

Resilient Experiments in Rural Housing: Architectural Experiments in Planned Housing

G Galford¹ and L M Tucker²

¹Assistant Professor, Residential Environments + Design, Virginia Tech, Blacksburg Virginia USA

²Professor, Interior Design Program, School of Architecture + Design, Virginia Tech, Blacksburg Virginia USA

ggalford@vt.edu

Abstract. Single family houses contribute substantially to climate change in the US and other parts of the world. In the US specifically, most housing has been designed by builders and developers. The motivation has not been sustainability and a knowledge of how to design net zero energy and net zero water dwelling is not commonly understood. This paper seeks to use a historical model as viewed through the lens of the Living Building Challenge to demonstrate how an architect designed historic example might provide a way of implementing a cutting-edge approach to sustainable housing today. Arthurdale was an early 20th century housing experiment that was conceptualized to provide for sustainable living in rural Appalachia. This paper presents the history of the region, an overview of the houses and the Living Building Challenge and then analyses how this historic prototype might model a sustainable housing development today using the Living Building Challenge system.

Keywords:

1. Introduction

According to the United States Green Building Council, buildings contribute significantly to global warming and climate change. “There's a consensus among the international scientific community that human activity is a driver of global warming. There's over a 95% probability that human actions over the past 50 years have warmed our planet, said the Intergovernmental Panel on Climate Change in its Fifth Assessment Report” [1]. Buildings and their construction together account for 39 percent of energy-related carbon dioxide emissions and 36 percent of global energy use annually, according to the United Nations Environment Program making building a significant contributor to global warming [1]. Further, in the US, commercial buildings use only 40% of all energy and residential construction is responsible for the other 60% [2]. As such, designing sustainable housing can have a major impact on climate change. In the US, most residential buildings are not designed by architects who are trying to impact climate change through building design. As such, committing to the Architecture 2030 challenge to eliminate the use of fossil fuels in buildings and the resulting work will impact fewer than half of all buildings. The sustainable design of residential buildings is critical to the reduction of greenhouse gasses and climate change.

The design of houses in the US has primarily been done by the construction industry, most specifically by residential property developers. For a variety of reasons (capitalism, lack of financial incentive, lack of interest by architects in houses for the middle class) house design has taken place outside of the domain of designers trained, educated and licensed to work for the public. This has led to a proliferation of large, inefficient, and mostly unsustainable residential construction. Fortunately, there are several historic examples of efforts to try and rectify this issue. In the early 20th century beginning with U.S. groups such as the Architects' Small House Service Bureau in the 1920s and 30s and followed by programs such as the federal subsistence homestead projects, architects and politicians focused on the issue of well-designed and affordable houses. With these programs, trained designers and architects produced house plans and kit houses that could be adapted to different areas of the country, sited to take advantage of local sun and wind patterns, and which could have gardens on the property to grow one's own food combined with root cellars and other sustainable features [3]. Using local materials and construction techniques, houses were sited to optimize the plot of land upon which they were built. Well-designed and efficient floor plans led to smaller houses and the use of less materials. Windows and doors planned for cross-ventilation resulted in comfortable interiors throughout the year.

This time period provides the best example of concerted efforts by the design community to improve housing for most people. Architects in the US have traditionally focused on high-end single-family houses for wealthy clients or on housing developments in urban areas as utopian visions for bettering the conditions for living among the lower class. Many of these visionary projects have failed. The living conditions of the majority of the population is not accounted for in this bifurcated approach. As such, the buildings are designed, constructed and driven by capitalism and financial gain and not by issues of efficiency, design, wellness of occupants, or sustainability.

It is theorized that this residential experiment in sustainable housing was not economically successful at the time, and was seen as a failure due to that lack of quick economic payback. It was a quest to use the powers of government to provide quick societal change. It needs to be viewed within a longitudinal framework that views its success over time. Critically utilizing its unique Appalachian vernacular architecture will provide insight into its success as well. This initial research is the beginning to a larger eventual study.

1.1 The Living Building Challenge

Of the current sustainability standards and guidelines, the most visionary platform comes from the International Living Building Institute with the Living Building Challenge for buildings and communities. The program is structured around seven areas (called petals after the idea that a building should grow in place like a flower). The seven petals include: Energy, Water, Place, Materials, Beauty, Health and Wellness and Equity. Like many green building programs, there is a focus on materials, energy and water. Where the LBC goes beyond typical sustainable building approaches is in the inclusion of design for Equity, Human Health, and climactic wellness. When first developed, the LBC was viewed as nearly impossible to achieve, but it had the impact of pushing industry partners, manufacturers, and regulatory bodies to accommodate the possibility of buildings that have both net zero energy use and net zero water use. Thus, a building can exist without taking anything from its surroundings and in fact can contribute to the health of the people and place. What was visionary is now possible to achieve.

1.2 Sustainable Housing and Vernacular Strategies

Since houses were first constructed in North America, vernacular strategies tended to be sustainable prior to the Industrial Revolution [4]. As with many parts of the world, the buildings and homeowners in America relied on locally available materials, cross ventilation, and preferable siting to take advantage of prevailing winds and to harvest daylight without creating solar gain in the interiors. An understanding of how to reduce heat build-up by raising a building off the ground or providing a central courtyard are regional variations on these traditions. In the eastern US, mountainous terrain allowed builders to use local wood, stone and even make bricks on site to construct houses. Slate was also widely available as

a roofing material as were wood shakes and other materials grown locally. Oftentimes, the front door would face south to allow the long side of the house to take advantage of sun in the winter and would be shaded by deciduous trees in the summer months. This prevented solar heat gain in the morning or evening on the east and west ends.

With the industrial revolution, many traditional ways of building and the use of local materials was supplanted by widely available manufactured materials first by rail and later through interstate trucking. New building systems such as indoor plumbing, electricity, and central heating transformed the American home [4]. More recently, a return to vernacular methods has been embraced as the urgent need to confront climate change has infiltrated the design and construction industries. The new Urbanism movement sought to recreate some of the neighbourhood connections of turn of the century developments. Specific Green standards now address single family houses in North America for example, LEED Homes and New Development Green Building Rating Systems, the Living Building Challenge (both for individual buildings and developments), PassivHaus standards and others. The need to address house design has been recognized but the path forward is less than clear as most houses are not designed by the professionals embracing these systems.

Having a series of model homes designed to meet sustainability criteria with specifications and siting adaptations have been proposed historically (Architects' Small House Service Bureau 1920s-1940s) and the Homesteader's Program in the 1940s. A modern version of this approach can be informed by these historic programs. When viewed through the lens of the LBC, the Arthurdale Appalachian housing project provides an historic example of how to achieve many of the aims of a sustainable housing stock.

2.1 This History of Arthurdale

The history of the region of Appalachia is unique within American history. The mountain range which defines its boundaries stretches from Georgia to New York [5]. This work focuses on areas closer to its centre, within the state of West Virginia. Early American colonial history saw these mountains as a natural barrier to settlement, providing a barricade that often-defined Native American lands [6]. The desire for new lands for settlement eventually brought incursion into the mountains with the original farming settlers being of English, German or Scots-Irish descent. Resiliency was required for these early settlers as outside support was minimal.

The Industrial Revolution of the late 19th century produced a need for raw materials to supply manufacturing facilities as well as to provide heat for burgeoning cities. The discovery of coal within the Appalachian Mountains, in an addition to its vast forests of timber, brought outside speculators into the region to begin a long process of land speculation [7] as underground mineral rights were sold by small farm land owners [8]. Ownership of land in Central Appalachia transitioned from a model of small landowner independence to one largely controlled by outside industrial speculators with little or no connection to area residents. From residential construction to steel production, the natural and human resources of Appalachia fuelled the American economy of the Industrial Revolution.

The region truly opened up with the construction of railroads into the mountains in the late nineteenth century [9]. The railroads were able to connect the population centres of the Eastern seaboard with the settlements of the Ohio River Valley and mid-western cities beyond. Providing access to Central Appalachia most importantly provided the means to move the timber and the coal from the mountains to the industrial cities that encircle the region [10]. The steel production that helped build the nation would not have occurred without its proximity to Appalachian coal [11].

There was not sufficient labour to do the necessary work, so outside coal and timber companies recruited newcomers to the area, whether African Americans from southern states, or new immigrants from Europe. This influx of labour to the mountains from distant regions re-shaped the culture of the region, in settlements planned, owned, and controlled by coal company operators [12]. These towns were connected to the mines they served, with necessary public services supplied by the coal company [13]. Schools, clinics, churches, department stores, recreational centres and even cultural venues were

incorporated into the original towns to attract and retain workers. Miners had to rent housing versus own their homes [14], and their pay was in company scrip, ensuring that the miner and his family were economically bound together with their employers [15]. Due to the rugged terrain, these towns were often isolated from each other, and contact with other areas of the country was difficult. Original mines and timber concerns often only housed workers, but families were soon included to maintain employee contentment. Hierarchies within these towns were often evident through the size of housing and location. Manager and owner housing would be of a larger type, and would be situated higher up the mountain side so that they would be able to observe workers from above. During the greatest expansion of these mines, these towns could be opulent in their civic architecture. Racial segregation was common in these towns, reflecting norms within the country [16].

Life within the mines in the late nineteenth and early twentieth centuries was indescribably hard. Men worked extremely long hours underground in dangerous conditions where a methane explosion or a roof collapse was not uncommon. Mine deaths were frequent. Women and children were dependent on the mine owners for both a livelihood and for housing, and when a husband was killed in a work accident, they often had to vacate as the town was only designed for those who contributed to its economic mission [17]. With time, labour movements in the rest of the country affected the coal fields and produced unionization movements [18]. Appalachian history is replete with violent battles between coal miners and mine operators which ultimately reduced the power of the United Mine Workers Association [19]. This eventually brought about improved living conditions, but the 1950s saw an increase in mechanization of the mines which reduced labour needs [20]. This has continued and the mining labour force in the region is presently a fraction of its peak. Strip mining and mountain top removal have left permanent environmental damage, as coal mining in the region is now affected by renewable energy sources that are now economically viable.

The coal company towns of the 1930s were deeply affected by the Great Depression as First Lady Eleanor Roosevelt visited towns devastated by the economic downturn [21]. One mining town she visited was Scott's Run, West Virginia [22]. Many residents were unemployed due to labour stoppages and conditions that were deemed deplorable [23]. The economic devastation in the coal fields was overwhelming, so she and other government planners used the opportunity to experiment with three new towns in the state that would be viewed as government-owned subsistence homesteads, meaning that they would be sustainable for the families who relocated there [24]. These communities had houses with indoor plumbing, electricity, sufficient land for gardening and food producing animals, and an underground root cellar. The most well-known of the three towns is Arthurdale in Preston County, WV. The town of 165 homes was comprised of two major types. The first was a prefabricated type from the E.F. Hodgson Co, that was designed for more seasonal use, and not for cold mountain winters. The second type was built locally and synchronized better with the climate [25]. This town also maintained its own school, a community building for public events, an artisan workshop for the production of woven goods and furniture, and a small nearby factory for the production of household appliances.

The initial costs of the housing for the community was more than anticipated and members of the US Congress were opposed to strong government intervention in the housing industry. The US federal government sold the town in 1946 to private owners, ending the governmental experiment. Arthurdale, as well as the other two towns in Randolph and Putnam counties in West Virginia, are all active communities today.

3.1 Methods

This study uses a case study approach [26] where Arthurdale is an example of an historic housing project that can inform the implementation of the Living Building Challenge. A comparison of the LBC to features of the Arthurdale homes demonstrates which sustainable features can be found in this type of vernacular architecture in Appalachia. Table 1 compares the key components of the Living Building Challenge (LBC) with the features of the house designs for Arthurdale.

Table 1. Comparison of Arthurdale Homes and LBC model

Living Building Challenge	Arthurdale Houses (Hodgson, Wagner and Stone)	Notes
PLACE		
01. Ecology of Place	Locally adapted to site	
02. Urban Agriculture	On-site agriculture (and livestock)	Cows, pigs and chickens
03. Habitat Exchange		Not applicable at the time
04. Human-Scaled Living	Porches	
WATER		
05. Responsible Water Use	Rain water collection?	Would need adaptation
06. Net Positive Water		
ENERGY		
07. Energy + Carbon Reduction	Double walls were designed with “arctic” lined Celotex insulation (1/2” cane fibre insulation); doors were fitted with screens to permit natural ventilation	Would need adaptation
08. Net Positive Carbon		No applicable at the time
HEALTH + HAPPINESS		
09. Healthy Interior Environment	Kitchen were designed to be of the latest “sanitary” technology. They were designed to be both cheerful (full of light) and convenient; sunrooms had plenty of natural light	
10. Healthy Interior Performance	Interiors were designed to evoke a sense of comfort and this was used in the advertising by Hodgson Company	
11. Access to Nature	Windows all rooms Sited for growing food and raising animals on the property	
MATERIALS		
12. Responsible Materials	Locally available Prefabricated panel construction used in phase 1	
13. Red List		Not applicable at the time/could be used
14. Responsible Sourcing	Locally available	
15. Living Economy Sourcing	Local workmanship/created jobs	
16. Net Positive Waste	Use of prefabricated construction resulted in a lack on construction waste on site	
EQUITY		
17. Universal Access	Most houses were located on a single level. Although ADA was not yet law, this would have contributed to a more accessible interior	
18. Inclusion	Economically equitable	
BEAUTY		
19. Beauty + Biophilia	Houses were designed with plenty of natural daylight and windows	

	for views. Lots were sized to accommodate growing food and other plants on the site.	
20. Inspiration + Education	The development relied on the Homesteading program as an educational tool for residents.	

3.2 Discussion

Historic housing projects can provide examples for how to take the complexity of the Living Building Challenge and scale it to a rural housing development. Instead of the typical approach US architects use towards designing one house at a time, these historic housing developments can provide a scalable model for implementation of sustainable housing for an entire neighbourhood development. Informed by good design practices focused on sustainability provided by the LBC and combined with historic large-scale developments both sustainability and scale can be achieved, which can inform both designers and residential developers. The Living Building Challenge also includes a provision for ‘scale jumping’ which allows for net zero energy and net zero water to be achieved at the level of neighbourhoods. This includes rain water catchment and on-site wetland water processing in combination with renewable energy strategies such as solar and wind collection that can fuel and provide water for all houses in the neighbourhood without being located discretely on each individual house.

The challenges faced in Appalachia related to climate change included the clear cutting of forests (ca. 1910) which resulted in flooding, fire and deforestation on a massive scale as well as the use of coal, the primary local industry [27]. Both of these can be mitigated through the LBC lens. For example, collecting rainwater and either providing on-site treatment to convert it to potable water or using it as grey water for toilet flushing are a way to prevent flooding. Xeriscape landscaping approaches wherein local plants are used to help absorb excess rain water are another solution. A neighbourhood solar array or wind turbines could supplement rooftop photovoltaics to provide 100% renewable energy stores for the houses. Treating the entire development as a living organism that is self-supporting would eradicate the ill-effects of climate change caused by the buildings themselves (both the construction and maintenance of them).

The housing for Arthurdale is an example of a political movement to “back to the land” which started with Ebenezer Howard’s Garden City concept and was extended to veterans in the late 19th century. Following the Depression, enabling legislation from 1933 sought to redistribute the population across the US. In response to an outpouring of letters to the President, Eleanor Roosevelt chose to take up the fight for miners in Appalachia and of the over 400 proposals, Arthurdale Sustenance Community was the project chosen for support [28]. The proposal included houses, community building and support systems for the residents of the area. *Each house had its own area for growing food, a place for a cow (which was free to each resident) and a root cellar.*

The houses in Arthurdale were built in phases. The first phase was based on a prefabricated modular unit by E.F. Hodgson Company. Modular construction saves on waste and is inherently sustainable as the panels are built to conventional material sizes. The first phase of houses in Arthurdale was the topic of an article in the *Saturday Evening Post* August 4, 1934. One of the Hodgson designs was shown in the article.

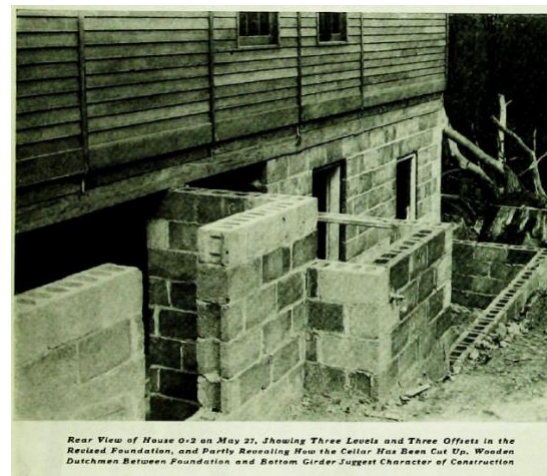


Figure 1. Image from Saturday Evening Post article August 4, 1934, p. 6.

The seams from the pre-constructed modular panels of the walls and roof are clearly visible in the photograph. Modular house design is something many architects focus on for sustainable construction today. According to S. Allen Chambers for Archipedia, the Hodgson Houses were built in shapes for which they were named: L, H, T, and I shaped. Fifty Hodgson houses were constructed of which 48 remain [29]. Each building site had one to four acres which included a combination cow shed/chicken house, vegetable garden space and flower gardens as well as a place for an orchard. Later phases were constructed on site. The later phases looked very different from the Hodgson houses. They were largely constructed from stone. The second phase consisted of 75 additional houses. The Wagner houses (named after the architect who designed them) were 1 ½ stories and either made from local lumber or stone set atop a concrete foundation. The third and final phase included 40 additional houses and were designed in one of three popular styles—Tudor Revival, Colonial Revival or 1 ½ story bungalows. A total of 165 houses comprised the final Arthurdale project which was completed in 1937 [29].

The Arthurdale project was not an economic success [30]. The houses cost twice as much as other comparable houses at the time. The community-based design concept was viewed by some as communist, and the overall approach was eventually abandoned and the development was sold. Despite this, this experiment represents one of the only times a holistic program for the poor based on sustenance housing was ever conceived and executed before or since in the US [30].

3.3 Conclusions

This paper demonstrates how a historic development (sustainable at its time in history) can provide a model for how to approach climate change in the house design and construction industry today. Although this work is an overview of the sustainable features that were integral to the Arthurdale houses, future work will focus on a mixed methods study that includes an analysis of current houses that remain from the different phases of construction and how they have been modified over time. Additionally, current and previous residents will be surveyed with some focus interviews. The three-part approach to sustainability—social, economic, and environmental—are all aspects contained within the Arthurdale project.

Works on ‘green’ housing often review vernacular architecture to learn lessons regarding construction techniques, but this work is focused on sustainability when performed by governments planning at a community scale. This work is unique in that it has a significant longitudinal advantage in how it can view the town, while using a modern system of sustainability to evaluate its success or failure. This work shows that current systems can evaluate historical models and can be applied to similar situations.

Future work will include a mixed methods study that will evaluate the current homes, from different phases of construction, and how they have been modified over time. Current and previous residents will be surveyed with limited focus interviews for the collection of qualitative data. Each successive phase will inform the next one. The goal is to provide deep evaluations of planned rural communities. The three-part approach to sustainability, social, economic, and environmental, are all aspects contained within the Arthurdale project.

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