



UNIVERSITY OF  
MARYLAND

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON 2017



reACT  
TEAM MARYLAND

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON 2017

**Contest 2: Market Potential Narrative**

August 10, 2017

reACT (resilient Adaptive Climate Technology) represents a new paradigm for housing, a regenerative model of sustainability, able to serve diverse communities, and be integrated with diverse natural ecosystems. The concepts, processes and technologies demonstrated in reACT are applicable to a wide range of scales, densities and formal configurations. The prototype is built upon providing a common 'DNA' for not just one house, but an entire range or community of homes or other smaller buildings. Regenerative design principles guided the Architectural design process recognizing that local climate, individual choice and culture influence the specific forms employed in the design of the reACT prototype, advanced for this competition. reACT seeks to avoid the "one off" limitations of many past U.S. Department of Energy Solar Decathlon competitors.

To demonstrate this, our initial target market is represented by a young Naticoke Indian couple starting a family in Denver, CO. We found inspiration in a well defined market whose members are deeply tied to nature, whose values are ecologically grounded, and whose culture reveres Mother Earth. Team Maryland hopes all American's will ultimately embrace these values, however, we are conscious that currently there is no well-defined cultural, political or ethnic group that is actively seeking sustainability and regeneration as we discovered Native Americans<sup>i</sup> to be. We chose Native Americans as our first target market because we believe that the technology and values embodied in reACT is appealing either to individuals or to a dedicated community, like a reservation. However, reACT will also appeal to individuals in the general American public who are seeking ecological, sustainable, and regenerative values when buying a home.

It should be emphasized that the the architecture of Team Maryland's Solar Decathlon 2017 dwelling is not limited to any specific Native American Tribe or vernacular tradition, but rather addresses the deeper traditional cultural values to seek balance and harmony with Nature. We believe that to build a truly sustainable future, these are the values that must be adopted by mainstream culture as well, and reACT is designed to help foster that broader market shift.

### Market Need for reACT and Its Features

In 2015, 6.6 million people in the US identified themselves as American Indian or Alaska Native, with another 1.2 million self-identifying as Native Hawaiians or Pacific Islanders, a total of 2% of the general population, with a projected growth to 10.2 million by 2060.<sup>ii</sup> According to the 2010 Census, 67-92% of American Indians and Alaska Natives reside outside tribal lands.<sup>iii</sup> A major challenge for Native American communities today is sustaining relationships between people and place, especially for those living in and around cities away from specific tribe of origin culture and identity. reACT is built to facilitate that deep attachment through the adaptive technologies developed by Team Maryland and improve connection to local ecosystems. reACT's sustainable and regenerative design principles are in harmony with indigenous deep sovereignty through promoting quality of life while simultaneously respecting Mother Earth's sacred resources. Regenerative design also involves a paradigm shift in cost accounting that recognizes the externalities of modern life. Any excesses are creatively reused to address needs and opportunities rather than expended as waste. This core ethic is at the root of reACT.

### Appealing to Urban Native Americans



The Native American model of keeping one foot in the past while making decisions considering seven generations into the future can also help industrialized societies advance the journey towards ecosystem-based decision-making and sustainability. The key to the Native American model is the intimate human connection to, and interdependence on, nature. For Native Americans, Mother Earth and her precious

resources are not negotiable items. Team Maryland is aligned with Native American value of the Earth and its resources. These shared values are evidenced in reACT's carefully designed HVAC, water, solar, living green wall systems and open source SmartHouse software.

Native American home buyers are increasingly seeking sustainable housing and renewable energy technologies to provide cultural renewal, self-sufficiency, economic opportunity, and sustainable returns on investment that compliment tribal culture. Moreover, a global Indigenous food movement was started with the Declaration of Atitlan in Guatemala.<sup>iv</sup> The declaration asserted that food sovereignty is a right for all Indigenous people, which includes finding ways to revitalized connections between themselves, the food of their ancestors, plants, animals, and place.<sup>v</sup> Native communities are actively combatting food deserts by building sustainable food systems in order to increase healthy food access and awareness in order to stimulate tribal economic growth. Revitalizing Indigenous cultures involves a careful relationship with local ecologies as well as food harvesting and gathering. Restoring Native food systems is an immediate and fundamental need for the continued survival, and physical and spiritual well-being of Native peoples and Mother Earth. One way that reACT directly addresses restoring Native food systems is the Three Sisters Garden.

### Three Sisters Garden

Native Americans are considered to be the first ethnobotanists of the Americas.<sup>vi</sup> The Western Hemisphere provided the world with at least 60% of the foods we know today, e.g., squash, potatoes, corn, peanuts, beans, cherries, blueberries, raspberries, and strawberries.<sup>vii</sup> Native Americans have traditionally valued harvesting most of their cultural foods from nature while the average westerner gets their organic food from the grocery store.



The “Three Sisters” are a Native American agricultural innovation of companion planting. Companion planting was practiced in various forms with various plants by the indigenous peoples of the Americas prior to the arrival of Europeans. Perhaps the most well known example of this technique, is squash, corn and climbing beans grown together to support each other in many beneficial ways. This tradition of planting corn, beans and squash is a sustainable system providing long-term soil fertility and a healthy diet to generations. The three crops create a system whereby water need is minimized, fertilizers are unnecessary, efficient use of space to grow these crops, and natural microenvironment for beans and squash to grow where normally they couldn't.<sup>viii</sup> Climbing or pole beans wrap upwards around the corn stalks, while the large squash leaves help to keep competitive plants out and shade the ground, and therefore provide moisture and protection for the corn roots. A properly maintained garden of Three Sisters can help ward off night-time visitors such as

raccoons, deer, and rabbits because of the densely grown vegetation and can provide shelter for birds.<sup>ix</sup>

### Client Challenges of Urban Native Americans<sup>x</sup>

While most Americans think of Native Americans as living on reservations, more than two-thirds of Native Americans live in urban areas, in large part due to US Indian Policies of 1943-1968 called Termination, which resulted in the immediate withdrawal of all Federal aid, services, and protection, as well as the end of reservations for affected Indian Tribes. The relocation of Tribal people from Native communities into larger, commercial U.S. cities became a general trend after World War II.<sup>xi</sup> Selected as one of the initial destination cities for the relocation and employment assistance programs of the Bureau of Indian Affairs (BIA), Denver

became a hub for American Indian migrants. The federal government hoped to assimilate relocated Indians by distancing them from reservation communities, but Denver Native Americans created an urban Indian community to support themselves and showed little interest in losing their tribal identities.<sup>xii</sup>

Since the 2010 Census, Colorado's Indian population has grown to over 107,000, with about eighty percent of this population living in metropolitan regions such as the Denver-metro area. According to the Colorado Commission of Indian Affairs, these population numbers are up 35.3 percent since the 2000, and the growing trend has continued. Centrally located, the Denver metropolitan area has become a hub for Indian Country. Two hundred plus tribal nations are an integral part of the city's social and economic life. Despite their diversity, they are a tight-knit group, sharing the same strong commitment to family and cultural survival.

Urban indigenous communities possess significant resilient strengths. Thousands of these "urban Natives" still return to their tribal communities throughout the year to participate in familial and tribal events and ceremonies. Reservations are more likely than metropolitan areas to provide a culturally-grounded homeland with familiar geographic features, a shared history, with plants and animals that form the basis for a traditional diet and source of medicines. The relocation of Native Americans from many different tribes to metropolitan areas has resulted in emerging multi-tribal urban Native communities and the development of a distinctly Native, identity.

As a hub for Indian Country, many Native Americans are drawn to Denver because of its wealth of community-based organizations that serve the needs of local urban Natives. These agencies receive federal, state, city, and private funding to provide health services, economic opportunities, continuing education support, and other resources to Denver's indigenous community. Our client couple works for a health and wellness non-profit organization serving the Denver Urban Native community.

### Our Client

reACT has been developed for a household of two married adults, in their late 20's, with a baby on the way, living as expats in the Denver Metropolitan area. While originally from the Eastern Shore of Maryland and enrolled members of the Nanticoke Indian Tribe,<sup>xiii</sup> they are among the majority Native Americans who live as expats from their traditional territory in urban centers. Both spouses are employed by The Herbal Garden Wellness Organization, a Pan-Indian service organization in downtown Denver.

The wife is a Registered Nurse Dietician (RND), she directs the Nutrition Management project where she serves indigenous community members who suffer from diseases such as Diabetes II, Cancer, and Anxiety. Because access to Native healthcare is a challenge for Urban Natives, tribal governments, urban Indian organizations, tribal food policy councils, and other community-driven groups are increasingly exploring comprehensive health and wellness policies and plans, the Herbal Garden Wellness Organization is an example of one.<sup>xiv</sup> RDNs have tremendous potential to shape the public health landscape to advance American Indian health.<sup>xv</sup> Likewise, service providers can network with each other and work to connect programs that serve urban Native people as a means to alleviate some of the fragmentation in the service delivery system and community. A more unified service delivery system can strengthen community infrastructure and counteract isolation of community residents.<sup>xvi</sup> The husband is a recent graduate of the University of Maryland's Agricultural Extension Program, with a focus on sustainable agricultural practices. He directs the Community Gardens project where he helps urban indigenous communities to become healthy & well through sustainable organic community gardens using ancestral methods.<sup>xvii</sup>

Both spouses are working to increase access to healthy, nutritious foods, while reducing reliance on commercially processed foods. Both are working towards establishing food systems that support indigenous self-determination, wellness, communities, families, economies and rebuild relationships with the land, water, plants and animals that sustain us.

## Other Challenges for our Nanticoke Couple

Our couple is challenged to live a meaningful Nanticoke lifestyle not only in an urban environment but in a completely different region of the country.<sup>xviii</sup> The Nanticoke are an Algonquian tidewater culture on the Atlantic seacoast who traditionally relied on farming and fishing for their needs. Our couple's Eastern Shore family home is located at sea level. Denver is called the Mile-High City because its official elevation is exactly a mile above sea-level or 5280'. The city is in a semi-arid continental climate zone, whereas the traditional lands of the Nanticoke are found on the Chesapeake watershed. Our young couple considers the gardens and landscape surrounding their home a vital part of the residence as a whole. Their way of adjusting is based upon the land they are now in, thus they prefer that reACT's garden and landscape embody the native Denver place.

reACT's sustainable and regenerative design principles are aligned with Nanticoke principles through promoting quality of life while simultaneously respecting Mother Earth and her sacred resources. The home's design is a way for our couple to live ethically and culturally authentic. Despite its humble size, reACT enables families to incrementally build larger and more technologically advanced infrastructures, creating a home capable of evolving with its occupants, as well as a region's dynamic weather patterns, while at the same time only using the footprint that is necessary at that time. In addition, reACT living systems' attention to optimizing resources by limiting waste are aligned with our couple's desire to reduce their negative impact on Mother Earth while living an urban life.

## Overall Attractiveness of the Design to Native Americans

Decades of research on global climate change shows that human activities are adversely affecting our ecosystem and the stability of our climate. Native American communities are especially vulnerable to the effects of climate change and it is important that through mitigating climate change that their cultural integrity be respected and they can succeed in a globalized society.<sup>xix</sup> We recognize the western scientific perspective on climate change is evolving to move more towards an understanding that affirms the global significance of indigenous knowledge systems (IKS). The principles of Agenda 21 reveal that sustainable development requires a conceptual differentiation that is able to meaningfully articulate scientific and indigenous forms of knowledge.<sup>xx</sup> Team Maryland believes that Native Americans can contribute valuably to more sustainable interactions with the natural world.

The agency of native cultural reclamation has been called **deep sovereignty**, i.e., agency in protecting core Indigenous values, knowledge systems, and ways of being.<sup>xxi</sup> Team Maryland supports Native American **deep sovereignty** by engaging in relationships rooted in Indigenous practices and worldviews. Our aim is to contribute to the thoughtful and respectful integration of indigenous knowledge with scientific data, analysis, and innovation so that the rich body of IKS can inform science and in turn, science can contribute tools that will allow indigenous communities to make informed decisions. We aspire to open a path for meaningful exchange of information, so that efforts to deal with climate change can be strengthened. reACT is a space where Native American and western scientific practices have the opportunity to connect in a joint effort to reduce the negative effects our current lifestyles have on Mother Earth. Through collaboration, we highlight the value of IKS by optimizing sacred resources: water, air, earth and sun, and we can begin to balance our desires for comfortable living with a mindfulness toward Mother Earth and future generations.

Team Maryland is committed to a long-term perspective that examines issues at a scale relevant to the functioning of the various ecosystems that we inhabit. This is similar to the Seven Generations Principle; we imagine the impact our sustainable technologies will have on future generations and on the sustainability of future ecosystems. We recognize Mother Earth as a living, breathing being. Through reACT, we attend to how the air (Mother Earth's breath) moves through the house through our unique heating ventilation and cooling system (HVAC) optimizing thermal efficiency. We bring the Earth into the house by incorporating

portable living green walls and outdoor living spaces. Our commitment to water protection is evident, each drop of water is accounted for and reused or recycled. The adaptive technologies developed through reACT are designed to improve our connection to local ecosystems. reACT recognizes that we as humans are intimately linked to all existence in an intricately designed web.

The plants in all reACT living systems were chosen mindfully and with intent, each with a specific use. Many of these plants, such as the herbs and vegetables, promote growth and healing for the inhabitants of the house, and also for a wide range of fauna that use these plants for various reasons. Using a very diverse pallet of plants is a common aspect throughout almost all of the Native American tribes in North America, and Team Maryland wants to stress the importance of this. Diversity, especially biodiversity, is an essential foundation of sustainability. High plant diversity fosters interactions between species creating functional communities that are much more productive than the systems functioning separately.

The sun's energy is directly harvested by reACT's PV solar panels complementing the role of the Greencourt. A major aspect of sustainability is independence from external energy sources. Harvesting onsite from the sun reACT's power and thermal excess allows us to take full advantage of an ever-present energy source. Solar energy is renewable everyday the sun shines, meaning that it is naturally and daily replenished. In contrast, fossil fuels are a finite resource that take millions of years to develop and will continue to diminish with use.

reACT's onsite water source begins in the rain-catchment system then filtered to potable standards. Treated and purified, some to potable standards and other to greywater, which will be used to irrigate and grow vegetables and plants, directly linking the water and earth, and mimicking earth's natural processes. Making every possible use out of natural products is a Pan-Indian value. Likewise, reACT aims to reuse every drop of water for another purpose after it is done its first task.

The Greencourt works as a mediating bridge between the inside and outside of the house, allowing for natural air to flow and give life to the house, while offering more space for seasonal and social uses with plants enhancing the benefits of human/nature connection. It also functions to let the house breathe. reACT utilizes the thermal nature of air to directing hot air from the greenhouse into the solar attic where the heat is harvested in the climate comfort system (HVAC).

#### Sustainability Features that Increase reACT's Marketability

In line with our design principles to minimize wasted energy, reACT has taken a comprehensive holistic approach to improve energy efficiency and residential comfort while also protecting the environment and fight global warming. Energy Star, started in 1992 by the US Environmental Protection Agency (EPA), is the most successful voluntary energy efficiency movement in history. In its 22-year existence, Energy Star has helped reduce greenhouse emissions by more than 2.4 billion metric tons.<sup>xxii</sup> reACT is among the millions of homes that increase its efficiency by using Energy Star products. Although reACT did not participate in the **Energy Star Certified Home** program, its design choices were guided by the program standards for energy efficiency, i.e., heating and cooling appliances; duct systems, seals, and insulation; lighting and appliances, and attic construction. All the appliances selected are Energy Star products, if eligible. Alone by choosing Energy Star products, Team Maryland increased reACT's energy efficiency by up to 20% over standard new construction.<sup>xxiii</sup>

By comparing post-construction energy efficiency to current industry home efficiency standards, the scoring system Home Efficiency Rating Score (HERS) Index quantifies added value.<sup>xxiv</sup> The lower the HERS Score, the better it is financially and environmentally. As a post-construction inspection and score, Team Maryland was unable to obtain a HERS score for reACT. However, design, insulation, lighting and appliance decisions were made with the intention of achieving a 0 score, or a home that produces as much energy through renewable sources as it consumes. This would confirm its claim to being a Net Zero Home, and qualify the

homeowner for a HUD FHA-insured Energy Efficient Mortgage (EEM).<sup>xxv</sup>

### Market Impact Potential

Team Maryland believes homes that grow and shrink with family or community needs are better for the market and are more ecologically sound. The modular and **disentangled** aspects of reACT are important to its unique market value. Team Maryland addresses the need for conventional housing to be easily upgraded, as technology develops, and expanded or reduced according to changing space needs over the life of a family. A major challenge to the sustainability of conventional housing is its inflexibility to its footprint. When a family is young it often needs to expand, but as the family matures it often finds it needs to downsize. reACT's **disentangled** design allows for the residence's footprint to scale to a family's economic and space needs at any given time.

### Impact on U.S. Residential Energy Efficiency and Renewable Energy Industries

reACT is positioned as an industry model, embracing principles of the Living Building Challenge<sup>xxvi</sup>, Responsible Industry<sup>xxvii</sup> and Net Zero Waste<sup>xxviii</sup> by exemplifying non-toxic, ecologically restorative, transparent, and socially equitable architecture. reACT's kit of parts is adaptable and scalable to a diverse range of climates, communities, construction technologies and ecological environments, as well as to other cultural and logistical variables such as building material supply chains. reACT's design philosophy will ultimately generate a broad range of suitable forms for specific conditions, offering families building expansion or contraction options with easily upgradeable advanced technical infrastructure and features into their evolving homes. Efficient local manufacture, transport and assembly is facilitated by design features such as Structural Insulated Panels (SIPS) and kit of parts, alongside flexible configuration, building sizes and forms. Over the long haul, the disentangled systems design decreases maintenance costs because modules can be easily separated, maintained and replaced as they wear out or are technologically upgraded. Moreover, by transferring intellectual property to like-minded housing industry partners, Team Maryland will speedily encourage bringing to market reACT's prototypical DNA and flexible configurations.

### Livability: Safe, Functional and Enjoyable

Native Americans continue to work to improve and protect their livelihoods, cultures and traditions, and many still practice a respectful and unique form of system-based approach to nature which humanizes sustainability practices. Understanding this approach helps us to recognize that human beings cannot be removed from nature, nor nature from human beings. A key element is to have values and cultures that are local or regionally placed and held by a community with a long history. Native Americans have decision making practices aimed for the betterment of the community, as opposed to one individual. Team Maryland contends that these are best practices for making ecosystem-based decisions and responding to disturbances that cycle through human landscapes.

Seven Generations and sustainably sourced material are two principles that go hand-in-hand. reACT incorporates native materials with significance to the diverse indigenous landscapes and biomes of America. The life cycle of each material has been considered with the intent of optimizing resources by limiting waste. Building materials and equipment are largely recycled and sustainably sourced.

### Well-Being

It is well documented that reducing stress and eating non-processed organic foods increases health and well-being. Elements such as engaging with nature is important for reducing stress, reACT is designed with multiple indoor and outdoor opportunities to engage with nature.<sup>xxix</sup> Architectural daylighting and access to unfiltered sunlight increase mood and have benefits such as raising vitamin D levels.<sup>xxx</sup> The Greencourt provides year round access to the health benefits of natural sunlight. Growing one's own food organically produces more nutritious meals with less exposure to heavy metals in fertilizers and pesticides. Herbs and berries, especially important in the traditional Native American diet, are sources of various phytochemicals,

many of which possess important antioxidants.<sup>xxx</sup>

### Design Details that Meet the Unique Requirements of Native Americans

Traditional Ecological Knowledge (TEK) does not take just one form. Indigenous communities have variable practices that keep them embedded in their cultures. It is important to state that there is not one model that Team Maryland adopted but that specific applications vary depending on the location of a community and how they have historically responded to their changing environment. Native Americans and other indigenous communities have strong local cultural roots and even today are unwilling to forgo certain traditions. The Three Sisters garden, other systems Living and Water, and HVAC appeal to Pan-Indian ecological and cultural traditions.

### Living Systems

Team Maryland recognizes the importance of indigenous peoples' connection to the land and sacred resources: earth, water, wind, and sun. The living systems within and surrounding reACT are considered an extension of the building and a vital part of the residence as a whole. We bring the Earth into reACT by incorporating portable living green walls and outdoor living spaces. Our commitment to water protection is evident in our water systems design, where water is accounted for and reused or recycled. reACT features a built interior surrounding a spacious glazed Greencourt that acts as a greenhouse for our movable green walls. In honor of our clients' sensibilities reACT's design makes specific celestial references, such as an east-facing main entrance and skylights that opens to the sky. By recalling the natural environment, reACT's design embodies returning to a Native place.

reACT's vertical hydroponic garden is a method of water conservation, a closed-loop subsurface irrigation system with small amounts of trace minerals and nutrients. Edible plants such as leafy greens grow using this system placed in the kitchen. This growing system only uses as much water as the plants need and recirculates water to minimize loss. Edibles can be grown year-round indoors and further limits the need for water replacement because there is less evaporation in the climate controlled interior. Our hydroponic system dramatically reduces the amount of nutrients required to grow these edible plants, and reduces need for pesticides or herbicides.

reACT's living systems are designed to aid homeowners in their understanding of food producing plants and their production techniques, especially in relation to water usage and waste. The nutrient cycle corridor includes a barrel-composter that minimizes food waste and maximizes nutrients for the exterior gardens, all the while raising the homeowners' awareness of their agency to cycle leftover nutrients from their edible plants to the soil and then back into their plants. reACT's living systems intentionally aid functional food web formation around its exterior. With a diverse array of plant and soil life, thriving communities of beneficial microbes, insects, and other pollinators are encouraged and thrive. By creating habitat for smaller organisms, allows larger organisms to move back into their natural habitat. This design praises and honors these important creatures that allow us to survive. No matter where reACT is placed geographically, vegetation shall be tweaked to fit the biome and corresponding food webs indigenous to that locality. The main goal of living systems is to create a sense of harmony and balance between the house, its human residents and the surrounding ecosystems.

Dismountable green-wall panels covered by planted trays can travel into the Greencourt for protection from frost and inclement conditions. There are numerous wellness benefits, the indoor human-nature connection improves both physical and psychological well-being, while also improve indoor air quality.

In order to conserve water, landscape benefits from xeriscape techniques including: choosing soil that drains quickly and stores water simultaneously; choosing regionally-specific, native plants; using mulch or plants that shade the soil; using drip-irrigation systems to avoid overwatering and evaporation; not cutting turf too short



and reducing its footprint as much as possible. reACT's landscape uses rainwater supplemented with gray-water filtered from the house for drip-irrigation and to minimize drip-irrigation, reACT's SmartHouse System monitors weather data in order to control its actions.

### Water

Water is sacred to American Indians as it should be to all humanity. Water is an especially scarce resource that societies cannot survive without and where current patterns of climate change is altering its ownership. reACT emphasizes remedies to potable water scarcity through careful design considerations and research of existing water filtration components to achieve potable standards. Rainwater filtration to potable quality standards has already proven achievable. Team Maryland challenged itself to achieve potable reuse of greywater through filtration. reACT features technology that separates rainwater and greywater, then based on its quality, channels it to appropriate filtration for reuse. Separating the two types of water helps guarantee the potable quality of filtered water. Team Maryland conducts immediate tests with samples also sent to an EPA-certified lab for independent verification to guarantee safety.

### HVAC

reACT's HVAC design makes cooling and heating affordable. By integrating a state-of-the-art most efficient variable refrigerant flow (VRF) air-conditioning system and heat pump water heater system (HPWH) with the Greencourt, reACT is able to provide comfort efficiently and affordably. reACT's VRF and HPWH systems reduce this cost by being installed in the solar attic adjacent to the courtyard solarium where they can absorb heat that is passively produced in the courtyard. Moreover, the Energy Recovery Ventilator (ERV) recovers energy from vent air and returns fresh air to the home supplementing the efficiency of the cooling system. These systems are prepared for severe winter storms, they harness heat from the Greencourt so that even in severe winter temperatures, reACT can efficiently provide enough heating.

### Climate Technology

reACT's SmartHouse Control system is based upon systems engineering that integrates HVAC, power, water and irrigation subsystems. Responding to climate data it directs architectural responses mimicking the manner in which practitioners of traditional ecological knowledge would manually respond. For example, the shading of the house reacts to daylighting data to keep the house cool in the summer and warm in the winter. Another example would be, when weather data indicates rain, the system shuts off the drip-irrigation system.

### Home Financing

Our young couple are members of the Nanticoke Indian Tribe, although the Nanticoke have had treaties with the Colony of Maryland predating the War of Independence and have been recognized by the State of Delaware since 1881, it is not a federally recognized tribe. As such, our client is not eligible for specific US Department of Housing and Urban Development (HUD) and its Office of Native American Programs (ONAP) mortgage programs, such as the Section 184 Indian Home Loan Guarantee Program. Thus, our client couple needs to finance reACT through a standard FHA loan, however, with a low HERS rating, the purchase of reACT will be eligible HUD FHA-insured Energy Efficient Mortgage (EEM).

#### Finance Facts

Median list price per square foot in the Denver Metro area is \$241, in Denver itself it is \$347<sup>xxxii</sup>

reACT: Actual Construction Cost of reACT is \$284/ft<sup>2</sup>; the Total Project Cost is \$302/ft<sup>2</sup>

reACT: 1000ft<sup>2</sup> median market listing price range is \$241,000 to \$347,000.

Wife's Income: \$59,800 (Colorado RDNs median salary)<sup>xxxiii</sup>

Husband's Income: \$58,220 (Colorado Agricultural Managers median salary)<sup>xxxiv</sup>

Combined income: \$118,020.

Pre-Qualify for an HUD FHA-insured EEM<sup>xxxv</sup> loan for a house costing maximum \$450,000

### Scenario 1

List Price: \$241,000 (\$241/ft<sup>2</sup>)  
Down Payment: \$8,500 (3.5% FHA minimum)  
Loan: \$232,500 for 30 years @ 4% APR  
Monthly Payment: \$1400

### Scenario 2

List Price: \$347,000 (\$347/ft<sup>2</sup>)  
Down Payment: \$12,145 (3.5% FHA minimum)  
Loan: \$334,855 for 30 years @ 4% APR  
Monthly Payment: \$2017

### True Cost of reACT

reACT compares favorably to the conventional housing market (10% site and foundation work; 15% for contractor overhead and profit; 25% for Exterior Enclosure; 25% for interior construction and finishes; 25% for mechanical). Literally, reACT is at 2% site and foundation work (no basement, temporary foundation and no real site work). Excess access ramps and decks for exhibition purposes can be exchanged for internal finishes and stairs, but all other categories in the below table are comparable.

	Conventional Housing Costs	reACT as built Cost
Site and Foundation Work	10%	4%
Contractor Overhead	15%	6%
Exterior Enclosure	25%	25%
Interior Construction and Finishes	25%	30%
Mechanical and Electrical Systems	25%	35%

With an established and efficient supply chain of core and modular components using LEAN construction and integrated project delivery (IPD) technologies, we feel reACT is a cost effective competitor to conventional housing with the additional benefits of being scalable, responsive and adaptable without cost premiums and burdens to the market.

### Cost-Effective Value to the Client

By adding life-cycle performance features over time, greater value can be created in direct relation to its availability and need. reACT produces as much energy as it consumes through renewable solar energy and can eliminate energy bills altogether. By using an electric car energized by solar energy, homeowners can eliminate gasoline bills. The nutrition producing living systems can lower grocery bills. The net zero loss water system can eliminate water bills. reACT will cost homeowners less to operate on a monthly basis than standard homes because it uses less energy. Homebuyers who choose energy efficient homes can afford to spend more on their mortgage loan because they will likely spend less on their energy costs.

### Cost-Effective Design Features

- Super-insulated SIP panels for walls and roofs and potentially floors
- Consolidation of infrastructure in accessible (*disentangled*) walls and spine facilitating ongoing maintenance
- Non-invasive systems and components welcome rather than resist technological advances and upgrades
- Layered and mediated interstitial space (Greencourt) for enhanced performance and social benefits
- Open-ended decision making for materials, finishes and personal cosmetic touches
- Modularity supports adaptable and scalable alternates while Core functions remain stable and dependable

### General Contractor's Ability to Estimate and Build

reACT has an ambitious goal of accelerating the transformation of the residential construction industry. Team Maryland seeks industrial leaders to leverage the research and development investments it has made in its Solar Decathlon 2017 entry, and by bringing to the negotiation table a ready and interested market. This interest is

not in the literal house constructed for Solar Decathlon 2017, but in its prototypical “DNA” and flexible configurations. By working with industry leaders to develop market “off-takers,” Team Maryland intends to generate greater industry investment and willingness to collaborate, in exchange for contractually sharing the fruits of a substantial market segment. reACT is positioned to accelerate the industry’s embrace of the Living Building Challenge goals and an emerging non-toxic and ecologically restorative healthy materials economy. reACT will serve as a seminal and flexible prototype for housing that is more readily adaptable to a diverse range of clients, communities, construction technologies, site geomorphologies, and ecological environments.

The choice of reACT target market of Native American communities is Team Maryland’s central strategy. Recognizing the extreme housing needs in many Native communities, reACT uses sustainability and regenerative design principles to promote quality of life and culture. reACT embraces emerging sustainable building practices that promise to transform and support tribal housing projects, while also providing the two-thirds of Native Americans living in urban centers with housing options that support a more harmonious, balanced and sustainable interactions with the natural world. reACT is dedicated to mindfully support tribal embrace of sustainability and self-determination. Team Maryland is seeking to influence manufacturing partners to develop production plants in close proximity to tribal lands, to contribute to expanding training and economic opportunities for members of the tribal community. Construction is the largest sector of American Indian owned businesses, we believe this will appeal to housing manufacturers as a second target market.

### Ease of Construction

reACT advances a design built on developing homes as kits of interactive and disentangled systems and parts that can be efficiently manufactured, transported, assembled and disassembled. The kit of parts is conceived as an effective new high performing combination of ingredients able to be arranged or configured into diverse and clearly differentiated building sizes and forms. Assembly, standardization, and flexibility of components, along with an intrinsic disentanglement (to better “future proof” home building) of systems and their interdependence are among the strategies the Team Maryland has employed to increase build-ability, reduce construction and transportation costs, while facilitating changes and/or upgrades over time. After the Solar Decathlon 2017, Team Maryland plans to partner with innovative housing industry leaders to produce housing based on the competition prototype for both broader American community applications and for tribal communities in particular. We intend to prototype new construction and explore additional transportation paradigms. The modular components of reACT (Bath, Kitchen & Mechanical Room, Solar Attic, Bedroom Wing, Living / Dining Wing, and Greencourt) comprise a kit of parts from which many different designs may be developed. We are developing three basic alternatives from which dozens of variations are possible, based on site, climate, budget, family make-up and levels of commitment to regeneration and sustainability. Additional components based on the same principles of sustainability will be developed over time.

reACT’s kit of parts is, in turn, comprised of components that can be mass produced in factories, efficiently transported to the building site and assembled by local labor. SIPs are a natural choice for walls and roof. They can be rapidly fabricated under controlled factory conditions using a variety of materials, both natural and industrial. The insulation core used in the reACT prototype is made of expanded polystyrene, but other materials can be substituted: cellulose honeycombs, mycelin (mushroom based) foam, mineral wool. Sheathing used in reACT’s SIPs is oriented strand board, but could also be made of fiber cement, wheatboard or other composites. Materials may therefore be selected based on locally / regionally available materials to enhance sustainability and affordable, and to promote local industry.

## Appendix I: ENDNOTES

---

- <sup>i</sup> Note: In this report, various names are used when describing Native American peoples: Native Americans, First Americans, First Nations, Indigenous People, Tribal Nations, Indian Tribe, Tribal Leaders, American Indians.
- <sup>ii</sup> <https://www.census.gov/newsroom/facts-for-features/2016/cb16-ff22.html>
- <sup>iii</sup> Norris et al., 2012
- <sup>iv</sup> Indigenous Peoples' Consultation on the Right to Food, 2002
- <sup>v</sup> Reinhardt, 2015
- <sup>vi</sup> Anderson, 2009
- <sup>vii</sup> Crosby, 1972
- <sup>viii</sup> Braun, 2017
- <sup>ix</sup> Mihusiah, 2003
- <sup>x</sup> Urban Native is a term given to those Native Americans living in greater metropolitan areas as opposed to rural reservation lands.
- <sup>xi</sup> US Nuclear Regulatory Commission, 2014
- <sup>xii</sup> <https://www.colorado.gov/pacific/ccia/urban-indian-population>
- <sup>xiii</sup> <http://naticokeindians.org/>
- <sup>xiv</sup> Weaver, 2012
- <sup>xv</sup> Fleischhacker, 2015
- <sup>xvi</sup> Weaver, 2012
- <sup>xvii</sup> Mehusiah, 2005
- <sup>xviii</sup> Weaver, 2012
- <sup>xix</sup> National Congress of American Indians, 2015
- <sup>xx</sup> United Nations Conference on Environment and Development, 1992
- <sup>xxi</sup> Enos, 2002
- <sup>xxii</sup> <https://www.energystar.gov/about?s=footer>
- <sup>xxiii</sup> <https://www.energystar.gov/campaign/improvements/benefits/savings>
- <sup>xxiv</sup> <https://www.resnet.us/hers-index-score-card>
- <sup>xxv</sup> An EEM (Energy Efficient Mortgage) can help you purchase an energy efficient home. The EEM recognizes that energy efficient homes cost homeowners less to operate on a monthly basis than standard homes because they use less energy. Homebuyers who choose energy efficient homes can afford to spend more on their mortgage loan because they will likely spend less on their energy costs.
- <sup>xxvi</sup> <https://living-future.org/lbc/>
- <sup>xxvii</sup> <https://www.unep.org/resourceefficiency/what-we-do/responsible-industry>
- <sup>xxviii</sup> <http://www.grm.org/page/what-zero-waste>
- <sup>xxix</sup> Green, 2011
- <sup>xxx</sup> Rockcastle, 2017
- <sup>xxxi</sup> Dragland, 2003
- <sup>xxxii</sup> <https://www.zillow.com/denver-co/home-values/>
- <sup>xxxiii</sup> According to the Bureau of Labor Statistics' Occupational Employment and Wages, May 2016, <https://www.bls.gov/oes/current/oes291031.htm#st>
- <sup>xxxiv</sup> According to the Bureau of Labor Statistics' Occupational Employment and Wages, May 2016, <https://www.bls.gov/oes/current/oes119013.htm#st>
- <sup>xxxv</sup> [https://www.energystar.gov/ia/partners/bldrs\\_lenders\\_raters/EEM\\_Fact\\_Sheet.pdf](https://www.energystar.gov/ia/partners/bldrs_lenders_raters/EEM_Fact_Sheet.pdf)

---

## Appendix 2: BIBLIOGRAPHY

- Alexander, C. et al. (2011) Linking indigenous and scientific knowledge of climate change. *BioScience* (61), 477-484.
- Anderson, K. (2009) Traditional ecological knowledge: An important facet of natural resource management. National Resource Conservation Services, USDA.  
[https://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/stelprdb1045244.pdf](https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045244.pdf)
- Aynur, T. (2010) Variable refrigerant flow systems: a review. *Energy and Building*, 42(7), 1106-1112.  
<https://doi.org/10.1016/j.enbuild.2010.01.024>
- Berkes, F. (1992) *Sacred Ecology: traditional ecological knowledge and resource management*. Philadelphia, PA: Taylor & Francis.
- Berkes, F., et al. (2000) Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications*, 10,1251-1262.
- Blandford, M., et al. (2013). Building Green and Respecting Native American Identity: Housing, culture and sustainability in Native American communities. *Community Investments*, 25(2), 13-17. [https://www.huduser.gov/portal/SCinIC/Building\\_Green.pdf](https://www.huduser.gov/portal/SCinIC/Building_Green.pdf)
- Bonny, E. & Berkes, F. (2008) "Communicating Traditional Environmental Knowledge: Addressing the Diversity of Knowledge, Audiences and Media Types." *Polar Record* 230(230): 243-54.
- Brand, R., & Karvonen, A. (2007). The Ecosystem of expertise: Complementary knowledges for sustainable development. *Sustainability: Science, Practice, & Policy*, 3(1), 21-31.
- Braun, L. (2017) Three Sisters Agriculture and how it can created more sustainable agricultural systems. <https://duesllc.wordpress.com/2017/03/06/three-sisters-agriculture-and-how-it-can-create-more-sustainable-agricultural-systems/>
- Capra, F. (1982) *Uncommon Wisdom*. Toronto, ONT: Bantam.
- Cawston, R. et al. (2013). *The River of Life: Sustainable Practices of Native Americans and Indigenous Peoples*. Berlin: De Gruyter.
- Chhetri, N. & Chhetri, N. (2015) *Alternative Imaginations: Examining Complementarities across knowledge systems*. In *Indigenous Innovation: Universalities and peculiarities*. Rotterdam: Sense Publishers. 11-23.
- Crosby, A. (1972) *The Columbian Exchange*. Westport CN: Greenwood.
- Dragland, S. et al. (2003) Several culinary and medicinal herbs are important sources of dietary antioxidants. *The Journal of nutrition* 133(5). 1286-90.
- Enos, A. (2002) *Deep Sovereignty: Education in Pueblo Indian Communities*. Paper presented at the Annual Meeting of the National Indian Education Association. Albuquerque, NM.
- Fleischhacker, S. (2015) *Emerging Opportunities for Registered Dietitian Nutritionists to Help Raise*

- 
- a Healthier Generation of Native American Youth. *Journal of the Academy of Nutrition and Dietetics*, 116(2), 219-225. <http://dx.doi.org/10.1016/j.jand.2015.10.018>
- Gordon, J. (1993) Ecosystem Management: An Idiosyncratic Overview. In Aplet, G. Defining sustainable forestry. Covelo, CA: Island Press. 240-244.
- Green, J. (2011) Research Shows Nature Helps with Stress. The DIRT: Uniting the Built Environment with Natural Environments. <https://dirt.asla.org/2011/09/08/research-shows-nature-helps-with-stress/>
- Hess, C., & Ostrom, E. (2007) Understanding knowledge as a commons. Cambridge, MA: MIT Press.
- ICMN (2014) First Nation Development Institute Awards \$400K to 12 Native Food-Systems Projects. *Indian Country Today*, June 3. Accessed June 30, 2017. <https://indiancountrymedianetwork.com/news/business/first-nations-development-institute-awards-400k-to-12-native-food-system-projects/>
- Indigenous Peoples' Consultation on the Right to Food (2002) Declaration Of Atitlán, Guatemala. [http://cdn5.iitc.org/wp-content/uploads/2013/07/FINAL\\_Atitlan-Declaration-Food-Security\\_Apr25\\_ENGL.pdf](http://cdn5.iitc.org/wp-content/uploads/2013/07/FINAL_Atitlan-Declaration-Food-Security_Apr25_ENGL.pdf)
- Institute for Government Research (1928). The Problem of Indian Administration. Baltimore: Johns Hopkins Press. <http://www.narf.org/nill/resources/meriam.html>
- International Living Future Institute (2014). Living Building Challenge, 3.0. <https://living-future.org/lbc/>
- (2017) Living Community Challenge, 1.2, Standard. <https://living-future.org/lcc/>
- Kaufman P, et al. (2014) Measuring access to healthful, affordable food in American Indian and Alaska Native Tribal areas. US Department of Agriculture Economic Research Service Economic Information Bulletin Number 131. Washington, DC: US Department of Agriculture Economic Research Service. <https://www.ers.usda.gov/publications/pub-details/?pubid=43908>
- Levi-Strauss, C. (1962) The Savage Mind. London, UK: Weidenfeld and Nicholson.
- Lewis, D. (1995) Native Americans and the environment: A survey of Twentieth-Century Issues. *American Indian Quarterly*, 19(3), 423-450.
- McGregor, D. (2004) Coming Full Circle: Indigenous Knowledge, Environment, and Our Future. *American Indian Quarterly*, 28(3-4), 389-410.
- "Medicines of the Turtle Mountain Chippewa." Turtle Mountain Chippewa Heritage Center. <http://www.chippewaheritage.com/heritage-blog/medicines-of-the-turtle-mountain-chippewa>. Web. 15 Apr. 2017.

- 
- Mihesuah, D. (2003) Decolonizing Our Diets by Recovering Our Ancestors' Gardens. *American Indian Quarterly*, 27(3/4), 807-839.
- (2005). *Recovering our ancestors' gardens: Indigenous recipes and guide to diet and fitness*. Lincoln, NE: University Press.
- Norrgard, C. (2009) From Berries to Orchards: Tracing the History of Berrying and Economic Transformation among Lake Superior Ojibwe. *American Indian Quarterly* 33(1), 33-61. <http://www.jstor.org/stable/25487918>
- Office of Energy Efficiency and Renewable Energy (2014). Energy Department Announces Up to \$7 Million to Expand Clean Energy and Energy Efficiency on Tribal Lands. Retrieved from [https://energy.gov/eere/articles/energy-department-announces-7-million-expand-clean-energy-and-energy-efficiency-tribal?utm\\_source=PA934&utm\\_medium=email&utm\\_campaign=ProgressAlerts](https://energy.gov/eere/articles/energy-department-announces-7-million-expand-clean-energy-and-energy-efficiency-tribal?utm_source=PA934&utm_medium=email&utm_campaign=ProgressAlerts)
- Ogunwole, S. (2002) *The American Indian and Alaska Native Population: 2000*. Washington, DC: US Census Bureau.
- Ortiz, E. (2017) After #NoDAPL, 'Water Protector' Movement Continues with Resistance Camps Across the U.S. Truthdig. Apr 21. [http://www.truthdig.com/avbooth/item/nodapl\\_movement\\_continues\\_with\\_resistance\\_camps\\_across\\_us\\_20170421](http://www.truthdig.com/avbooth/item/nodapl_movement_continues_with_resistance_camps_across_us_20170421)
- Paris, D. & Samy Alim, H. (2017) *Culturally Sustaining Pedagogies : Teaching and Learning for Justice in a Changing World*. New York: Teachers College Press.
- Reinhardt, M. (2015). Spirit Food. In *Indigenous Innovation*. Sense Publishers, 81-105.
- Rist, S. & Dahdouh-Guebas, F. (2006) Ethnoscience—a step towards the integration of scientific and indigenous forms of knowledge in the management of natural resources for the future. *Environment, Development and Sustainability*, 8, 467-493.
- Rockcastle, S. (2017) *Perceptual dynamics of daylight in architecture*. PhD dissertation. Switzerland: Ecole Polytechnique Federale de Lausanne.
- Sarewitz, D. & Pielke, R. (2007) The Neglected heart of science policy: Reconciling supply of and demand for science. *Environmental Science*, (1), 5-16.
- Simpson, L. (2004) Anticolonial Strategies for the Recovery and Maintenance of Indigenous Knowledge. *The American Indian Quarterly*, (28/3), 373-384. Project MUSE, [doi:10.1353/aiq.2004.0107](https://doi.org/10.1353/aiq.2004.0107)
- United Nations Conference on Environment and Development. (1992) *The Global Partnership for Environment and Development : A Guide to Agenda 21*. Geneva: UNCED.
- U.S. Nuclear Regulatory Commission. (2014) [The Tribal Protocol Manual](#).

---

Vogt, K. et al. (2010) Sustainability unpacked: Food, energy and water for resilient environments and societies. UK: Earthscan.

Weaver, H. (2012) Urban and Indigenous: The Challenges of being a Native American in the City. *Journal of Community Practice*, 20(4), 470-488.  
<http://dx.doi.org/10.1080/10705422.2012.732001>