, it seeks to reduce hyperbolic discounting by seeing the decision through the lens of their future self. Lastly, it changes the procedure the subject uses to determine the affordability of a house (or rental unit) to one that weights energy and repair costs.

METHODOLOGY & VALIDATION

Methodology. We've conducted numerous key informant interviews and conducted a preliminary literature review. For the next stage of development of this intervention further information about the population and about the context of the behaviors will be collected through surveys and key informant interviews.

Foundation. The Theory Of Planned Behavior is being used to design this intervention. Ajzen and Fishbein's Theory Of Planned Behavior is an evidence-based theory used to predict if an individual will perform a certain behavior and used in the design of behavioral interventions. Numerous studies have shown Theory Of Planned Behavior to be effective in predicting behavior and it has been used successfully in hundreds of different applications.

Validation. The elements of this intervention (such as use of loss aversion and the use of the future self to reduce future discounting) are supported by existing research. In addition, this intervention will also be validated through a survey and a pilot of the intervention.

The aim is for a home buyer to appropriately value the energy savings of a passive home

Desired Impact.
There are three desired impacts of this intervention.

Subject will place a **higher value on energy savings** and assign a monetary value to it	Subjects will use a **more effective methodology** to determine affordability	Subjects **more likely to opt for an energy efficient passive building** over a conventional one

The aim is for a home buyer (and, in the future, a renter) to appropriately value the energy savings of a passive home and see the importance of those savings for their lives. For example, in the hypothetical case of a home buyer presented a choice between a $350,000 passive house and a $300,000 conventional house with typical energy costs, the home buyer would see the $350,000 passive house as the more affordable option.

Intervention Parameters

Action	Read and watch intervention materials, add up energy savings and use affordability calculator
Context	Architect's or builder's office
Population	Home buyers for market-rate home
Time	Home buyer's meeting with architect or builder
Target Biases & Risk Behaviors	• Discount energy costs from a conventional building or savings from a high performance one • Use ad hoc or flawed method to determine affordability • Focus on price instead of the monthly aggregate payments that result from ownership • Agreeing to financial obligations and liabilities before understanding those obligations • Failure to look for ways to limit the amount of out of pocket expenses (and the risks associated with those costs)

See Appendix C for a list of our other year one programs.

A ONE HUNDRED YEAR DECISION

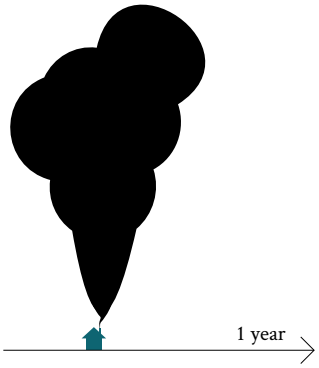
Because the life of a building is often a hundred years or more, a decision to build a conventional building results in the burning of fossil fuels for a hundred years or more. It is a decision with a lasting effect. The construction of each new conventional building adds to the inventory of long term emissions sources and limits our ability to reduce emissions to adequate levels in the future.

In short, the decision to buy, build or fund a building is a one hundred year decision. So it's reckless not to focus on it. The implications of this one decision are too serious not to see what is behind it and how best to intervene so as to produce better individual and social outcomes.

With 40% of emissions coming from buildings and with $1.2 trillion being invested in new construction each year, including 1.1 million new homes, the trajectory is toward a growing inventory of fossil fuel-reliant buildings and fewer ways to respond to climate change.

The combined individual and social costs of a small number of attitudes, behaviors and biases is large and growing.

CO2 From A Typical Conventional Home



26,480 pounds CO2
Annual CO2 Emissions from a Typical Home

2,648,000 pounds CO2
100 Years of CO2 Emissions

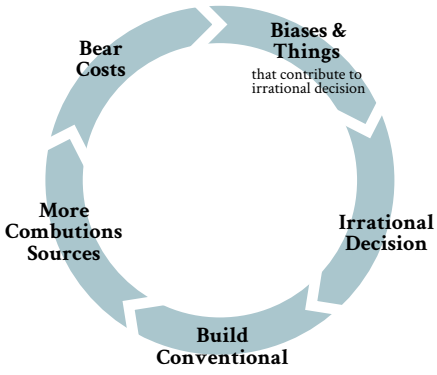
But we can change this cycle by targeting a small number of biases and behaviors.

Based on current rough estimates, we expect our first program to have an approximate average cost of $50 per individual home buyer opting for a passive house over a conventional one, with costs declining substantially as the program scales. So that would be $50 to reduce the amount of CO2 going into the atmosphere by nearly 2.65 million pounds over a 100 year period and prevent another source of combustion being added to the existing inventory. We expect the costs per conversion of our other programs to be in this same range or below.

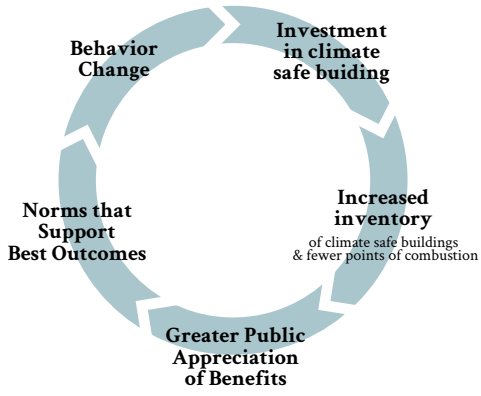
With each decision to construct a building comes a choice between there being more or less sources of combustion. However, through these efforts we can make it easy for people to make a better hundred year decisions and drive up demand for climate safe buildings.

An End To The Build/Burn Cycle

The Build/Burn Feedback Loop



The Climate Safe Building Feedback Loop



ABOUT US

James Geppner
Executive Director
Following his years in Project Finance, where he evaluated companies and studied markets, he has applied social science (and competitive theory) to a range of issues in order to see what's shaping a market, a cause or a behavior. He has advised nonprofits, new ventures and global companies. Most recently he did an extensive analysis of the market for passive buildings and the decision-making process of buyers, funders and end users in order to find clues as to how to increase the size of the market and how to reduce the barriers to widespread adoption of passive technology. He founded Erase40 in order to develop market based initiatives that drive up demand for passive buildings and in order to serve as a decision lab for different players in the building ecosystem. He is a graduate of NYU and of SGIB's investment banking program. 917-803-3888

Julian Leon
Head of Program Materials Design and User Experience
Julian designs objects and materials for Erase40's programs and interventions. His expertise is in environmental design, interactive experiences and situational art. He uses a visual and narrative language to produce an effective user experience and frames ideas so that they elicit a sense of immediacy in the users. Previously he's worked on projects for Google, YouTube, Earth Matter (DSNY), Samsung, Unhooked Media, Netflix and Spotify, as well as a number of early stage companies. Julian has also collaborated with MAS Event Design to see how two-dimensional design can expand into live site-specific experiences that focus on a certain idea. In addition to his role at Erase40 he gives artistic and design consultation to a theater collective in NYC. He graduated from the Fashion Institute of Technology and later joined the AF Design Lab, where he studied architecture and industrial design. Julian grew up in Bogotá and attended a school nestled in the Andes mountains, surrounded by untouched forests, guerrillas, myths and bright midnight skies.

ADVISORS

Jeffrey Domanski
IBTS
Jeffrey Domanski is a multi-disciplined environmental professional with more than 20 years of energy and environmental program and project management experience. His areas of expertise include the use of behavioral, organizational, financial, communications, and technological strategies. He is a Senior Manager of Energy and Sustainability programs at IBTS, a not-for-profit focused on serving municipal and other non-profit organizations, where he works on energy efficiency and renewable energy strategies, and professional education and training programs – including numerous projects focused on state energy codes. He has worked in-house and as consultant to public, private, and academic organizations. He has served as a primary energy and sustainability subject matter expert for numerous large and globally recognized organizations, including the U.S. Department of Energy, Connecticut Energy and Finance Investment Authority/Green Bank, New York State Energy Research and Development Authority, New York State Department of Transportation, the Port Authority

of New York and New Jersey, Princeton University, the University of Pennsylvania, Cushman & Wakefield, and The World Bank. He is a LEED AP with specialty in both new building design and existing building operations and is an expert in human behavior-focused strategies, which he has used to increase technology use and program participation. Jeff received his bachelor of science in Chemistry from SUNY ESF at Syracuse, and a master in public administration from Princeton University and is working to complete his doctorate at Princeton. He proudly served in the U.S. Peace Corps. He very happily resides in the heart of the Hudson Valley in New York.

Shari Short
Big Yellow Cab
A developmental psychologist, Ms. Short has researched decision-making and behaviors in fields including health care, museum administration, tourism, higher education, finance and residential real estate. With more than 20 years of experience in behavior change, research and planning, Ms. Short has held positions with the National Cancer Institute, Centers for Disease Control, Virginia Department of Health and Aloysius Butler and Clark. Shari received her M.A. in developmental psychology from Columbia University Teachers College.

James Hartford
River Architects
James Hartford is a Certified Passive House Consultant and a partner of River Architects, which specializes in Passive House buildings. He leads the sustainable design process for each of the firm's projects and in interested in ways to scale up the use of passive technology. His Passive House projects includes single family home retrofits and new construction, multi-unit urban row houses, and an organic hard cider mill in the Catskills. He is the founder and the Acting President of Passive House Alliance US-Hudson Valley Chapter. Prior to River Architects, James was a Project Architect with Rogers Marvel Architects and James Gainfort AIA Architect, where he contributed to award-winning renovation and rehabilitation projects such as the Pratt Institute School of Architecture, Carnegie Hall, the Governor's and Admiral's Houses on Governors Island, and the Brooklyn Museum Entrance Reconstruction & Water Fountain Project.

Alan Gibson
G O Logic

Alan Gibson is a builder and partner in G O Logic LLC of Belfast, Maine, where he is chiefly responsible for construction operations. Since 2009 he has managed construction of three certified passive buildings and a 36-unit cohousing community built to near-passive standards. The GO Home, completed in 2010, was the first certified passive house in Maine and recipient of the US Green Building Council's Residential Project of the Year award in 2011. Terrahaus, the country's first passive house-certified dormitory, received the Evergreen Award from Eco-Structure magazine in 2012. Alan is a Certified Passive House Builder and Designer, is an officer on the managing council of the Passive House Alliance US, and speaks widely on passive design and construction.

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APPENDIX A:

THE UNITED NATIONS "FRAMEWORK PRINCIPLES FOR BUILDING STANDARDS"

Global Transformation of Buildings in the Built Environment: Framing the design, delivery and operation of buildings as integrated, thermodynamic and environmental systems

I. INTRODUCTION

Buildings are central to meeting the sustainability challenge. In the developed world, buildings consume over 70% of the electrical power generated and 40% of primary energy, and are responsible for 40% of CO2 emissions from combustion. While developing countries will need to accommodate 2.4 billion new urban residents by 2050, in Europe 75-90% of buildings standing today are expected to remain in use through 2050. Renewable energy technology alone cannot meet those requirements, despite recent improvements. The energy performance of buildings must be managed, but the capability to meet this challenge is in place.

Standards are an effective instrument for addressing energy efficiency in buildings. Development and deployment of standards support the achievements of the targets set by several international initiatives such as the Sustainable Development Goals, the Sustainable Energy for All Initiative, and the Geneva UN Charter on Sustainable Housing. The concepts set forth herein go well beyond the incremental, components approach of existing building standards. Rather, they represent a principles-based performance guidance for building energy standards that is outcome-based, anchored in energy actually consumed, and designed to project a vision of holistically designed and operated, ultra-high performance buildings as part of an integrated sustainable energy system.

II. GOAL

Economic growth and the quality of indoor environments have depended on increased primary energy use. Shifting that reliance to renewables requires a holistic, systems approach to building design, delivery and operation and a paradigm that envisions buildings as energy generators and not solely or primarily as energy sinks. At costs equal or close to those of traditional buildings, it is possible with today's technology to transform buildings to align with the highest standards of health, comfort, well-being and sustainability, including improving energy productivity and reducing CO2 emissions.

The energy required by buildings can be reduced to a level that can be supplied largely, perhaps exclusively, by non-carbon-based energy. While further improvement in renewable energy technology and electrical and thermal storage is to be expected, the results will be more immediate and robust if buildings are transformed fundamentally in terms of their energy performance. In parallel, there will be need for effective controls for generation, distribution, and emission at full and partial demand loads to match energy use with building and occupant needs.

III. THE PRINCIPLES

The principles required for an era of truly sustainable buildings emerge from building science, materials science, digital science, information and communication technology and more. They reflect accumulated lessons learned and best practices of building owners, designers, engineers, builders, managers, policy makers, and more. The principles shift the building industry paradigm from fragmented and serial to holistic and integrated.

The principles cannot be prescriptive because of the vast diversity of circumstances and conditions experienced around the world. Rather, the principles provide guidance for planners, builders, and the entire building delivery and management chain as elements of innovative sustainability strategy.

The principles for sustainable buildings cluster under three headings:

A. STRATEGIC

Buildings must be:

- ☐ **Science-based:** design, construction, and management
- ☐ **Financed through policies** recognizing the value of better buildings
- ☐ **Service-oriented:** meet the sustainability demands of the populations served
- ☐ **Integrated** with their built environment life-cycle to connect buildings as energy generators and consumers
- ☐ **Cost effective** to mobilize private investment and entrepreneurs
- ☐ **Performance-monitored** with feedback loops to operations and design tools
- ☐ **Performance-based:** evaluated by system outcomes, not component prescriptions

B. DESIGN AND CONSTRUCTION

of buildings must be:

- ☐ **Holistic and integrated:** recognize buildings and their environment are part of a system.
- ☐ **Affordable:** high performance buildings costing the same as or less than in 2016
- ☐ **Validated:** based on energy models that reliably predict actual building performance
- ☐ **Sustainable:** made using sustainable materials, equipment, construction, management and retirement practices
- ☐ **Code-driven:** with local adaptation of global building standards
- ☐ **Skills based:** develop work-forces to provide technology/ skills needed for design, construction and operation

C. MANAGEMENT

over their life-cycle:

- ☐ **Commissioning:** With commissioning and re-commissioning of active systems
- ☐ **Performance-based:** With on-going benchmarking, monitoring and reporting of performance data
- ☐ **Certification:** Maintain certification or labelling to ensure energy performance is incorporated in to asset value
- ☐ **Managed:** professionally managed large or complex buildings with ethos of sustainability and social responsibility
- ☐ **Data-linked:** with advanced building information management capacity, where public infrastructure permits
- ☐ **Evaluated:** Ongoing performance evaluation and improvement
- ☐ **City-scaled:** information analysis and outcomes
- ☐ **Life cycle-based:** with long term analysis

IV. IMPLEMENTATION

Transformative change in buildings is possible, and the capabilities to create a new world of buildings and energy is in hand or within reach. Already today we have the techniques to achieve climate neutrality in the building sector until 2050/2060. Progress will require follow-on action in five areas to support the Framework and make its vision a reality:

- ☐ **Dissemination:** national, regional and municipal leaders in the public, private, research and education sectors must be made aware of the framework – its vision, logic, practicality, and advantages.
- ☐ **Education:** information, guidance, instruction, and avenues to ongoing dialogue and knowledge resources must be provided to policy, market, and knowledge stakeholders to foster local development of building standards, codes and practices aligned with the Framework.
- ☐ **Research:** through collaborations among leaders in science and technology, focused on the frontier challenges in such areas as: (1) building components and materials; (2) building design, construction and monitoring; (3) energy generation and distribution; (4) integrated urban systems and life cycle management; and (5) strategies for each country and climate zone to be carbon-free in 2050/2060.
- ☐ **Consultation:** formal and informal channels with local policy, market, and knowledge stakeholders for evaluation of impact, dialogue on in impact strategy, addressing discovered or unanticipated challenges, and cultivating global consensus in support of the Framework.
- ☐ **Participation:** networks of support and engagement among leading corporations, foundations, universities, professions, civil society and others with the array of resources – intellectual, experiential, financial, and relational – that will be required to make transformation a grass roots or deep market movement.

APPENDIX B

THE PROBLEM OF INDUSTRY FRAGMENTATION

The building industry is a largely fragmented industry and this results in a coordination problem between the players in the industry. The fragmentation can make it difficult for the players to make the necessary investments in the development of that industry.

The example below illustrates the difference between what occurs in a consolidated versus a fragmented industry.

What would a dominant soda company do in the following scenario? Let's say there's a country with only state owned beverage distribution centers but one region in the country lacks a distribution center and this is hurting the company's sales in that area. Would it make sense for the soda company to fund the construction of the distribution center in that region even though it would be state owned and all soda manufacturers could use it to distribute their products?

Company A (in a consolidated industry) with a market share of 50% invests a $100 to solve an industry wide problem and this effort produces $1000 of incremental revenue. Company A gets $500 of this incremental revenue with a profit of $400.

Company B (in a fragmented industry) with a market share of 1% invests a $100 to solve an industry wide problem and this effort produces $1000 of incremental revenue. Company B gets $10 of this incremental revenue with a $90 loss.

The company will ask, What is our return if we fund what will be a state owned distribution center that all beverage companies could use? Do the benefits of this investment accrue to us? Because it's a consolidated industry with only a few players, each with a large market share, the answer is likely to be yes.

When it comes to developing the passive building market and funding demand side initiatives, individual firms are limited in what they can do. Firms may be too small to make significant investments and, if they did make such investments, may only reap a small portion of the benefits of an investment in the category because the rewards are broadly shared between a number of firms. The result is a relatively low spending on initiatives to develop the market.

There is a third scenario in the example above. **Company C with a market share of 1%** invests a $1 through an associations or organizations to solve an industry wide problem and this effort produces $1000 of incremental revenue. Company C gets $10 of this incremental revenue with a $9 profit.

What is necessary to solve the coordination problem is an entity to fund certain initiatives.

APPENDIX C
ERASE40 IN THE FIRST YEAR

Here's a list of programs we expect to develop in the first year.

AFFORDABILITY METHODOLOGY INITIATIVE

Home buyers often focus exclusively on the price of a home and overlook costs of ownership (fuel costs, repairs, electricity). This can result in poor purchase decisions and in home buyers who face unexpected costs and, occasionally, financial distress. This initiative will give people a more effective way of determining affordability, thereby reducing the likelihood that they unwittingly make a risky financial decision. We'll also slightly modify this same tool so that it can be used by renters.

Home buyers and renters commonly agree to financial obligations and liabilities before understanding those obligations or using a reliable procedure to assess their own ability to handle these costs and liabilities. The negative outcomes that result from these behaviors include financial stress and uncertainty, mortgage default, low savings rates, dependence on energy assistance programs and loss of opportunity. One potential impact of this program is to reduce the number of people who, in the future, require energy assistance or suffer financial uncertainty or hardship due to energy costs.

HOUSE TOUR INITIATIVE

Adopting certain behaviors during the tour of a house that is for sale can change the way a person sees a house and what they want from a house. The purpose of this initiative is to elicit certain behaviors from a potential buyer as they tour a house that is for sale. It will shape the criteria they use when they assess a house during a tour of that house with a realtor, getting the buyer to look at things that are important to their long-term outcomes that they might otherwise overlook.

RURAL WORKFORCE RETENTION PROGRAM

Young farmers, despite years of experience, often are forced to leave their community because of high housing costs. The same is true for other members of the rural workforce. The result is a loss in social cohesion as residents of a community move away, a labor and skills shortage and reduced viability of certain conservation efforts. However, by replicating an existing housing model which significantly lowered housing costs, these individuals would be able to stay in their communities. Scaling this housing model will allow more skilled members of the rural workforce to stay in their rural communities, allow the young farmers and others continue in their current careers and for conservation efforts to be able to find the skilled labor necessary to make those efforts a success.

BUILDING SCORE & VALUATION INITIATIVE

The aim of this program is to allow buyers and renters see how a building scores along the lines of a number of criteria so that it's easier to compare one building to another. The score would include measures on the buildings likely impact on the residents' health and the ongoing costs the owner would bear—as well as the resilience of the building and number of other criteria.

This program can reduce the information asymmetry that current exists between sellers and buyers or between landlords and renters. Sellers and landlords and builders possess information about the quality of construction, the likelihood of certain repair costs, the risk of mold growth and energy costs but this information is rarely disclosed to the buyer or renter. This information asymmetry allows sellers and landlords to transfer certain risks and liabilities to the buyer or renter without the buyer or renter's knowledge. This lack of transparency and lack of information provided to the buyer or renter can expose the buyer or renter to inflated prices, exposure to unexpected repair costs and exposure to factors in the home or apartment that effects the occupants health. These risks and costs can fall particularly hard on the shoulders of the poor as low income people lack the savings and mobility that would reduce the impact of these events on people with higher incomes. Once these risks and liabilities are transferred to the renter or buyer there is usually no legal or practical recourse available to them, and so no way to escape these costs, liabilities and health risks.