

Campus Farm Green: A Paradigm for Regeneratively Sustainable Communities

Abstract

By 2050 more than a third of Tucson Arizona's days will have a heat index of 104 degrees or greater if current excessive energy use behavior continues (Climate Central 2016). During the 20th century, the water table of Tucson's aquifer dropped 200' because of excessive water use. (Arizona-Sonora Desert Museum, 2013)

Our communities and buildings so far have not incorporated regenerative sustainability, the sustainable design and construction practices that could help avoid these problems.

Campus Farm Green, a new-home community in Tucson, is working to change that. "The Green" explores a new paradigm for developing regeneratively sustainable homes and neighborhoods that goes beyond reducing harm to the environment to helping to heal the environment. The Green has been designed to generate and return to the grid more electricity than it uses, and capture and return to the ground more water than it buys from the water utility. It does this while providing homes that can be sold for a profit at market prices.

This paper describes the challenges and solutions of the sustainably regenerative design and construction that is at the heart of The Green.

Executive Summary

Heat is the number one weather-related killer (Climate Central 2016). An extreme heat wave in northern Europe in August 2003 killed more than 70,000 people (DeFries 2019). Tucson, already much warmer than northern Europe, has become, and will continue to become, hotter. In addition to the projected future temperature increase mentioned above, in the past, between 2007 and 2016, Tucson was the U.S. city with the second greatest increase in the average number of days in a year when temperatures reached or exceeded 90 degrees (Climate Central 2016).

Tucson communities and buildings, as well as those of the rest of the U.S. have not been designed to adequately incorporate sustainability elements such as energy and water-use efficiency, bikeability and walkability, and proximity to public transportation, that can help avoid increased temperatures. Because of this, neighborhoods and homes in Tucson, as well as

the rest of the United States are significant causes of greenhouse gas emissions, and by extension climate change and its devastating effects. Additionally, they use more water than they need to.

Campus Farm Green (The Green) is a residential community created by the real estate developer Tucson Artisan Builders to reimagine communities and homes by integrating regenerative sustainability into design and construction to solve the energy and water problems previously mentioned. The Green will do this by 1. maximizing the energy efficiency of its homes so that they are able to generate and return to the grid more electricity than they use and 2. maximizing the water efficiency of its homes and landscape so that they are able to capture and return more water to the ground than they buy from the water utility.

Following this Executive Summary, the body of this paper will explore in detail the origin, purpose, and implementation of the Green.

Regenerative sustainability was pioneered at the University of British Columbia and The Green's design employs and extends those lessons. Because of the project's innovative nature, approval considerations were more challenging than for conventional projects. To obtain necessary buy-in and approvals, stakeholder partnerships and strategic collaborations were critical.

Demand and supply for sustainable projects appears to be imbalanced. Potential demand appears to be large, while supply is small. The Green utilizes a marketing strategy that reinforces the aspirations of an audience whose values most align with the project's design. It also raises public consciousness about how housing choices impact the local and global environments and introduces the public to new regeneratively sustainable housing-choice opportunities that heal the environment.

Introduction & Journey

I grew up in Pittsburgh, Pennsylvania in the 1960s when it was the steel capital of the world. That meant living with non-stop coal burning from the electric utility, steel mills, and other heavy industries along with industrial waste discharge that caused our air and water then to look like Beijing's today. My parents kept the windows of our home closed year round because of the grit in the air that settled on everything. I had "allergies" that disappeared when I left the city. No one swam or fished in any of Pittsburgh's three rivers. I knew fifty years ago that we couldn't keep doing what we were doing to the environment. So once I could, I started my own

"green" home building and real estate development business. For more than 25 years I've been trying to do my part to help the environment. But now I realize that I've only been following, rather than leading, the market for sustainable homes. That's no longer good enough.

The Challenge

Burning fossil fuels to heat, cool, and power our buildings and travel to and from where we live and work creates greenhouse gasses that cause harmful climate change including the hotter temperatures for Tucson already discussed. Climate change and common building-water-use practices exacerbate water shortages. As the Southwest heats up there will be less snow pack, more evaporation from reservoirs, and less available groundwater. Also increased energy demand from air conditioning will likely lead to increased water demand, since electricity generation is heavily water dependent (Gordon 2014). Likewise in Arizona, water supply is heavily electricity dependent. The Central Arizona Project, which provides water to Tucson and much of Southern Arizona, is the largest electricity user in the State (Central Arizona Project n.d.).

Buildings consume about 40% of the energy used in the United States (U.S. Energy Information Administration, 2019). The energy sector uses about 40% of the surface and ground water extracted in the U.S. (Grubert, 2018). Wasteful energy and water consumption associated with buildings and building infrastructure needs to be reduced and energy needs to be generated from renewable sources, not fossil fuels. Campus Farm Green (The Green) does this.

Meeting the Challenge

I, along with my company, Tucson Artisan Builders LLC (Artisan), and the wider real estate development community need to become market-movers working to increase the supply of and demand for sustainable regenerative development, development that facilitates the environment's natural regenerative ability.

Artisan's initial step toward that is the creation a profitable regeneratively sustainable project, Campus Farm Green. The Green is a model project exemplifying what is possible. It has three overarching goals that guide its development.

1st: Generate and return to the grid more electricity than it uses.

2nd: Capture and return more water to the ground than it buys from Tucson Water.

3rd: Demonstrate the environmental and financial benefits of regeneratively sustainable communities to the Tucson public, governmental staff and officials, designers, and developers.

Hopefully this will raise expectations and increase market demand and supply for regeneratively sustainable development in Tucson.

Project Execution

Regenerative Design

What is regeneratively sustainable development? The Centre for Interactive Research on Sustainability (CIRS) at the University of British Columbia was one of the pioneers of regenerative sustainability, or as it's also known, regenerative design. Here's how CIRS describes regenerative sustainability. "We need to think of every aspect of modern economic activity, including the acts of building and developing land, as acts of restoration and regeneration. This shift in perspective has the potential to motivate us to move beyond a practice of trying to create buildings and urban settings that are simply "less bad", into a new paradigm that strives to achieve the creation of "good" development. It helps us shift our mindset from measuring *impacts* into providing *benefits*; from *sacrifice* to *contribution* and finally from *net zero* to *net positive*. This is the foundation of *regenerative sustainability*" (The University of British Columbia Centre for Interactive Research on Sustainability n.d.).

The Green's Regeneratively Sustainable Design Elements

The Green incorporates a number of regeneratively sustainable design elements. Discussion of some of those is organized according to the "five enablers" of regenerative design set forth by CIRS.

systems thinking and integration. Rather than evaluating and "optimizing" individual project components in isolation, each component is evaluated to optimize the entire system. For instance the local flood map that encompasses The Green is out of date and does not take into account projects that have been completed in the last several years that eliminate the street flooding indicated on the map. This challenge could be solved in two ways; have an engineering study performed to revise the map, or design the floor levels of the homes to be above the current incorrect flood elevation. If this question were considered in isolation, performing the engineering study would probably be the solution chosen because that is less expensive than elevating the floor levels. However when considering the challenge as part of the overall

community system, elevating floor levels provides the benefit of making water harvesting basins and creating gravity-flow from rainwater-capture cisterns to irrigate rain gardens easier, and probably less expensive, to accomplish.

Likewise it is relatively easy in Arizona to install enough solar panels on an average-energy-use home to enable it to generate more electricity than it uses. However systems thinking quickly leads to the realization that from an embodied carbon viewpoint using more solar panels, or any material, than is absolutely necessary is wasteful. So before determining how large a photovoltaic system is necessary to make a home energy-positive, determining how to make the home most efficient with respect to energy is necessary.

adoption of industrial ecology. The basic notion is that "by-products" can be used for other purposes. There is an existing concrete-block structure at The Green that needs to be demolished. Rather than disposing of the block in a landfill is crushed and used for fill under the elevated floor slabs discussed above. Likewise other components of the existing structure are reused in the new buildings, donated to Habitat for Humanity for reuse offsite, or commercially recycled.

carbon sequestration. The goal of this principal is to create buildings that have the amount of carbon stored in the wood that they use be greater than the amount of carbon emitted during construction, including material extraction, manufacturing, and transportation. There is a large (44" diameter trunk) dying eucalyptus on the property to be cut down. Rather than taking the cut-down tree to a landfill or having it hauled away by a firewood contractor, is incorporated into the new project as furniture and mulch so that the bulk of its embodied carbon is not released into the atmosphere (Livesly, S. et al. 2010)

use natural resources rationally. This enabler reduces the amount of resources used by facilitating resource reuse. Homes at The Green use gray water from showers and clothes washers and capture streetwater to irrigate vegetation.

empower building occupants to become building inhabitants. The aim is to empower homeowners to become involved in their home's energy and water operations and optimization. To that end The Green's homes include a prominently displayed real-time circuit-by-circuit as well as aggregate electricity-use monitoring system. Like the instantaneous mileage display pioneered by the Toyota Prius, the goal of The Green's energy monitoring systems is to make

"driving" your home's energy consumption an activity where self-competition for improvement motivates more efficient home energy utilization.

Development Approval Challenges

Several aspects of The Green's development plan arising from regenerative sustainability community design considerations require approval under special provisions (the Flexible Lot Development (FLD) option) of the Tucson Land Use Code. Reduced lot sizes and building setbacks (the distance that a house needs to be from its lot lines) are examples. These measures allow more efficient land use, which results in greater neighborhood density. When greater neighborhood density results in greater community density that in turn can facilitate better transit infrastructure and active transportation, like walking and cycling.

Other community design aspects will require waivers from official Development Standards. These include, but are not limited to narrower on-site travel lane widths and porous pavement surfaces. Finally, the conveyance of off-site street-water runoff onto the site for vegetation watering use and recharge had never been done before in Tucson and required the development of new review and approval procedures. This element will be discussed in more detail later.

Stakeholder Engagement & Collaborative Partnerships - Successes and Surprises

neighborhood association. In light of the above development approval consideration, neighborhood support for the project seemed especially important. So empathetic engagement with the surrounding neighborhood association was one of the first project steps taken. The initial meeting with the Campus Farm Neighborhood Association was only to meet their leaders, introduce myself, let them know that I wanted to develop the Campus Farm Green, and get their input about what they would like to see developed. Since the neighborhood was worried that the land would be developed into apartments or attached townhomes, my intention of developing single-family detached homes was well received. Follow up meetings created a development concept that satisfied both the neighborhood's and my goals.

Tu Nidito. With neighborhood association support in hand, engagement efforts turned to a neighboring non-profit social services agency, Tu Nidito. I reached out and had a brief phone call with the agency's executive director during which I suggested we work together to build an

annex to their campus on The Green's corner lot. We arranged to meet with the agency's treasurer to flesh out the idea. That meeting went differently than expected. I had assumed that our partnership would include financial participation on their part. The had assumed that our "partnership" would include Tucson Artisan Builders donating them a to-be-built building. Perhaps neither of us had been as empathetic as we should have been during our phone call. We didn't come to agreement about the building, but we got to know each other better and left the door open to future cooperation.

living laboratory and citizen science. One of The Green's tactics to demonstrate the environmental and financial benefits of regeneratively sustainable communities is to serve as a living laboratory to develop and refine built-environment sustainability practices. To add credibility to its efforts along these lines, the project wants to partner with established sustainability research and advocacy groups so I've begun to participate in the efforts of three such groups. I've become a research volunteer for the University of Arizona's "Off the Roof" and "Project Harvest" harvested-rainwater-quality studies. Also I've had several street-water harvesting brainstorming meetings with and become a minor financial contributor to the local advocacy group, The Water Management Group. The expectation is that the connections made through these efforts will support not just The Green's living laboratory efforts, but may also help provide technical expertise for obtaining City approvals for the development.

city staff and elected officials. A broad network of peers having mutual trust and respect built up over time is beneficial to any professional endeavor. The next section discusses one example of the importance of this to The Green.

Pilot Projects - Challenges and Successes

Four rooftop solar, two rainwater harvesting, and one electricity consumption monitoring proof-of-concept pilot projects have been carried out in preparation for physical development of The Campus Farm Green. Others, including the one described below, are still in the works.

streetwater harvesting. By far the most challenging pilot project has been streetwater harvesting. Although Tucson pioneered streetwater harvesting to water landscape on public land, when I initially began dialog with the City about water harvesting onto private land, which had never been done in the City, no one was willing, or seemed to have authority, to make a determination about whether or not it was, or could be, allowed.

Luckily I was able to connect with a staff member, who I first met in the 1980s, who had been internally lobbying for the idea and we collaborated. My request provide the outside impetus for her to be able convene a group of mid-level decision makers to meet about the question. But those decision makers decided that current City policies would not allow what we wanted to do. For a while, I wasn't sure where to go next, but then I received a newsletter from a City Council member, who years ago appointed me to the City Sign Code Committed, extolling the benefits of neighborhood streetwater harvesting. When I brought it to his attention that staff was not allowing streetwater harvesting onto private property, he arranged a meeting of top-level City staff at his office and started the meeting by stating that he and the rest of the Council wanted to find ways to harvest as much streetwater as possible. Senior staff agreed that there should be a way to establish procedures that would allow harvesting onto private property.

A few weeks later at a Council meeting, the City Manager, the City Attorney, and the Department of Transportation Head all publicly stated that they would put into place procedures for the review and approval of projects that harvest streetwater for use on private property. A few months after that a public notice encouraging streetwater harvesting onto private property was distributed. Since then, we've identified the location for a pilot project and are proceeding with the documents needed for approval. So, for sustainability, you can fight, or more accurately lead, City Hall.

Market Considerations

demand. At the macro level, approximately 40% of Americans are alarmed or concerned by climate change (Hoffman 2012). Both groups are convinced that climate change is happening. The Alarmed are likely to hold relatively strong egalitarian values and be college educated, upper income, active in their communities, and moderate to liberal Democrats. Protecting the environment is a high priority for them. The Concerned group is representative of the full diversity of the U.S. in age, income, education, and ethnicity and tends toward moderate Democrats (Hoffman 2012).

At the local level, Pima County is one of the most liberal regions of Arizona. In the county 38% of registered voters are Democrats. 31% are independents. 30% are Republicans (Arizona Secretary of State, 2016). The City of Tucson is more liberal than Pima County with a higher percentage of registered Democrats

Independent of attitude toward climate change, a survey of home buyers across the U.S. showed that nearly 50% are willing to invest between \$1,000 and \$10,000 to achieve \$1,000 of annual utility bill savings. 37% are willing to spend more than \$10,000 (National Association of Home Builders 2019). A 2014 study of home buyers in eight states ranging from Florida to Massachusetts to California indicated that buyers were willing to pay a purchase price premium of \$4/W for homes with rooftop solar systems (Hoen, B. et al 2014)

Based on the above, demand for sustainable development in Tucson is likely to be strong. But supply of sustainable new residential development appears to be low.

supply. Online research that reviewed the websites of Tucson homebuilders who are members of the Southern Arizona Home Builder's Association (SAHBA) or who Google searches of "new homes in Tucson AZ" and "new sustainable homes in Tucson AZ" returned showed that website mention of energy and water efficiency and sustainability is minimal and mention of regenerative sustainability or net-positive energy or water homes is nonexistent. Additionally only three builders, of whom Tucson Artisan Builders is one, are members of and regularly attend SAHBA Green Build Committee meetings.

Marketing Strategy

People don't follow leaders for the leader; they follow leaders for themselves (Sinek 2010). In other words, people don't take action because of what others tell them. They take action because the action aligns with their personal beliefs and aspirations. Because of this, The Green will focus initially on connecting with the "tribe" described previously that already wants to live sustainably, the Alarmed and Concerned.

Knowing your audience/stakeholders/customers in a "god-like" empathetic way is crucial. When the audience is small, the best way to do that is through face-to-face interviews. However, even in Tucson, the audience of potential alarmed and concerned innovators and early adopters isn't small enough to meet all of them. But I have met with a few and can extrapolate from there to create representative customer personas based on an abbreviated Story Cycle format.

The Green's marketing Story will focus on how living at The Green will help the target audience live according to their personal sustainability values - for example, reduce their personal carbon and water footprints, drive less, walk and bike more, connect with neighbors,

and be an example for others. The fact that a sustainable home is a better more comfortable and healthy home which costs less to maintain and has lower electricity and water bills will just be the rationale to justify the value-emotions that motivate the decision to become part of The Green's community.

The Green's audience is small enough that person-to-person message delivery to all primary stakeholders, including serious homebuyer prospects (after being led to us from the overall audience by other communication methods) is possible and anticipated to be most effective. This is consistent with my natural behavior style.

How will we reach the general audience of potential homebuyers from which the face-to-face subset will emerge? As discovered through interviews, The Green's audience is tech-savvy. Several potential residents of The Green have already connected with me because of Tucson Artisan Builders website. That website is out of date and doesn't mention The Green, so the new website being developed for the initiative, <https://campusfarmgreen.org>, in conjunction with a comprehensive web-based marketing program utilizing several different message reinforcing channels should be productive in reaching The Green's overall potential audience.

Pro Forma - Value Added from Sustainability

Key to The Green's success as an example of a regeneratively sustainable community that raises the consciousness of both the home-buying market and residential developers is that can be financially successful. Assuming that homes at The Green sell for prices comparable to similar current new home infill communities in Tucson, the project should be successful.

LAND DEVELOPMENT

| | |
|-------------------------|--|
| \$160,000 | land cost |
| \$ 30,000 | land development consultants |
| \$ 20,000 | land development review and approval fees |
| <u>\$150,000</u> | <u>land development construction and fees</u> |
| \$360,000 | SUBTOTAL land developments costs |
| \$425,000 | finished lot value (5 lots @ \$85,000 average) |
| \$ 65,000 | gross land development margin - 18% |

BUILDING CONSTRUCTION & SALE

| | |
|-----------------|-----------------------------------|
| \$50,000 | building design fees/compensation |
|-----------------|-----------------------------------|

| | |
|-----------------|--|
| \$100,000 | building review and impact fees (5*\$20,000) |
| \$1,200,000 | building and site finish construction (5*1600sf*\$150/sf) |
| \$104,000 | sales tax ((sales revenue-(land+development) cost)*.65*8.7%) |
| \$20,000 | finance costs |
| <u>\$88,000</u> | <u>sales commissions & marketing (sales revenue*4%)</u> |
| \$1,562,000 | SUBTOTAL building construction and sale costs |
| \$1,922,000 | TOTAL land + building construction and sale costs |
| \$2,200,000 | total sales revenue (5*1600sf*\$275/sf) |
| \$ 278,000 | <i>gross project margin - 14%</i> |

If sales premiums similar to those described in Market Considerations section for homes with energy-efficient performance and rooftop solar are achieved project financial success will be greater.

Strengths, Weaknesses, Opportunities, and Threats - SWOT Analysis

In addition to the financial pro forma analysis, the SWOT analysis for the project is also positive.

strengths.

location. The Green is within convenient walking or bicycling distance (one mile or less) of all daily-life activities - employment, grocery stores, restaurants and cafes, an elementary school, health care providers, a fitness club, and a 130 mile-long bike/walking path. It is adjacent to both a bus line and a major bike route. The fields of the 160-acre University of Arizona Campus Farm are across the street. The University of Arizona main campus is three miles directly south and the center of downtown Tucson is five miles away.

initiative differentiation & innovation.

- Energy positive. Minimal carbon lifecycle footprint.
- Capture rooftop rainwater, street stormwater, and shower, lavatory, and washer gray water. Recharge more water to the aquifer than it purchases. No purchased water used to irrigate common area rainwater garden landscape.
- Zero demolition and site clearing waste.

- Zero landscape maintenance waste.
- Report community per capita energy and water consumption and recycling and solid waste amounts and compile data showing actual energy and water use compared to design projections. This will be accomplished by the *Measured Gets Managed* Home Owners Association initiative that will be concurrently developed.

political support. Engagement with the neighborhood association and City Council members has created support for the project.

weaknesses.

location. Home values in the surrounding neighborhood are not high. The adjacent streets have moderately noisy traffic.

opportunities.

technology advances. PV electricity generation and battery storage costs are rapidly decreasing. HVAC system equipment and control efficiency technologies are evolving.

economic outlook. The local and national economies are improving. Wages are increasing.

demographic changes. Millennials and are becoming more financially secure and prefer urban living (Florida 2019).

mortgage rules easing. It is likely that mortgages will become easier to obtain.

Presidential election rebound. After the election of Donald Trump, those who are Alarmed and Concerned about climate change are likely to be even more motivated to take personal sustainability action.

threats.

PV tax credit phase out. The current Federal 30% tax credit decreases in 2020 and ends on December 31, 2021.

Conclusion

Increasing temperatures and decreasing water supplies caused by climate change are becoming significant problems for Tucson, Arizona and the desert Southwest. By 2050 more than a third of Tucson's days will have a heat index of 104 degrees or greater if current excessive energy use behavior continues (Climate Central 2016). Inefficient energy and water use by buildings and communities significantly exacerbate the problems because buildings consume

approximately 40% of the energy used in the U.S. (U.S. Energy Information Administration, 2019).

But homes and neighborhoods designed and built following regenerative sustainability principles can help solve these problems. Campus Farm Green is one such community that is moving from concept to reality

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