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This study of mid-century modern residences focuses on how they may be successfully rehabilitated according to *The Secretary of the Interiors Standards for Rehabilitation with Guidelines for Historic Buildings* and how the process may serve as a model for future rehabilitation strategies for similar resources. With documented case studies, interviews, and diagnostic data from a sampling of seven mid-century modern resources located in Greensboro, North Carolina, the researcher provides strategies for rehabilitating these dwellings that will not jeopardize future nomination for historic recognition on the local, state and national level, allowing the resources to represent the intent of the designer through aesthetics, durability, comfort and, efficiency. Like many suburban buildings throughout United States, the sophisticated use of prefabricated standardized industrial materials, large span glazing, flat roofs, plywood, and aluminum, concrete and, industrial steel framing as well as careful site orientation characterize the buildings in the case study. As they reach their natural life cycle, the researcher addresses the very materials and systems deployed in homes after World War II, a significant challenge to the continued, viable use of the recent past structures.

CONSERVING AMERICA'S RECENT PAST HERITAGE:

THE MID-CENTURY MODERN

REHABILITATION PROCESS

by

Vanessa Jean Morehead

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Approved by

Patrick Lee Lucas (Signed)
Committee Chair

To John and Doris,

who love me unconditionally and

to My Adonai,

You are the maker of each moment,

Father of my hope and freedom.

APPROVAL PAGE

This thesis has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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The author also wishes to extend special recognition to the Loewenstein homeowner participants; thank you for sharing your lives with me and extending great kindness, generosity and hospitality.

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CHAPTER I

ENGAGING THE BUILDINGS OF THE MODERN MOVEMENT

Within the past ten years, new interest in mid-twentieth century culture has emerged, ranging from television programs to product design to advertising. *Dwell*, *Atomic Ranch*, *Modernism*, and *Metropolis* suggest a few of many niche periodicals featuring retro modernism, often pairing the detailed interest in mid-century architecture and design along with the practicality of the sustainability movement now prevalent in the United States. Lambin (2007) and Shiffer (1995), indicate that many people maintain a perception that mid-century resources are too young and not worthy of conservation. Due to our disposable consumer culture and short-sightedness, Americans place low value on things created in the last fifty years, not easily believing that these resources can possibly possess the depth and significance of older resources (Goldberger, 2008).

Even some preservationists have difficulty in valuing newer modernist structures because they feel that they have not had time to gain significance. Further, because modernist structures sit within the suburban landscape and quite often occupy large tracts of land, the property on which these houses sit represents a greater perceived commodity than the houses themselves, particularly by developers who seek to maximize investment on such land by demolishing recent past structures and subdividing their lots for multiple houses.

Finally, and particularly germane to this story, mid-century buildings contain materials and systems that have reached maximum life cycle and must be repaired or replaced. Confounding this process, quite a number of the specialized materials, or the processes that yielded them, are no longer viable (Goldberger, 2008; Prudon, 2007; Lambin, 2007).

Not only do age, land use, and materiality indicate challenges to conservation, the thermal comfort of the spaces they enclose suggests another contributing factor of viability. Though mostly-concealed HVAC systems do not directly define the character of mid-century buildings, these often outdated and improperly functioning systems contribute immensely to poor indoor air quality and reduced energy efficiency, in turn compromising the health and safety of inhabitants and countering current sustainability practices. Fortunately, technological innovation has resulted in drastic improvements over the original mechanical aspects of residential construction, with far more efficient, less invasive and more affordable systems as substitutes for outdated technology. Besides the threat of occupying large tracts of prime suburban land, engaging the buildings of the Modern movement often means addressing resources that contain materials of limited life spans, such as deteriorating wood siding, failing precast concrete, mold accumulating on aluminum siding and, sliding glass doors with worn out rollers, to name a few of the most commonly observed issues with recent past resources. With both sensitivity and balance, conservation of modern resources often may mean the replacement or substitution of materials as a solution for material degradation. In such cases, preservationists may find that acknowledging the original designer's intent a helpful strategy to successfully conserving the recent past resources, consistent with rehabilitation strategies of nineteenth century resources. The *Secretary of the Interiors Standards for Rehabilitation* outlines an acceptable protocol for treatment of materials, placing emphasis on minimal change to distinctive materials. The guidelines discourage removal of distinctive materials while encouraging the preservation of materials, features, finishes and construction techniques that characterize a property. They address a repair rather than a replacement strategy where possible or, in the case of severe deterioration, replacement of a distinctive feature with the new feature matching "the old in design, color, texture, and, where possible, materials," all substantiated by documentation and existing physical evidence (National Park Service, 1992). As pertinent to materials, changes undertaken must be reversible, "undertaken in a manner that, if removed in the future, the essential form and integrity of the historic property" remain intact (Weeks,1995). Perhaps for recent past resources, just as with traditional resources, designers must engage in a critical dialogue with the essence of the original design, the idea, the material, and the systems, rather than treating the resource as a fixed object awaiting the overlay of the intervention (Fixler, 2007).

In the end, mid-century design carries significance in a way different than other periods and styles, in large part because the buildings produced in the era lack surface decoration and instead rely on simple forms, exposed structure, partially concealed HVAC systems, and surface treatments that celebrate new materials and technologies borne from post-war technology. This unique set of materials and their installation methods suggest the potentiality for alternative interpretations of the *Standards,* a necessary step in preserving these resources in the decades to come (Prudon, 2007). To fully understand these challenges, we must understand the place of recent past resources in the context of historic preservation, both in terms of value and practicality. As illustrated in the literature review that follows in the next chapter, these challenges indicate that perceptions of mid-century modern structures measure out far differently than the realities of their circumstances.

CHAPTER II

VIEWS OF THE RECENT PAST

Historic preservation professionals utilize the term “recent past” to describe historic resources less than fifty years old, and an astonishing seventy percent of our built environment constructed since the mid-twentieth century comprises this recent past (Lambin, 2007; Shiffer,1995). In the mid-1990s, cultural resource professionals began to define the recent past and formulate arguments for the preservation of its buildings and landscapes. Since then, media attention about preservation gains and losses, scholarly publications, and grassroots, word-of-mouth conversations have all raised public awareness of the significance and state of the twentieth-century built environment and cultural landscapes. Renowned scholars within the historic preservation community enthusiastically have studied these mid-century, post-war resources and have argued for their documentation, classification and value in concert with resources from earlier time periods (Lambin, 2007; Longstreth, 2000; Shull, 1995).

The Value of the Recent Past

The years following World War II represented an era with a sudden increase of architectural and engineering innovation and social change resulting in a dramatically changed American landscape (Lambin, 2007). The emergence of suburban communities such as Levitt Town witnessed the disappearance of vast swaths of farmland and brought forth ranch houses, new roads and shopping malls. Preserving and appreciating what remains of the recent past tells an extremely important story of America as an emerging political and cultural leader after World War II and that story centers in the American suburb.

Unfortunately, people perceive many recent past resources as expendable, unattractive and, too many times, unworthy of preservation. Just as each generation favors one style of architecture, that same generation also regards another style of architecture as expendable and unattractive (Longstreth, 2000; Goldberger, 2008). The architecture of the Victorian era, for example, once considered ornamentally excessive in its use of machined elements, earned a disparaging reputation by proponents of the more clean-lined Arts and Crafts style. In turn, mid-century modern paradigms shifted the perception of Arts and Crafts as old fashioned and accentuated instead buildings and places that acknowledged (and perhaps even celebrated) the presence of the automobile in the suburban landscape.

It follows that recent past resources should not be casually dismissed as unworthy of conservation since, in the total context of American heritage, they give insight to social and economic culture expressed through the built environment. Longstreth (2000) suggests this as a continuum of on-going events represented by structures of the recent past, importantly not separated from resources of earlier periods. Traditionally, historic districts have been defined by their periods of significance leaving recent past resources ineligible for heritage recognition because of the fifty-year rule that establishes eligibility for the National Register of Historic Places. According to Longstreth (1995), preservation's purpose does not lie in second guessing the past, nor improving upon it, nor judging it by today's standards, instead preserving the past on its own terms.

When evaluating recent past resources, continuity and the ability to recognize original design intent suggest two critical aspects in the preservation of modern architecture. The first, as building ages, changes occur in the fabric to create a patina and instill the structure with "age value," an essential category utilized for the last century as a touchstone for determining the importance of historic structures (Riegl, 1982; Heath, 2002). The second, what Riegl describes as "newness value," in opposition to age value, requires "flawless integrity of form," inescapably lost with the process of aging (Fixler, 2009). In considering age value versus newness value, renovators of the mid-century Lever House challenged the relationship between authenticity and material replacement, demonstrating that repair may not always be technically or economically feasible, instead specifying substitute materials for the entire exterior envelope. With the Lever House example in mind, the significance of mid-century modern architecture lies in the combination of both design intent and material authenticity with, probably, a somewhat greater priority placed on the design idea (Prudon, 2007; Fixler 2009).

The Material Dimension of the Recent Past

Inspired by modern materials such as concrete, glass, and steel, mid-century modern structures demonstrate minimal use or absence of decoration, bringing the philosophy to bear that the material itself made its own statement negating the need for surface ornamentation (Prudon, 2007). Thus, materiality defines one critical factor that sets more modern buildings apart from their pre-war counterparts, because post-war design included the opportunity for fragile, experimental, or short-lived materials – such as plywood, plastics, glass curtain walls, structural steel, and concrete (Lambin, 2007). Prior buildings utilized more traditional materials (brick, wood, and glass), more easily sourced and repaired through traditional means. Still a nascent field, the conservation of recent past materials promises far more complexities than the care of traditional materials and finishes such as wood, bricks, paint, and mortar. The unprecedented growth of many twentieth-century manufactured building materials has included materials that have already passed out of use, such as zenitherm and flexboard, all long gone from the shelves of the lumber yard and home center, necessitating a re-evaluation of typical preservation practices to replace materials in kind (Shiffer,1995).

With deceptively high maintenance materials, mid-century modern residences show that material obsolescence forms the single greatest challenge to these dwellings. For example, machined parts fail, water penetrates unprotected wood siding, seals around large spans of glazing wear out, precast concrete cracks due to building settlement, and flat roofs leak, a common complaint of property owners. Brand (1994) suggests that we tend to see the negative instead of the rewards in repairing and that not maintaining a building, in the end, can be costly and disastrous. This advice finds roots deep in the nineteenth century, when Ruskin (1849) advocated maintenance as the Holy Grail for structures:

> Take proper care of your monuments, and you will not need to restore them. A few sheets of lead put in time upon the roof, a few dead leaves and sticks swept in time out of a water-course, will save both roof and walls from ruin. Watch an old building with an anxious care; guard it as best you may, and at any cost, from every influence of dilapidation. (*Lamp of Memory*, p. 261)

The same philosophy, echoed a century and a half later in the *Secretary of Interior Standards and Guidelines for the Treatment of Historic Buildings* (1992), in guidelines neither technical nor prescriptive published by the National Park Service, promote responsible preservation practices to protect historic structures. At the core, the *Standards* suggest four treatment approaches: preservation, rehabilitation, restoration, and reconstruction, as detailed next.

Preservation places a high premium on the retention of all historic fabric through conservation, maintenance and repair and reflects a building's continuum over time, through successive occupancies, and through respectful changes and alterations. Rehabilitation emphasizes the retention and repair of historic materials, with more latitude for replacement and the implicit assumption of more deterioration in the structure. Both preservation and rehabilitation standards focus attention on the retention and care for materials, features, finishes, spaces, and spatial relationships that, together, give a property its historic character. Restoration, the third treatment, focuses on the retention of materials from the most significant time in a property's history, while permitting the removal of materials from other periods. And finally, reconstruction establishes limited opportunities to re-create a non-surviving site, landscape, building, structure, or object in all new materials.

The *Standards*, in and of themselves, cannot be used to make essential decisions about which features of the historic building should be saved and which can be changed. But once a treatment is selected, the *Standards* provide philosophical consistency to the work. Before beginning any modification of a historic or future historic resource, designers consider the three R's of the *Standards*: retain, repair and replace, setting forth the philosophy and order in which designers should consider work undertaken on a historic structure. The *Standards* emphasize protection, maintenance, and repair and minimize alternatives relating to replacement (National Park Service, 1992; Weeks & Grimmer, 1995). Within the *Standards*, the rehabilitation strategy opens the door for recent past resources, which often have extensive deterioration, damage, or missing features, due to the fleeting quality of some of the materials. Of the four treatments, only rehabilitation includes an opportunity to make possible an efficient contemporary use through alterations and additions (National Park Service, 1992; Weeks & Grimmer, 1995).

In identifying the character of a historic building, a first important step for a historic structure of any age, the *Standards* suggest consideration of exterior materials and features as well as interior materials, and features, starting with materials and working toward details and spatial relations defined by the surface materials. A secondary consideration of structural and mechanical systems; and the building's site and setting complete the identification process (National Park Service, 1992; Weeks & Grimmer, 1995). Once designers identify important materials and features, the *Standards* make provision for protecting and maintaining (National Park Service, 1992; Weeks & Grimmer, 1995) and thus address stabilization during the rehabilitation process.

In the preservation philosophy embedded in the *Standards*, guidance for repairing a historic material always begins with the least degree of intervention possible. Repairing masonry as well as wood and architectural metal features may also include patching, splicing, or otherwise reinforcing them, using recognized preservation methods. In dealing with the unique qualities of post World War II structures, the preservation approach provides for augmenting a structural system with contemporary materials such as steel rods, provided that such changes represent work physically and visually compatible and identifiable upon close inspection, and documented for future research (National Park Service, 1992; Weeks & Grimmer, 1995).

In the rehabilitation approach, the *Standards* include limited replacement in-kind or with compatible substitute material of extensively deteriorated or missing parts of features,. Under this rubric, designers can specify substitute material if the form and design as well as the substitute material itself conveys the visual appearance of the remaining parts of the feature and finish (National Park Service, 1992; Weeks & Grimmer, 1995).

When missing, severely deteriorated, or no longer defining the historic character of the building, the *Standards* recommend that replacement of interior or exterior features only occur through the process of carefully documenting the historical appearance. Although accepting the loss of exterior features represents one possible approach, the *Standards* advocate for replacement as the preferred course of action. Thus, if adequate historical, pictorial, and physical documentation of the feature exists for its accurate reproduction, and if the designer wishes to re-establish the feature as part of the building's historical appearance, then the Guidelines permit the design and construction of the replacement feature. A second acceptable option for replacement, a compatible new design, calls for appropriate size, scale, and material as well as clear differentiation to avoid a false historical appearance. The preferred option, the replacement of the entire feature in-kind with the same material, not always technically or economically feasible with mid-century modern resources, yields to the use of a compatible substitute material. It should be noted that, while the Standards never recommend removal and replacement with new material of a feature that, although damaged or deteriorated, could reasonably be repaired and thus preserved (National Park Service, 1992; Weeks & Grimmer, 1995).

When faced with the issue of authenticating character defining features of recent past resources, because of their machine-made characteristics, Fixler (2009) and Trilling (1972) advocate that the mechanical quality defines the authenticating principle of the modern lifestyle, based upon a philosophy that the use of industrial materials and process appropriately characterizes modern architecture. As preservationists and communities contemplate strategies for rehabilitation of works of the modern movement, questions about authenticity and change come to mind, and shape the preservation practices for modern resources (Fixler, 2009; Lambin, 2007; Shiffer, 1995). This observation clearly articulates the problem that preservationists face in sustaining the authentic aura of a modern building, way beyond what Hughes (1980) called “the shock of the new,” leaving preservationists and historians to argue that the best modern designers envisioned logical, inspiring, and reassuring spaces and buildings, designed to promote human interaction.

Material Performance

In 1980, long before the word "sustainability" came into widespread use, the National Trust issued a Preservation Week poster that depicted an old building in the shape of a gas can as a reminder that reusing an existing building, instead of demolishing it and replacing it with a new one, suggested a good way to conserve energy. As sustainability has increased in popularity as both a social phenomena and a design strategy in the last decade, many have sought ways to form strong relationships between the two advocacy paths and communities (Campagna, 2009).

What does the concern of a sustainable community have to do with mid-century modern resources? Post World War II residential architecture accounts for far more than half of the buildings standing in the United States. Despite this, as these resources become aesthetically and technologically obsolete, property owners demolish them in order to make room for homes that are not expected to exceed a life cycle of fifteen to twenty years (Lambin, 2007). In reclaiming the suburban lots on which many of these residential buildings sit, one could argue a case for sustainability. But in accounting for all of the materials thrown away it hardly seems possible to encourage good stewardship approaches from such practices. As Campagna (2009) advocates, historic preservation and sustainability strategies make an equal and natural partnership with sustainable benefits, first and foremost, in the reuse of an existing shell and any interior components, the very material of the mid-century world.

The *Standards* advocate increasing building and material performance in terms of energy efficiency resulting in new thinking about indoor environment and air quality. Prudon (2007) notes that building performance and current research correlate fresh air exchange for increased health quality rather than for heating and cooling. Designers of many mid-century modern homes encouraged cross ventilation (glass curtain walls open to allow a merging of inside and outside spaces, e.g.) in the decades when designers and architects first deployed mechanical air conditioning units in residential structures. As the *Standards* indicate, retrofitting to improve energy efficiency must be assessed for its potential impact on the historic building (National Park Service, 1995) The *Standards* emphasize restoration of features such as cupolas, shutters, transoms, skylights, sun rooms, porches, and landscaping to make homes more energy efficient. The first step, the identification and evaluation of existing historic features, allows assessment of their inherent energy-conserving potential. Then contractors and owners must carry out the work with particular care to ensure restoration of the building's historic character. (http://www.nps.gov/history/hps/tps/standguide/overview/overview_energy.htm).

In updating systems, the *Standards* acknowledge that the greatest impacts of the twentieth century mechanicals relate to usage for interior lighting, forced air ventilation systems, exterior lighting and electric heat. The new age of technology after World War II also resulted in an increasingly high level of design and decorative art to many of the functional elements of mechanical, electrical and plumbing systems. The *Standards* further advise that the visible decorative features of historic mechanical systems such as grilles, lighting fixtures, and ornamental switch plates contribute to the overall historic character of the building, thus calling for their identification, evaluation, and re-use in the rehabilitated structure. The *Standards* further recognize that mechanical systems need to work efficiently so many older systems, such as compressors and their ductwork, and wiring and pipes often need to be upgraded or entirely replaced in order to meet modern requirements. Such an approach opens the door for increasing the performance of resources without jeopardizing potential recognition when executed in a sensitive, thoughtful and creative manner.

Architects designed mid-century modern residential resources with building performance in mind, for example as most employ non-solid shelter belts, such as trees and shrubs, which offer summer shading and winter sun penetration (Cutchin, 2008). Passive measures like these allow homeowners to lower the thermostat in the winter and raise it in the summer. In addition, instead of relying on electricity as main heating source, many mid-century moderns utilize more efficient natural gas systems (Cutchin, 2008; Smith, 2001).

Other methods of increasing building performance in terms of energy efficiency include updating insulation, eliminating cold bridges or drafts with proper seals, and properly insulating hot water storage systems. When considering HVAC systems, the Standards suggest installation of high efficiency heating systems, appropriately sized condensing boilers, space heating and hot water systems. Controls, programmers and thermostats should be appropriate to the task and correctly positioned and the heating system, geared to the thermal response of the home and occupancy (Smith, 2001; Wade, 1980).

Finally, many mid-century modern resources have reached the age for changes, repairs or perhaps the need for substantial alterations often the result of deferred or inadequate maintenance. Prudon (2007) advises that materials last longer and buildings perform better when properly maintained on a regular basis. To counter the perception of obsolescence, preservation organizations, and other advocates have formed alliances and organizations such as Eichler Homes Network, Triangle Modernist House, DoCoMoMo and Recent Past Network which provide awareness and resources for conservation strategies for mid-century modern homes (Arbunich, 2010; Smart, 2010; Prudon, 2000; Coleman, 2000).

Advocacy for the Recent Past

In support of preservation of post World War II resources, Longstreth (2000), strongly advocates that the architectural heritage of modernism should be documented, classified, and valued in the same manner as the architecture of any historic period. For example, the Gropius house stands as a symbol of modern architecture in the United States, since it was built in 1938 and opened to the public for the first time in June 1985. For years the Gropius family informally shared the white, geometric, flat-roofed, surprisingly modest house with visitors and professionals. A model of the new architecture Walter Gropius brought from Germany, he designed the structure using standard, mass-produced and off-the-shelf materials. In addition, the house incorporates elements of traditional New

England wooden architecture, painted white with dark trim. The Gropius house presented restoration difficulties for the Society for the Preservation of New England Antiquities because production of some industrial materials and parts, such as 1930's window hardware, has been discontinued (Giovanni, 1985). A similar shortage of materials and finishes faced Brent and Beth Harris, the owners since 1993 of Richard Neutra's Kaufmann House, who, working with architects Leo Marmol and Ron Radziner, sought out the original providers of paint and fixtures, purchased a metal-crimping machine to reproduce the sheet-metal fascia that lined the roof, and convinced owners of a long-closed section of a Utah quarry to mine matching stone to replace what had been removed or damaged (Wyatt, 2007). Not only did the Harris' meticulously restore the buildings according to the Neutra plans, they researched and thoroughly examined dozens of Julius Shulman photographs of the property leading to re-establishing the desert buffer that Neutra envisioned, successfully rebuilding the pool house (the main viewing pavilion for the main house) and retaining a tennis court adjacent to the original Kaufmann property, all heralded as a major accomplishment towards awareness of modern resources (Wyatt, 2007).

Other notable architects and designers contributing to the nation's heritage of mid-century modern architecture include Frank Lloyd Wright, Le Corbusier, Phillip Johnson, Charles and Ray Eames, Craig Ellwood, John Black Lee, Pierre Koenig, Mies van der Rohe, and Richard Meier. Like the Kaufman House, their buildings represent a built legacy that merits conservation as part of our past. Their work has inspired generations of American architects to create environments that inspired the creation of a new modern vernacular, sometimes borrowing on regional ideas about architecture and design, and melding them to Modernist philosophies, thus challenging the way we define habitable space and interact in it. In addition, the contributions of these iconic architects to the community of American architecture and design, served as motivation for architects like Edward Loewenstein to express his vision of modernism for Greensboro and to bring to fruition an innovative design philosophy relying on the use of unconventional and industrial materials (glass curtain walls and steel structural frames) for residential buildings alongside indigenous Carolina fieldstone, brick, slate, and pecky cypress (Lucas, 2007).

These localized examples of the buildings of the recent past, so ripe for study in the absence of qualitative and quantitative data, represent but one designer's work from the mid-century as an example of buildings that merit special attention in our marking of the past. But because so little literature directly bears on the practicalities of their retention and re-use, the researcher has relied on a grounded theory approach (Groat, 2002), combining that approach with critical analysis of energy bills (Jax, 1985).

As unfolded in the following chapter, this brief methodology provides the ground-level kind of study useful for others to take and incorporate in additional comprehensive studies of the recent past.

CHAPTER III

CONSIDERING DURABILITY, COMFORT, AND AESTHETICS

In this examination of materials used in the construction of mid-century modern resources, the researcher investigated durability, comfort and aesthetics as key criteria for evaluation of materials in recent past resources. The researcher aimed this assessment at a series of mid-century modern resources to offer an accepted strategy to protect the authenticity of their character-defining features and bolster arguments for their advocacy. This project relied on a grounded theory approach, correlating that important base-level research with information garnered from diagnostic studies of material performance and durability (Groat, 2002; Jax, 1985).

To begin, the researcher selected a purposeful sample of mid-century residential dwellings designed during 1946-1970 by Edward Loewenstein in Guilford County, North Carolina (Table 1). Though innovative material selection and detailing characterize these structures, the key criteria for inclusion in the study resulted from the continuity in ownership of the property along with the presence of detailed electric and gas bills and a willingness to participate in the study.

Sample Participants

NAME OF RESIDENCE	YEAR	NUMBER STORIES	HEATED SQUARE FOOTAGE	PLAN TYPE
House A	1951	1	4207	L-shaped
House B	1954	1-	5109	L-shaped
House C	1955	2-	4510	rectangular
House D	1961	1- MDF L	3000	L-shaped
House E	1964	2- Split	2852	rectangular
House F	1965	1	3338	L-shaped
House G	1966	2-Split	3630	rectangular

Table 1. Sample Participants.

During the summer of 2009, the researcher began investigation of the sample by visiting each site to take photographs and make notes. She then scrutinized construction documents, conducted focused interviews with participants and administered a concentrated survey. Review of information gained from these sources helped in establishing artistic intent with respect to selection of site, construction materials and the specific needs of the original homeowner. The researcher also undertook critical analysis based on specific data gathered from a year history of energy usage. To gain a better understanding of material longevity and performance as a result of human interaction, exposure to natural elements and normal wear and tear, the researcher surveyed current property owners around queries about durability, comfort, and aesthetics (Energy Consumption Questionnaire, Appendix C).

Formal analysis of the samples included comparison of evidence from each of them to discern patterns of similarity and sub categories of character-defining features, including observation of durability in glass curtain walls, wood and aluminum sliding doors, light fixtures, built-in furnishings, floors, as well as evidence of kitchen and bathroom remodeling; comfort in cross ventilation, floor plan and structure orientation, insulation and seals, and the presence and state of repair in electric and natural gas HVAC systems; and aesthetic considerations such as site selection of structure, presence of landscape elements, material balance and harmony, and notations of additions and modifications to the structure. Review of the construction documents, specifically the floor plans, helped the researcher gain a better understanding of materials, finish, and systems selections.

During the site inspection, the researcher took field notes while observing materials in their current state, grading them in levels of deterioration from high (all material intact) to medium (75% intact) to low (50% intact) or not present (25% or below intact). Similarly, the researcher evaluated the condition of the materials along a similar scale of percentages (good, fair, deteriorated, in ruin). The researcher administered an additional questionnaire to gather data relevant to quantitative analysis to evaluate comfort (Loewenstein Historical Resource Questionnaire, Appendix D).

The researcher entered the data in a spreadsheet to compare monthly and yearly energy usage to understand the seasonal load to cost relationship for each property individually. In addition, the researcher compared individual houses in the sample based on square footage, number and age of occupants, number and type of windows, type of heating and cooling systems employed, building orientation and regional location. The researcher then compared the results to similar data generated through *The Home Energy Saver Pro* energy analysis software to assist in determining areas to save energy consumption and cost.

Following accumulation of documentation, interviews and questionnaires, the researcher studied all data to gain an understanding of the role that preservation holds in the future rehabilitation and conservation for the properties. The researcher also speculated about the modifications possible to keep the buildings in good repair and use without compromising their future recognition as historic resources. The researcher tabulated the observations and comparisons into summary reports distributed to the property owners. In analyzing this data, the researcher observed a striking pattern for mid-century residences in the sample that challenges perceptions of their viability, a topic taken up in the subsequent chapter.

CHAPTER IV

REVEALING THE PATTERNS IN THE SAMPLE

By examining the evidence and data collected from the sample properties – the archival floor plans, photo-documentation, and survey data – this study answered key questions concerning material deterioration and performance relative to durability, comfort and aesthetics. In this process, the researcher evaluated the houses in the sample, pinpointed causes for deterioration, analyzed system performance, and delineated appropriate strategies for the continued use of the structures to suit today's needs. In summary, the researcher traced the symbiotic relationship between homeowner and home, noting that understanding the home and the changes made to it through time allowed home owners to sensitively care for and occupy the structure. Significantly, the researcher showed that materials in residential sphere do not deteriorate as significantly as their commercial counterparts. The researcher linked this lack of deterioration with the regular, preventive maintenance of many homeowners in the sample, issues that certainly link to the limited scholarship about recent past resources. In contrast to corrective maintenance, which necessitates the outlay of significant investment in capital and resources, ongoing maintenance (and the close observation it requires) reduces costs and increases a home's performance. With ongoing maintenance and care, the researcher showed that homeowners can better manage their properties and thus extend the life cycle of the materials themselves and the homes, thus enabling recent past resources to remain viable in community as a significant part of our cultural heritage.

In the sample investigated in this study, only two of the original homeowners currently occupy their mid-century modern residence designed by Edward Loewenstein. As recent past resources become available to new generations of owners, they wish, as any homeowners would, to modify the buildings to more present-day standards of living and comfort. The analytical data that follows – part gleaned from interviews, part from researcher observation on site – indicates that recent past resources may require a different mindset to understanding integrity in the absence of more traditional materials, details, and decorative systems. Consistent with the many scholars writing about these resources (Fixler, 2009; Prudon, 2007), this grounded theory based project provides significant evidence for an assessment of mid-century design for residential rather than commercial resources, a topic addressed in chapter five.

Client Recollections

Focused interviews, essential to gaining an understanding of the essence of the homes as well as the relationship between Edward Loewenstein and his clients, offer a rich place to begin understanding the value of the recent past resources in the sample. All homeowners, whether original or second generation, suggested that the open quality of the dwellings made the properties ideal for family and social activities. Original homeowners also noted the affordability of the original construction, especially when compared with traditional buildings. According to oral history interviews conducted by the researcher, homeowners requested Edward Loewenstein to design and build their homes because of his reputation as an innovative architect with an affection and understanding of modern design. To address the concern of affordability, Loewenstein modeled the design of his modern creations employing Frank Lloyd Wright's Usonian philosophy of open living spaces, abundant use of brick, wood and indigenous materials on both the interior and exterior. Each participant expressed that the spatial arrangement follow a natural flow, appreciating the fact that public spaces do not spill into private spaces. Following Usonian school philosophies, Loewenstein designed a central fireplace for warmth and as a symbol representative of the heart of the family who lived within. Demonstrated in all the houses, Loewenstein employed divided wings laid out in an L-shaped or modified L-shape with specific usage to maximize space and as the main method to separate private spaces from public.

Also, each homeowner mentioned that character defining features – built-in cabinetry and bookshelves, bathroom vanities, sleeping alcoves, sun porches and court yards, curtain walls, picture windows and in-door barbeque pits – contributed toward their purchase and/or long period of residence in the same house. Repeatedly, each homeowner expressed that they enjoyed entertaining in and showing off their homes. Clearly, all owners in the sample appreciated the aesthetics of the structures. From the researcher's point of view, in moving beyond merely an aesthetics-only consideration, many of the very same features in common throughout the sample contributed to efficient building performance in cost, material usage, and energy use reduction. Five of the structures, with a concrete slab foundation and a carport instead of a garage, efficiently occupied a one-story plan. At the House C and House E, both with very limited sites, Loewenstein took advantage of a two-story scheme, no less efficient than their one-story counterparts, in terms of layout and proximity within the plan. In all of the dwellings, Loewenstein also wisely incorporated methods to reduce high energy cost – natural cross ventilation, active solar gain, and careful site selection – all suggest an economy of building still contributing to lower energy costs today. In specifying materials for both exteriors and interiors of the houses – glass, brick and wood – Loewenstein minimized the need for paint and wallpaper, thus reducing initial construction and finish costs.

The Patterns Revealed

After reviewing the collected data, the researcher determined that nearly all the sample participants followed a regular maintenance plan to ensure durability of the materials specifically and the home as a whole. Owners of only two of the sample properties changed some of the original doors and windows because of significant deterioration of open/closure systems. However, all property participants installed HVAC systems within the last ten years, and all have maintained the interior and exterior aesthetics as close as possible to the original design. In three properties current owners upgraded kitchen and bathroom areas with new plumbing, cabinetry, countertops, and sky lights.

In surface application, homeowners accomplished significant changes in surface decoration. The analysis revealed that homeowners progressively sought ways to reduce energy usage in terms of building performance. They all agreed that responsible stewardship of fuel and electricity led them to investigate and buy appliances, as well as, heating and cooling systems that performed at a more efficient level (Tables 2 and 3).

Durability and Aesthetics Comparison

Durability	Repair	Replace	Remodel	New Addition
HOUSE A 1951	*Plumbing Issues *(in progress)*	* Radiant Flooring *(in progress)*		
HOUSE B 1954		Roof *(1993)*		
HOUSE C 1955	Re-Stain Siding *(current issue)*	Roof *(1990)*		
HOUSE D 1961	Pat'd Driveway *(1990)*	Roof, Storm Water Drain Pipes *(1980)*		
HOUSE E 1964	Drive-wy. Roof			
HOUSE F 1965		Cypress Fascia and Siding to PVC Board (orig. not avail.) *(2008 -2009)*	New Storm. Water Drain Pipes *(2008 -2009)*	
HOUSE G 1966		Kitchen, Living RM Flooring Asbestos Ceiling Storm Water Drain Pipes *(2005)*		
Aesthetics	**Repair**	**Replace**	**Remodel**	**New Addition**
HOUSE A				
HOUSE B		Kitchen Interior Paneling to Wall Paper, Kitchen Flooring *(1993)*		
HOUSE C				
HOUSE D		New Main Entry Door – Cust. (1970) Basement Flooring Material *(2000)*	Hallway. Sky Lights; Per Plans *(1970)*	
HOUSE E	Painted Interior /Exterior	Louvered Door to Glass Door Built-In Hallway Cabinetry Formica to Marble Counter Tops *(1997)*	Den Cabinetry Bath RM. Solar Tube *(1997)*	Detached Garage *(1999)*
HOUSE F		Replaced Kitchen Flooring Replaced Appliances Carpet/Bedrooms and Hallway (2008-2009)	Skylights MBDR. Kitchen MBath/ Laundry RM Screen North Porch Updated Bathrooms (2008-2009)	
HOUSE G		Updated Kitchen Cabinetry		

Table 2. Durability and Aesthetics Comparison.

Data From Loewenstein Historic Resource Questionnaire; Appendix. C.

Thermal Comfort and Efficiency Comparison

Thermal Comfort	**Replace HVAC Water Heater Appliances**	**Windows /Doors**	**Insulation**	**Landscapin g**
HOUSE A	*New Water Heater *(2004)*	New Seals Around Doors *(2009)* *Replace Single Pane Glazing with Low E Pane. *(in progress)*	Insulated Attic & Exterior North Sunroom Walls *(2009)*	* (in progress)
HOUSE B	Oil Heating and Electric Air Cond. *(1993)*	Replaced Secondary Windows and Doors Employ Black Out Blinds *(1993)*	Improve Insulation *(1993)*	Yes
HOUSE C	Oil Heating and Electric Air Cond. *(1990)*	Installed Storm Windows Insulated Glass Walls *(1980)*	Improve Insulation (1980)	Yes
HOUSE D	Oil Heating and Electric Air Cond. *(1980)*			Yes
HOUSE E	Oil Heating and Electric Air Cond. *(1997)*	Double Pane Windows Utilize Passive Solar Improve Seals at Drafts *(1997)*	Improve Insulation *(1997)*	Yes
HOUSE F	Oil Heating and Electric Air Cond. Energy Star Appl. *(2004)*	Bed RM, Kitchen (Storm Windows) (2008-2009)		Yes
HOUSE G	Oil Heating and Electric Air Cond. New Water Heater Energy Star Appl. *(2006)*			Yes

Table 3. Thermal Comfort and Efficiency Comparison.

Data From Loewenstein Historic Resource Questionnaire; Appendix. C.

Because participants shared that energy efficiency ranked high in maintaining their homes, the researcher sought tools to assist homeowners in making well-informed decisions towards future modifications. The criteria for the tools, readily accessible and free to the homeowners and supported by the Department of Energy, advised that formal audits be performed by an industry professional. The comprehensive tool offered by Duke Energy allows the homeowner to utilize a number of efficiency calculators for heating, cooling and appliances but the researcher observed that the site does not directly consider material performance of windows, doors, roofing material or site orientation (http://www.duke-energy.com/north-carolina/savings.asp). *Home Energy Saver Pro*, a comprehensive preliminary energy audit tool, requires homeowners enter information related directly to heating and cooling systems, as well as types of windows, roofing, insulation, and site orientation. Undertaking these analyses yielded reports largely consistent with holistic visual assessments of the homes undertaken by the researcher. Consistent with the data obtained from the Energy Consumption Questionnaire, the owners of house D spent about $1,138.66 for heating in the winter months and $1,142.36 for cooling, appliances and lighting during the summer months (Figure 1).

Sample Property House D

Home Energy Saver Pro™ AUDITOR & INSPECTOR TOOL

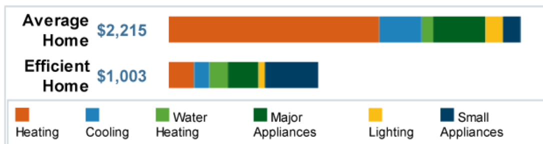
Alpha Prototype

This is a printed version of your Home Energy Saver Pro results, created at http://hespro.lbl.gov. Use the Session ID shown at the right to retrieve the session information for further analysis

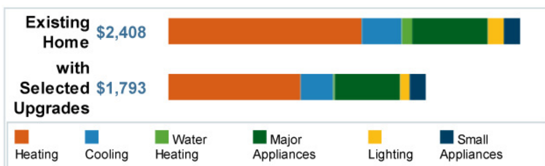
Identifier:
Session ID: 1534818
Zip Code: 27313
Location:

Energy Bill for Typical Homes in PLEASANT GARDEN, NORTH CAROLINA ($/year)

Based on default values for the zip code you entered, here is a comparison of the energy costs (in $/year) for an average home and an energy-efficient home in your area.



Energy Bill for Your Modeled Home ($/year)



Potential Annual Savings

Money:	$615
Energy:	2,769 kWh 397 Therms
Emissions:	8,218 lb. CO2

	Totals	Heating	Cooling	Water Heating	Major Appliances	Lighting	Small Appliances
Existing Home	**$2,408**	$1,324	$274	$71	$519	$108	$112
with Selected Upgrades	**$1,793**	$922	$227	$11	$456	$65	$112
Savings	**$615**	**$402**	**$47**	**$60**	**$63**	**$43**	**$0**

Important Note: These are initial estimates only, and your results may vary. If you have not already done so, we strongly encourage you to retain a professional energy auditor to develop a detailed work scope and budget for improving your home. We also recommend the Home Performance with ENERGY STAR program when considering home improvement.

Upgrade Recomendations

Upgrade	Bill savings compared to Existing	Bill savings compared to New	Estimated added cost	Max cost for 10 year payback	Simple payback time	Estimated ROI
Total for recommended upgrades	**$615**	**$611**	**$1,286**	**$3,055**	**2**	**47%**
Electric clothes dryer: Switch to gas dryer	$83	$83	$50	$415	1	167%
Thermostat: ENERGY STAR-labeled programmable	$103	$103	$70	$515	1	147%
Duct Sealing: Reduce leakage to 6% of total airflow	$271	$271	$300	$1,355	1	90%
Indoor lights: CFLs in high-use fixtures	$65	$65	$96	$325	1	61%
Dishwasher: EF=0.58 (ENERGY STAR)	$38	$20	$30	$100	2	67%
Air sealing: 25% air leakage reduction	$161	$161	$400	$805	2	40%
Gas water heater: EF=0.62	$38	$38	$130	$190	3	29%
Clothes washer: MEF=1.42 WF=9.5 (ENERGY STAR)	$108	$62	$210	$310	3	28%

Figure 1. Home Energy Report House D.

Even though the researcher observed normal wear and tear of materials for this building, the homeowners have meticulously maintained the structure for over five decades. The Energy Saver Analysis report reveals that the homeowners should check and improve seals at draft areas as well as upgrading to more energy efficient appliances. All of the original appliances survive in this structure, highlighting a dilemma about contributing character - defining features relative to the space. In the end, replacement of the original appliances may not have a large impact on energy usage. From the researcher's perspective, investigating smaller appliances and energy vampires represents an alternative strategy for the homeowners to reduce power costs. Defined as devices that use electricity even when turned off, energy vampires (cell phone chargers, laptop computer power bricks, entertainment equipment, e.g.) often account for as much as 20 percent of an electric bill.

The report for house B indicates consistency with observations and homeowner concerns as expressed to the researcher. The data gathered from the Energy Consumption Questionnaire reveals homeowners spent $3,000.00 for winter heating and approximately $1,300.00 toward cooling and appliance usage (Figure 2). Interviews with the owners revealed that they believed the abundance of glass as well as the lack of insulation in the ceilings contributed to high consumption cost. In the mild months, the owners mentioned that they opened the house to allow fresh air to flow through.

Sample Property House B

Home Energy Saver Pro™ AUDITOR & INSPECTOR TOOL

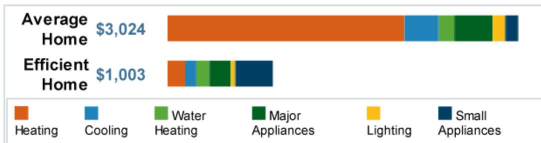
Alpha Prototype

This is a printed version of your Home Energy Saver Pro results, created at http://hespro.lbl.gov. Use the Session ID shown at the right to retrieve the session information for further analysis

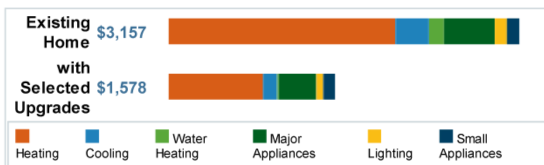
Identifier:
Session ID: 1534935
Zip Code: 27408
Location:

Energy Bill for Typical Homes in GREENSBORO, NORTH CAROLINA ($/year)

Based on default values for the zip code you entered, here is a comparison of the energy costs (in $/year) for an average home and an energy-efficient home in your area.



Energy Bill for Your Modeled Home ($/year)



Potential Annual Savings

Money:	$1,579
Energy:	4,439 kWh 1201 Therms
Emissions:	19,770 lb. CO2

	Totals	Heating	Cooling	Water Heating	Major Appliances	Lighting	Small Appliances
Existing Home	**$3,157**	$2,041	$304	$134	$458	$108	$112
with Selected Upgrades	**$1,578**	$895	$135	$15	$356	$65	$112
Savings	**$1,579**	**$1,146**	**$169**	**$119**	**$102**	**$43**	**$0**

Upgrade Recomendations

Upgrade	Bill savings compared to Existing	New	Estimated added cost	Max cost for 10 year payback	Simple payback time	Estimated ROI
Total for recommended upgrades	**$1,579**	**$1,517**	**$6,952**	**$15,170**	**5**	**21%**
Thermostat: ENERGY STAR-labeled programmable	$150	$150	$70	$1,500	0	213%
Electric clothes dryer: Switch to gas dryer	$83	$83	$50	$830	1	167%
Duct Sealing: Reduce leakage to 6% of total airflow	$401	$401	$300	$4,010	1	133%
Indoor lights: CFLs in high-use fixtures	$65	$65	$96	$650	1	61%
Air sealing: 25% air leakage reduction	$228	$228	$400	$2,280	2	57%
Dishwasher: EF=0.58 (ENERGY STAR)	$30	$16	$30	$160	2	53%
Wall insulation: R-11 wall + R-5 exterior foam sheathing	$304	$304	$1,049	$3,040	3	29%
Gas water heater: EF=0.62	$60	$37	$130	$370	4	28%
Clothes washer: MEF=1.42 WF=9.5 (ENERGY STAR)	$83	$52	$210	$520	4	23%
Duct Insulation: R-6	$92	$92	$460	$920	5	18%
Attic insulation: R-38	$250	$250	$1,527	$2,500	6	16%
Gas furnace: AFUE=90 (ENERGY STAR)	$272	$272	$1,871	$2,720	7	13%
Windows: 2-pane/solar-control low-E/argon gas/wood (ENERGY STAR)	$86	$86	$709	$860	8	12%
Refrigerator: 15% better than standard (ENERGY STAR)	$39	$5	$50	$50	10	9%

Figure 2. Home Energy Report House B.

At house B (Figure 3), a few leaky seals and several windows in need of repair define two easily remedied changes to positively impact the cost of energy. The homeowners also mentioned that the canted glass curtain wall located at the south elevation exhibits very little heat gain in the summer due to its innovative design technology.

Figure 3. House B Windows and Doors.

The ceiling and roof assembly over the main living area, less than 18” in depth, prevents easy access to this area which makes it difficult to insulate, as does the lack of space in the assembly. Homeowners also mentioned interest in alternative energy modifications not in conflict with national recognition status. The analysis from the gathered data revealed that homeowners could benefit from repairing seals where possible and consider making a few appliance changes.

At house E (Figure 4), interviews with the homeowners remained in line with the analysis findings revealing higher winter energy costs to accommodate comfort levels of aging occupants.

The data from the questionnaire shows that for a seven month period, homeowners on average spent approximately $2,750.00 to heat the 2,852 square-foot home (Figure 5). The relatively low cooling cost suggests several economizing measures, as observed by the researcher and gleaned from the in-person interviews. First, the homeowners often spend the late spring through early fall at their beach home. Second, the modifications made within the last five years of installing double pane windows, utilizing passive practices with landscaping, and replacing the air conditioner to a more efficient model helped to reduce usage and cost.

Figure 4. House E Windows and Doors.

Sample Property House E

Home Energy Saver Pro™ AUDITOR & INSPECTOR TOOL

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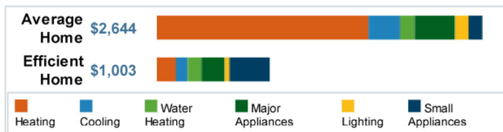
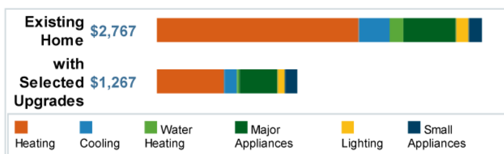
Identifier:
Session ID: 1534910
Zip Code: 27408
Location:

Energy Bill for Typical Homes in GREENSBORO, NORTH CAROLINA ($/year)

Based on default values for the zip code you entered, here is a comparison of the energy costs (in $/year) for an average home and an energy-efficient home in your area.



Energy Bill for Your Modeled Home ($/year)



Potential Annual Savings

Money:	$1,500
Energy:	4,204 kWh 1163 Therms
Emissions:	19,022 lb. CO2

	Totals	Heating	Cooling	Water Heating	Major Appliances	Lighting	Small Appliances
Existing Home	**$2,767**	$1,719	$262	$118	$448	$108	$112
with Selected Upgrades	**$1,267**	$607	$115	$22	$346	$65	$112
Savings	**$1,500**	**$1,112**	**$147**	**$96**	**$102**	**$43**	**$0**

Upgrade Recomendations

Upgrade	Bill savings compared to Existing	New	Estimated added cost	Max cost for 10 year payback	Simple payback time	Estimated ROI
Total for recommended upgrades	**$1,500**	**$1,461**	**$6,699**	**$14,610**	**5**	**21%**
Thermostat: ENERGY STAR-labeled programmable	$125	$125	$70	$1,250	1	179%
Electric clothes dryer: Switch to gas dryer	$83	$83	$50	$830	1	167%
Duct Sealing: Reduce leakage to 6% of total airflow	$338	$338	$300	$3,380	1	112%
Indoor lights: CFLs in high-use fixtures	$65	$65	$96	$650	1	61%
Air sealing: 25% air leakage reduction	$214	$214	$400	$2,140	2	53%
Dishwasher: EF=0.58 (ENERGY STAR)	$28	$15	$30	$150	2	50%
Wall insulation: R-11 wall + R-5 exterior foam sheathing	$317	$317	$1,134	$3,170	4	28%
Gas water heater: EF=0.62	$37	$37	$130	$370	4	28%
Clothes washer: MEF=1.42 WF=9.5 (ENERGY STAR)	$79	$51	$210	$510	4	23%
Windows: 2-pane/solar-control low-E/argon gas/wood (ENERGY STAR)	$85	$85	$432	$850	5	20%
Attic insulation: R-38	$235	$235	$1,527	$2,350	6	15%
Duct Insulation: R-6	$78	$78	$460	$780	6	15%
Gas furnace: AFUE=90 (ENERGY STAR)	$129	$244	$1,810	$2,440	7	12%
Refrigerator: 15% better than standard (ENERGY STAR)	$39	$5	$50	$50	10	9%

Figure 5. Home Energy Report House E.

When compared to the other houses, house C exhibited a dramatically higher thermal usage. The homeowner felt that the installation of a new furnace and replacement of bedroom and kitchen windows represented factors contributing to energy efficiency. Though the homeowner highlighted the tight seals around the original character - defining casement windows located on the north elevation, the researcher observed that infiltration or air leakage might occur at the glass curtain wall located at south elevation and picture windows located at north and east elevations (Figure 6).

Figure 6. House C Windows and Doors.

Eliminating or reducing these paths of heat flow can greatly improve the energy efficiency of windows and, ultimately, of homes. Several options help to reduce air leaks around windows; low-cost options such as caulking and weather-stripping, followed by more expensive replacement of window frames and components. Other feasible strategies include duct and attic insulation and regular inspections by an industry professional.

The researcher rated all properties in the sample at medium for overall material integrity and good for material condition. A focused interview with the current owner of house F served as a premium demonstration of repairing or replacement to maintain overall integrity and increase performance. At this residence, the homeowner took on replacement of extremely deteriorated exterior siding (mostly due to the wooden structure's placement on a heavily wooded lot), replacement of all exterior and interior insulation, replacement of plumbing, installation of new heating and cooling systems, resealing all exterior concrete, and installation of a new storm water drainage system (Figure 7).

Figure 7. House F Repair and Replacement.

All of these measures proved that, with concerted efforts, homeowners can make necessary changes and still remain in compliance with the *Standards*. The researcher ranked exterior materials, wood siding, concrete and out-dated clay drainage system as fair and deteriorated respectively for the House A and House G. When the researcher investigated the latter house, she observed reduction of material condition at the exterior storm water drainage system. Noticeable shattering and clogging of clay pipes present a flooding concern and could lead deterioration at key locations of the structure. Following that investigation the homeowner contacted the researcher and inquired of a landscape architect and appropriate strategy to alleviate the problem. After receiving a referral the homeowner followed through resulting in a strategy that involved removal of ground cover and plants that impeded surface flow, installed a 12” catch basin at the back corner of the house and ran corrugated pipe underground to the street. The owners graded the soil on the north side of the house, which received the greatest degree of flooding, to create a swale and installed a water-impermeable retaining wall by the crawlspace access to prevent surface water from flowing into the crawl space. Lastly, the owner countered erosion damage in the crawlspace with fill dirt.

The current homeowners of the House A faced replacement and HVAC challenges with the purchase of the home in 2004. From the interviews, the researcher learned of the measures to improve energy efficiency in the sunroom, attic, and east wing of the house. Because of the recent *National Register of Historic Places* status, the homeowners requested review of the improvements by the North Carolina Department of Cultural Resources (NCDCR) for guidance and approval. Minor modifications included improving seals around windows and doorways. Major modifications involved insulating the attic as well as the west walls of the sunroom, the transition entry from the carport and the west wall of the east wing and the transition entry from the exterior courtyard (Figure 8).

Figure 8. House A Repair and Replacement.

Since the modifications required removal of the exterior wood siding, the condition of approval mandated execution in a sensitive manner with re-installation to emulate the original state. Though the homeowners understood the challenges with introducing new features, they submitted photographs demonstrating the preservation of the wood siding and the NCDCR approved all modifications. In February 2010, the researcher learned that the homeowners experienced reduced energy consumption for the home by fifty percent because of these changes. On the day of visitation, with the outdoor temperature at 35 degrees Fahrenheit, the interior temperature measured out to a surprising 60 degrees Fahrenheit. From the homeowner's perspective, this was a major improvement over a similar cold spell the previous year, where they had to set the thermostat at 80 degrees to maintain the interior temperature at a level of comfort.

Materials and Systems Maintenance

This examination of the Loewenstein modernist properties revealed valid parameters for discussion of materials and their performance when they come together in an innovative manner to provide shelter in an aesthetic that is comfortable and durable. To extend the life cycle of their homes, each sample participant agreed that preventative maintenance remained a paramount responsibility for owning these properties. The researcher noted that preventative maintenance rated more significantly than corrective maintenance for the homeowners. Not only valid for materials, homeowners turned their attention to mechanical systems as well.

Overall, the researcher learned that the majority of the sample participants kept their heating and cooling systems updated and scheduled them for maintenance checks as required. The researcher observed that the heating or cooling system had little to no effect on original materials in each building. Instead, the original placement of ductwork, sometimes in an incompatible manner, resulted in the damage of some materials or a compromise because the new ductworks obscured original materials. The researcher noted that many window and door seals, as well as other protective caulking, remained largely intact in the sample, with the careful suggestion that vigilance in these measures could result in substantial impact energy consumption.

In terms of comfort explicitly, oral interviews and responses from questionnaires and interviews revealed that property owners ranked energy efficiency as a major concern. Although heating and cooling systems do not directly define the character of recent past resources, reliable information regarding the design and installation of an appropriate system stood as a determining factor in original purchase. As new homeowners have contemplated and actually purchased the structures, this issue remains a paramount concern.

The Energy Consumption Questionnaire assisted the researcher in understanding how each home performed in relation to the needs of the homeowner prompting them to evaluate how much they were spending for thermal comfort and why. The homeowners also wanted to know if the windows, doors, and roof compromised the energy efficiency of their home and, if so, how to make changes as well as reasonable expected results. To provide the homeowners with easy to use diagnostics, the researcher employed two user-friendly tools to answer these questions, the *Duke Energy Assessment Calculators* and the *Home Energy Saver Pro Energy Audit*. The reports generated served as tools to assist the homeowner in making informed decisions related to heating and cooling systems. This represents a key undertaking in this research and a key outcome for each homeowner, a specific and analytical investigation on site to determine efficiency and energy use. The researcher notes here that both diagnostics tools used together helped the homeowner consider how to assist their homes performance, a demonstration perhaps of a renewed interest in energy efficiency and assessment due to the current economic climate.

Materials and National Register Eligibility

At all houses, the researcher also noted that past or current modifications considered for the properties took place largely in agreement with the original Loewenstein plans, a positive for potential *National Register* listing, one aim of this study. At three of the houses (House E, House F, and House G), some materials treatments and performance modifications compromise aspects of the integrity of these structures relative to *National Register* listing. For example, for

House F, the homeowners introduced skylights not on the original plans and also screened in the sun porch, both relatively minor changes from a physical perspective, but greatly differing in terms of experience. In the case of the skylights, the perception of the bedroom as a light-filled space stands separate from Loewenstein's design intentions. The screened porch results in less intrusion into the scheme from an experiential frame as a translucent skin added to the structure (Figure 9). Of more major concern in terms of interior changes, at both House G and House E, homeowners significantly upgraded the kitchen spaces, installing not only new appliances but cabinetry, lighting, hardware, and other features vastly different from the Loewenstein plans.

Figure 9. House F Modifications.

At a North Carolina National Register Review Commission meeting in February 2010, the members discussed the importance of interior integrity as well as exterior in considering eligibility (personal observation by researcher, February 16, 2010). In light of this conversation, the researcher believes that some of the changes – though not necessarily all described above – may prove to be challenges in the *National Register* process for these specific resources.

Notwithstanding the conversation at the National Register meeting where interior integrity seemed of greater importance to the listing of recent past resources, the philosophy and methodology adopted for the conservation of recent past resources should be no different than that of traditionally recognized historic resources. But some may argue that structural and material innovation pose new conservation challenges for the original fabric and this characterization would be correct if the homeowners themselves or professionals retained did not undertake comparable research and understanding processes for these modern resources as those applied to traditional structures.

Materials and Recent Past Resources: A Holistic View

Underscored in this study, the researcher discovered that individuals must analyze residential properties as a whole by looking at the materials, the component parts, AND the systems, as well as the site conditions, in one integrated assessment. By understanding these structures from this more holistic view, the details of changing materials, parts, and systems take on a different scale than mid-century modern commercial resources. Thus some of the concerns raised about material qualities and performance, while perhaps daunting for a commercial building, can easily be resolved in the residential sphere. They key here is material analysis. By looking at the characteristics, properties, and state of repair for the materials themselves – a strategy used for historic resources of all ages – the researcher advocates for durability, comfort, and aesthetics as key criteria for assessing materials in recent past resources.

By identifying durability, comfort and aesthetics as the key criteria for evaluating materials in recent past resources, the researcher placed these three criteria within the more complete system integrating the spaces, materials, and HVAC equipment. As a result, the researcher untangled the delicate balance between authenticity of character defining features and current-day use. In strengthening arguments for protection and longevity of mid-century resources, the researcher learned that, in large part, the sample properties contained historical merit and retained value of innovative materials and details that characterized these structures. By looking at the buildings themselves, and then talking with homeowners on several occasions, the researcher verified a broad understanding of the value of on-going maintenance and repair as key strategies for maintaining the utility of the buildings, both to the present and to the future.

CHAPTER V

THE FUTURE OF RECENT PAST RESOURCES

In living with recent past resources, homeowners and preservation professionals must adopt a new attitude toward the buildings, understanding them not so much as a fixed commodity but rather as an ever-changing backdrop for human activity. As we make modifications to these structures, we must look and listen and recognize their important features, spatial relationships, support through mechanical systems, and above all, the material qualities that they emanate.

With this study of houses designed by architect Edward Loewenstein, the researcher learned that there is a great need for advocacy of recent past resources and that a thirty year eligibility is adequate when considering recent past resources for local, state and *National* recognition. In addition, the researcher believes that the Secretary of the Interior's Standards offer a framework that supports the rehabilitation of resent past resources but a critical dialogue between designers and preservation professionals is key to interpreting the *Standards* to arrive at creative and appropriate strategies on a case – by – case basis which keep recent past resources viable in our communities.

The researcher also observed a true difference in scale between the kinds of issues and challenges of materials for residences than for commercial buildings of the same vintage. For example, when homeowners replaced windows in their living room, they corrected the challenging problem of sweating aluminum frames by cladding them with wood. Where this might be an insurmountable problem for a commercial structure of great size and height (such as the Lever Building example provided in Chapter Two), these homeowners resolved a common complaint about mid-century modern materials. By listening to the building and by observing closely the particular challenges there, these homeowners demonstrated that recent past resources may certainly require new preservation strategies and assessments tied specifically to materials and their uses. The issue of materials remains key in recent past resources – in their durability and aesthetics – and in their comfort – as defined in the interplay between the materials and the systems that serve the building. The way that homeowners, preservation professionals, and contractors interact with these materials defines the success of the survival and successful re-use of these important relics from our past. Like generations of buildings before them, the recent past resources under scrutiny here share a common legacy of re-purposing and re-awakening that comes as human beings move from generation to generation. With the renewed interest in the recent past and in the availability of these resources, as their original owners release them to the next generation, their appealing qualities as easy-to-use, clean-lined dwellings bring timelessness to the landscape. Their conservation remains a significant strategy that we must address in the preservation world to ensure continuity from the mid-twentieth century into the present one. This study, in some part, provided information to help counter the perception that such resources represent a maintenance nightmare and that the structures could be understood as energy inefficiency. On balance, quite the opposite is true, as this study suggests.

Future Research

To supplement the findings of this work, three future research paths could be investigated. First, researchers could use this case study as an example of how to evaluate materials relevant to recent past resources and systems holistically, exploring appropriate strategies of rehabilitation on a case by case basis. Future researchers may also use this study as a catalyst to demonstrate further how recent past resources are adaptable to today's standards of energy efficiency. The researcher found it challenging to locate performance software specifically designed to evaluate the performance of recent past resources, future research could lead to development of such software to assist homeowners in making appropriate decisions regarding HVAC system upgrades.

The findings of this research could be especially useful in generating discussion and advocacy toward conserving recent past resources demonstrating that the concerns of conserving recent past resources present challenges no different than those of traditional residential resources and that maintenance of recent past residential resources are just manageable as any other resource.

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Appendix: A

NPS: Standards and Guidelines

Introduction and History:

The Standards are neither technical nor prescriptive, but are intended to promote responsible preservation practices that help protect our Nation's irreplaceable cultural resources. For example, they cannot, in and of themselves, be used to make essential decisions about which features of the historic building should be saved and which can be changed. But once a treatment is selected, the Standards provide philosophical consistency to the work.

The four treatment approaches are **Preservation, Rehabilitation, Restoration, and Reconstruction,** outlined below in hierarchical order and explained:

The first treatment, **Preservation**, places a high premium on the retention of all historic fabric through conservation, maintenance and repair. It reflects a building's continuum over time, through successive occupancies, and the respectful changes and alterations that are made.

Rehabilitation, the second treatment, emphasizes the retention and repair of historic materials, but more latitude is provided for replacement because it is assumed the property is more deteriorated prior to work. (Both Preservation and Rehabilitation standards focus attention on the preservation of those materials, feature, finishes, spaces, and spatial relationships that, together, give a property its historic character.)

Restoration, the third treatment, focuses on the retention of materials from the most significant time in a property's history, while permitting the removal of materials from other periods.

Reconstruction, the fourth treatment, establishes limited opportunities to re-create a non-surviving site, landscape, building, structure, or object in all new materials.

Choosing the most appropriate treatment for a building requires careful decision-making about a building's historical significance, as well taking into account a number of other considerations:

Relative importance in history: Is the building a nationally significant resource--a rare survivor or the work of a master architect or craftsman? Did an important event take place in it? National Historic Landmarks, designated for their "exceptional significance in American history," or many buildings individually listed in the National Register often warrant Preservation or Restoration. Buildings that contribute to the significance of a historic district but are not individually listed in the National Register more frequently undergo Rehabilitation for a compatible new use.

Physical condition: What is the existing condition--or degree of material integrity--of the building prior to work? Has the original form survived largely intact or has it been altered over time? Are the alterations an important part of the building's history? Preservation may be appropriate if distinctive materials, features, and spaces are essentially intact and convey the building's historical significance. If the building requires more extensive repair and replacement, or if alterations or additions are necessary for a new use, then Rehabilitation is probably the most appropriate treatment. These key questions play major roles in determining what treatment is selected.

Proposed use: An essential, practical question to ask is: Will the building be used as it was historically or will it be given a new use? Many historic buildings can be adapted for new uses without seriously damaging their historic character; special-use properties such as grain silos, forts, ice houses, or windmills may be extremely difficult to adapt to new uses without major intervention and a resulting loss of historic character and even integrity.

Mandated Code Requirements: Regardless of the treatment, code requirements will need to be taken into consideration. But if hastily or poorly designed, a series of code-required actions may jeopardize a building's materials as well as its historic character. Thus, if a building needs to be seismically upgraded, modifications to the historic appearance should be minimal. Abatement of lead paint and asbestos within historic buildings requires particular care if important historic finishes are not to be adversely affected. Finally, alterations and new construction needed to meet accessibility requirements under the Americans with Disabilities Act of 1990 should be designed to minimize material loss and visual change to a historic building.

Appendix: B
NPS: The Secretary of The Interior's Standards

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.

2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

3. Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.

4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.

10. New additions and adjacent or related new construction will be undertaken in a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Appendix: C
Sample Participant Questionnaire
UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

Loewenstein Historical Resource Questionnaire

General Interest and Aesthetics

1. *How long have you live in your home?*
2. *What design features attracted you to the house?*
3. *What attracted you to the site?*
4. *Is there anything that you would change or wish were not part of the initial design?*
5. *What lead or will lead you to make changes, alterations or additions?*
6. *Why?*

Repairs

7. *What types of repairs and the frequency have been made within the past 5, 10, 15, 20+ years?*
8. *What repairs should be made but have not and why?*

Replacements

9. *What types of replacement of major features and the frequency have been made within the past 5 - 10 years?*
10. *On a scale from 0 to 10 with, 0 being the lowest, 5 being average, and 10 being the highest; how difficult was it to make repairs?*

11. On a scale from 0 to 10 with, 0 being the lowest, 5 being average, and 10 being the highest; how difficult was it to find replacement parts/materials?

12. Please list these materials and parts.

Significance

13. Have you ever considered selling your home?

14. Why?

15. If yes will your new home have features similar to your current home? Which features?

16. Would you consider historical designation of your home?

Energy Efficiency and Site Orientation

17. Would you consider your home energy efficient?

18. Why?

19. What measures have you taken to make your home energy efficient?

20. If not would you be interested in exploring increasing energy efficiency without compromising the character defining features of your home?

21. Do you rely on air conditioning as a major source for cooling or airing out your home?

22. Why?

23. How often do you allow fresh air to circulate through your home? (opening windows)

24. Do you employ landscaping to shade heated areas of the site

25. Would you consider passive solar strategies?

26. If you had an unlimited budget, what changes or repairs would you make?

27. If you had a limited budget, what would the top five (5) changes or repairs would you make? (list in order of importance)

a. ______________________

b. ______________________

c. ____________________

d. ____________________

e. ____________________

Appendix: D
Energy Consumption Questionnaire

Energy Consumption Questionnaire

What you need to know to get started

- **Your energy use and costs for the last year:** You'll need your last 12 months of utility bills OR a 12-month summary statement from your utility company. (Duke Energy Offers this information free of cost on line at www.dukeenergy.com . You will need to have your account number to access your information.)

- **Energy sources for your home:**
    - natural gas,
    - electricity,
    - fuel oil,
    - propane and/or kerosene?

- **The square footage of your home. ______________**

Enter your monthly energy use and cost information using your utility bills.

Note: Fuel Oil, Propane, and Kerosene are often not billed monthly. Therefore, only fill in as many rows as you have bill statements.

Residential natural gas use is typically measured in CCF (hundred cubic feet) or therms. One therm is approximately equal to 1 CCF of natural gas. Sometimes it is measured in dekatherms (dkt). To convert dkt to CCF multiply by 9.7561.

Billing Period Use (KWH) Cost (USD)

Year 2009

January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

Recruitment Email:

Hi everyone

It was a pleasure to meet you at the Loewenstein Homeowners/ Friends meeting this past summer. As I mentioned , I have and interest in mid-century modern architecture and my research involves evaluating relevant building materials + systems to investigate wear-ability and functionality; both life cycle issues in a handful of Loewenstein houses.

My study of residential mid-century modern resources focuses on how they may be successfully rehabilitated according to The Secretary of the Interiors Standards and how the process may serve as a model for future rehabilitation strategies for similar resources. The researcher anticipates that analysis of documented case studies, interviews, and diagnostic data from a sampling of eight mid-century modern resources located in Greensboro, North Carolina will lead to strategies that support the idea that there is an acceptable process for rehabilitating these resources that will not jeopardize future nomination for historic recognition on the local, state and national level allowing the resources to represent the intent of the designer through aesthetics, durability, comfort and, efficiency.

If you would like to participate please contact me, Vanessa J. Morehead at 336.253.5956 or by email: mstyle3@netscape.net . I will promptly send you a consent form for your review; after you have completed the consent form I will be contacting you to schedule interviews at your convenience.

I would like to say thank you in advance,

Respectfully,

Vanessa J. Morehead

Appendix: E
Home Energy Saver Report House B

Home Energy Saver Pro™ AUDITOR & INSPECTOR TOOL

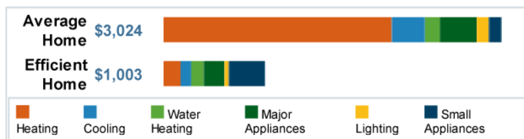
Alpha Prototype

This is a printed version of your Home Energy Saver Pro results, created at http://hespro.lbl.gov. Use the Session ID shown at the right to retrieve the session information for further analysis

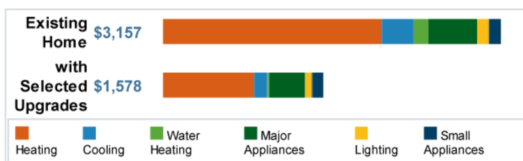
Identifier: 2010LVY
Session ID: 1534935
Zip Code: 27408
Location: Greensboro, NC

Energy Bill for Typical Homes in GREENSBORO, NORTH CAROLINA ($/year)

Based on default values for the zip code you entered, here is a comparison of the energy costs (in $/year) for an average home and an energy-efficient home in your area.



Energy Bill for Your Modeled Home ($/year)



Potential Annual Savings

Money:	$1,579
Energy:	4,439 kWh 1201 Therms
Emissions:	19,770 lb. CO2

	Totals	Heating	Cooling	Water Heating	Major Appliances	Lighting	Small Appliances
Existing Home	**$3,157**	$2,041	$304	$134	$458	$108	$112
with Selected Upgrades	**$1,578**	$895	$135	$15	$356	$65	$112
Savings	**$1,579**	**$1,146**	**$169**	**$119**	**$102**	**$43**	**$0**

Upgrade Recomendations

Upgrade	Bill savings compared to Existing	New	Estimated added cost	Max cost for 10 year payback	Simple payback time	Estimated ROI
Total for recommended upgrades	**$1,579**	**$1,517**	**$6,952**	**$15,170**	**5**	**21%**
Thermostat: ENERGY STAR-labeled programmable	$150	$150	$70	$1,500	0	213%
Electric clothes dryer: Switch to gas dryer	$83	$83	$50	$830	1	167%
Duct Sealing: Reduce leakage to 6% of total airflow	$401	$401	$300	$4,010	1	133%
Indoor lights: CFLs in high-use fixtures	$65	$65	$96	$650	1	61%
Air sealing: 25% air leakage reduction	$228	$228	$400	$2,280	2	57%
Dishwasher: EF=0.58 (ENERGY STAR)	$30	$16	$30	$160	2	53%
Wall insulation: R-11 wall + R-5 exterior foam sheathing	$304	$304	$1,049	$3,040	3	29%
Gas water heater: EF=0.62	$60	$37	$130	$370	4	28%
Clothes washer: MEF=1.42 WF=9.5 (ENERGY STAR)	$83	$52	$210	$520	4	23%
Duct Insulation: R-6	$92	$92	$460	$920	5	18%
Attic insulation: R-38	$250	$250	$1,527	$2,500	6	16%
Gas furnace: AFUE=90 (ENERGY STAR)	$272	$272	$1,871	$2,720	7	13%
Windows: 2-pane/solar-control low-E/argon gas/wood (ENERGY STAR)	$86	$86	$709	$860	8	12%
Refrigerator: 15% better than standard (ENERGY STAR)	$39	$5	$50	$50	10	9%

Appendix: F
Home Energy Saver Report House C

Home Energy Saver Pro™ AUDITOR & INSPECTOR TOOL

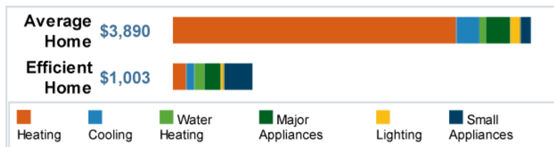
Alpha Prototype

This is a printed version of your Home Energy Saver Pro results, created at http://hespro.lbl.gov. Use the Session ID shown at the right to retrieve the session information for further analysis

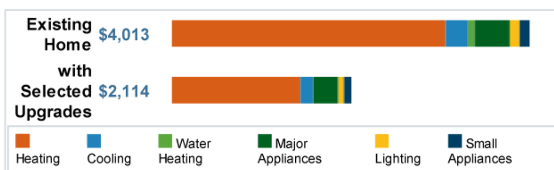
Identifier: 2010STN
Session ID: 1534889
Zip Code: 27408
Location: Greensboro, NC

Energy Bill for Typical Homes in GREENSBORO, NORTH CAROLINA ($/year)

Based on default values for the zip code you entered, here is a comparison of the energy costs (in $/year) for an average home and an energy-efficient home in your area.



Energy Bill for Your Modeled Home ($/year)



Potential Annual Savings

Money:	$1,899
Energy:	21,908 kWh 22 Therms
Emissions:	28,581 lb. CO2

	Totals	Heating	Cooling	Water Heating	Major Appliances	Lighting	Small Appliances
Existing Home	**$4,013**	$3,068	$255	$73	$397	$108	$112
with Selected Upgrades	**$2,114**	$1,512	$154	$-24	$295	$65	$112
Savings	**$1,899**	**$1,556**	**$101**	**$97**	**$102**	**$43**	**$0**

Upgrade Recomendations

Upgrade	Bill savings compared to Existing	Bill savings compared to New	Estimated added cost	Max cost for 10 year payback	Simple payback time	Estimated ROI
Total for recommended upgrades	**$1,899**	**$1,861**	**$6,467**	**$18,610**	**3**	**29%**
Duct Insulation: R-6	$1,665	$1,665	$460	$16,650	0	357%
Thermostat: ENERGY STAR-labeled programmable	$222	$222	$70	$2,220	0	312%
Duct Sealing: Reduce leakage to 6% of total airflow	$575	$575	$300	$5,750	1	192%
Electric clothes dryer: Switch to gas dryer	$83	$83	$50	$830	1	167%
Air sealing: 25% air leakage reduction	$372	$372	$400	$3,720	1	93%
Indoor lights: CFLs in high-use fixtures	$65	$65	$96	$650	1	61%
Dishwasher: EF=0.58 (ENERGY STAR)	$30	$16	$30	$160	2	53%
Gas water heater: EF=0.62	$38	$38	$130	$380	3	29%
Clothes washer: MEF=1.42 WF=9.5 (ENERGY STAR)	$84	$53	$210	$530	4	24%
Attic insulation: R-49	$416	$416	$1,891	$4,160	5	22%
Floor insulation: R-25	$446	$446	$2,194	$4,460	5	20%
Windows: 2-pane/solar-control low-E/argon gas/wood (ENERGY STAR)	$86	$86	$586	$860	7	14%
Refrigerator: 15% better than standard (ENERGY STAR)	$39	$5	$50	$50	10	9%

Appendix: G
Home Energy Saver Report House D

Home Energy Saver Pro™ AUDITOR & INSPECTOR TOOL

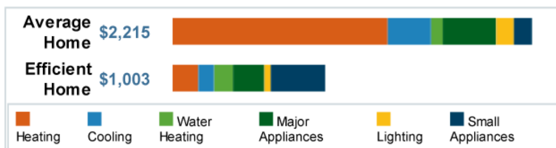
Alpha Prototype

This is a printed version of your Home Energy Saver Pro results, created at http://hespro.lbl.gov. Use the Session ID shown at the right to retrieve the session information for further analysis

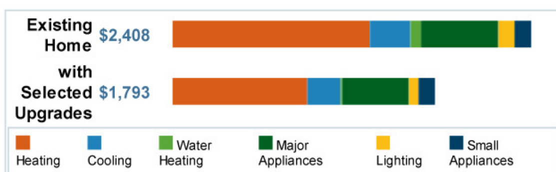
Identifier: 2010DVS
Session ID: 1534818
Zip Code: 27313
Location: Pleasant Garden, NC

Energy Bill for Typical Homes in PLEASANT GARDEN, NORTH CAROLINA ($/year)

Based on default values for the zip code you entered, here is a comparison of the energy costs (in $/year) for an average home and an energy-efficient home in your area.



Energy Bill for Your Modeled Home ($/year)



Potential Annual Savings

Money:	$615
Energy:	2,769 kWh 397 Therms
Emissions:	8,218 lb. CO2

	Totals	Heating	Cooling	Water Heating	Major Appliances	Lighting	Small Appliances
Existing Home	**$2,408**	$1,324	$274	$71	$519	$108	$112
with Selected Upgrades	**$1,793**	$922	$227	$11	$456	$65	$112
Savings	**$615**	**$402**	**$47**	**$60**	**$63**	**$43**	**$0**

Important Note: These are initial estimates only, and your results may vary. If you have not already done so, we strongly encourage you to retain a professional energy auditor to develop a detailed work scope and budget for improving your home. We also recommend the Home Performance with ENERGY STAR program when considering home improvement.

Upgrade Recomendations

Upgrade	Bill savings compared to Existing	Bill savings compared to New	Estimated added cost	Max cost for 10 year payback	Simple payback time	Estimated ROI
Total for recommended upgrades	**$615**	**$611**	**$1,286**	**$3,055**	**2**	**47%**
Electric clothes dryer: Switch to gas dryer	$83	$83	$50	$415	1	167%
Thermostat: ENERGY STAR-labeled programmable	$103	$103	$70	$515	1	147%
Duct Sealing: Reduce leakage to 6% of total airflow	$271	$271	$300	$1,355	1	90%
Indoor lights: CFLs in high-use fixtures	$65	$65	$96	$325	1	61%
Dishwasher: EF=0.58 (ENERGY STAR)	$38	$20	$30	$100	2	67%
Air sealing: 25% air leakage reduction	$161	$161	$400	$805	2	40%
Gas water heater: EF=0.62	$38	$38	$130	$190	3	29%
Clothes washer: MEF=1.42 WF=9.5 (ENERGY STAR)	$108	$62	$210	$310	3	28%

Appendix: H
Home Energy Saver Report House E

Home Energy Saver Pro™ AUDITOR & INSPECTOR TOOL

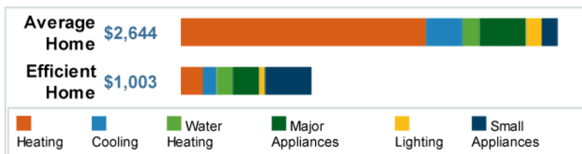
Alpha Prototype

This is a printed version of your Home Energy Saver Pro results, created at http://hespro.lbl.gov. Use the Session ID shown at the right to retrieve the session information for further analysis

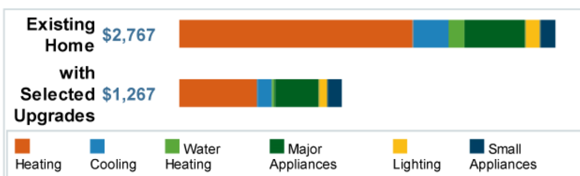
Identifier: 2010BLK
Session ID: 1534910
Zip Code: 27408
Location: Greensboro, NC

Energy Bill for Typical Homes in GREENSBORO, NORTH CAROLINA ($/year)

Based on default values for the zip code you entered, here is a comparison of the energy costs (in $/year) for an average home and an energy-efficient home in your area.



Energy Bill for Your Modeled Home ($/year)



Potential Annual Savings

Money:	$1,500
Energy:	4,204 kWh 1163 Therms
Emissions:	19,022 lb. CO2

	Totals	Heating	Cooling	Water Heating	Major Appliances	Lighting	Small Appliances
Existing Home	**$2,767**	$1,719	$262	$118	$448	$108	$112
with Selected Upgrades	**$1,267**	$607	$115	$22	$346	$65	$112
Savings	**$1,500**	**$1,112**	**$147**	**$96**	**$102**	**$43**	**$0**

Upgrade Recomendations

Upgrade	Bill savings compared to Existing	New	Estimated added cost	Max cost for 10 year payback	Simple payback time	Estimated ROI
Total for recommended upgrades	**$1,500**	**$1,461**	**$6,699**	**$14,610**	**5**	**21%**
Thermostat: ENERGY STAR-labeled programmable	$125	$125	$70	$1,250	1	179%
Electric clothes dryer: Switch to gas dryer	$83	$83	$50	$830	1	167%
Duct Sealing: Reduce leakage to 6% of total airflow	$338	$338	$300	$3,380	1	112%
Indoor lights: CFLs in high-use fixtures	$65	$65	$96	$650	1	61%
Air sealing: 25% air leakage reduction	$214	$214	$400	$2,140	2	53%
Dishwasher: EF=0.58 (ENERGY STAR)	$28	$15	$30	$150	2	50%
Wall insulation: R-11 wall + R-5 exterior foam sheathing	$317	$317	$1,134	$3,170	4	28%
Gas water heater: EF=0.62	$37	$37	$130	$370	4	28%
Clothes washer: MEF=1.42 WF=9.5 (ENERGY STAR)	$79	$51	$210	$510	4	23%
Windows: 2-pane/solar-control low-E/argon gas/wood (ENERGY STAR)	$85	$85	$432	$850	5	20%
Attic insulation: R-38	$235	$235	$1,527	$2,350	6	15%
Duct Insulation: R-6	$78	$78	$460	$780	6	15%
Gas furnace: AFUE=90 (ENERGY STAR)	$129	$244	$1,810	$2,440	7	12%
Refrigerator: 15% better than standard (ENERGY STAR)	$39	$5	$50	$50	10	9%

Appendix: I
Home Energy Saver Report House F

Home Energy Saver Pro™ AUDITOR & INSPECTOR TOOL

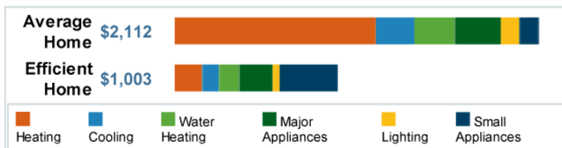
Alpha Prototype

This is a printed version of your Home Energy Saver Pro results, created at http://hespro.lbl.gov. Use the Session ID shown at the right to retrieve the session information for further analysis

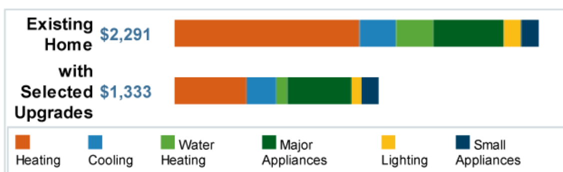
Identifier: 2010 JNS
Session ID: 1534851
Zip Code: 27408
Location: Greensboro, NC

Energy Bill for Typical Homes in GREENSBORO, NORTH CAROLINA ($/year)

Based on default values for the zip code you entered, here is a comparison of the energy costs (in $/year) for an average home and an energy-efficient home in your area.



Energy Bill for Your Modeled Home ($/year)



Potential Annual Savings

Money:	$958
Energy:	11,368 kWh
Emissions:	14,697 lb. CO2

	Totals	Heating	Cooling	Water Heating	Major Appliances	Lighting	Small Appliances
Existing Home	**$2,291**	$1,164	$229	$235	$443	$108	$112
with Selected Upgrades	**$1,333**	$471	$194	$72	$419	$65	$112
Savings	**$958**	**$693**	**$35**	**$163**	**$24**	**$43**	**$0**

Upgrade Recomendations

Upgrade	Bill savings compared to Existing	Bill savings compared to New	Estimated added cost	Max cost for 10 year payback	Simple payback time	Estimated ROI
Total for recommended upgrades	**$958**	**$955**	**$1,486**	**$4,775**	**2**	**64%**
Thermostat: ENERGY STAR-labeled programmable	$71	$71	$70	$355	1	101%
Duct Sealing: Reduce leakage to 6% of total airflow	$237	$237	$300	$1,185	1	79%
Indoor lights: CFLs in high-use fixtures	$65	$65	$96	$325	1	61%
Dishwasher: EF=0.58 (ENERGY STAR)	$37	$20	$30	$100	2	67%
Electric water heater: EF=0.95	$44	$44	$70	$220	2	63%
Air sealing: 25% air leakage reduction	$202	$202	$400	$1,010	2	51%
Heat pump: SEER=14 HSPF=8.2 (ENERGY STAR)	$-40	$95	$310	$475	3	29%
Clothes washer: MEF=1.42 WF=9.5 (ENERGY STAR)	$103	$60	$210	$300	4	27%