COMMUNITY SUPPORTED SUSTAINABILITY:

HOW ECOVILLAGES MODEL MORE SUSTAINABLE COMMUNITY

By

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ABSTRACT OF THE DISSERTATION

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Ecovillages are small, intentional communities which focus on reducing environmental impact while creating a community that incorporates the natural world. Despite varying approaches, each ecovillage attempts to create a community that integrates the social, economic, and environmental dimensions of sustainability. This study investigates several of these communities to better understand two key questions: 1) to what extent do ecovillage residents have a lower environmental impact than residents of nearby communities and the national average? and 2) how is the reduction in environmental impact achieved? These questions are addressed through the use of life cycle assessment and qualitative case studies of three sites, specifically one suburban and two rural ecovillages. Comparisons with nearby communities and the national average are made, and the results show that the case study ecovillages have a much lower per capita environmental impact. My research suggests that this is achieved through a combination of physical (village building and planning) and behavioral adaptations supported by community ideals and norms.

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Chapter 1: Introduction

According to the Union of Concerned Scientists (1992, p. 1), "human beings and the natural world are on a collision course." Specifically, they warn that our patterns of population growth, resource consumption, and waste disposal threaten the integrity of the biological systems which support our existence. Their *Warning to Humanity* was signed by 1,700 of the world's leading scientists, including the majority of the Nobel laureates in the sciences, but it is by no means the only such warning. *Our Common Future*, widely considered to be the establishing document for sustainable development, cites growth in population and resource consumption, as well as poverty and inequality, as the major threats to the future of humanity (Brundtland, 1987). Renowned biologist E.O. Wilson (2002, p. 88) goes further, describing a world where current trends in consumption and population growth continue as a "hellish place to exist."

While many such warnings exist, they are by no means uncontested. It is necessary to move beyond warnings to an understanding of the scope of humanity's impact on the biological systems that sustain us. Vitousek, et al. (1986) calculated the net primary production (NPP) of the Earth (the total biological energy available) and the human use of NPP, taking into account both food consumption and land transformation. At the time of publication, humanity appropriated 40% of potential terrestrial NPP and 25% of aquatic NPP. Thus in 1986, humans were consuming 40% of all biological energy available on land and one quarter of all biological energy available in the in the waters. The world population has since grown from 4.9 billion in 1986 to 7 billion in 2013, an increase of 43% (US Census Bureau, 2013). In addition to the issue of NPP, humanity is also responsible for the transformation of at least one-third of the Earth's land area, as much nitrogen fixing as all natural terrestrial processes combined, and the extinction of numerous species (Vitousek, 1997).

While it is clear that human activity has a powerful impact on the biosphere, there is still the question of whether our current consumption patterns can be sustained. Ecological Footprinting is a technique for measuring environmental impact, with the result establishing the amount of land area in global hectares (gha) that a population requires to provide their resources and absorb their wastes, with respect to the Earth's biological capacity (Rees and Wackernagel, 1994). According to the most recent calculations of the Global Footprint Network (2010), humanity is using the biological capacity equal to 2.7 hectares per person, but the Earth only has 1.8 hectares per person available. Thus as a species we are using resources equivalent to 1.5 planets Earth. This result not only shows the unsustainability of our current consumption practices (possible only because we are making extensive use of fossil fuels, which represent the collected solar energy of millions of years), but also conceals large disparities in consumption. Citizens of the United States have an average footprint of 8.0 hectares (almost three times the world average), while citizens of many developing nations, have average footprints closer to 1.0 hectare.

This disparity in consumption patterns exposes the flaw in one of the main strategies for achieving a stable population and ultimately a sustainable society. It has been proposed that if the entire world was wealthy (i.e., had consumption patterns on par with the US or Europe) that population would stabilize, as it has in wealthy countries, resulting in a more sustainable society. However, if the entire world were to consume at the European level of 4.7 hectares per capita (significantly less than the US Average of 8.0), it would require the biological capacity of more than 2.5 planets Earth. This ecological accounting strongly suggests that to achieve a sustainable level of consumption, not only must population growth be curtailed, but those in the most developed nations, particularly the United States, must reduce their per capita consumption.

However, some economists have criticized models which suggest there are physical or biological limits to the growth of the economy and consumption. Their arguments often rely on the ingenuity of humanity, the substitutability of resources, and the failure of past predictions to manifest (e.g. Malthus, Club of Rome, etc.) (Nordhaus, 1992; Simon, 1998). While the repeated successes in increasing food yields to meet the needs of a growing population and consistently low energy prices have seemed to support these arguments, challenges to this viewpoint have emerged. Economists typically focus on resource substitutability, while those more involved in ecology warn us that “a profound humility needs to be instilled about the limits of human capacity to control, restore, and substitute for ecosystem goods and services;” often all that can be done is to try to create opportunities for nature to repair itself (Lebel, 2005, p. 12). Our numerous, ongoing attempts to clean up toxic sites and restore ecosystems demonstrate the truth of this statement.

There is also opposition to this argument against limits from an economic perspective. In an article entitled *Are We Consuming Too Much?,* a number of prominent economists point out that resource prices often do not reflect their scarcity because a large part of the world’s ecological resources are not owned, so their degradation and destruction is not reflected in prices (Arrow, 2002). This same article concludes that “the available evidence, though incomplete, is sufficient to generate significant concerns about the ability of societies to maintain current consumption under existing policies” (Arrow, 2002, p. 18).

In addition to addressing the question of the sustainability of our current consumption patterns, Arrow, et al. (2002) also point out the inequality of the results of global climate change and ecological decline: for example, tens of millions of Bangladeshi citizens will have their homes and land flooded by rising sea levels, and yet they do not have the economic clout to exert pressure on markets to increase the cost of climate altering activity. Meanwhile, those responsible for the majority of the emissions, citizens of industrialized nations, will be far less affected by the results of climate change.

To summarize, humanity is appropriating almost half of the world's photosynthetic output and is consuming resources and producing waste at a rate that is beyond the capacity of our world to sustain (in fact, as of 2010 it would take 1.5 Earths to sustain consumption rates). The world population continues to grow, and resource consumption is as much as eight times higher in the developed nations than in the undeveloped. This disparity in wealth and consumption means that those responsible for the ecological damage will continue to experience less of the effect of their actions than will the world's poorer and more vulnerable citizens. It is clear that a sustainable and equitable solution to these problems cannot be achieved through the worldwide replication of the lifestyles of the industrialized nations. A new lifestyle which achieves high quality of life with significantly less consumption and waste is needed.

E.O. Wilson (2002) frames this issue as the question of the century, "How best can we shift to a culture of permanence, both for ourselves and for the biosphere that sustains us?" A culture of permanence would require lifestyles that can be continued indefinitely, lifestyles that make use of the products of nature but which leave the underlying biosphere intact and able to sustain both us and itself. This effort takes two different forms - one in the developed world and one in the less developed worlds. Sustainable consumption is the effort by the affluent to reduce their environmental impact while maintaining a high quality of life. Sustainable livelihood is the effort to improve the quality of life of the world's poorer residents without significantly increasing their environmental impact (Hertwich, 2005a). These complementary efforts, along with a stable population, are necessary if we are ever to achieve the culture of permanence, a society that is sustainable over the long term.

If we accept the necessity of creating a culture of permanence, a sustainable society, the question becomes, “How do we make this transition?” There are numerous efforts underway to reduce the environmental impact of our activities, to make what we do more efficient and less damaging. The growth of green building has led to the creation of more efficient buildings, both in terms of construction materials and lifetime energy use. There is a large and growing market of “green” products which advertise their energy efficiency, lack of toxic chemicals, and reduced environmental impact. Taxes and high energy prices have incentivized the purchase of more efficient vehicles and appliances.

However, these marketplace shifts often have less of an impact than would be expected. One of the main reasons for this reduced impact is the rebound effect, which takes place when an action which reduces environmental impact creates a secondary effect that decreases or even negates that reduction of environmental impact (Hertwich, 2005b). One example of the rebound effect could occur when a homeowner installs better insulation reducing the cost of heating their home, but then due to the reduced cost, the homeowner then decides to keep the home at a warmer temperature, negating the energy savings. At a larger scale, this effect can be seen in the fact that while the United States has experienced a growth in home energy efficiency and the use of efficient vehicles, the environmental benefits of these activities have been outweighed by rising vehicle ownership rates, increases in miles driven, larger homes, and the purchase of more appliances (Taylor, 2000).

While there are numerous public and private sector efforts to make our society function in a more sustainable way, it is also clear that these efforts have not been enough to achieve the radical reductions in consumption, environmental damage, and inequality that are necessary to achieve a sustainable society. Ecovillages are small, intentional communities where the residents have chosen to focus on reducing their environmental impact, and preliminary research suggests that ecovillages may be achieving these necessary and radical reductions in environmental impact (Kasper, 2008; Tinsley, 2006; Moos, 2006). Specifically, a study of Findhorn, an ecovillage in Scotland, found that the average ecological footprint per resident was 50% lower for ecovillage residents compared to the average resident of Scotland (Tinsley, 2006).

With these achievements, Findhorn represents a practical application of the degrowth concept. Sustainable degrowth is defined as an "equitable downscaling of production and consumption that increases human wellbeing and enhances ecological conditions at the local and global level, in the short and long term" (Schneider, 2010). Findhorn, and perhaps other ecovillages, show a significant reduction in consumption (and related production) while being a community that fosters both human and ecological well-being. While Findhorn is only operating at a local scale, the worldwide growth of the ecovillage movement shows its applicability at a global scale. Ecovillages offer a community level approach to the application of the degrowth concept.

As we face our current situation of the new and substantial problems of environmental damage caused by our current growth and consumption patterns, looking to these intentional communities may again provide insight and useful strategies for addressing both the ideological and technical issues associated with achieving sustainability.

Intentional communities are voluntary, value-based social orders, and they have a long history of addressing societal problems. When the pressure on the social, religious, and/or economic fabric of society increases, the tendency to address these pressures through the development of intentional communities increases (Kanter, 1972). Regardless of whether the cause is religious, political, or social, the founders of intentional communities believe that the change they desire can best be achieved through the creation of a model community which will form a template for communities that will follow. The development of a new community is a protest that is non-violent, yet complete in scope, and it can have great appeal in the face of the failure of dissent and gradualist reform movements (Hayden, 1976).

An example of this process can be seen in the emergence of many utopian communities during the industrial revolution. The sudden change in the systems of production led to a series of new issues facing society. Poor living conditions for workers, insufficient sanitation systems, extensive poverty, increases in the density and size of communities, and close crowding of industry and residential areas all posed major challenges to communities which were growing and changing rapidly under the influence of the industrial revolution. In response to these problems, numerous utopian communities were founded to create communities that could flourish under the new conditions that were challenging the viability of established communities and norms. During the period from 1780 to 1860, approximately one hundred known utopian communities were founded with the peak of activity occurring between 1840 and 1860 (Kanter, 1972). These communities were devoted to finding ways of living that worked better under the new conditions than did traditional practices by testing new physical layouts and social policies. Although no single community became the model of a new society, the multitude functioned as technical and ideological experiments that allowed the development of many of the solutions that we use today (Benevolo, 1971).

In the present, many see the gradual reform of the current environmental movement as insufficient, and they seek a new way of living that can achieve demonstrable results. The authors of *The Ecology of Place* capture the vision that drives the formation of these communities, the desire for a way of living where

> "…the land is consumed sparingly, landscapes are cherished, and cities and towns are compact, vibrant and green… These are communities in which the economic base is

> viable as well as environmentally and socially restorative. This vision of place emphasizes both the ecological and the social, where quantity of consumption is replaced with the quality of relationships" (Beatley & Manning, 1997, p. 1.).

The impetus to develop these communities can be seen in the fact that the Global Ecovillage Network has 638 ecovillages registered worldwide, 76 of which were registered in the past two years (GEN, 2011; GEN 2013). Ecovillages exist in many countries around the world, in various sizes and types of settings, including rural, suburban and urban. The Los Angeles Ecovillage occupies two blocks in the East Hollywood neighborhood of Los Angeles, consisting of approximately 40 members, and it represents one end of the ecovillage spectrum, both in terms of size and its urban, developed world location. Aurorville, located in the Indian state of Tamil Nadu and home to more than 2,000 members seeking to improve the local ecosystem health and develop new ways of life, represents another end of the spectrum, being large, rural, and located in the developing world (Liftin, 2014).

While the appeal of these communities is evidenced by their growing numbers, their actual achievements in terms of environmental impact reductions and their methods for achieving these reductions are less clear. The goal of this research is to clarify these points through the examination of several ecovillages. In regard to the case study ecovillages, this research will attempt to answer two key questions:

- To what extent do ecovillage residents have a lower environmental impact than residents of nearby communities and the national average?
- How have ecovillage residents achieved these reductions in environmental impact?

These questions are addressed through a combination of Life Cycle Assessment (LCA) and qualitative case studies. LCA addresses the quantitative question of environmental impact reduction through the collection and analysis of data on energy and material use and waste production. The question of how these reductions occur is addressed through the qualitative case studies, developed through extensive stays at each ecovillage, interviews with community members, participation in community activities, and a review of published and unpublished documents produced by the ecovillages and individual community members. These case studies attempt to provide an understanding of life in the ecovillages, and how its culture and practices lead to a healthier relationship with the land and local ecosystems.

The answers to these questions will help us to understand how ecovillages can contribute to the development of a more sustainable society. Specifically, the results will provide a better understanding of the level of environmental impact reduction that can be achieved by communities within the United States and how ecovillage life contributes to these reductions.

Given the global, interconnected, and often highly technical nature of the environmental problems that we face as a society, it could be argued that the community level is not an appropriate scale at which to address these problems. Certainly it seems that the issues of world trade regulations, industrial pollution control, carbon taxes, etc., cannot be significantly addressed by small communities, which often comprise less than 500 people. *The Charter of the New Urbanism* addresses a similar critique, saying, "We recognize that physical solutions [regarding community design] by themselves will not solve social and economic problems, but neither can economic vitality, community stability, and environmental health be sustained without a coherent and supportive physical framework" (Leccese & McCormick Eds., 2000, p. *v*). The value of ecovillages is not only the environmental impact reductions achieved within the community, but also an understanding of how the culture and ethos of the ecovillages leads to those reductions and how those insights can be applied on a wider scale.

Ecovillages exist because they address the desire for places that emphasize "both the ecological and the social, where quantity of consumption is replaced with the quality of relationships." These communities require and support strong relationships among their members, and the ecovillage community includes not only the human members, but also the natural world. Ecovillages embody the land ethic espoused by Aldo Leopold (1949, p204), which "enlarges the boundaries of community to include soils, waters, plants, and animals, or collectively: the land." An ecovillage's success is tied directly to the commitment of its members, as is true for all intentional communities (Kanter, 1972). And it is this commitment to all its members, including the land, which leads to the reductions in environmental impact achieved in ecovillages. The culture and practices that emerge in the ecovillages are born of this commitment, and are reflections of the ethos of the community.

Kasper (2008) links the way of thinking and living developing in ecovillages to the development of a sustainable society.

> "The ecovillage model suggests that the possibility of a sustainable society depends not only on what we do, but on how we think, and the understanding that these mutually influence one another. Concepts without practical applications are impotent, and actions not grounded in systems of belief are vulnerable to competing influences" (Kasper, 2008, p. 23).

In discussing the development of a sustainable society, one ecovillage member relates her conclusion "that information is not the place to start ... the problems stem from a deeper source — how they [people] experience themselves in the world" (Kasper, 2008, p. 20). In creating a society that includes nature as a member of the community, ecovillages create an inherent respect for and involvement with nature that may be a key aspect to the development of a sustainable society.

Based on their integration of nature into their communities, each ecovillage develops its own culture, and from that culture emerge strategies for reducing their negative impacts and creating a more positive relationship with the environment. These strategies take the form of physical planning, ecological building practices, cultural norms of sharing and gathering, decision-making structures, and others. Each ecovillage develops its own understanding of its purpose and relationship to the natural world, with the particular practices emerging from this understanding.

In his discussion of the failures of the one-size-fits-all model of development, Graham comments on the need to replace the monoculture of knowledge with ecologies of knowledges and experience (Graham, 2005). The western model of development, which has been dominant in the modern era, is directly related to our current social and environmental problems, as discussed above. The thousands of ecovillages around the world are engaged in creating ecologies of knowledges which draw on the social and ecological relationships that emerge in each particular community. Each community develops its own understanding of how people and the natural world can live together in a more sustainable way. Each community is an experiment, providing solutions and insights, and each community is a potential source of inspiration for others in the drive to develop a more sustainable society.

Chapter 2. Literature Review

1. Sustainable Development

Although sustainable development has become a mainstay of modern environmental policy, its exact nature and how to put it into practice are still in question. Literature on sustainability can be drawn from many sources and fields. The topic has been approached as an ethical, political, ecological, economic, and technical issue (Alrøe, 2001; El Serafy, 1993; Wilson, 1992; Berry, 1993). This confusion yields a situation where sustainable development is seen by many as a laudable goal, but an understanding of how to achieve sustainable development or identify a sustainable society remains elusive. In the following section, I will outline several approaches that have been taken toward defining sustainability.

The most commonly cited definition of sustainable development comes from *Our Common Future,* the final report of the Brundtland Commission. The Brundtland Commission was a committee created in 1983 by the U.N. General Assembly to review testimony and data from governmental, scientific, business, and other sources to develop an understanding of the long-term effects of the damage being done to the environment. In *Our Common Future* (1987, p. 41), sustainable development is defined as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition contains the key themes which are present in all concepts of sustainability: the need to recognize and provide for future generations, the need to act in the present toward that end, and the need to provide equitably for the current generation.

This definition of sustainable development provides an ideal that many find it easy to agree with, but it does not provide a clear method for testing whether an action is sustainable. For example, it is difficult to know if our current use of fossil fuels will prevent future generations from meeting their needs, or if they will have sufficient access to alternate sources of energy. Future generations may have fuel sources that are currently unavailable to us, just as nuclear power was unavailable to our ancestors. However, our current extensive use of fossil fuels and their associated effects on the environment may deprive future generations of the resources they will need to sustain themselves. These quandaries highlight the difficulty of creating a functional definition of sustainable development as well as the question of how to determine what future generations will need to sustain themselves.

Two main visions developed during the process of creating a more functional concept of sustainability: these are referred to as strong and weak sustainability. Strong sustainability assumes that nature is vulnerable to the actions of society and that society is dependent on nature for basic life support services (Alrøe, 2001). Some of these basic life support services include the conversion of carbon dioxide to oxygen, the infiltration of groundwater and flood control, and the stabilization of weather patterns and climate. These services are extremely valuable and the human ability to control, restore, and substitute for ecological goods is extremely limited (Lebel, 2005).

Weak sustainability takes a more economic perspective, assuming that capital and natural resources are substitutable. It treats any form of savings, be it financial capital or rainforest land, as a resource which can be converted into what is needed. Weak sustainability uses the economic concepts of capital, depreciation, savings, income, etc. to measure progress (El Serafy, 1993).

These two definitions have very different implications regarding the actions that should be taken to ensure sustainable development. Strong sustainability requires a strong ethic of conservation of natural resources and ecosystems; according to strong sustainability, these ecosystems must continue to function if we are to sustain human life. Weak sustainability requires only that we ensure enough capital is available to sustain future generations, and that capital can take any number of forms. Under this system, the careful managing of resources is important, but the health of ecosystems and the particular mixture of resources available is less important (Beckerman, 1994).

Neither of these concepts of sustainability, however, has been directly adopted by the practitioners in the field. Businesses, governments, and non-governmental organizations (NGOs) have instead settled on an understanding of sustainable development that is based on a tripartite structure consisting of the environment, the economy, and human society. This conceptual structure is illustrated by the International Institute for Sustainable Development's (IISD) explanation of sustainable development. The IISD states that that "for development to be sustainable it must integrate environmental stewardship, economic development and the well-being of all people-not just for today but for countless generations to come"(IISD, 2006). The environmental perspective of strong sustainability can be seen in the environmental dimension of this definition, while the economic focus of weak sustainability can be seen in the inclusion of economic development. This definition also includes the more communitarian ideals of environmental justice and societal equity as its third dimension (Portney, 2003). However, although this definition includes elements of strong and weak sustainability, it does not resolve any of the conflicts between the strong and weak perspectives. This new definition also fails to be more operationally effective than the original definition provided by the Brundtland Commission.

In addition to these institutional and academic approaches to sustainable development, there have also been efforts to understand sustainable development from an ethical perspective. Alrøe and Kristensen (2001, p. 8) describe the ethical requirements of sustainability.

> "In the traditional ethics, the right way of acting was determined from the immediate consequences, and far and future effects were left to the workings of chance, fate or providence. The practical knowledge necessary for living a good life was not dependent on any special, expert knowledge. No-one was held responsible for the unintended long-term effects of his well-intentioned, well-considered and well-performed act… The expansion of the range and impact of our collective actions and our increased awareness of possible far and future consequences moves the principle of responsibility into the very centre of ethics."

This passage illustrates the ethical implications of sustainable development. Alrøe and Kristensen claim that sustainable development requires an understanding that extends far beyond the immediate consequences of our actions. Through the actions made possible by technology and the choices of societies, we collectively influence the state of the entire Earth. We can see examples of this in some of the challenges we currently face (e.g., global climate change, declining international fisheries, and mass extinctions). To behave ethically and sustainably within this expanded world, Alrøe and Kristensen suggest that we must expand our sense of responsibility to include the widespread and long-term consequences of our actions.

When all of these concepts of sustainable development are examined, we are left more with a goal of sustainable development than a clear definition. Practitioners of sustainable development seek to create development that will "integrate environmental stewardship, economic development and the well-being of all people-not just for today but for countless generations to come," development that "meets the needs of the present without compromising the ability of future generations to meet their own needs," and development that includes a "systemic ethic of responsible acting" (Alrøe, 2001; Brundtland, 1987; IISD, 2006). And despite the lack of a clear method for measuring our progress toward this ideal, efforts are being made by a myriad of actors (e.g., governments, businesses, NGOs, and communities) to realize these ideals. 'Sustainable' practices are integrated into businesses, communities, and policies, creating experiments in sustainability throughout the world. Many of these experiments involve attempts to build sustainable communities, physical and social places that embody the ideals of sustainability.

2. Sustainable Communities

According to Kline (1997 p. 1), “a sustainable community is one which strives, over time, to become more environmentally sound, economically viable, socially just, and democratic.” Included in this definition is the tripartite understanding of sustainability discussed above (socially just and democratic both falling under the social dimension), as well as the idea of sustainability as a goal to progress toward rather than a state that can be readily identified and achieved. Similar theoretical frameworks for identifying sustainable communities appear elsewhere, including Dale and Newman’s (2010a, p. 6) three imperatives of sustainable communities: “(i) the ecological imperative to live within global biophysical carrying capacity and maintain biodiversity, (ii) the social imperative to ensure the development of democratic systems of governance that can effectively propagate and sustain the values that people wish to live by, and (iii) the economic imperative to ensure that basic needs are met.”

The shift from the general concept of sustainable development to the more concrete sustainable community alleviates some of the vagueness and abstraction that plagues the concept of sustainability. As Bridger and Luloff (1999, p. 380) observe,

> “by shifting the focus on sustainability to the local level changes are seen and felt in a much more immediate manner… The locality… is the level of social organization where the consequences of environmental degradation are most keenly felt and where successful intervention is most noticeable.”

By establishing sustainable development at a local level it becomes something that people can interact with and understand, and thus the community level may be the most effective scale for demonstrating that sustainability can be achieved (Yanarella, 1992).

While developing sustainable communities creates a tangible form for sustainable development, the challenges inherent in creating such communities are significant. Sustainable communities are a nested matrix of decisions and interactions in the social, ecological and economic spheres (Dale, 2010b). In addition, Kline's definition of sustainable communities, describes them as communities "striving" to achieve their ideals because there are no known communities that have fully realized these goals. However, communities striving toward sustainability are part of a long tradition of communities that are attempting to make a utopian goal a reality.

3. Utopian and Intentional Communities

Kanter (1972, p. 1) defines utopia as "the imaginary society in which humankind's deepest yearnings, noblest dreams, and highest aspirations come to fulfillment, where all physical, social, and spiritual forces work together, in harmony, to permit the attainment of everything people find necessary and desirable." Utopian communities are created in pursuit of this vision, or at least in response to mainstream society's failure to accomplish it. Three types of critiques of society have traditionally provided the basis for the development of utopian communities: religious, economic, and psychological (Kanter, 1972). More recent utopian communities have arisen in critique of society's relationship to the environment and lack of community (Kasper, 2008; Bang, 2005; Meijering, 2007).

Utopian communities have a long history. The period between 1780 and 1860 saw the founding of almost one hundred known utopian communities in the United States, and while some of these communities lasted less than a year, others, such as the Shakers, are still active today (Kanter, 1972). During the 1960s and 1970s utopian communities experienced a resurgence, and currently there are more than 1500 intentional communities listed in the United States (FIC, 2012a).

Not all intentional communities are explicitly utopian. The Fellowship for Intentional Community (FIC, 2012b) defines intentional community as "a group of people who have chosen to live together with a common purpose, working cooperatively to create a lifestyle that reflects their shared core values" (FIC, 2012a). Some intentional communities were formed to improve the lives of those with disabilities (such as Camphill), while others were formed primarily to create more social interaction among members. However, even those that are not overtly utopian represent a critique of some aspect of mainstream society and seek to correct the perceived flaw.

Kanter (1972) identified several characteristics of intentional communities. These communities seek self-determination, often making their own laws and refusing to obey some of those set by the larger society. They are identifiable as an entity, having both physical and social boundaries and a way of distinguishing between members and non-members. They have intentionality, having been planned in order to bring about the attainment of certain ideals, and operating decisions are made in terms of those values. Despite these common characteristics, intentional communities also exhibit a wide diversity of forms and ideologies.

The FIC lists many types of intentional communities on its website, including ecovillages, cohousing communities, residential land trusts, communes, student co-ops, urban housing cooperatives, intentional living, alternative communities, and cooperative living (FIC, 2013). However, this list is neither exhaustive, nor are the categories mutually exclusive. Meijering, et al. (2007) developed a more rigorous typology through a study of more than 1,000 intentional communities. This typology identifies four primary categories of intentional community based on the dimensions of location, ideology, and economic and social systems. These four categories are religious, ecological, communal, and practical, each of which is described below.

Religious Communities:

- are characterized and unified by strong ideological values, based on religious or spiritual beliefs.
- focus on these norms and values and as a result tend to withdraw from mainstream society.
- have contact with the outside primarily to attempt to help the poor, disabled, or elderly.
- create a sense of community and a sense of home through communal rituals, such as celebrations, religious services, and spiritual gatherings, as well as common meals and work.
- create networks through contact with other, like-minded communities.
- are not specifically concentrated in rural or urban settings.

Ecological Communities:

- usually withdraw to remote locations, where they attempt to live up to their ecological ideals by developing sustainable lifestyles.
- actively reduce the necessity of economic relations with society by reducing the use of consumer goods, limiting work in paid jobs outside the community, producing food and energy onsite.
- participate in social life with outsiders, both in and outside the community by sustaining social contacts with family and friends, and giving courses to outsiders.
- sometimes recreate rural traditions, such as the celebration of the summer and winter solstices.
- are generally found in rural and remote locations.

Communal Communities:

- have a primary ideological focus on interpersonal contacts between members.
- often provide facilities, such as a common garden, a dining room and kitchen, a common house, pub, playground, sports facilities, and offices.
- have strong social ties not only within the community, but also remain relatively outward oriented with respect to their social lives as well, often through close contacts with friends and family outside the community.
- are generally found in rural areas and villages.

Practical Communities:

- are bound together by practical reasons rather than ideology: life is cheaper in a community, as facilities and goods are shared. Examples include sharing a house, common use of a kitchen, maintaining a common garden, sharing household appliances, and carpooling.
- remain integrated economically and socially with society. Members make frequent use of services outside the community, and often work outside the community in comparison with members of the other types of communities
- are socially outward oriented, through contacts with friends, family and neighbors.
- are mostly located in urban and suburban areas.

These four categories provide a general understanding of types, but also suggest some distinctions which may not be present in any given community. For example a community may be both ecological and religious, with these two aspects making up the guiding ideology. However, this typology does align with the critiques Kanter (1972) and others identified as leading to the formation of intentional communities and does provide an initial guide for understanding a given community's ideology and relationship to larger society. As each community develops in pursuit of ideology or practicality, it has the ability to influence not just its members, but also the larger society in which it is embedded.

The ideas and alternatives embodied in the community can exert influence beyond its borders. Lurton (1998) describes this process as "today's utopias, once articulated, hav[ing] a chance to become tomorrow's society." Benevolo (1971) cites the utopian communities of the 19th century as a major influence on the development of modern municipal planning. Kanter (1972) describes utopian communities as providing alternatives for dealing with individuals with mental and developmental challenges, rural poverty and racial tension, and decentralized systems of production and consumption.

In a study of kibbutzim, intentional communities with a long history in Israel, Near (1985) identified specific ways that this influence can work. These methods for utopian communities to influence mainstream society include 1) as a pioneer, a cell from which a new society can grow; 2) as a model society that others will emulate; 3) as a prototype, a model that can be amended based on its successes and failures; 4) as a leader, with members providing social and political leadership, and 5) as an educator, sharing knowledge and understanding with the larger society. These methods of influence apply not only in kibbutzim, but other utopian communities as well.

In *Ecological Literacy*, David Orr (1991, p. 17) poses the question "is cleverness enough, or will we have to be good in both the moral and ecological sense of the word?" If cleverness (i.e., new technology) is enough to deal with the growing environmental and social problems, then the contribution of utopian communities to the growth of a sustainable society may be minor. However if, as suggested by multiple researchers (Jackson , 2005; Princen, 2002; Rayner, 1998; Lebel, 2005), attaining the goal of a sustainable society requires changes in our culture, values, and/or social structure, then the contribution of utopian communities devoted to achieving sustainability may be significant.

4. Ecovillages

Ecovillages can be considered a particular type of utopian community, defined by their aspirations toward sustainability. In Meijering's typology above, they would fall into the ecological community category. Preliminary research suggests that ecovillage life can significantly reduce the environmental burden of its members while maintaining a high quality of life and expanding the notion of community to include the natural world (Kasper, 2008; Tinsley, 2006; Moos, 2006). The impact of these ecovillages extends beyond their borders; they serve as examples, inspiration, and educators to surrounding communities.

Currently, there is relatively little research available on ecovillages, but the research that exists has developed along two main lines. In literature from the Western world, the focus has been on the ecovillages as intentional communities that are begun by concerned individuals gathering to live in a way that expresses their ethic of sustainability and the importance of nature. These analyses have been mostly qualitative in nature (Kasper, 2008; Meijering, 2007; Kirby, 2003). These sources generally define ecovillages according to their characteristics and aspirations, using descriptions such as the one below, provided by Parr (2009 p. 62),

> "Generally speaking [the ecovillage] is a semi-self-sufficient, human-scale, cooperative, sustainable settlement that integrates all the primary facets of life—sociality, alternative economics, food production, energy, shelter, recreation, and manufacturing—with a sensitivity toward the environment and its natural cycles."

Research from the Eastern world, particularly China and Japan, tends to focus on the ability of ecovillages to provide an economically viable life for villagers while reducing the environmental burden of such communities (Hu, 1998; Sanders, 2000; Takecuchi, 1998). These sources tend to define ecovillages more in terms of what they can produce or maintain, such as the definition below:

> An eco-village is defined as a self-supporting area in which, with the support of environmental conservation technologies, both a productive economy and the maintenance of semi-natural environmental systems can be realized. (Takecuchi, 1998, p. 178).

This project uses an approach that unites these perspectives, assessing environmental performance, while also examining the ways that ecovillage life becomes more sustainable.

In examining the social and political functioning of ecovillages, Kasper's (2008) qualitative research describes ecovillages as organizing village design to encourage interaction among the members through the use of proximity, common meals and facilities, and recreational areas. She describes a much higher level of social interaction than is common in many modern neighborhood developments. Her research also describes the members of ecovillages as “convey[ing] an acute awareness of their sources of energy and water, the practical importance of solar aspect for lighting, heating, and powering their homes, and the ecological implications of daily processes like eating, bathing, and disposing of waste” (Kasper, 2008, p. 18). Bang (2005) also describes the social organization of ecovillages, characterizing the decision-making process in many ecovillages as a process of consensus where “one member can effectively veto a process” which demands that members understand and trust one another.

There is a general expectation that ecovillage life will result in a reduced environmental impact, and preliminary studies of energy and chemical use support this expectation (Hu, 1998; Sanders, 2000). However, relatively little data has been published that attempts to comprehensively analyze the environmental impact of ecovillage members and compare them to residents of mainstream communities. The *Ecological Footprint of the Findhorn Foundation and Community,* an analysis of an ecovillage in Scotland, is one of very few examples of this type of analysis.

Ecological Footprinting is a technique for measuring environmental impact, with the result establishing the amount of land in global hectares (gha) that the population requires to provide their resources and absorb their wastes, based on the Earth’s biological capacity (Rees and Wackernagel, 1994). This primary finding of the Findhorn report was that the average ecological footprint for a resident of the Findhorn Ecovillage was 2.71 gha, while the ecological footprint for a non-ecovillage resident of Scotland was 5.37 gha (Tinsley, 2006). This is a reduction in environmental impact on a per person basis of 49.5%. Building on these findings, this project will examine three ecovillages in the United States to determine if these ecovillages achieve similar results to those of the Findhorn study.

Despite their potential for contributing to an understanding of the processes and challenges of developing a sustainable community, ecovillages are a relatively new phenomenon and little research has been conducted examining them. The research that exists suggests that the early years of these communities involve a great deal of experimentation and struggle to find a system that allows the members to govern themselves and meet their goals (Bang, 2005; Kasper, 2008). Those villages that have been through this process and have developed their techniques will have the most to offer in terms of data to be analyzed and lessons learned. The ecovillage movement is gaining strength and growing, so now is an ideal time to begin to assess what it offers for the development of sustainable communities.

5. Sustainable Consumption

Sustainable consumption can be defined as "patterns of consumption that satisfy basic needs, offer humans the freedom to develop their potential, and are replicable across the whole globe without compromising the Earth's carrying capacity" (Hertwich, 2005a, p. 4673). This concept is sometimes broken into two pieces with sustainable consumption being the effort to reduce the environmental impact of the affluent while maintaining quality of life, and with sustainable livelihood being the effort to increase quality of life for the poor while maintaining low environmental impact. Achieving sustainable development will require the implementation of both sustainable consumption and sustainable livelihood (Hertwich, 2005b).

Implementing sustainable consumption will require significant changes in the consumption patterns of the industrialized world. Human beings' desires are often described as insatiable, or as Dawkins (2001) puts it, "sustainability doesn't come naturally." However, there is some evidence to suggest that greater consumption is not tied directly to higher perceived quality of life. Studies from the 1970s through the 1990s have shown that increases in GDP are not directly related to increases in reported well-being, and in some cases well-being was found to decrease while personal incomes increased (Scitovsky, 1976; Worcester, 1998; Myers, 1996).

More recent evidence shows a weak positive relationship between GDP and well-being in developing nations, but in the U.S. and Britain perceived well-being has remained almost unchanged for the past three decades (Donovan, 2002).

This weak relationship between GDP and well-being suggests that it is possible to experience high quality of life without the need for ever-increasing consumption. Thus the task becomes to find a way to maintain a high perceived quality of life while decreasing consumption and environmental impact. Some progress can be achieved through improvements in efficiency and production techniques, but that progress will not be sufficient (Schor,2005; Jackson, 2005). Changes in consumer behavior will be necessary to achieve sustainable consumption, and the question becomes how to make those changes.

The results of appealing purely to altruism and individual restraint are likely to be limited (Jackson, 2005). Strategies which create supportive social environments through participation, role models, and fostering a sense of community are likely to be more effective (Tukker, 2010). To create changes in behavior the guidance must be direct and emotionally engaging, occur repeatedly, and be enforced by outside elements (Holdsworth, 2004). And along with these motivational strategies must come the creation of alternative opportunities for fulfilling the needs that were previously fulfilled through consumption (Tukker, 2010). Ecovillages create these types of social environments, where the group norms are supportive of decreasing consumption and of fulfilling needs through increased social interaction and interaction with nature. Studying these communities can help us to understand how effective these techniques are and to what extent ecovillages model sustainable consumption.

6. Life Cycle Assessment

Life cycle assessment (LCA) is a standardized method to determine the environmental impacts of a product, process or activity over its entire lifespan (ISO, 2000). LCA identifies and quantifies the energy and materials used and the wastes released from a product or process and assesses the impact of those inputs and outputs. LCA considers the entire life cycle of the product or process: extraction and processing of raw materials; manufacturing, transportation and distribution; use, reuse, and maintenance; and recycling and final disposal. Life cycle assessment consists of three major steps. The first, inventory analysis, aims to quantify the inputs and outputs of the system or product being examined. The result of an inventory analysis is a long list of material and energy requirements, products and co-products, and wastes released into the air, soil and water. The second stage, impact assessment, attempts to interpret the inventory analysis by estimating the impact of each output and input so that alternatives can be compared. The final step in this process involves valuation. In this step, the contributions from the different impact categories are weighed so they can be compared among themselves (Miettinen, 1997).

LCA environmental impacts are measured per a functional unit (e.g., a single car trip, a cup of coffee), which provides an understanding of all of the impacts related to consuming that unit (Nissinen, 2007). Assigning impacts to the consumption of the end unit, in contrast to an entire sector of the economy, provides the ability to model the impacts associated with particular choices. Comparisons can be made between a wide range of lifestyle choices (e.g., commuting alone compared to carpooling, or installing additional insulation on a home). LCA has thus far been widely used by business owners and policy makers to understand the effects that changes to a product design or policy will have on the environment. The Johannesburg Plan of Implementation, adopted in 2002, specifically endorses the use of LCA to design tools, policies, and assessment mechanisms to promote sustainable patterns of production and consumption (UN General Assembly, 2002).

In addition to business- and policy-scale decisions, there has been growing interest in using LCA to develop consumer information to promote sustainable consumption (Nissinen, 2007). Developing consumer information tools based on LCA data would require the modeling of a wide range of products so that individuals could gather information on the potential environmental impacts of alternatives, much the way they can currently do so for prices or for calorie content in food.

LCA models and methodology have also been used to investigate environmental impacts at the household level. Household environmental impact analysis has used household consumption surveys and national input-output models for multiple industry sectors to examine the environmental impact of various household activities. The results show that home heating and cooling, transportation, and food are consistently the most important consumption categories, in both the U.S. and Norway (Hertwich, 2005a).

Hertwich (2005a, p. 4682) suggests that the life cycle approach should "inform sustainable development policy not only through empirical assessments of the current situation and projections of probable future developments but also through an evaluation of how sustainable development could be achieved through a combination of possible technological, social, and economic changes." The ecovillage communities examined in this study have engaged in technological, social, and economic experiments, and analysis of these experiments will demonstrate how effective those experiments have been and may also provide insight into how sustainable development can be achieved.

Chapter 3. Case Study Methodology

This and following chapters develop case studies of three ecovillages: Ecovillage at Ithaca, Earthaven, and Sirius Community. These case studies explore the organization, decision-making, membership processes, planning and building practices, use and protection of resources, social institutions, and attitudes and values prevalent at each ecovillage. They were developed through the review of many existing data sources, in-person interviews, and participant-observation. A consistent structure is maintained throughout the case studies to support comparisons across the case studies. Each of the next three chapters contains one case study, and the chapter following the case studies addresses the common themes across the three ecovillages.

The choice of a case study methodology was based on the nature the research question: “How have ecovillage residents achieved these reductions in environmental impact?” Yin (2009) suggests that a case study design should be considered when: a) the focus of the study is to answer “how” and “why” questions; b) the researcher cannot manipulate the behavior of those involved in the study; and c) the boundaries between the phenomenon and context are not clear. All of these conditions apply to the ecovillages under examination: a) the focus of the study is clearly a ‘how’ question; b) these communities are not subject to my manipulation; and c) there is no clear distinction between the reduced impacts achieved in these communities and the communities themselves. Thus, a case study methodology is appropriate here.

According to Yin (2009, p28), a case study should include propositions that direct “attention to something that should be examined within the scope of the study.” These propositions are a subset of the overall research question and provide the researcher with guidance as to how to specifically answer the main research question. The propositions for this study are the four criteria for the success of an ecovillage posited by Hu and Wang (1998), which are:

(1) implementing ecological engineering in environmental protection and the comprehensive utilization of local resources;
(2) ecologically planning and designing village development;
(3) establishing social institutions to manage man-environment relations; and
(4) remaking local culture in its dimensions of behavior, psychology, intelligence and consciousness.

These four criteria provided the initial structure for data collection and also form several of the major section headings within the case studies. These major headings have been supplemented with subsections, and several new major sections were developed based on themes that emerged from the data and the need for context.

While the propositions used to guide this research could be applied to a single case, the goal of this research is to draw out the policies and practices that allow the ecovillages to reduce their environmental impact. A multiple case study methodology focuses on the similarities and differences between the cases, drawing out trends and providing results that are often considered more robust and reliable than a single case study. Multiple cases can also provide the ability to predict similar results across cases due to the replication of cases (Yin, 2009). For these reasons, a multiple case study methodology was chosen for this study.

The case, or unit of analysis, in this study is the community. While both of the research questions refer to ‘residents of ecovillages,’ the goal of this study is not to compare individual residents. This research is focused on comparing the environmental impact of the average ecovillage resident to the average resident of the nearby community and the average U.S. resident. Thus the resident is acting as a measureable stand-in for the community of which they are a resident. Similarly, the second part of this research is focused on how residents of each ecovillage reduce their environmental impact. These ecovillages are tightly knit communities where it is difficult or impossible to separate the behaviors of the community members from the norms and expected behaviors of the community: through their communal decision-making process, it is the community members who define the rules and expectations of the community. Thus, it is the community itself which forms the unit of analysis, and for this analysis the useful comparisons will be drawn across communities, rather than across individual community members.

The development of the case studies for this research is rooted in post-positivist and constructivist paradigms. While the positivist paradigm insists on a single objective reality and is concerned with only the facts, the post-positivist paradigm accepts the concept of an objective reality, but acknowledges that the background, knowledge and values of the researcher can influence what is observed (Robson, 2002). The influence of the post-positivist paradigm can be seen in my attempt to describe the ecovillages in an objective fashion. Each case study includes a section on village description, community organization, environmental protection and resource use, ecological planning and development, and social institutions and local culture. Each of these sections is approached as an opportunity to describe what has occurred and is occurring within the community. While the attempt is made to be objective in these descriptions, it is impossible, and perhaps not always desirable, to remove all of the author's bias or perspective. However, quotations from community members and material from other documents are used throughout to mitigate the effect of bias.

The constructivist paradigm goes further in the relativist direction as it "recognizes the importance of the subjective human creation of meaning, but doesn't reject outright some notion of objectivity" (Miller, 1999, p. 10). Constructivism is built upon the idea of a social construction of reality (Searle, 1995). This approach has the advantage of close collaboration between the researcher and the participant, enabling participants to tell their stories (Miller, 1999). Through their stories, participants describe their views of reality, and this enables the researcher to better understand the participants' actions (Lather, 1992; Robottom, 1993). The influence of the constructivist paradigm on the case studies is more subtle than that of the post-positivist. While the case studies attempt to describe reality, ecovillages, as communities, are essentially social constructs. The community exists at the intersection of the perspectives of its members, and the community also influences the values and behaviors of its members. Relating the reality of the community requires an understanding of the perspectives of its members. The effort to relate these perspectives is particularly apparent in the sections on the attitude of experimentation and value shifting, but is an important influence on the entire case study.

Developing the case studies for this analysis consisted of three major steps: 1) the selection of the case study sites, 2) an initial review of data about ecovillages and the specific case study ecovillages, and 3) the process of site visits, interviews, and follow-up. This process extended over several years and involved the periodic review of websites and blogs published by ecovillage members as well as in-person interviews, phone interviews, email correspondence, and extended stays at each ecovillage. The resulting case studies contain many perspectives, including those of ecovillage residents, former members of the community, neighbors, and others who have interacted with the ecovillages, and my own. This qualitative approach provides a rich, contextual view of how each ecovillage functions.

The first step in selecting case study sites was to determine the pool of available sites. This was accomplished using the Global Ecovillage Network[1] database, which is a repository of information on existing and forming ecovillage communities around the world. The primary criteria used for selecting potential case study sites were as follows.

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[1] http://gen.ecovillage.org/

(1) The community had been in place (built and inhabited) for at least 10 years. This ensured that the community had actual operating data and had developed their social structure and practices.
(2) The community must be open to visitors and willing to share data on energy use, transportation, etc.
(3) The community must be located such that I could pay several extended visits over the course of the project.

Based on these criteria, I selected three ecovillages: Ecovillage at Ithaca (EVI), Earthaven, and Sirius Community. I made initial contacts with members of these ecovillage to plan my first visits and conducted background research on each community.

Background materials on each ecovillage provided essential context for preparing for the site visits. Each ecovillage maintains its own website[2] that includes documents, studies, blogs, photos, maps, and general information about the ecovillage and how it functions. In addition, many members of these ecovillages have maintained blogs and sent out newsletters, all of which provided an understanding of these communities. I reviewed books and articles about ecovillages in general and the case study ecovillages in specific (Bang, 2005; Conrad, 1996; Dawson, 2006; Kasper, 2008; Sanders, 2000; Takeuchi, 1998; Walker, 2005). Information from these sources and from the interviews and observations was sorted and coded in the process of developing this case study document.

I conducted site visits at each of the case study sites during the spring and summer of 2010 and 2012. Each visit lasted between one and two weeks, and I visited each community at least two times. At each ecovillage I lived in a tent or guest room on site, participated in communal dinners, community meetings, social events, work projects, and generally

[2] EVI: http://ecovillageithaca.org/evi/
Earthaven: http://www.earthaven.org/
Sirius Community: http://www.siriuscommunity.org/

participated in community life. During these visits I also walked the village lands, explored the nearby towns, and took extensive photos and notes.

Before the site visits, I sent environmental impact surveys to all the community members via email. During the visits I followed up with members about the surveys and followed-up on missing or vague answers during interviews. I also distributed paper copies of the survey held presentations to gather support and interest for my research. These surveys provided the core of data for the Life Cycle Assessment detailed in Chapter 8.

In addition to the surveys, I also conducted interviews with many village members, former members, and outsiders who had interacted with the ecovillage. The interviews were semi-structured, open-ended interviews focused on how the various aspects of the community function and specific activities with which the person had engaged. These interviews were recorded, transcribed, and subjected to inductive analysis to develop the themes/sections that are addressed in each case study. Follow-up on important or unclear aspects of the interviews was conducted via email and phone over the following months and then with a second round of site visits and interviews. Each interview lasted between 45 minutes and 1.5 hours with 10-15 people being interviewed at each ecovillage. In general, the process of interviewing and follow-up continued in an attempt to reach the point of saturation, where continued interaction no longer yielded additional useful data (Rubin, 2005). In reality, it was impossible to reach a point where each interview did not provide a new perspective, if not new information. In general, the interviews continued until I had answers to all of the questions I had at that time and follow-up questions and further visits allowed for an iterative process of interviewing, reflection, development of new questions, and further interviewing.

All of data from the interviews and other sources was organized into the case studies that follow. Included are maps, photos, and figures developed by both myself and community members; narratives; observations made by community members, myself and others; and information from published and unpublished sources. The case studies are organized into five main parts: an introduction to and description of the community, a description and analysis of the community organization, a review of the environmental protection and resource use practices, a review of the village planning and homebuilding practices, and an investigation of the social practices and local culture and the way that these reinforce the community values.

Chapter 4. Ecovillage at Ithaca

> The ultimate goal of EcoVillage at Ithaca is nothing less than the redesign of the human habitat. We are creating a model community of some 500 residents that will exemplify sustainable systems of living – systems that are not only practical in themselves, but replicable by others. The completed project will demonstrate the feasibility of a design that meets basic human needs such as shelter, food production, energy, social interaction, work, and recreation while preserving natural ecosystems.
>
> -Ecovillage at Ithaca Mission Statement,
> adopted by the EVI Board of Directors, 1994

1. Village Description

Ecovillage at Ithaca (EVI) rests on a 175 acre plot of high meadow two miles outside of, and well above, the city of Ithaca. One can't see the ecovillage from the road, only a grassy hillside and a street sign for Rachel Carson Way. On the eastern side of the ecovillage are mostly suburban homes, while as you move west and away from the city farms become more common. Most of EVI's land is covered in tall grass, wildflowers, and shrubs with mown paths that are used for exercising and strolling about. From certain spots you can see down into the valley where the city of Ithaca sits and across to the lines of ridge tops disappearing into the distance.

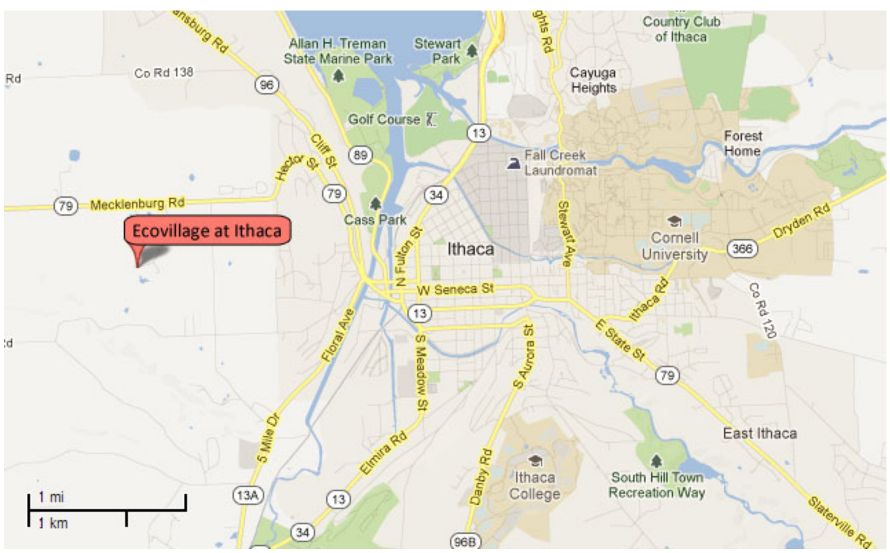

Figure 1-A EVI location map[3]

[3] Map Data: Google

The ecovillage site had long been farmland. Farming there had depleted the soil to the point where nearby farmers would not take the hay produced on the land, saying its low nutrient value made it essentially worthless (Walker, 2005). The farmland in this area is slowly giving way to the push of suburban development. The ecovillage site is surrounded by suburban housing, and being largely level in a landscape of valleys and ridges, it was attractive to builders.

Before it was purchased by EVI, the land was owned by a developer who planned a typical suburban development where 150 homes would be built on one acre lots, occupying 90% of the land area with roads, homes, and lawns. In contrast to this development plan, EVI was intended to have the same number of homes, while preserving 90% of the land as open space. This was to take place through the construction of five neighborhoods, each a set of tightly clustered homes planned based on the cohousing model.

The cohousing model was developed in Denmark and strives to combine the privacy of individual homes with a strong sense of community. At EVI each neighborhood consists of 30-40 homes, all oriented toward a central park-like pedestrian area, and cars are kept to the periphery. This creates an area for adults to gather and children to play. Each neighborhood also includes a common house where the community can gather for home-cooked meals several times a week. The common houses also include living rooms, offices, laundry facilities, playrooms, and other resources. Fig 1-B, below, shows the pedestrian area in the neighborhood known as FROG.

Figure 1-B Park-like grounds between the homes in the FROG neighborhood

EVI currently has two neighborhoods, the First Residents Group, known as FROG, and the Second Neighborhood Group, known as SONG. FROG was completed in 1997, and SONG was completed in 2006. The third neighborhood, or Third Residential Ecovillage Experience, known as TREE, began construction in 2012 and is expected to be completed in 2013. Each neighborhood consists of 30 homes, but the design of the homes of in each neighborhood varies considerably based on lessons learned and the changing needs of the village. The two existing neighborhoods comprise 60 homes with approximately 100 adults and 60 children in residence. Each neighborhood includes a common house in addition to the homes.

Figure 1-C The FROG Common House

TREE is planned to include 40 residences, which is expected to add roughly 100 residents, bringing the total to close to 260 residents. Each neighborhood occupies about five acres, thus with all three neighborhoods built the residential development footprint will occupy 15 acres, or 8.5% of the land area available.

In addition to the homes, there are two farms on the land. West Haven farm occupies ten acres of EVI's land and functions as a Community Supported Agriculture (CSA) farm. The Kestrel Perch Berry Farm occupies five acres and supplies berries using the CSA and U-pick models. The land occupied by the farms is still considered to be open space. The rest of EVI's land is undeveloped, providing recreation and natural space for wildlife.

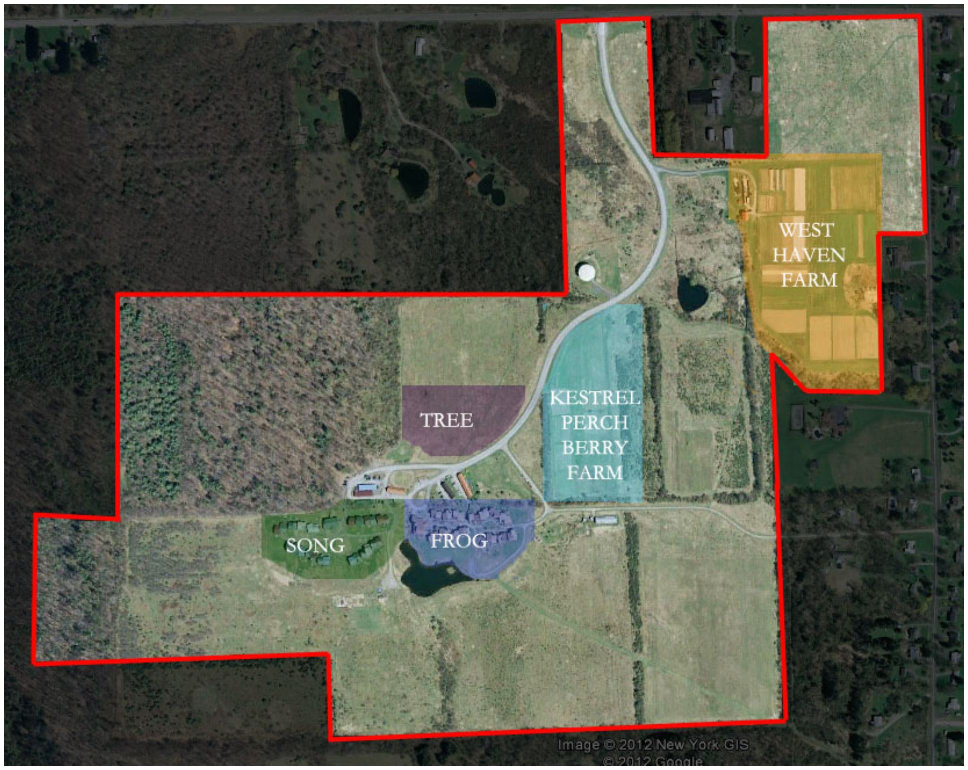

Figure 1-D Map of EVI based on aerial photograph[4]

EVI consists of a number of different legal entities. Each neighborhood within the village (FROG, SONG, and TREE) is a separate housing co-op that owns the homes and the roughly five acres of land that comprise the neighborhood. There is also a village association, which is a non-profit organization that owns the common resources that serve all the neighborhoods, including the roads, parking areas, and the pond. The village association owns about 20 acres of the land. EVI, Inc., a 501.c3 non-profit, owns and administers the remaining 140 acres of land. EVI, Inc. is the organization that leases land to the two farms. Although this is a complicated legal structure, it was necessitated by the multiple missions of the ecovillage. The housing co-ops and village association provide for the legal and infrastructure needs of the residential mission. However, the agricultural and educational components of the village interact with the larger non-profit, EVI, Inc., which would not be able to maintain its non-profit status if it directly

[4] Aerial Image: Google

provided the housing. There is an additional entity that administers the educational programs and grants, which will be explained in more detail later.

Figure 1-E EVI organizational structure[5]

While this description provides some idea of life at EVI, it is important to also understand the perspective of the residents themselves. One resident described his experience of EVI to me,

> “It's a place where people come in saying, ‘I want more sense of community and to live lighter on the land.’ So for me, I like walking out of my house and bumping into people and not having to hop in my car every time I wanted play a little music or have a party. And it's peaceful and beautiful here. It's really kind of a luxury. And it's autonomy to a large degree. You can make more of the rules yourself up here. You know it's a double-edged sword though, it's a lot of work and frustration getting through that [consensus decision-making], which you find out once you get here.”

[5] Image courtesy of Ecovillage at Ithaca

2. Community Organization

The importance of community involvement at EVI is reflected in the layout of the homes and the organization of the common spaces. The clustered development with houses facing toward the pedestrian community space facilitates interactions with neighbors. Common meals are held four days a week where neighbors can gather to have dinner together in the common house. The common houses themselves provide a natural gathering place for events and meetings, and there are regular meetings to discuss and make decisions about issues and opportunities that face the community. EVI is distinct from a typical suburban neighborhood not just because of its physical design, but also because of the decisions made by its founders and the ongoing decisions made by its members. EVI has developed its own decision-making process, ownership practices, membership process, and understanding of acceptable and unacceptable behaviors, and it continues to do so as the community develops.

Figure 2-A The interior view of the FROG common house

2.1 Decision-making

The primary process for decision-making at EVI is consensus. Each neighborhood meets as a group on a monthly basis to address issues and make decisions. In a consensus decision-making structure, the goal is to seek a decision which everyone in the community can agree with or, if that is not possible, a decision everyone can abide by. At EVI any member of the community can block a decision, but if the process is working well, this is a very rare occurrence. Proposals usually only come to the floor for decision after weeks of discussion, proposal writing, and committee meetings, so making the choice to block a decision very serious (Walker, 2005).

There are several levels of decision-making. Most issues involve one neighborhood and are resolved at the regular neighborhood meetings. However, if an issue affects not just one neighborhood, but the whole village, then it will be passed on the village meeting where the whole village meets as a group. However, the decision-making seems to become progressively more difficult as the number of people involved grows. With the addition of TREE, village level decisions will become even more difficult due to the sheer size of such meetings. There is some concern that with the addition of the third neighborhood whole village consensus will not be a practicable process, and another decision-making process will have to be implemented.

It can be hard to get residents to participate in self-governance. Typically each neighborhood, once built, has a monthly meeting of three hours. There is also a village meeting of one and a half hours. It is often hard to get a quorum of one third of the households for either the neighborhood or Village meetings. Members of the ecovillages cited busy lives, family commitments, and a lack of interest in the topics under discussion as reasons for not attending the meetings. A small core group tends to be very actively engaged, but two thirds of the people at any one time may choose not to come to meetings (Walker, 2012).

Currently most of the village level decisions are made by the board because of the difficulty of gathering a quorum. The board includes members from both neighborhoods, and they make decisions when too few people come to a meeting to achieve quorum. Any member of the village can come to board meetings and raise concerns, and if an issue seems controversial it can be referred back to the community as a whole, but many of the routine decisions, particularly at the village level, are made by the board. Each neighborhood also has its own board, which makes decisions when there is not a quorum at the neighborhood level.

Each neighborhood and the village as whole has a process committee, whose job is to support the decision-making process. These process committees establish an agenda for meetings based on input from the community, ensure that there is enough time on the agenda to discuss each issue, and make certain that two controversial issues are not discussed one after another. The process committee also finds facilitators for the community meetings and ensures that the person raising the issue is not the facilitator. They also make certain that the community is informed about the issues that will be raised before the meeting actually occurs.

The process committee is an important part of the decision-making process because consensus requires a high level of understanding of both the issues and conflict management. Decisions can be blocked by any member of the community, so the process of decision-making can be lengthy, often taking months to resolve difficult issues. However once a decision is reached, it is not easily reversed or altered, as it has the support of all or nearly all of the community. The nature of this consensus process is such that it not only results in decisions, but also changes personal opinions and the community culture. One resident described the value of consensus to me,

> “I do like the idea of consensus in that it's kind of like, let’s slow down and really try to work through all the different ideas and points of view on something. And you really get surprised sometimes. There are a handful of topics that have come up where I have said, ‘Wow, I never thought about that idea or that concern, and that's a good idea or concern.’ Well that's cool, I just got smarter. My neighbor has enlightened me a little bit.
>
> When you vote on stuff, there is a set period of time where you go over the pros and cons, and it's done. In a way you are working towards this vote. However I think when you say we really have to reach a consensus, people are going to a different frame of mind. They're not just waiting to get to the vote and get what they want. They really are encouraged to work with others and hear each other out, so it's different that way. I think you go deeper into the issues.”

Another resident told me that with consensus he was “disappointed if the discussion doesn’t change [his] mind on an issue, which was never true before [joining EVI].”

The range of issues that are addressed by the community decision-making process is varied, but almost all touch on issues of common resources. This can include acceptable uses for the common house, development of new recreational areas and equipment, the installation and management of renewable energy systems, and the number of outdoor cats that can be allowed in each neighborhood. This last issue was a surprisingly contentious one where the conflict centered on the impact of outdoor cats on the local wildlife. Cats, as predators, can kill a remarkable number of birds and other wildlife. Many neighbors were concerned about the impact that the outdoor cats were having, and some felt that outdoor cats were an "invasive species" that had absolutely no place in at EVI. Other neighbors regarded their cats as family members and couldn't bear the thought of denying them the pleasure of the outdoors.

After many meetings and discussions, the decision that was reached grandfathered in the current outdoor cats and allows for two outdoor cats per neighborhood, with a waiting list when one of those cats dies or leaves the neighborhood. Outdoor cats already living in the two existing neighborhoods were grandfathered in, leaving both neighborhoods with outdoor cats well in excess of the agreed-upon two until those cats die or leave the neighborhood. This decision shows the difficulties that arise in the balance between the personal and common spheres while trying to limit negative impacts to the environment.

2.2 Ownership/Public vs. Private/Individual vs. Common

The wide range of common resources is one of the major differences in organization between the EVI and many other American neighborhoods. Aside from the inside of their homes and a small plot of yard, almost all resources are common resources. EVI is legally a housing co-op under NY law. As a co-op, EVI sells shares to homebuyers that are roughly proportional to the number of square feet in the home. As a member of the co-op, a person has complete control over the inside of their home and partial control over the small plots in front of and behind the homes. Residents can mostly do what they want with the space, but for certain actions that will affect other community members, such as building a fence, they must get approval from the community. The exterior of the homes is owned and maintained by the community, much as it is in other co-op and condo arrangements.

However, by joining EVI a new member gains access to far more than what they personally own. The common houses, which include kitchen space, laundry facilities, exercise equipment and areas, and recreational spaces are major community assets. EVI members also gain access to community assets that include common yard tools (including electric mowers), over 100 acres of open space, community garden space, and the ability to make use of community resources such as a fully outfitted woodshop and office space. In addition, members also get to shape the community and make decisions about future community endeavors.

This focus on common resources also results in a high level of social interaction in the course of daily activities. With all of the houses oriented toward common space, you are greeted by other members of the community as you walk from place to place, community dinners are held four nights a week in one of the common house kitchens, and chores like laundry and yard work often lead to conversations with neighbors. EVI's particular structure provides a form of home ownership that would be familiar to many Americans, while also providing access to a wealth of common resources and social interaction that goes far beyond what is seen in many neighborhoods. One resident who had been a lifelong renter described her experience of homeownership at EVI this way,

> "It's been really nice. This is the first time that I've owned a home. I find the actual home ownership burdensome because the majority of the maintenance requirements fall on me, instead of being able to call a landlord. But it's really nice to have the outdoor space, it's always been my dream to have an herb garden right out by the kitchen door. We're really happy with the house and pleased with the way it turned out."

Figure 2.2-A The view from the porch of the FROG common house

2.3 Membership Process

EVI has the least formal of the membership processes of the three ecovillages included in this study, but they have designed a system of education and orientation to ensure that both the new member and the community are well aware of each other. Potential new members are encouraged to take a tour, come for an extended visit, and to carefully read the EVI website and Liz's book about EVI. They are also invited to come to community meals, talk to people, participate in community work, and they must attend a community orientation and a neighborhood meeting. If they are purchasing a home, the new member must be approved by the neighborhood board. In reference to membership at EVI, one resident told me, “It's a very self selecting. It's amazing how many people come here and decide it is or isn't for me. It works out pretty well.”

3. Environmental Protection and Resource Use

Environmental protection is an essential aspect of Ecovillage at Ithaca. The desire to preserve natural ecosystems is included in the mission statement and is readily apparent to any visitor. From more apparent strategies, such as the preservation of open space or the use of photovoltaic panels, to small details such as the clotheslines at each common house that replace the dryers on sunny days, the efforts to make the most of local resources and to protect the natural world are integrated into every aspect of EVI. And the desire to not just reduce impacts, but actually improve the land was expressed by many residents. One person explained that we should always be asking ourselves, “How am I sustaining the life around me?” not just “How am I minimizing my impact?”

However, this focus on the use of local resources has not led to a desire to create a completely self-sufficient society. There is a general opinion that reliance on local resources and nearby communities is better than relying on long-distance imports, but the themes of interdependence and the importance of working with communities and individuals outside of EVI recurred frequently. The residents of EVI seem to view EVI as a healthy model of community, but not as a way of life that can or should be self-sufficient or separate. When asked about the importance of self-sufficiency, one resident explained that self-sufficiency is

> "…not really important value. I don't like that concept of a closed community. I think interdependence on a local level is very important. I think the problem is that we have an overdependence on things that have no connection to our local community. Oil from the Middle East, food from South America. I believe in more dependence on the local region. Self-sufficiency would put a wall around us. It scares me a little bit, seems a bit cultish."

3.1 Open Space Preservation

The preservation of open space is one of the clearest environmental protection practices in place at EVI. Of the 175 acres, only 15 acres (between three neighborhoods) is used for housing and lawns. The initial goal of keeping 90% of the site as open space demonstrates the conscious desire to preserve as much of the site as possible. Currently, 30 acres of the site are specifically set aside for wildlife habitat and 110 acres are set aside for potential agricultural use, although only the West Haven Farm and Kestrel Perch Berry Patch are being actively farmed. Of the 110 acres set aside for agricultural use, 55 acres of the prime agricultural land are also under an agricultural conservation easement with the Finger Lakes Land Trust, which protects this land from future development in perpetuity.

Figure 3.1-A Open space on the EVI land

3.2 Onsite Renewable Energy Use

Solar, wind, and hydro power are generally the most readily available forms of renewable energy. However, there are limitations on each form of energy in terms of dependability and availability. The EVI site does not receive steady winds of a high enough speed to make wind turbines practical, and it does not have the elevation changes or streams to make use of water. However, the site is mostly open meadow, allowing for significant amounts of solar energy despite weather that is often overcast.

EVI is connected to the electric power grid and receives a steady supply of electricity from traditional sources, and there have been no serious efforts to attempt to supply all of their electricity demand through local renewable. However, there are several installations that take advantage of readily available solar energy to create both electricity and hot water. The homes in SONG were designed to create roofs with clear southern exposure. This allowed SONG home owners to install photovoltaic panels and solar hot water systems, which also function as supplemental home heating systems. In addition to these individual systems, the FROG common house has a 6 kW system that provides most of the common house energy, and a larger 50 kW system was recently installed just east of the FROG neighborhood to provide electricity to the homes in FROG. This new system provided 51% of the electricity used by the entire neighborhood (30 homes).

Figure 3.2-A The 50 kW photovoltaic system near FROG

3.3 Onsite Food Production

The site where EVI is located was partially chosen for its agricultural land. Fifty-five acres of the site is under an agricultural conservation easement and so will be used solely for agriculture or remain as undeveloped open space. Food at EVI is produced not only at the two CSA farms, but also in the three community gardens and in individual yards.

West Haven farm was started in 1992, shortly after the land was purchased, by two residents of EVI. The farm is a certified organic farm that grows 250 varieties of fruits, flowers, and herbs on its ten acres. It provides 250 CSA shares which are available to members of EVI as well as the surrounding community, and sells produce at the Ithaca Farmer's Market each week. It is estimated that the food from West Haven feeds 1,000 people each week during the growing season.

Kestrel Perch Berry Farm grows six varieties of berries and provides them through CSA shares and a "U-pick" model. The farm occupies five acres of EVI land and is run by Katie Creeger, an EVI resident. Katie described her reasons for locating the berry farm at EVI.

> "I chose to start the berry farm here, partly because of the presence of West Haven Farm. I thought vegetables versus fruit would be a good division of labor, but I don't think I could have done it here without the two built-in target audiences of the West Haven CSA and the ecovillage households."

Both farms lease land from EVI, Inc. for the cost of the taxes paid on the land.

The food production at EVI is not solely for the residents and actually provides a link between the ecovillage and the surrounding community. When talking to people outside of EVI, those who had heard of EVI often only knew about the CSA farms. These farms bring in summer workers from the surrounding communities, provide food at the local farmer's market, and provide a tangible connection between EVI and the surrounding community.

Figure 3.3-A The West Haven farm greenhouse

3.4 Waste Reduction

Through the recycling, reuse, and composting, the residents of EVI have reduced their need for garbage services by 75%. Sixty households generate approximately 100 cubic feet of trash per week, or 1.7 cubic feet per household per week. There are a number of different practices in place at EVI that contribute to this reduction.

Nearly all non-meat food scraps are composted. FROG maintains a community compost pile that is maintained by the outdoor team. Kitchen scraps from FROG households and common meals are added the compost pile along with leaves collected by the City of Ithaca as part of their yard waste collection. The finished compost is available to FROG members as well as the farms. SONG has a similar community compost pile, but many residents also maintain backyard compost piles for their own gardens.

EVI also makes extensive use of recycling and reuse. A comprehensive single-stream recycling program run by the county ensures that paper, cardboard, metals and plastics can all be recycled easily. In addition, members of EVI have created multiple practices to enable reuse of both disposable and durable products. Cardboard and paper are often collected and used for sheet mulching before they could be recycled. The community maintains a reuse room that provides a place for people to donate and collect clothing, shoes, and household goods. There is also a free resident library stocked with donated books, DVDs, and CDs. In addition to these formal programs, there is a lot of informal passing on of clothing and goods through events like the Women's Clothing Exchange and through children's clothing exchanges between neighbors. When someone decides to buy a new piece of furniture or appliance, they often offer the old item for free or at low cost to other residents over email, and leftovers from community meals are sold at just $1.50/quart, so it is rare to have much left at the end of the meal. All of these practices contribute to the very low levels of waste generation and represent an attitude that recognizes the usefulness of objects that would typically be thrown out.

4. Ecological Planning and Village Development

4.1 Ecovillage Location

The choice of where to build was one of the first major decisions made by the group that would become EVI. There were three main options available: the 175 acre plot two miles outside of Ithaca, another large plot 10 miles from Ithaca that would be provided for free if EVI would build a house for the current owner of the land, and an old gun factory site located in the middle of Ithaca. The gun factory offered ready access to the city, but no open space for farming and other activities (and the land was later found to be contaminated). The plot ten miles from the city would limit access to the city of Ithaca and require everyone to drive further, isolating the village and making the educational mission of the village more difficult to uphold (Walker, 2005). The location two miles from the city was chosen as the site for EVI, and the land was purchased in 1992. In addition to the practical reasons for the site selection, one resident explained another reason for choosing the site. "We purposely wanted to be on the urban edge, partly because that's a major growth area in this country, and we were staking our model on that particular niche. "

EVI's location close to the city provides a variety of benefits. The proximity to the city of Ithaca allows residents of EVI easy access to jobs, shops, and cultural opportunities. A majority of the EVI's members work outside the ecovillage, so the location provides an easy commute to jobs in Ithaca. It also provides easy travel for students and visitors that come to the community or participate in one educational programs run by EVI. EVI is by far the closest of the three case study sites to a city, and that closeness and interaction shapes the structure of the village and the lives of the villagers.

The physical proximity to Ithaca means that EVI falls within the area served by the local sewer and water district, which allowed (and, in fact, required) EVI to connect to the water and sewer systems. This made it unnecessary to drill wells and install septic systems to provide for the residents of EVI, but it also prevents them from installing and making effective use of ecology-based waste water treatment systems, such as a living machine. The proximity to Ithaca also provides for some access to public transportation: EVI lobbied for a bus stop, and an Ithaca city bus now stops at the property entrance five times per day inbound and outbound. Ithaca Car Share also tried locating a car at the village, but it did not get enough use to make it financially viable. There is hope that the increase in population after TREE is built will improve the car share and the bus access.

Although sometimes criticized for being a greenfield (undeveloped) site, the fact that this was former farmland meant few trees needed to be removed for construction purposes, and the preservation of 90% of the land has allowed the farming tradition to be continued. In addition, the open nature of the site lends to beautiful views of the hills and mountains that surround Ithaca, and wildflowers grow throughout the spring and summer. The natural beauty of the site and the open space that provides farming and wildlife habitat combined with the ready access to all of the assets of a city make it in many ways the best of both worlds.

However, there are some drawbacks to the location. The slope between EVI and the city is significant, creating a barrier to walking, and especially biking, back and forth from the city. In addition, the location falls between the urban and rural boundaries, making the community ineligible for affordable housing and other funds which are designated for either area. Access to city services has also come with a cost, namely the need to comply with city regulations. The city required that EVI build their own access road to meet strict requirements and requires that they pump their water up from the city below, which requires a large amount of electricity.

Figure 4.1-A EVI topography map[6]

EVI's location in many ways defines it as a suburb, as it exists in that area between the city and the rural countryside. Several residents referred to EVI as an alternative to suburbia in their interviews, and one provided this succinct description.

> "I think we are the mainstream fringe of the ecovillage movement. We probably should have called ourselves an eco-suburb. The intent of this community was never to be self-sufficient and off the grid. It was designed to serve as a possible alternative to standard suburban development, both in terms of landuse and the integration of agriculture."

EVI does demonstrate an alternate model to the standard suburban development that it replaced – one where zoning and building codes are met, city services are used, and yet an entirely different community emerges. EVI is a community that occupies the same type of space that is typically "cookie cutter" developments, but instead makes extensive use of its local resource, grows its own food, preserves open space, and makes conscious decisions about what type of community it wants to be.

[6] Map Data: Google

4.2 Homebuilding and Neighborhood Development

EVI is currently composed of two neighborhoods, the First Residents Group (FROG) and the Second Neighborhood Group (SONG). The design and building processes as well as the details of the resulting homes vary significantly between the two neighborhoods. The third neighborhood which is currently in development, TREE (Third Residential Ecovillage Experience), is using aspects from both of the previous development processes, but represents a third experiment in ecovillage neighborhood construction.

FROG used an experienced development management team, including an architect, who developed five home designs and a common house design through a participatory design charette process that included extensive input from the members of FROG. The five home designs varied in size from 900-1,650 square feet and included from one to four bedrooms, with one of the designs being wheelchair accessible. These homes were designed to minimize their physical footprint, and so run to multiple levels with a minimum of space between duplexes. All 30 homes in the neighborhood occupy only 2.1 acres, including the buildings, yards, and neighborhood space. The homes are built in two rows running east-west, with the neighborhood space being the land and pathway between the two rows of homes.

Figure 4.2-A Architectural drawing of the FROG neighborhood and common house[7]

Members of FROG were given the option of choosing between the five models and worked closely with the architect to choose the most affordable and environmentally friendly materials for construction. Members of FROG were very limited in their ability to customize the homes, being given choices only in regards to a few interior features. The homes were constructed eight at a time by workers hired by the development team. The development team also oversaw construction management. Through the use of the professional development team and limited customization, project cost and complexity were minimized.

Figure 4.2-B Exterior view of several FROG houses

[7] Image courtesy of Ecovillage at Ithaca

In regards to green building features, all of the homes in FROG are double walled and insulated using blown-in cellulose (made from recycled newspaper). These practices result in a highly insulated home, and triple paned windows add to the energy efficient envelope. In addition, all of the homes are oriented to make maximum use of solar energy (passive solar orientation), providing free heating and lighting to the homes. The homes in FROG are all constructed as duplexes, with the common wall reducing energy loss, and are heated by mini-district heating systems. Each mini-district heating system provides heat and hot water to a cluster of six to eight homes.

Figure 4.2-C The interior view of a FROG home[8]

[8] Photo courtesy of Richard Franke

The members of SONG, in contrast, pursued a self-development strategy. One resident explained to me that

> "Song developed in reaction to and reaction against FROG, mainly in terms of how the building and development process worked. It attracted a lot of people that did not want FROG-type house designs. It attracted people who wanted to design, and in some cases build, their own houses."

Instead of hiring a professional development team, the members of SONG chose to act as their own developers. A construction manager was hired to coordinate the construction processes, while the residents relied on their own expertise for much of the design and construction as well as legal, financial and business issues. The result was a great deal more variation in the design of the homes and a much greater use of "sweat equity," i.e., the members of SONG doing much of the construction themselves. Two of the homes in SONG were actually built from the ground entirely by the owners. While the homes still maintain a consistent outward appearance, the construction materials, interiors, and use of renewable energy all vary significantly by home. The freedom of the owners in making design choices and managing home construction also led to higher costs overall.

Figure 4.2-D Construction of a home in SONG using straw bale techniques[9]

[9] Photo courtesy of Richard Franke

The homes in SONG range in size from 750-2,500 square feet, with one to five bedrooms. The homes were constructed as duplexes, as in FROG, but with more spacing between the homes, particularly in terms of the neighborhood space between the two rows of homes. Figure 4.2-E below shows the FROG neighborhood on the right and the SONG neighborhood on the left. The 30 homes in SONG neighborhood occupy only 2.9 acres for the buildings, yards, and neighborhood space, as opposed to 2.1 acres in FROG.

Figure 4.2-E Aerial view of FROG and SONG neighborhoods[10]

Most of the homes in SONG are constructed from Structural Insulated Panels (SIPs), which are composed of a layer of insulted foam between two layers of oriented strand board (OSB). SIPs arrive at the building site precut and so are quick to assemble and create airtight construction, reducing energy loss in the building. Two homes in SONG used timber frame construction with straw bales for insulation, and one home is timber framed with standard batt insulation. Many of the homes in SONG also include photovoltaic panels on the roof, and some include solar hot water systems which provide domestic hot water and/or supplement radiant

[10] Image courtesy of Ecovillage at Ithaca

heating systems. All of the homes in SONG maintained the passive solar orientation that makes the most of the available solar energy.

Figure 4.2-F Exterior view of several SONG houses

The result is that SONG's homes are more widely spaced creating what has been described as a more seemingly American neighborhood, as opposed to the more tightly clustered European feel of FROG. The homes in SONG are more varied, but are generally only two levels, although some stretch to three. The homes in SONG were designed to reflect the desire of individual builders, resulting in interesting variations, while the homes in FROG were designed to reflect the communal desires of its members and presents a more cohesive identity.

TREE, the neighborhood currently under construction, is returning to the standardized design process and will include 40 homes on only 2.1 acres. New in the design of TREE is a four-story common house that will include 15 apartments, ranging from a 450 square foot studio to a 1,150 square foot three-bedroom. The remaining 25 homes will range from two to four bedrooms. The buildings in TREE will take their efforts to reduce home energy use even further, building to the strict Passivhaus[11] standard. This standard requires the construction of air-tight, super-insulated homes which reduce up to 90% of the energy needed for heating and cooling

[11] http://www.passivhaus.org.uk/

the house. Indoor air quality is assured due to the incoming air fed through of an Energy Recovery Ventilator (ERV), which recaptures heat the exhaust air, and uses it to pre-heat incoming fresh air. TREE is also built with a focus on wheelchair accessibility and aging in place. Construction of TREE is expected to be complete in 2013.

Figure 4.2-G Architectural renderings of the TREE neighborhood[12]

4.3 Village Commerce

Although EVI is primarily a residential area without a planned commercial space, in addition to the farms there are a number of businesses that are now located in the village. According to a survey done in 2011, 45% of wage-earning adults in the community make their living on-site. To facilitate running a business from the village, there is office space available in each of the common houses (eight offices in the FROG common house and three in SONG). These on-site jobs cover a wide range of occupations, including a child-care provider, operators of a bed and breakfast, environmental educators, attorneys, musicians, farmers, graphic artists, green builders, software engineers, therapists, writers, a sound engineer, gardeners, a

[12] Image courtesy of Ecovillage at Ithaca

housekeeper, and others. Many of these services are used extensively by the residents. The child care provider takes care of many of EVI's younger children and the attorney handles legal business for the community as a whole as well as many residents.

Despite these achievements, according to residents, the economic aspect of the village has not been a primary focus.

> "We never really committed to a particular economic development model. It's mostly a bedroom community. There are a couple of farmers and a couple of people with offices, but we're not really generating new economic opportunities here. Gradually we are, but it wasn't really a focus, and we don't really have the infrastructure to create small businesses together. The village was really created with a social and ecological focus."

As TREE is being planned and constructed, members of EVI are revisiting the economic aspect, particularly in light of the opportunities offered by the increase in population.

5. Social Institutions and Local Culture

5.1 Decision-making

The decision-making process used at EVI is described in detail above, however the decision-making process also has a strong influence on the social development of the ecovillage. The consensus process that is currently in place is very demanding: it requires "emotionally mature participants who are willing to come into a meeting with an open mind, and who are willing to relinquish being in charge of a particular outcome. They must also have the patience, fortitude and interest to sit and listen to their neighbors, sometimes for hours" (Walker, 2012). Members of the community have commented on the fact that interest in and attendance at meetings tends to wane as time passes. Several residents explained their choice to decrease their meeting attendance.

> "I was initially more involved, but at the moment have very little involvement [with the decision-making]. There's only so many meetings that a hands-on person can stand to go to. I pick and choose which ones I go to now."

> "We don't go to a lot of meetings any more. We went to a lot in the early years, but got kind of burnt out. Of, course we still do things for the community…"

> "I stopped going to meetings because I found them very stressful. People weren't always nice to each other. It became a struggle between those who didn't feel everyone was being taken into account and those who felt that if everyone got to talk, no decision would be made."

The reduction in attendance has led to the situation where most routine decisions are handled by the neighborhood or village boards, and only controversial decisions are decided by consensus of the full group.

However the move to making many decisions in committees has not reduced the ability of individuals to comment or block decisions. Any member of the community may express their opinions and thoughts to the board and if the decision becomes contentious it moves back to the larger group. Thus, only those decisions where there are multiple strong opinions are decided by the full group, and more routine decisions are handled by the boards more quickly and efficiently.

The general repeated opinion of the consensus process that I heard was that it was a slow, sometimes frustrating process, but that it also brought people together and caused individuals to look at the issues in new way, often leading them to a better understanding of their neighbors. In essence, the decisions made by consensus give shape to the community. One resident expressed it,

> "I think we've created a really nice place to live. It is frustrating at times when you are just trying to break new ground… Is this community going to be worth the investment of their time and energy? Some people have left, some have stayed. It's a continual process of redefining the place."

The consensus process as it is in place enables each person to speak up on any issue they are concerned with and ensures that they will be heard because of the power of any one person to block decisions. This process results in decisions that have been considered from many angles and which everyone can live with, if not fully support. Thus, these are by nature long-term decisions. As one resident put it, “we don’t want to waste the effort on short term fixes.” When an issue may take as long as a year to resolve, the goal is to make a decision that will be applicable and effective for as long as possible.

The structure of the village bears out this process. All of the buildings and processes evince the long-term planning and discussion that shaped them. There are no quick fixes, instead care and planning are evident everywhere. The way that the decisions are made ensures that. However, as the village grows, especially with the advent of the third neighborhood, decision-making processes will be revisited.

> “We make our decisions by consensus, and as we grow to a village scale that becomes increasingly difficult. Many of us are eager to have a different, more streamlined decision-making process.”

The time and complexity of consensus decision-making may not work at the larger scale and alternatives that continue the long-term perspective and participatory nature of consensus, but work with larger groups are being examined.

5.2 Sharing and Cooperation

Sharing is a common activity at Ecovillage at Ithaca. One resident explained,

> “We are living really close together, so by sharing common meals and common work, we tend to already be sharing a lot of resources. This tends to naturally lead to things like carpooling, and some of us actually share cars. My partner and I actually share a car with another couple.”

The section above on waste reduction referenced the shared library of books, DVDs, and CDs as well as the Reuse room and the Women’s Clothing Exchange. There is also the informal passing along of clothing, appliances, furniture and other goods throughout the village. However, a story told to me by one of the residents seems to exemplify the attitude of sharing and cooperation that I found at EVI.

A member of EVI had hired a painter to work on her house and he needed a stepstool to complete his work. The homeowner didn't have one, but was sure her neighbor did. She sent out a short email on the village listserv, and in five minutes she had several replies from neighbors who had stepstools and before she could reply, her next-door neighbor was knocking on the front door carrying a stepstool for the painter. When she told me this story at a presentation in the common house, everyone nodded and agreed that this kind of thing happened all the time.

This remarkable ethic of sharing was repeated in a multitude of ways during my stay at the ecovillage. I saw neighbors taking care of each other's children. One person told me about being taught how to grow and dry garlic by his neighbor. I was offered help and in turn offered help to others when doing laundry at the common house. One of the members of the ecovillage even cooked breakfast and dinner for me nearly every day I was there. Some residents describe the village as their extended family, and from my experience it is easy to see why.

This thriving culture of sharing is supported by all of the common resources and group enterprises that are going on in the village. Yard tools and mowers are shared in each neighborhood, as are the washers and dryers in the common houses. Exercise equipment, ping pong and pool tables, a sauna, and other recreational spaces are all present in the common houses. There are yoga classes and meditation events nearly every day, and there are numerous examples of neighbors buying in bulk to get better deals.

In addition to these informal enterprises, there are also multiple co-ops that have formed. A member of the EVI community recently wrote an article about some of the co-ops that have been created at EVI. One co-op was created when a group of EVI members all contributed money to buy a high-end digital photo printer. The co-op maintains the printer in the common house and sells prints to any member of the community. Thus, instead of many families needing to buy a printer or travel out of the village to print photos, the service is available to all in the village. Another co-op was created to buy root vegetables in bulk from surrounding organic farms and yet another was created to manage the process of paying for the photovoltaic panels recently installed near FROG. These co-ops make projects possible that would not be feasible for any one individual. One resident described the cooperative nature of the village as "an economy of scale of human resources." The author of the co-op article states that "creating co-ops at EVI is probably easier than in mainstream communities because here there is already a conscious ethic of cooperation" (Franke, 2011).

Figure 5.2-A Root cellar built to house root vegetables purchased by co-op[13]

[13] Photo courtesy of Richard Franke

5.3 Village Service

Each member of EVI is expected to work two to four hours a week on village tasks. This is done by being a member of one of the many committees, boards, and teams that help the ecovillage to function. This work is not tracked and this has created some controversy about whether some people are neglecting their commitments. However, at least one resident I spoke to works far more than his required hours but doesn't want the time to be logged and tracked. He sees it as a gift to the community and would be unhappy with a system that treated the work as an obligation. There is no doubt that many members of the village give large amounts of their time and expertise to the village to make its many endeavors successful.

5.4 Educational Projects

Part of the mission of the founders of EVI is education. While many of the residents of the village are focused on working out the issues involved in trying to live more cooperatively and sustainably, the board of the EVI, Inc. focuses on the educational mission. The Ecovillage at Ithaca – Center for Sustainability Education (EVI-CSE) is a project of the Center for Transformative Action at Cornell, which serves as its fiscal sponsor. EVI-CSE works with students and researchers, often by utilizing the "living laboratory" of the ecovillage and small farms (Walker, 2012). Some of the key EVI-CSE programs are listed below.

Groundswell

The Groundswell Center for Local Food and Farming focuses on teaching young people important food and farming skills. They offer multiple educational programs and will soon begin allowing students to create incubator farms on EVI land. This program recently won a major USDA grant to teach beginning farmers all aspects of starting small farms.

EPA Climate Showcase Communities

This grant is for the application of the innovative and successful methods of green building, mixed-use land planning, and community development created by EVI, to more mainstream settings. This model was designed to incorporate thoughtful design of the built environment and to facilitate more thoughtful individual and community behavior choices (TCPD, 2013).

Partnership with Ithaca College

EVI-CSE has developed a partnership with the Environmental Studies Department of Ithaca College under the auspices of a three-year National Science Foundation grant. EVI-CSE works closely with Ithaca College and provides at least one accredited course per semester on the topic of community sustainability. The partnership has increasingly spent time in cultivating partnerships with downtown communities, and provides cultural competency trainings to Ithaca College professors and students.

Ecovillage Visits and Tours

EVI-CSE provides tours to over a thousand visitors annually.

5.5 Community Celebrations

The members of EVI come together regularly through common house meal and impromptu social gatherings, but they also have developed their village culture through community celebrations. These celebrations demonstrate and reinforce the values of the community. Guys Baking Pies is one such celebration where the men and boys of EVI spend the whole day picking wild blackberries and make dozens of pies for a community party. This simple event shows both the value placed on interacting with and enjoying the community land and the importance of giving to the community.

Another frequently referenced community celebration is the Winter Spiral. This is a celebration where people gather in the common house after dark on the winter solstice, the longest night. The common house has been decorated with pine boughs and pinecones, shaping a large spiral. First the children and then the adults walk the spiral and light candles, starting in the center. Eventually a glowing spiral of candles decorates the common house floor. They celebrate the returning of the longer days and sunlight and affirm their connection to the land and to each other.

Figure 5.5-A May Day celebration at EVI[14]

There are numerous other celebrations, including ecovillage specific ones such as Sparkfest, the local arts festival, and the Strawberry Solstice. There more common celebrations including a potato latke dinner during Chanukah and an Easter egg hunt. The celebrations help to shape the culture of the ecovillage, affirming their connections to each other and to the natural world they are living with.

[14] Photo courtesy of Jim Bosjolie

5.6 Attitude of Experimentation

One of the most common statements that you hear when you ask about the ecovillage is “this is not a utopia.” There is not a sense of having achieved an ideal, but instead there is an attitude of experimentation. This community is an attempt to find a way of living that is satisfying to its members while being more in harmony with the natural world, and they are constantly trying to find better ways to achieve those goals. Throughout our interviews the residents repeat this theme.

> “This place is … a living laboratory. That's what I keep calling it. It's not a perfect model of how to live.”
>
> “EVI is a great stepping stone. No one here thinks this is a perfect utopia with a clear conscience. We all feel like this is baby steps toward ‘sustainability.’ We are trying to be a non-impact if not a positive, and to provide a model for others.”
>
> “I consider that we are one experiment in sustainable community, and we have a lot of systems in place and a lot of systems that are not in place yet. “

The shift in building materials and strategies from neighborhood to neighborhood exemplifies this pattern. There is a process of learning from what has been done, looking for new processes and technologies, reassessing what is possible, and trying to get closer to their goals. Numerous other experiments exist within the village from the Kestrel Perch Berry Farm, which may be the only berry farm in the US using both the U-pick and CSA models, to community root cellar that was built as part of a school project.

5.7 Behavioral Shifts

There is no doubt that EVI is composed of a group of people that are interested in living in a close-knit community and in reducing their environmental impact. However, by living in community with each other they also reaffirm and reinforce these values in each other, resulting in patterns of behavior amongst the residents that may not have occurred if they lived outside of the community. One result of being such a close-knit community is that it is relatively easy to for behaviors and ideas to spread from one household to another. The motivational effect of community members finding ways to live out the community values can have a profound effect in such a close-knit community.

While staying in these communities I felt the influence of the examples of the other community members on my behavior. I found myself hanging my clothes out on the community clothesline rather than using the dryers. My diet also shifted, partly because I was eating many community meals which were vegetarian, and when I shopped for food in Ithaca, I went to the co-op that most of the residents visited. It wasn't that I felt pressured to conform to the community's norms, but instead the examples of the community members incorporating these more environmentally sound practices into their lives made me want to do the same.

Several community members provided narratives of these types of behavioral shifts that have occurred both throughout the village and in their own lives. Below is a short description of the spread of bicycle commuting through the village.

> "I also think there is all kinds of behavioral change that happens. One example is bike commuting. I remember when the first resident here started bike commuting. He used to bike down the hill, work all day, and then bike back up the hill. I used to watch him and think, 'Well if he can do it, then I can do it.' So, I started bike commuting to Cornell, which has two hills. And so because I started doing it, Jared, my partner, started bike commuting to the hospital. So it just sort of caught on.
>
> Now the latest thing is electric bikes. One of the residents in SONG gets these electric bike kits and builds them. He's built 8 or 9. With an electric bike you get a boost coming up the hill. A lot of people have taken advantage of these to bike commute. And most of these people wouldn't have even known about the electric bike option if they hadn't seen residents using them."

The story below shows the way that living in EVI helped to alter one resident's relationship with food.

> When I was growing up, we lived in a small city, and my parents gardened. My mother created a large vegetable garden that took up half of our long, narrow back yard, and

her flowers beautified the other half. My father was an organic gardener who composted long before it was widely known. I was raised with the tradition of growing food to put on the table.

After I left home, I drifted away from that tradition. I lived in cities and never had a place where I could garden. I had to rely on supermarkets for my food; although I always bought fresh fruits and vegetables, organic foods were not readily available. I thought our family ate well, especially since I prepared fresh foods and we avoided buying processed foods.

When I bought my house at Ecovillage, I was inspired by all the gardening going on around me. I was thrilled that I would be able to get back in touch with the gardening tradition of our family. However, I didn't have a gardening plan, and needed to learn a lot about what and when and how to plant. My goal was to grow a few vegetables to supplement what I would need to buy at the supermarket.

I discovered I had many food-shopping options: Tops, Wegmans, and Green Star. I began buying my food at Tops but soon switched to Wegmans because they have a larger organic section. Occasionally I would buy food at Green Star too, and I visited the Farmers' Market from time to time when it was open. I signed up for a CSA share with West Haven Farm, and found myself trying out many tasty vegetables that were new to me. I signed up for a berry farm CSA share, thinking how much I would love eating all those berries! Gradually my mind began opening to new possibilities.

As time passed, I found myself focusing more on buying local, organic foods rather than transported, mass-produced supermarket foods. I stopped buying meats from the supermarket, and sought out local farmers at the Farmers' Market. I was growing my own onions and garlic, decided to see if I could grow enough food to see me through the winter. I planned my garden so that I planted veggies I liked and that would preserve well, and I planted winter squash that would keep without preservation. As my freezer filled, I realized I would need additional storage. I bought a small chest freezer to accommodate the overflow. My plan was working--I was eating organic food that I had grown myself! Berries from the CSA also filled my freezer and I began making my own jams and jellies.

Now it's May and I am eating vegetables from last summer's garden. I have pickles, jams, jellies, chutney, and pickled cabbage in my pantry. I rarely visit a supermarket, although sometimes I do need something there. I do most of my shopping at Green Star, and then mostly for items like dairy products, eggs, coffee, grains, and flours. Occasionally I buy vegetables that I don't grow. I look back and see how my perspective has altered and how my food consumption has changed. It would not have happened if I had not moved to Ecovillage.

Chapter 5. Earthaven

Mission: To create a village which is a living laboratory and educational seed bank for a sustainable human future.
Vision: In the midst of planetary change the Earthaven experiment helps inform and inspire a global flowering of bioregionally appropriate cultures.
Goals:
0) To promote and ensure the long-term structural integrity of the community.
1) To catalyze local and global change through learning, teaching, and networking.
2) To shift from wasteful to regenerative use of resources.
3) To use and develop ecologically sound technologies for water, waste, energy, construction, and other essential systems.
4) To develop and support a thriving local economy.
5) To grow, raise, and trade our own food, medicines, and forestry products in an environmentally responsible, bioregional network.
6) To practice fair, participatory, and effective self-governance.
7) To encourage an atmosphere in which diverse spiritual practices, conscious connection to all beings, and progressive social action can thrive.
8) To nurture personal growth, interpersonal understanding, and mutual trust, as the foundation for a deeply connected human community.
9) To practice healthy, holistic lifestyles that balance self-care with care for others.
10) To create a culture of celebration, beauty, and pleasure.
11) To use capital and labor resources to provide common infrastructure and meet our collective needs.

—Approved by Earthaven Council, 2009

1. Village Description

Earthaven rests at the end of the paved road, deep in the mountains of North Carolina. It is 30 miles from Asheville, the nearest city, and about 10 miles south of Interstate 40 between Black Mountain, NC and Old Fort, NC. Driving there requires navigating winding roads and switchbacks through rural, forested countryside. Although there are homes and developments along the route, most of the trip is through forested ridges and farmed mountain valleys.

Figure 1-A Earthaven location map[15]

The dirt and gravel road that leads into Earthaven is named "Another Way," providing a warning and introduction for visitors. The members of Earthaven are actively seeking another way of living, one that provides personal satisfaction, closeness to neighbors and nature, and protection for and communion with the land. Their pursuit of this alternate path is given shape in the Earthaven Ecovillage by the physical and social structures that constitute the village.

Earthaven's land comprises 320 acres of the ridges and valleys that are ubiquitous in Western North Carolina. The elevation changes more than 200 feet from the highest point on the land to the lowest, and most of Earthaven is on some sort of slope. The slopes are a challenge for both building and farming and make erosion control a serious concern throughout. Earthaven is in a temperate rainforest, with high humidity, frequent rainfall, and nearly continuous tree cover. However, these trees are mostly less than 100 years old, as this is recovering farmland. There is one large creek with several branches that runs through the ecovillage, as can be seen on the topographical map. There are several springs on the land that feed these creeks, and these springs provide much of the water used in the village.

[15] Map Data: Google

Figure 1-B Earthaven topological map[16]

Earthaven is separated into fourteen neighborhoods. Each is a part of the whole but also has its own personality. Some of the neighborhoods are currently undeveloped while others may contain several small homes and buildings or one building that houses several people. There neighborhoods are shown on the map in Figure 1-C below, and are described in more detail in section 4.2. The Forest Garden neighborhood does not show on the map, as it is located within the area labeled as Main Street. Figure 1-C also shows how densely forested Earthaven is. Even the areas marked as neighborhoods show very little disturbance to the forested areas. Because of the scattered nature of the development, cars are sometimes used to travel from one part of the village to another, and trucks are frequently used for moving materials between neighborhoods.

[16] Map Data: Google

Figure 1-C Earthaven neighborhood map[17]

Earthaven was founded as a community on September 11, 1994 by a group of twelve people who found and collectively pledged $100,000 towards the purchase of the land. Over the next several months, a campaign to find more members and raise funds resulted in the land purchase on December 31, 1994. The members of Earthaven characterize the history of the community following its founding in "waves." Throughout this discussion, the number of people joining the community is mentioned; there is less data on the number of people leaving, so it is not mentioned. However, turnover at Earthaven can be high, with as many as half of the people who join in one wave leaving in another.

The first wave (1994-1995) consisted of the pioneers, a group of about 20 members who began to live on the land while trying to develop the norms, procedures, and documents the community needed. At the same time, they worked to better understand the nature of the land they had purchased, to build homes, to raise money, and to increase membership. The second wave (1995-1996) saw the addition of 15 residents and the beginning of the Hut Hamlet, the first neighborhood developed at Earthaven. This group focused on attracting more families and

[17] Aerial Image: Google

refining and testing the community processes including consensus decision-making. It was a small, intimate group, which made decision-making and community action easier to accomplish. During the third wave (1997-1998), ten residents joined Earthaven. This was a period of immense physical work by the community, described as “grounding ideals in physical reality.” The Forestry Cooperative was established during this wave, and it was responsible for selectively logging the Earthaven land and building many of the community’s homes. The fourth wave (1998-1999) added another twelve members to the community. During this period the Forestry Cooperative gained strength and became more active. Meanwhile, the community improved its organizational skills, and a great deal of energy was put into preparing for potential Year 2000 (Y2K) issues. The members of Earthaven took the potential damage to society by Y2K seriously, and as a remote and somewhat self-sufficient community, they stockpiled essential resources in case they would be necessary.

The fifth wave (200-2002) arrived after the Y2K scare. Earthaven added another 15 residents, and there was a sense of chaos in the community. There was a loss of intimacy in the community due to its growth, and there were concerns by members about their ability to meet their families’ needs. Serious questions were raised about the nature of the Earthaven community, and despite a Revisioning Retreat in January of 2002 to address the serious issues of population capacity, food sustainability, and diversity, these questions seemed unresolvable. The sixth wave (2002-2004) prompted some major changes in the community. The Forestry Cooperative, a driving force for physical development, dissolved, and in general, the need for constant and intense physical labor subsided. There was also a general feeling of acceptance that this larger community needed new ways of relating. Therefore, a process of experimenting with new social processes took place. The seventh wave (2004-2007) saw the addition of 16 people and the establishment of the Gateway, Yellowroot, and Imani farms. More young people explored the community as provisional members. Earthaven came into conflict with the local health department over which sources of water on the land were suitable for visitors. The result was that Earthaven was forced to dig a well to provide all of the water for Earthaven visitors. The eighth wave (2008-present) is the current wave. It has seen the addition of another 10 residents to the community and the continued development of decision-making and other social processes as well as greater engagement with the outside world.

Earthaven currently has about 55 full-time residents and another 20 residents who are there through Earthaven's work exchange program. There are also many members of the community who do not live on the land. The details of different types of membership are described later in section 4.2. The 320 acres of the site contains five farms and orchards: Gateway Farm, Yellowroot Farm, Imani Farm, Forest Garden Orchard, and Hidden Valley Orchard. In addition to the farms and orchards, there are also a number of businesses located in Earthaven, including builders, wild-crafted herb sellers, a nursery and landscaper, and other small businesses.

Earthaven is organized legally as a homeowners association (HOA) that owns all of Earthaven's land. As an HOA, Earthaven has the ability to create rules and covenants that all members of the HOA, meaning all residents of Earthaven, are required to abide by. While the members of the community can own their home, the land remains owned by Earthaven and is leased to the community member.

2. Community Organization

Although the buildings and residents are more widely dispersed at Eathaven than at EVI or Sirius, the layout of the community still demonstrates their commitment to community. Earthaven is laid out in a rough wheel and spoke pattern. The council house, village green, dining tent, and trading post are all at the rough center of this wheel, with the roads radiating from this rough center to the various neighborhoods. Potluck meals are held every Tuesday and Friday at the dining tent, and these meals often include 20 or more different dishes contributed by members of the community. The dining tent also hosts the "Coffee and Trade" event every Tuesday, where members of Earthaven and outside communities bring food and crafts for sale and trade. The council house hosts all community meetings, and it is used for many community celebrations as well as classes, meditation, yoga, etc.

Figure 2-A Earthaven Council House

2.1 Decision-making

Earthaven conducts its decision-making using consensus. The consensus process at Earthaven was recently revised. Previously, all decisions had to be reached by full consensus, the agreement of all full members. However as of January 2013, the following changes were approved:

- To approve incoming new members previous consensus method is retained.
- For all other proposals, a block (a vote against a decision) can be overridden if 85% of Council members present agree that the block is invalid.
- For any remaining blocks that have been declared valid, the blockers and several proposal advocates participate in up to three solution-oriented meetings to co-create a new proposal that addresses the same issues as the first proposal. If they cannot, the original proposal comes back to the next Council for a decision using consensus-minus-one (meaning it takes two blocks, not one, to stop the proposal).
  (Christian, 2013)

Council meetings are held twice a month, usually on Sunday afternoons. These meetings are open to all members of Earthaven, but only full members participate in the consensus decision-making. Decision-making at Earthaven is by full members only. Visitors and other types of members can speak on issues if allowed by the council, but they do not participate in consensus. An agenda is posted several days prior to the meeting so that community members can review the issues under discussion and decide whether to attend. Typical agenda items include committee reports, proposals for changes in Earthaven policy, reviewing special requests, and other matters that cannot be handled in committees. In my experience, between eight and ten full members attend most council meetings. If a controversial issue arises, the meeting attendance increases.

Figure 2.1-A Council House interior and mosaic floor

While some decisions are made at the council meetings, the majority of the decisions are made at committee meetings. There are committees devoted almost every aspect of Earthaven, including a Safety Committee, Strategic Planning Committee, Finance Committee, Land Use Committee, Membership Committee, and Projects Committee. At these committees decisions are also made using consensus, just as they are at Council meetings. To ensure that the community has the opportunity to review and respond to these decisions, committees post their minutes and decisions for a three-week review period. During this period, any full member of Earthaven may object to the decision. If an objection occurs, the committee may revisit the issue with that person or it may be referred to Council. Either way, the issue will be resolved via consensus.

Earthaven divides its administration into four divisions related to the elements: fire, water, air and earth. Fire is related to social interactions and structures, water is related to finances, air is related to communication and relations with the world outside of Earthaven, and earth is related to physical infrastructure. The chart below provides an overview of Earthaven's major offices and committees.

Firekeeper Orbo	Waterbearer Orbo	Airspinner Orbo	Earthdelver Orbo
Firekeeper -Looks out for the well-being of the community -Analagous to the President of Earthaven	**Waterbearer** -Responsible for the community's financial and legal policy -Analagous to the Treasurer of Earthaven	**Airspinner** -Responsible for communication and record-keeping -Analagous to the Secretary of Earthaven	**Earthdelver** -Oversees physical infrastructure -Analagous to the Vice-President of Earthaven
Agenda Planners -Help clarify and keep track of times being presented to Council	**Finance Committee** -Adminster collection of income and payment of expenses	**Visitor Committee** -Interacts with visitors, manages campground, leads community tours	**Projects Committee** -Reviews and assesses community infrastructure and other projects
Fire Tenders -Advisory group to the Firekeeper that administer several sub-committees: -Care Team -Safety Committee -Spiritwalker	**CurrentSee Committee** -Administers Earthaven's alternate currency, the Leap	**Promotions Committee** -Responsible for media communication, brochures, etc.	**Land Use Committee** -Administers site plans for home and business sites and associated environmental issues
Strategic Planning Committee - Focus on assessing and revising community goals and recommend strategies for accomplishing these goals		**Membership Committee** -Oversees the membership process	**Forestry and Agriculture Committee** -Administers Earhaven forests, agricultural leases and policy
		New Roots Committee -Orients non-member residents to Earthaven life	**Water Committee** -Oversees the Earthaven water system and wells

Figure 2.1-B Earthaven organizational chart

2.2 Ownership/Public vs. Private/Individual vs. Common

Earthaven is organized as a homeowner association (HOA), as are many other neighborhoods throughout the United States. However at Earthaven, all of the land is owned by the HOA. Each member of Earthaven can lease a homesite from the community through a 99-year, renewable, transferable lease. An individual who builds a home on one of the leased homesites owns the home, but he or she may only sell it to the community or another member of Earthaven. [18]

Joining Earthaven, however, is about far more than ownership. In becoming a member of Earthaven, one becomes a member of a community that includes land, ecosystem, and people. Earthaven is 320 acres of mountain valleys, most of which is forested and crisscrossed with trails. A member can wander the woods, relax in the swimming hole and sauna, play on the village green, and participate in shaping the community through council and committee meetings. There are shared resources, including the common tools in the storage barn and a community tractor. There are also numerous community gatherings and projects to participate in, and members have the chance to develop ideas about how to add to the community of Earthaven.

Earthaven's home ownership model can cause financial difficulties for members because it is very different from typical practices. Bank loans are nearly impossible to obtain for many community members because they do not own land or home in the typical fashion. Private loans from Earthaven members and family members have become the primary means of financing in the village. While joining the community can provide a wealth of experience and community, it does not provide the financial security that typically goes along with home ownership. As one community member described it, "if you come with a strong sense of financial ownership, this is a difficult place." Another member of the community felt that the focus on ownership in mainstream society is misguided.

> "It's a trust thing. People want to own things because they aren't confident that their needs will be met otherwise. I have a high level of trust and believe that whatever happens I will deal with it. I am not attached to a particular outcome. Ownership is fear

[18] The homes at Earthaven are owned in the sense that everyone acknowledges that the home is owned. However, as the land is owned by the HOA, these homes cannot be used as collateral for a loan or other transactions. Earthaven maintains control of the land and homes, thus controlling their sale.

> based, and it's one of the hardest things to overcome because, [ownership] is what everything out there is based on."

2.3 Membership Process

Earthaven has a multi-tiered membership system which provides several steps along the way to full membership, as well as other types of membership. Supporting membership is often the first step towards joining Earthaven. As a supporting member, a person contributes $10 per month to Earthaven and as a supporting member receives several connections to the community. A supporting member can camp at the Earthaven campground for free for two weeks, receive the Earthaven newsletter and committee meeting minutes, observe council meetings, and may live at Earthaven temporarily under one of the systems in place (e.g., work exchange program). Supporting membership provides a way for a person to get to know Earthaven life without committing to the full membership process. This membership category also provides a distributed network of people who provide some financial support to the community and stay connected to events at Earthaven.

Provisional membership is a six month or longer process of exploring life at Earthaven. A provisional member is considered to be a "member-in-training." Provisional members go through the New Roots Program, an extended orientation program that helps newcomers understand and adapt to life at Earthaven. Within the first month, a provisional member is expected to attend a council meeting and to work four hours per week for the Earthaven community. This is also a period which allows existing Earthaven members to assess the provisional members.

After a period of provisional membership, and with the approval of the community, a person can become a full member of the Earthaven community. Full members can live at Earthaven, lease a home or business site, build on leased site, own and operate an on-site business or agricultural project, have an indoor dog or cat, draft community proposals, attend council and committee meetings, participate in decision-making and be counted for quorum, and are considered co-owners all Earthaven property and common facilities with the exception of privately leased sites. Full members also have a number of responsibilities that accompany their privileges. Full members are expected to abide by all Earthaven agreements and policies as well as council and committee decisions. They are expected to contribute 1500 hours of Earthaven community service, Leaps (Earhaven's alternative currency), or their monetary equivalent ($10 per Leap) in the first ten years of membership and to pay annual dues. Full members also pay a one-time joining fee of approximately $4000 and are expected to become affiliated with a homesite, either by joining an existing site or leasing one of their own. The ability to participate in decision-making is contingent on remaining a member in good standing, which requires the member to pay all dues and fees and meet the community service requirements.

Other membership categories include sustaining members, student members, honorary lifetime members, and lifetime supporting members. Individuals who have completed the membership process but have decided not to become or remain full members are considered Sustaining Members. Student membership is a temporary membership offered to those attending classes and workshops at Earthaven. Honorary lifetime membership honors the contributions of the founding members who are no longer living at Earthaven. Lifetime supporting membership is offered to those who have made significant financial contributions to Earthaven.

The adjustment involved in joining Earthaven can be significant and, according to one member, the multi-stage membership process acts as a kind of "filter." She states that, "there are certain things we need people to come with," including openness to permaculture, to nonviolent communication, and to other community processes. The multi-stage membership process allows people to come as far into the community as they are comfortable while giving the community members time to assess how well prospective new members will fit into Earthaven.

In the early history of Earthaven, the membership process was a significant challenge. According to one community member, many of the second and third wave members weren't fully committed to the values and vision of Earthaven. This caused a struggle between those with the image of Earthaven as an intimate, intentional community and those who wanted it to be a more loosely structured village that allowed more separation between members. She describes the original members as being "willing to take risks" and "all for one and one for all," while the later members were "tilting the Earthaven toward the mainstream." The membership process that has developed is intended to ensure that potential members fully understand and are committed to Earthaven before they become full members.

3. Environmental Protection and Resource Use

Earthaven's mission statement includes the intention "to shift from wasteful to regenerative use of resources," and "to use and develop ecologically sound technologies for water, waste, energy, construction, and other essential systems." The commitment to achieving these goals can be seen in the many aspects of the ecovillage, from the reliance on renewable energy to the detailed forestry plan. The careful and considerate use of resources is an essential part of Earthaven.

3.1 Open Space Preservation

Most of Earthaven's land is heavily wooded with the only large clearings being used for agriculture and the village green. The homesites and buildings are nestled into the woods and the clearance of forest is kept to a minimum, even during construction. None of the land is under conservation easement or protected through legal means. However, all of the sites not designated for home, business, or agricultural use are planned to be left as perpetual forest. The aerial photograph of Earthaven, below, shows how effective the community has been at preserving the forest.

Figure 3.1-A Earthaven aerial photograph[19]

3.2 Onsite Renewable Energy Use

Earthaven generates all of its electricity on-site. A micro-hydro plant provides electricity to the Council House, Hickory Knob, and the woodshop. Water is diverted from a stream at high elevation, and it runs downhill through a 5-inch diameter pipe and is channeled through a small turbine; this produces electricity which is either used immediately or stored in a series of batteries for later use. The rest of Earthaven's electricity comes from shared or individual solar panel systems. Some of these systems are professionally installed and include battery back-ups,

[19] Aerial Image: Google

while others consist of roughly mounted panels that only provide electricity during part of the day. Propane and wood are used extensively for heating and cooking, with most of the wood coming from onsite as well.

Figure 3.2-A Earthaven micro-hydro turbine and photovoltaic panel photographs

3.3 Onsite Water Supply and Wastewater Treatment

Earthaven collects its own water and processes its own wastewater. Their onsite water supply comes from several springs that are located on the property, and the infrastructure includes a 10,000 gallon storage tank that supplies water to much of the village. Many homes also make use of their roofs to collect water with rain barrels that are connected to gutter downspouts. Most homes use composting toilets, so there is very little sewage to be treated. Wastewater is run through constructed wetlands to purify it. There is one flush toilet in the Council House connected to a septic system.

3.4 Onsite Food Production and Forestry

The residents of Earthaven use the land to produce food and forest products in a variety of ways. The intention of the community is to “use agriculture to provide sustenance and livelihood for ourselves, through a regenerative relationship with the Earth, peaceful trade with our neighbors, and demonstration of our values.” All of the agricultural endeavors and businesses that work the land are carefully reviewed by the community before any clearing or other activities take place.

Figure 3.4-A Yellowroot Farm

Approximately 40 acres of the site have been cleared as agricultural land for several farms (Gateway Farm, Yellowroot Farm, and Imani farm) as well as neighborhood farms and gardens. In addition to crops, these farms produce eggs, poultry, sheep, pigs, and dairy cows. Several of these farms have CSA shares that can be purchased by residents. The farm products are also sold directly Earthaven residents and to those outside the ecovillage. Earthaven has a number of orchards as well, including the Hidden Valley Orchard and the Forest Garden. Orchards are also attached to several of the farms and neighborhood gardens. There is also a trout pond that can be fished by the members of the community when the trout have grown to full size.

While 40 acres has been cleared for agricultural use, the remaining 280 acres of Earthaven is almost all forest. Earthaven has developed a comprehensive management plan to protect and improve the health of the forest. Clear guidelines have been created for tree harvesting with the goal of making the forest healthier:

- Log in winter to minimize damage.
- Don't fell adjacent to streams to reduce erosion and maintain shade for streams.
- Harvest smallest and least healthy trees to leave best genetic stock to propagate.

3.5 Waste Reduction

All of the ecovillages showed dramatic reductions in waste per resident compared to a non-ecovillage resident. As at EVI, Earthaven accomplishes this reduction in waste through a combination of extensive composting, recycling, and reuse. Earthaven also uses a technique they call "carbon dumps," which involves gathering wood, paper, cardboard, and old leaves and dumping them in a hole dug on the property. When the hole is full, it is covered over with soil, and the tree-products within are allowed to decompose gradually into soil.

Nearly all food-waste, except for meat, is composted in Earthaven. There are compost collection bins in every kitchen, and most neighborhoods have their own compost piles as do the farms. This results in almost zero food waste that has to be disposed of off-site. Earthaven also has a Free Store, which is a building where any resident may bring items that are still in good condition but are no longer needed. The Free Store often contains clothing, children's toys, appliances, and tools. Any member of the community can visit the Free Store and take anything that they want. This process ensures that many things which might otherwise be thrown away are put to good use by another community member.

Materials that cannot be composted, added to a carbon dump, or reused are disposed of or recycled. Earthaven has recycling collection bins in all the common buildings and common kitchens. The result is that almost all recyclable materials are collected and sent to the recycling center. The effectiveness of these waste reduction techniques can be seen in the fact that for approximately 80 residents, Earthaven has only 6-8 family-sized waste bins that the garbage trucks pick up each week.

4. Ecological Planning and Village Development

Permaculture is a major guiding principle in the development of Earthaven. Permaculture is a contraction of **perma**nent agri**culture**, which is defined as the conscious design and maintenance of agriculturally productive ecosystems to have the diversity, stability and resilience of natural ecosystems and to harmoniously integrate the landscape and people, providing food, energy, shelter, and non-material needs in a sustainable way (Mollison, 1988). One of the first tasks undertaken in designing Earthaven was to develop a permaculture-based site plan that identified sacred sites, land to remain forested, sites for gardening, farming, orchards, ponds and hydro-power stations, roads and paths, community buildings and residential neighborhoods. This plan resulted in decisions to build on slopes and save flat land for agriculture, to retain as much water through roof catchments and swales, to regenerate soil with biomass (compost, carbon dumps, etc.), and to make careful use of available energy and resources through passive solar design and natural construction materials.

4.1 Ecovillage Location

Earthaven is located in a relatively remote, rural, mountainous area in North Carolina. The ecovillage is 15 miles from Black Mountain, the nearest town, and 30 miles from Asheville, the nearest city. There is no access to a municipal water or sewer system, so the members of

Earthaven have had to focus on securing a sufficient source of water and minimizing and treating their own wastewater.

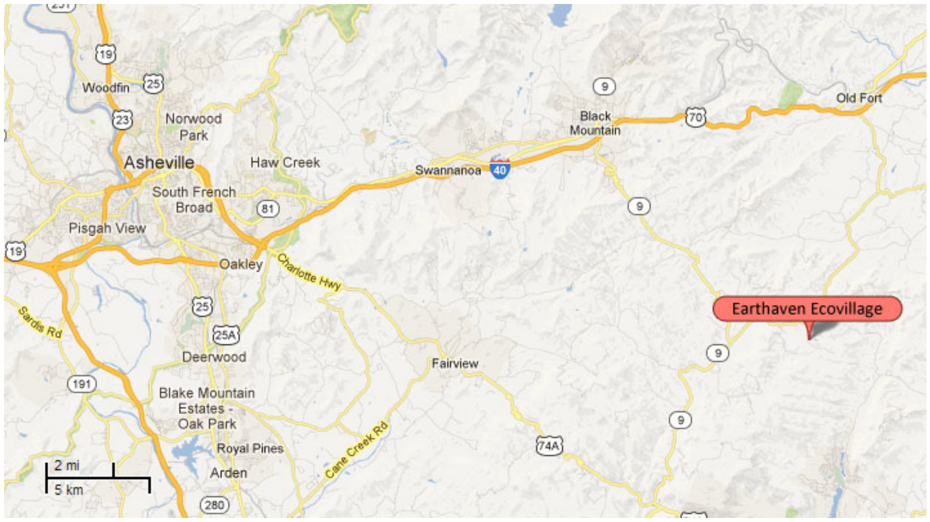

Figure 4.1-A Earthaven Location Map[20]

The group that eventually founded Earthaven, known as the early founders, was originally looking for a farmstead where they could raise crops without having to cut down trees, but they were unable to find one with a sufficient water supply for the community they envisioned. The current Earthaven site was originally rejected because it had been a tobacco and corn farm and is now a recovering forest. The soil was low in nutrients, and the early founders didn't want to interfere with the land's return to a forest by cutting trees and growing crops. There was confusion among the members about what to do, because they had not found the type of site they were looking for. One member told me that at this point, site selection was a unilateral move by Valerie, one of the community founders. She "made the decision to take a contract on the land because she was worried the group would fall apart. She called everyone involved in the project and said she needed 44 people to put up $10,000 each before the end of the year. By December 31, 1994, she had $180,000 as a down payment on the land."

[20] Map Data: Google

By early 1995 some people had begun to live on the land. The mountainous nature of the site limited areas for farming and homebuilding, and a dispersed pattern of development emerged in the early days. Several members told me that by the time the ecovillage was five years old, they realized that they should have used a more clustered design but it was too late to change the structure of the village.

The remote location means that people tend to minimize their trips into town, carpooling or trading within the ecovillage where possible. Most of the homes were built using lumber and other materials from the land, and oversight by the housing inspector and other government agencies has been sparse.

4.2 Homebuilding and Neighborhood Development

Earthaven has 14 planned neighborhoods with between two and eight homesites each. Some neighborhoods have developed sites and homes; others are in the early stages of development or still undeveloped. Each full-member of Earthaven must purchase a homesite or join an existing home. Full homesites are approximately one-quarter acre, which up to four people can share. Compact homesites are approximately one-eighth of an acre, which two people can share. When acquiring a homesite, the member must pay a one-time site lease fee of $20,000 for a full site or $12,000 for a compact site. If after building a home on a homesite a member wishes to move, he or she can only sell the buildings and other improvements to another Earthaven member following the approved guidelines.

Figure 4.2-A Earthaven home under construction

The homes and other buildings at Earthaven were largely built by Earthaven members, either as individuals or as members of the Forestry Co-op. The Forestry Co-op was a group of people that worked together to develop Earthaven, learning tree identification, felling practices, and timber framing construction. The Co-op was active from the late 1990s through the early 2000s and was responsible for the construction of the White Owl, Trading Post, House in Hawk Holler, Bellavia, Village Terraces, and the Storage Barn. After their dissolution, building construction at Earthaven has slowed.

In describing the building process at Earthaven, one member told me,

> "I'm a pirate myself and I believe it's my duty to break the law because the law is not always serving Gaia. What laws? Building codes. Building codes may have originally been designed to serve public safety, but now economic interests have taken over. I want to start with what the land needs and then create new agreements and codes. What we have going on here is a renaissance. At Earthaven we have good neighbor guidelines and building guidelines. We have a team of peers that look at your design and provide feedback. You redesign based on feedback and then get approval."

This theme of creating a new and better way of living is pervasive at Earthaven, and while not all of their experiments have been successes, the members seemed generally satisfied with Earthaven's built environment. According to one member, "the buildings and infrastructure are working very well. We have a high level of comfort if you want it, and there is a variation of comfort and affordability." According to several members, the main housing challenge at Earthaven currently is the housing shortage, which has kept the population from growing over the past two years (2011-2012).

Earthaven's neighborhoods are briefly described below:

- Gateway is located near the entrance to Earthaven. It is mostly farmland and includes a home, the Micro-Hut (kitchen, bedroom, office, and den in an 11' x 11' building), and a barn.
- The Forest garden lies along the road leading to the village center. It currently consists of three homes and businesses.
- The Hut Hamlet is near the center of the Village and is the oldest neighborhood at Earthaven. It was intended to offer temporary housing as people built homes in other Earthaven neighborhoods, but now has residents that have lived there for several years. The Hamlet is structurally diverse, consisting of straw bale cabins, a cob building, several elevated yurts, and other unusual designs. The neighborhood clusters around a shared kitchen/bathhouse, several gardens, and a playground for children.
- The Village Center is the site of the Council Hall, Village Green, White Owl Lodge, and the Trading Post. This is Earthaven's central gathering point where meetings, events, and celebrations are held. There are a few compact sites available.
- The Village Terraces are a cohousing neighborhood on a terrace near the center of the village. It currently consists of two structures, the common house and a duplex called "Pokeberry," one of the community's newest homes. Village Terraces has a large community garden and hosts Imani Farm and Red Moon Herbs.

Figure 4.2-B Village Terraces building

- The Hickory Knob Compact Neighborhood is between the Village Terraces and Village Center. Currently this area hosts the campground where many visitors stay, but no homes have been constructed here yet.
- The Bellavia Gardens are near center of Earthaven, southeast of the Village Center Several homes have been built here as well as a neighborhood community building. Several homesites are as yet undeveloped.

Figure 4.2-C Bellavia Gardens home

- The Medicine Wheel House is a three-story cooperative residence that houses long-time members and offers lodging to apprentices and work exchangers. It is surrounded by a large garden that is tended by the residents of Medicine Wheel. The garden is a constantly evolving experiment in permaculture.
- Hawk Holler includes the first home built by the Forestry Co-op and is a 10-minute walk from the Village Center. It is a relatively remote neighborhood with several open homesites.
- East End is out beyond Hawk Holler at the end of the East End Road. It currently has no developed homesites.
- Lower Rosy Branch is along the road beyond the Village Terraces, about a seven minute walk from the Village Center. It currently has two homes.
- Middle Rosy Branch is just beyond Lower Rosy Branch. It currently has one home and several homesites.
- Upper Rosy Branch is beyond Middle Rosy Branch at the western edge of Earthaven's property, about a 15-minute walk from the center of the village. It has two homes so far and four remaining homesites.
- Piney Knob is south of the Rosy Branch neighborhoods across Rosy Branch Creek, about a 15-minute walk from the center of the village. It currently has one home.

4.3 Village Commerce

Earthaven residents face specific economic challenges based on the ecovillage's location. As one Earthaven member describes it,

> "We're too far from Asheville to support commuting to jobs. There are no large employers within 20 miles, and local service jobs are mostly 10-15 miles away over winding mountain roads" (Christian, 2009).

There are a number of businesses within Earthaven that employ community members and provide services to Earthaven and the surrounding areas. The farms and other agricultural projects at Earthaven (described above) provide some employment, but most barely break even financially. In addition there are several businesses and endeavors that have developed at Earthaven, including Red Moon Herbs*,* which makes and distributes herbal products, the Useful Plants Nursery, which raises and sells organic fruit trees and berry bushes, Road Warrior Construction, which builds passive-solar, off-grid homes for Earthaven members and neighbors, and the Forest Children's Program, a nonprofit homeschool program that serves children aged three to nine.

Even with these onsite businesses, it can be a significant economic challenge to live at Earthaven. One member described the economic situation at Earthaven.

> "There are economic challenges. Making a living here can be difficult. It's an impoverished county and a lot of us don't have money to pay each other. We don't have a lot common industries that people can plug into. We need more industries that people can make money at, that bring money from the outside world into the community. People here have called that money laundering. We take in money from the outside world, even through tours and such, and use it as much inside the community as possible before it goes out a little [ecologically] cleaner."

Another member points out, "We don't have a viable village economy here. We don't have enough people yet." And yet another member described her own economic and job experiences at Earthaven,

> "I have worked doing cleaning in the village and worked for Red Moon Herbs. There are number of retired people in the village who have that income, some people make part of their income from in village activity, although that tends to ebb and flow. I've spent most of life living off of not much money. I don't think I've ever made more than $10,000 a year."

Even when village members have goods and services to exchange, they may not have the money to pay to one another. The LEAP, Earthaven's internal currency, has been developed improve the flow of goods and services within Earthaven. Each LEAP represents an hour of work contributed to the village of Earthaven. Any hours worked beyond those required (work requirements are described in the Membership section above) earns a LEAP which has a nominal value of $10. These LEAPs can then be traded to other Earthaven members, and they ultimately can be turned back in to Earthaven as one hour of community work.

Earthaven has developed a LEAP directory where community members can submit information on the goods and services that they will provide for LEAPs. The paper directory includes some goods and many services in a variety of categories, including knitting, sewing, logo creation, child care, computer consulting, permaculture consulting, medicinal herbs, baked goods, wild mushrooms, homebrewed beer, haircuts, homeopathy, massage, chimney cleaning, tree removal, carpentry, proofreading, grant writing, and others. The wide array of offerings showcases the skills of the Earthaven members, many of whom would not necessarily be able to offer their goods/services for sale because of required certifications and approvals. There is also an online version of the LEAP directory that is similar to the classified ads website *Craigslist*, providing a listing of both offered services and required services.

5. Social Institutions and Local Culture

5.1 Decision-making and Organization

The decision-making process at Earthaven is described in detail above. However, the decision-making process also has a strong influence on the social development of the ecovillage. Consensus decision-making is very demanding as it requires everyone to agree before a decision can be implemented. The process of consensus decision making can be challenging, particularly when contentious topics arise. One member described the process, pointing out that

> "...whenever a proposal is introduced it doesn't belong to the individual anymore; it belongs to the group. Whenever you have an idea here and you discuss it with the group, you lose ownership. Which I think is a good thing. If someone has an issue with you, they can't criticize the proposal because of it. It's not your proposal. It's the group's. Everything has to go through the group."

While most of the day-to-day decisions are made by committees, contentious issues are generally returned to the council where they are often subject to long discussion, multiple rounds of proposals, and blocks by one or more of the community members. The development of the decision-making process is ongoing, as can be seen from the recent revisions. These revisions include the change to allow blocks to be overridden if 85% of the council members agree that the block is invalid, which it is hoped will address some of the challenges that Earthaven has been experiencing with the consensus process.

One source of difficulty with consensus at Earthaven relates to the different perspectives about the mission of Earthaven and the nature of sustainability that exist among the members. An example of this can be seen in the debate over the agricultural and other entrepreneurial enterprises at Earthaven. While many members support these efforts, others believe that businesses, due to their focus on money and budgets, contradict the ecovillage's values. The onsite agriculture also comes under criticism because some believe that it risks the excesses of industrialized agriculture, causing pollution of soil and water, while others in the community view the farms as sustainable agricultural projects that will build Earthaven's soil and protect its streams and groundwater. In this debate people have sometimes

> "…blocked a proposal because of their own interpretation of the word 'sustainability' or how the proposal violated the community's mission and purpose. People also began realizing that Earthaven's unwritten criteria for what constitutes a principled block is vague enough to also be multiply interpretable, and blocks have rarely been tested against these criteria anyway. Thus blocking for personal reasons has gone unchecked" (Christian, 2009).

Another challenge with the consensus process at Earthaven has been the varying approaches to conflict within the community. One resident explained to me:

> "Cultures have different approaches to conflict. Some people yell and argue and then get over it, while others are meek and quiet. Both are acting in the way they think appropriate, but when you mix cultures it can feel very hurtful. You get some of that here, and it causes conflict because people get hurt. We try to deal with it in Council, but it's difficult."

There are a number of mechanisms for defusing and mediating conflicts between individuals and groups at Earthaven, and most residents seemed to feel these were effective measures, but it is clear that relying on consensus decision-making amongst a group with diverse backgrounds and interpretations of the community mission can be very challenging.

Despite these challenges, most of the residents that I spoke to seemed to feel that the decision-making process works well. They felt that they would always be heard, that proposals and decisions were communicated clearly to the entire community, and that generally projects that would be detrimental to Earthaven are not allowed to go forward. The greatest source of frustration seemed to arise from the issues addressed above, particularly from varying ideas of what Earthaven should be and the difficulties surrounding making and implementing new decisions.

5.2 Sharing and Cooperation

Sharing is an essential part of life at Earthaven. There are numerous formal and informal networks for sharing useful tools, vehicles, entertainment material, child care, food and cooking responsibilities, and household goods. The Free Store, which is located in one of the barns at Earthaven, is a prime example of the sharing networks that have developed. The Free Store was originally an idea developed by one of the Earthaven members who got approval to start the project, cleared out and cleaned the area he wanted to locate the Free Store, and began accepting donations from the community. The Free Store is essentially a place to take any useful item that you own but don't want anymore. It has collections of books, clothing, children's toys, tools, appliances, and many other items. The store is maintained by community members, who can receive LEAPs for working there, and it is open to anyone in the community to take whatever they find appealing. It provides access to many useful items, especially in a community that is far from large shopping areas and where money can be scarce, while also minimizing waste. Other formal networks for sharing at Earthaven include the common kitchens at Medicine Wheel and the Hut Hamlet, the tool and tractor share, and the DVD library in the Council House.

There are also many informal networks of sharing between neighbors. Car use is one particularly important service that is typically handled through informal sharing. Some members who join Earthaven decide to give up their cars, which can provide logistical challenges when there is very little within walking or bicycle distance of the community. One member who arrived with a car sold it because she "wanted to experiment with a carless existence." She described her experience with car sharing and other types of sharing at Earthaven.

> "I came in with a car, but I don't have one now. I sold my car. I didn't know if I could make it without a car. Cars are freedom. Now, I use a car cooperatively. I share my books and art supplies. There are tool libraries here. I need a car tomorrow. I talked to Will about it. He will lend me his car, and I will pay for the mileage."

She explained to me that there are several people at Earthaven who are known to share their cars, and when she needs to get into town, she talks to one of them about borrowing their car for the day. If the person who owns a car can't share it for some reason, she tries someone else or just waits to go into town another day. This type of informal sharing doesn't provide guaranteed access to a car, but it seems to provide enough access for many of the members of Earthaven, and it results in a much lower car to person ratio within the village than is seen in most suburban or rural communities.

5.3 Village Service

Each member of Earthaven is obliged to work four hours a week on village tasks, which is often referred to as community service. This work is essential to the functioning of the community and many members are known for working many more hours than are required. As one member put it, "Everyone is doing their community service hours, and most are going above and beyond. There is just so much giving. The people here are committed and effective at doing stuff."

This service is done by being a member of one of the many committees that help the ecovillage to function or by doing work on a task that has been approved as "LEAP-able." LEAP-able tasks are ones where the LEAP committee has approved the task as qualifying as community service. These tasks also provide members that work more than the required number of hours with LEAPs, Earthaven's alternative currency.

Different levels of membership give people different timeframes to complete their required hours of service. Exploring members are expected to contribute four hours a week, provisional members are expected to provide 32 hours every two months, and full members are expected to provide 1500 hours over ten years. This village service is essential to the functioning of Earthaven, providing a workforce for the many physical and administrative tasks that keep the village going. The LEAP currency also provides an incentive for working more than the required hours, and that extra work has greatly aided the community.

5.4 Community Celebrations

The members of Earthaven come together in a variety of ways, from the weekly council meetings to impromptu social gatherings. There are always events posted on the social calendar, including membership rituals, yoga and meditation gatherings, group meetings, etc. There is also the weekly potluck dinner where everyone brings a dish, there is often a bonfire, and people play music, talk, and dance. These weekly gatherings keep the village members in touch with another and aware of what is going on in the community. Each potluck begins with people sharing what is important to them at that moment and what they are grateful for, providing a quick way to better understand the other ecovillage members.

In addition to these regular gatherings, there are also a variety of community celebrations that Earthaven has developed and included as part of their community culture. The Founding Day parade, which takes place annually on September 11, celebrates the founding of

Earthaven. The parade travels through the village and includes floats made by different neighborhoods. Many people wear costumes, and everyone celebrates living in Earthaven. Events like this reaffirm the value of the community and the commitment of its members to making Earthaven work.

Figure 5.4-A Founding Day Parade 2011[21]

In addition to Founding Day, Earthaven also holds a yearly harvest festival in the fall as the crops come in. This is a festival focused on food and celebration. People share the food they have grown and harvested that year and vendors also come from outside Earthaven to participate and share with the community. Near Christmas there is the Bizarre Bazaar, where members of Earthaven sell crafts and specialties. In May, the village erects a maypole, and there is dancing, eating, and music. In addition to these events, many members celebrate the Solstices and Equinoxes, acknowledging the role of the seasons and nature in their lives. These

[21] Photo courtesy of Diana Leafe Christian

celebrations help to shape the culture of the ecovillage, affirming their connections to each other and to the natural world they are living with.

5.5 Attitude of Experimentation

During my first phone call with the Airspinner (person designated for communication with the public) at Earthaven, I was told that "Earthaven is not a utopia." This message was reinforced by many members through the course of our interviews. Instead, Earthaven was described as a "living laboratory for sustainability." One member told me that they "give people permission to experiment," and another said, "We are trying to do things here that we don't see elsewhere."

This attitude of experimentation is especially clear at Earthaven. Each home is built in a different fashion, showing alternate attempts at ecologically sound housing. Earthaven also provides an environment that encourages new projects, with many members trying to create small businesses within the community or to create community projects. One member told me that one of the best things about Earthaven was the ability to try out his ideas. The Free Store (described above) was one of his ideas. Originally the barn where it is located had been "full of junk." He cleaned it out and began organizing the useful materials. He let the community know that they could bring useful, but unwanted items there, and the Free Store was started. There are also experiments in interpersonal relations and social processes. While I was staying with them, Earthaven members were trying new methods for dealing with conflict, referred to as Forums and Restorative Circles.

The members of Earthaven I spoke to did not claim to have worked out how to live sustainably, but they expressed commitment to the process of experimentation and learning. One member summed up the Earthaven experience this way.

> "We don't have the answer. Someone called Earthaven a seven-generation project. What if we don't get there in seven generations? That's ok. I'm just trying to be healthy and happy and contribute while enjoying my life."

5.6 Behavioral Shifts

By choosing to live at Earthaven, a person is committing to living in a close-knit community and in reducing their environmental impact. However, living in community with each other also reaffirms and reinforces the community values, resulting in perspectives and behaviors that may not have manifested outside the community. The use of non-violent communication (NVC) is one example of a shift in behavior that the Earthaven community supports. NVC is a communication strategy focused on empathy and compassion (CNVC, 2012). At Earthaven, this takes the form of people editing typical phrases and sayings to remove references to war and gender stereotypes. In describing the use of NVC at Earthaven one member said,

> "I started to use expression 'double edged sword' but stopped because at Earthaven we don't use anything that is war-based or domination-based or gender-based. We are trying to extract that language. So instead of saying 'two birds with one stone' they'll say something like 'two friends with one hug.' It's a mental thing that frames your existence."

The use of NVC at Earthaven can seem strange at first, but it is part of a larger effort to create a more community-oriented attitude. Many members commented on how mainstream culture is so individual-oriented that joining Earthaven can be a difficult adjustment for many people. Another member said that the biggest change she had experienced in being a part of Earthaven was that she couldn't just walk away from conflict or back out of the community. Joining this community requires a commitment to become a part of the community, and in doing so people change their behaviors in way that would not have occurred otherwise.

Chapter 6. Sirius Community

> Sirius Community has a fourfold purpose: spiritual cultivation, ecological design, fostering community, and education:
> - Spiritual Cultivation: In a non-sectarian fashion, we access guidance through individually chosen spiritual practices, and through group meditative processes addressing conflict, decision-making, and governance.
> - Ecological Design: We aspire to be a developing ecovillage, modeling permaculture principles in our design of gardens, homes, guest facilities, and outbuildings. Living in harmony with Nature is pointedly emphasized, as our physical lives are seen as direct reflections of our relationship with spiritually, which is our primary concern.
> - Fostering Community: We seek a workable balance between work and play in all activities, between individual and collective needs, spiritual and worldly pursuit, and between hierarchy and egalitarianism.
> - Education: Sirius is organized as a 501.c3 educational non-profit, and offers an array of educational programs.
>
> -Sirius Community Website

1. Village Description

Sirius Community is just off of Baker Road in rural Shutesbury, Massachusetts, eight miles from Amherst, MA. The surrounding land is mostly farms and forests with a few widely spaced homes. Sirius Community consists of 80 acres of heavily forested land, with only a few clearings for gardens and buildings. The forest here is a northern hardwood forest, dominated by white pine, oaks, and hemlocks. Sirius community was started by Bruce and Linda Davidson (who still live there) in 1978, after they left the Findhorn community in Scotland. They consider it a spiritual successor to Findhorn, and describe it as “spiritual, but in non-sectarian manner that allows for each person to find their own way to the heart of all beingness and reality. The shared expression reflects the reverence for all Life and willingness to live in accord with this intention as much as possible” (Sirius Community, 2013). The focus on the spirit and spiritual practice is much stronger at Sirius than at either EVI or Earthaven.

Figure 1-A Sirius Community Entrance

Sirius Community is quite small, with only about 30 residents in five main buildings: the Long House, Community Center, Phoenix House, the Farm House, and Kailasha/Light House. These buildings are arranged in a semi-clustered development pattern with all of them built on about ¼ of the total land area, and it is an easy walk from one to the other. In addition to these main buildings there are several others which are built further back into the property, including the Retreat House, the Cob House, two yurts, and a screened in “summer house” where some members choose to live in the summer. There are also two large gardens that grow many of the vegetables eaten at Sirius. The map below shows the locations of the main buildings and tow large gardens, as well as several other community features.

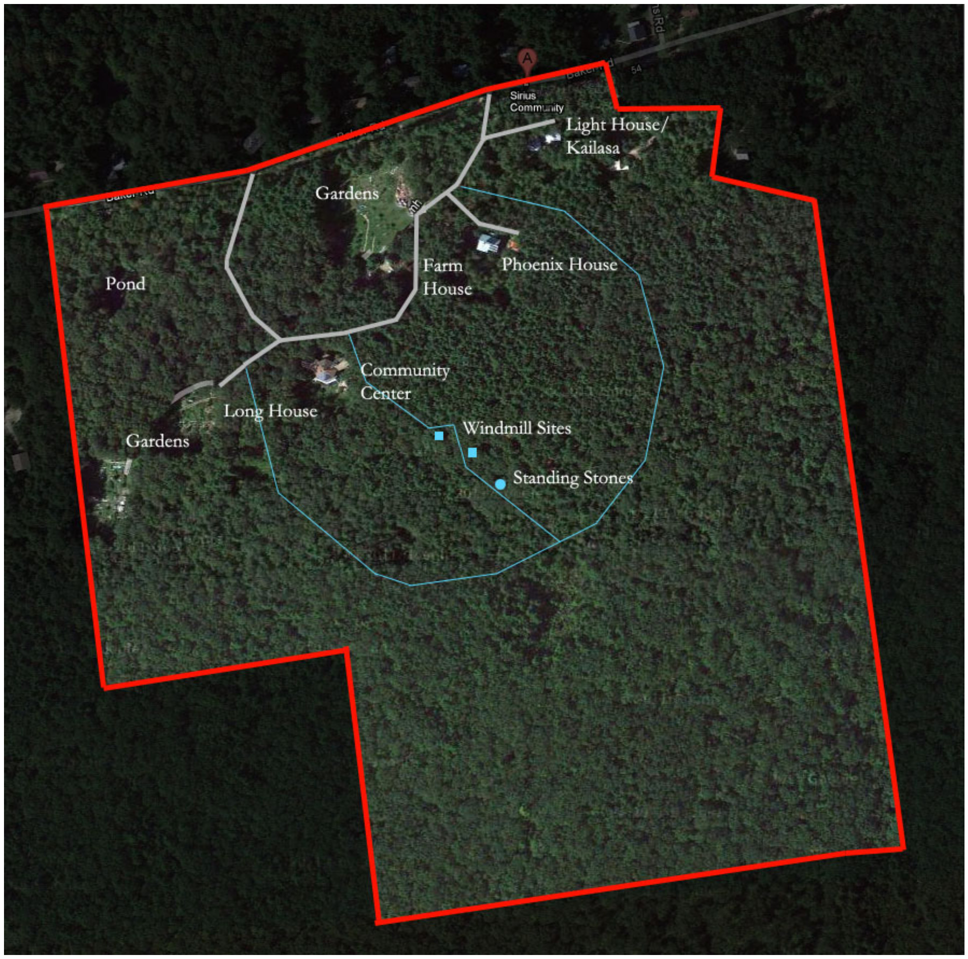

Figure 1-B Sirius Community Map[22]

While visiting Sirius, I asked one of the founders about their relationship to the surrounding communities. He responded by saying that

> "…our vision is to be part of a larger local community and help as many people as possible to learn how to be self-sufficient in their own way, to be more independent in terms of energy and all that because it's going to be needed in the future. If you're just a single cell and you've got all these other cells out here wanting and you're not going to maintain your single cellness for very long. So you have to support on a much larger scale than just a single cell.
>
> It's ridiculous to think that you can be individually or even collectively independent of the larger society. It's a fairytale I think. So, you've got to look toward the whole larger community and how can you support the development of the larger community, meeting the needs of the larger community. That's the educational intent of Sirius, to help the larger community to understand what's going on and to prepare for whatever

[22] Aerial Image: Google

> is going to come down. Our thing is to be as open as possible: permeable, open, and transparent. We talked about this as a group. We all came to the same conclusion that there's no way to hoard anything. You need to be willing to help as many people as possible."

The members of Sirius are not attempting to remove themselves from society, or to become completely self-sufficient, but instead to be a resource and inspiration for the larger community.

Sirius is organized legally as an educational non-profit, commonly referred to as a 501.c3 due to its designation under the tax code. Sirius Community, the non-profit, owns all of the land and buildings on the site, and residents pay rent and fees to the non-profit for their housing and other services. The Community Center provides housing and conference space for the permaculture workshops, retreats, and other events and classes that are held at Sirius. The money made from these events provides a large part of the funding that keeps Sirius running, and at one member described Sirius Community as "an educational institution with a small residential component, rather than the other way around."

While Sirius itself is quite small, it is a part of a larger community of people that share much of the same ethos called Hearthstone Village. This includes The Ark, another intentional community in a single, large house, which is across the road from the entrance to Sirius as well as many of the homes along Baker Road, which include many former Sirius residents and people closely associated with the community.

Figure 1-C The Ark

2. Community Organization

Sirius is a small and tight-knit community. With only 20-30 members, everyone is a familiar face, and informal meals and gatherings occur frequently. Sirius also has community meals at least two days a week at the Community Center. Often, people who attend include people from outside of Sirius. The Community Center is the primary indoor meeting space for Sirius with a large kitchen, a dining room, and the Octagon upstairs (a large octagonal room used for meetings, events, classes, etc.). Members of the community also gather weekly for a community meeting where issues are discussed and consensus decisions are made.

While the community aspect of Sirius offers a lot of support and interaction to its members, it also demands significant amounts of time and engagement. Members are expected to attend the decision-making meetings and to give their time and energy for the betterment of the community. One former member of Sirius described the misunderstanding about community that many people experience.

> "Community it attracts a lot of people who are looking for support, and they see it as sort of a personal security blanket. I can do my thing here. And in community it's kind

> of like, no. We'll see what we can do. If you're going to be here you need to be part of the collective. You need to do what needs to be done for the community, and if that's shoveling shit in the compost, you've got to do that. And if you just want to do your art that's not going to work."

Despite the challenges inherent in being a member of a small community like Sirius, members also find many rewards. A relatively new member to the community described her experience of being a member of Sirius to me.

> "I am thoroughly myself here. I'm not denying any parts of my personality. I'm fully who I am, and I fully meet whoever else is here and am excited to learn that they are. I don't think there's any way to generalize about the people at Sirius. It's diverse, probably most visibly age-wise and ability-wise. It is so rewarding to be in a place like this. … When I lived in New York in my own apartment, I would check in with my neighbors, but I didn't get this sense of interdependency. I think a community like this a sustainable because it's a great place for your entire life. It's not as a place where you can only live when you are young and healthy, but you will have to leave and go to an old age home. No, this is a great place for you to live if you're not doing that well because we younger more able members of the community care for you. And it's rewarding for us too. I get something out that. There is worlds to learn from people with more experience. I came here as a completely blank slate and there's so much to learn."

2.1 Decision making

Sirius makes its decisions through the process of meditative consensus. The main difference between meditative consensus and the consensus processes in the other ecovillages is that each meeting is preceded by a 20 minute meditation where each attendee at the meeting tries to open themselves up to what will be for the highest good of the community as a whole. The meditation is then followed by people sharing what they gained from the meditation as well as any other personal issues or ideas that they feel are pertinent. The purpose of the meditation and sharing is to try and ensure that each person is focused on the good of the community, rather than on their own opinions.

One member described the importance of the meditative consensus process this way.

> "I have been in a number of meetings where there was a decision to be made and people kind of had a sense of where it was going, and then we would have a 20 minute

> meditation and say let's kind of just go inside and look what of us can happen and then we would go around and someone would say, something came up and I want to share it, and the next person would say, that's a good point, and the whole decision would take a different track. And so holding that silence and spaciousness for decisions is really important."

Other members also commented on situations where the entire group had already settled on a particular decision going into the meeting, but after the mediation, they were far less certain that it was the right choice and instead explored alternative options. In at least one case the meditation completely changed the direction of the decision.

> "There was one case where we discussing this one issue and we were all convinced that we were going to make a decision in one particular direction and everybody came out of the meditative consensus with the opposite idea. And we made the opposite decision. We always go by the meditative thing, and time proved us right. The meditative decision was correct and the other one would have been a mistake."

Even with meditation to guide the process, the decision-making process at Sirius can be difficult and contentious. In meetings that I observed, sometimes the business was simple and issues were passed on to committees or resolved by the Core Group. However, contentious issues also arose: one issue that caused a great deal of conflict among the members of the community was the question of whether to serving meat to guests through the Community Center kitchen, which is currently exclusively vegetarian. This issue was brought up in response to some financial issues, and the person proposing the change thought that Sirius was losing the opportunity to host certain groups in its Community Center because Sirius would not prepare meat in the kitchen. Hosting groups in the Community Center is a major source of revenue, so this could be considered a very important issue in its own right. However, the intense debate which followed the proposal extended to issues far beyond dietary preferences. To some residents and members at least one member of the Core Group, vegetarianism embodied the values of the community, including respect of the land and animals. They argued that the decision to serve meat in would be a blow to the community, compromising the very meaning of

Sirius. On the other side, people discussed their own personal decisions to transition from a vegetarian diet to one that included meat and the fact that certain community members and outsiders might feel discriminated against. After at least an hour of debate, the call was made for a decision and one of the core group members chose to block the decision, with the intention to revisit it after private discussions among the proponents and opponents. This issue had been raised in previous meetings and clearly would be raised again.

The amount of time and debate that has been devoted to this and other contentious issues brings into focus one of the main complaints about consensus that I heard – that it is inefficient, taking far too long to settle on a decision. One member of the community addressed this in an interview.

> "Some people say that it takes a really long time, but other people say if you look at the full lifecycle of the decision, from the problem to full implementation of the solution, consensus can actually be very efficient. Using the democratic model you might decide something very quickly, but it might be sabotaged because you don't have full support by the by the community. In a small community like Sirius you can only enforce decisions that at least a supermajority supports. And so those decisions that seem like they happen very quickly are actually inefficient in the longer term. So if you can take that time and really build consensus you can often channel a lot of energy that can move big things quickly."

As the number of decision-makers grows, the process of coming to a consensus can become more unwieldy, but Sirius handles this by making only a subset of the community able to block decisions. The Core Group, as these community members are known, are a group that take on financial and legal responsibility for Sirius and also act as the Board of Directors for the Sirius Community non-profit organization. Other full members of the community are welcome to speak and express opinions at the meetings, and they may ask the Core Group to reconsider a decision, but they cannot actually block a decision. The Core Group is the heart of the community and its primary leadership. They are also primarily the older members of the community, which has led to some concerns about the future of Sirius.

One resident discussed the need to develop the next generation of leadership at Sirius with me. He said that without new leadership, he could see Sirius "becoming a museum of what an ecovillage used to look like in the 20th century, with a dwindling amount of financial input until it dissolves or gets taken over by another non-profit." This transition is going to be a big challenge for Sirius over the coming years as the founders and other Core Group members age.

2.2 Ownership/Public vs. Private/Individual vs. Common

All of the land and buildings that make up Sirius are owned by the non-profit, and members and residents pay rent and fees to be able to live there and use the common resources. The decision to organize the community this way was made for both legal and philosophical reasons. From a legal perspective, having everything owned by the non-profit provided more flexibility in the location, clustering, and type of buildings. Zoning laws would have restricted what could be built and where if the community were not organized as a single non-profit. However, Bruce, one of the community founders explained that his beliefs and relationship to the land were also a powerful factor in choosing to own the land communally.

> "I don't feel like I want to own anything. I own a couple old trucks and some tools, but personally I have no need to own the Earth. The Earth doesn't belong to me. Why should I feel like I own something. I'm a custodian of it, making sure it's being dealt with fairly. People are free to come use the land, but they have to take care of it. Have to respect the land. Not showing respect for the land is not okay with me. I'm kind of like the guardian of the land in a certain way… not heavily just to ensure the land is being respected. I think we all do, all the people who live here feel that way too. That we are here to take care of it and make sure that it is being honored and taken care of."

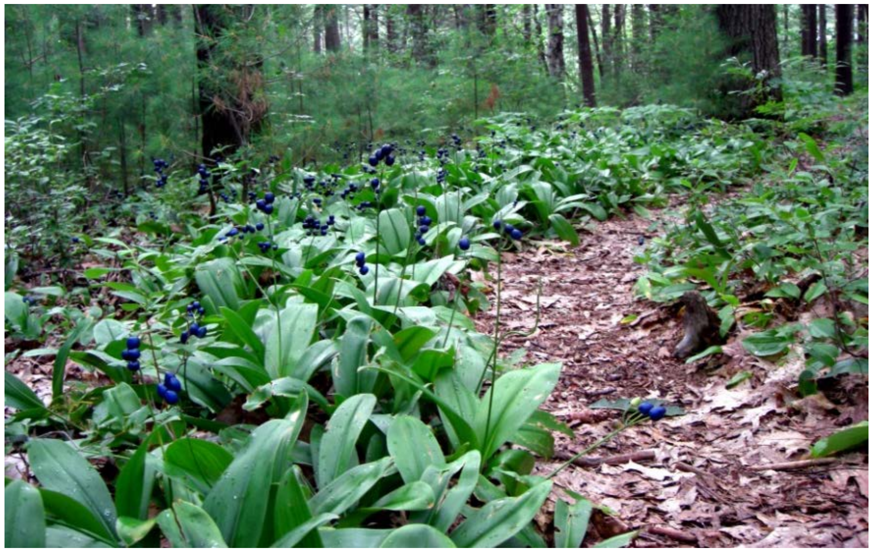

Figure 2.2-A hiking trail at Sirius

Joining Sirius grants someone access to a wide array of community resources as well as a home. The 80 acres of forested land are crossed by hiking trails and include a small retreat house that members can make use of. The Community Center contains a large kitchen, dining room, gathering space, and grassy green that can all be used by community members. There is also a sauna and cob pizza oven for community use. The Sirius gardens produce a variety of vegetables that members can access. There is a tool share, biodiesel club, and small village store where bulk food can be purchased.

Figure 2.2-B Sirius Community Retreat House

Being a member of the community also ties you to the other community members who work and play together and provide support through difficult times. One member I spoke to had been injured shortly after joining the community. He was ready to move into town to get care, but the members of the community insisted he stay in one of the Community Center's guest rooms so they could care for him. He described it as a difficult transition, but one that made him firmly a part of the community.

> "I had been living as a hermit, interacting with people only as much as necessary, but you can't live that way here. Here you are intimately involved in every aspect of other people's lives and they with yours. There are real relationships here."

The demands of such a tight community and lack of land ownership can also prove a challenge to potential members of Sirius and other communities. As one former member of Sirius explained to me:

> "When you are young, it's not an issue, but at a certain age people need to start building equity and its difficult to do that in community. So, it's a challenging thing about a lot of communities… It can support people at a very low income, but it can also be a bit of a trap because then you don't have the opportunity to leave if you think you might want to. When you join you think, 'Wow I can really kind of scale down,' but when you need something that requires more money, that can be hard. This was a big issue when I was living there because of my children."

2.3 Membership Process

Sirius has a multi-tiered membership system with different types of membership based on the level of commitment to the community. One former member of Sirius described it this way:

> "There's full member, there's supporting member, there's extended member, there's associate member, and exploring member. And even within the community there's another community; there's the Core Group. So, it's not like you're in or you're out; it's like, what's your level of relationship? When we moved in we were members for a year and a half, maybe two years, and now we live across the road. So now we are part of that extended community and I'm focusing my energies there on the wider onion. It's not that one is necessarily better than the other, but the small Core Group is kind of the small onion and then there's a larger ring of people around it."

Sirius tries to make it easy to be affiliated with the community by providing these multiple levels and types of membership.

Resident is a designation for someone who lives on the Sirius land but isn't considered a member. Residents live on the land and are expected to provide four hours a week of community service, but they are not expected to attend the weekly meeting and don't have the ability to speak if they do attend the meetings unless a member of the Core Group allows it. The residents at Sirius that I interviewed said they chose this option because they weren't ready to commit to the eight hours of community service and meeting attendance that goes along with being a full member.

Exploring member is a label for someone who is considering full membership at Sirius. This may be a resident who is considering increasing their role in the community, or it may be someone from outside the community who wants to learn more and consider joining Sirius. Exploring membership is a year long process where individual enjoy the privileges and obligations associated with full membership and experience sixteen hours of instruction about membership at Sirius.

Many of those who live at Sirius are full members, but full members don't have to be residents of the community. They can live elsewhere as long as they fulfill the other requirements of membership. To become a full member, an individual must go through an interview with the Core Group and be approved by all of the members. Full members are required to contribute eight hours of community service per week and are expected to attend the weekly meetings. Members are entitled to speak at these meetings, although they cannot block consensus. Members also receive several perks including preference in housing choice, the ability to have guests stay at the community center for a minimal fee, and a discount when using the sauna.

The Core Group is the decision-making body at Sirius, and they are also the Board of Directors for Sirius non-profit. The members of the Core Group take on fiscal and legal responsibility for the community. They are expected to balance and manage the budget, to oversee all legal matters and respond to any legal challenges, and they are the only members who can block consensus. If a member of the community disagrees with a decision that the Core Group has made, they can ask the Core Group to reconsider, but he or she cannot block the decision. Being a member of the Core Group requires a very high level of commitment to Sirius, and most members of the Core Group heavily involved in the day-to-day management of the community as well as guiding its long-term development. To become a member of the Core Group, a member of the community must be in good standing for a full year (meaning they have completed all their service hours, paid all rent and fees, and regularly attended the weekly meetings), and he or she must go through an interview process with and be approved by the current Core Group and the other community members.

Over the several years that I visited Sirius, I saw several members come and go, and my interviews with other members and former members suggest that there is a high turnover rate amongst members at Sirius although the Core Group has remained relatively static. One former member described his situation to me. He had been active in the community but once he had a family and a job outside of the community the 8 hours of community service and weekly meetings became a strain. Ultimately, he and his family moved across the street to a single family home, and while they remain involved with Sirius, they are no longer members. He described the process of people moving through the community this way.

"Bounce rate is the metric for a website of the people who come and visit your home page and then leave. They don't stay. And I think Sirius really has a pretty high bounce rate. Meaning that there are a lot of people that come, they stay for a day, a week, couple weeks, even a couple months, but it's not sticky. It's not welcoming in a way that supports people's deeper engagement. There are a lot of reasons for that, and I can understand it, but I think

Sirius has some reflection to do if they want to become a community that more people are attracted to and stay."

3. Environmental Protection and Resource Use

The attitude at Sirius toward the natural world was summed up by one member: "the people who stay here live by focusing on contributing to the land rather than taking." When Sirius started 35 years ago, the soil was so poor that it was difficult to grow much, but through careful management and extensive composting the soil has improved dramatically. There is a strong ethic of stewardship and protection of the land throughout the community, which can be seen in their land management practices.

3.1 Open Space Preservation

The members of Sirius have worked hard to minimize disturbance to the land throughout the ecovillage's development. The homesites are nestled generally into the woods with very few trees taken down, and the only major clearings in the village are the two gardens and the yard behind the community center. The 80 acres of land is owned by the Sirius non-profit and is not under any conservation easements, but those areas not cleared for buildings and gardens are intended to be kept as perpetual forest. The approach to the management of the forests at Sirius goes well beyond preservation. The members of Sirius want to help the land become healthier, and use selective logging, soil improvement, and planting to improve the health of their forest.

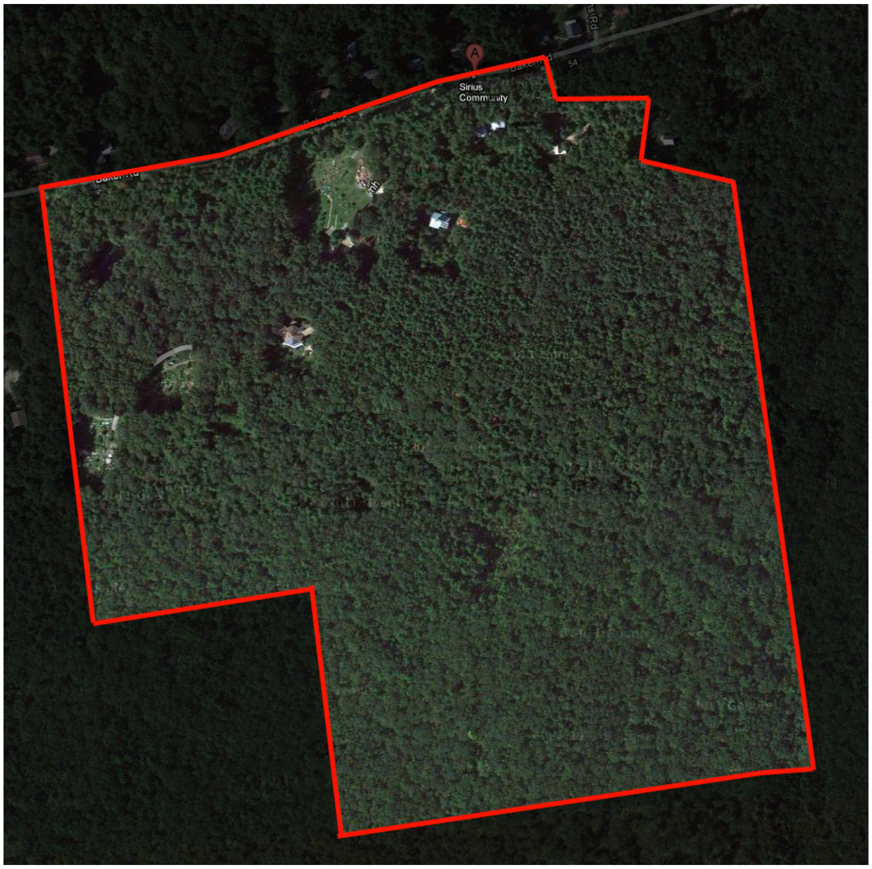

Figure 3.1-A Sirius Community aerial photo[23]

3.2 Onsite Renewable Energy Use

Sirius has experimented with a number of different ways to make use of renewable energy. There are photovoltaic and solar hot water panels on the Community Center and the Phoenix House. These supply most of the electricity and hot water for these two buildings. A 10 kW wind turbine was in the process of being erected when I visited in May of 2012 which will provide electricity to several of the buildings onsite. Another major source of onsite energy is the wood harvested from Sirius land and from nearby sites by one of the community founders through his arborists business. Wood is the primary heating fuel used throughout Sirius, and the careful management of the Sirius forests provides most, and sometimes all, of the village's wood

[23] Aerial Image: Google

needs. Sirius also has a used vegetable oil club, which obtains used vegetable oil from local businesses and the Sirius kitchen and provides it to club members for use in their cars as fuel. Several members of Sirius are part of the club, but it is also open to those outside the community.

Figure 3.2-A Renewable energy at Sirius

Although Sirius still receives much of its electricity from outside the community, the principle of resilience can be seen in the use of onsite energy. Wood, wind, and sunlight all supply energy, and Sirius continues to deploy new systems as technologies prove themselves and funding becomes available. The description of what happened at Sirius during a recent ice storm shows how effective this strategy has been.

> "Last year there was this horrific hurricane ice storm that hit us. A bunch of cars got destroyed, trees were down, and Shutesbury was out of electricity for close to a week, and it was hard. At Sirius it was a blast! We all brought our food together and we just cooked big meals for each other and got the sauna going, which was wood fired. It was one of the most beautiful times of community that I can remember and we almost thought we should have a no energy day once a year, and just kind of do that again."

3.3 Onsite Food Production and Forestry

Sirius has extensive forests and two large gardens as well as a greenhouse in the Community Center. In the spring, summer, and early fall, the gardens provide a large supply of produce which is available to all the members of the community. Residents and members of Sirius pay $25 a month and are able to take as much produce as they need. Several of those I spoke to said that during the summer the gardens provide all of their vegetables, and even in the cold seasons the gardens still provide about half of their vegetables. As discussed above, the forests provide much of the wood needed at Sirius, both for construction purposes and for fuel.

Figure 3.3-A Lower gardens at Sirius

However, the members of Sirius aren't focused on being able to provide for all of their own needs just through their own production. Bruce, one of the founders of Sirius, explained it to me this way.

> "It's ridiculous to think that you can be individually or even collectively independent of the larger society… We don't necessarily need to produce all of our food here. They're growing an organic farm right around the corner, you know, and we can support them somehow. So it isn't that we're trying to be independently self-sufficient. We're trying to live as simply as we can on the land with the least amount of environmental impact. And sometimes that's really hard to do in your own individual unit, but if you broaden out and you start looking at the broader community it becomes easier to do. So we're

> really into supporting other people who are doing the same thing. And we don't necessarily feel like we need to do everything, but we need to do our piece and do it well."

3.4 Waste Reduction

As at the other ecovillages, extensive use of composting, recycling, and reuse results in very low amounts of trash. Nearly all food-waste is composted and the compost is used in the gardens to improve the soil. This results in almost zero food waste that is disposed of off-site. Recycling bins are located throughout the Community Center and at each building, and I observed a very high level of recycling, as well as the widespread reuse of containers, during my visits. Sirius has municipal trash and recycling service, which are collected at the community entrance.

Wastewater is handled by septic systems at Sirius, and this has been a limiting factor on the number of building sites available on the land. The Community Center and several of the other buildings include composting toilets which reduce the load on the septic systems and provide another source of compost. Sirius considers very little material to be actual waste, and the members try to find a use for anything before considering throwing it away.

4. Ecological Planning and Village Development

4.1 Ecovillage Location

Sirius is located in a rural area that feels remote, although it is only eight miles from Amherst, MA. When the land was purchased in 1978, there was almost no nearby development. Now there are scattered homes and farms in the surrounding area, and a number of homes and another cooperative community, the Ark, have been built along Baker Road, where Sirius is located. The Sirius Community site is far enough from an established town that it does not have access to city water or sewer systems, which has been a constraint on the ability to build on the site.

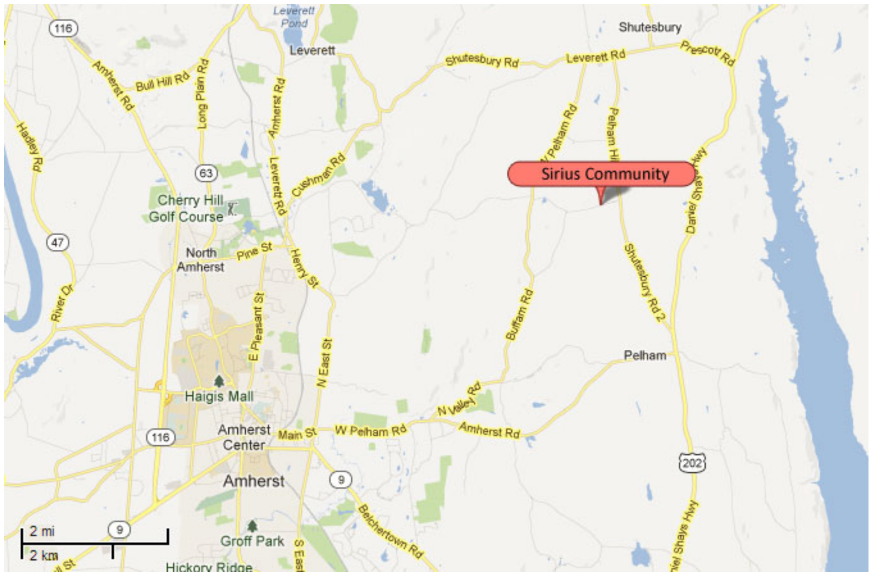

Figure 4.1-A Sirius Community location map[24]

The 80 acres that make up Sirius are hilly and rocky with occasional large outcrops of stone. Nearly the entire site remains forested, and a trail system has been established that connects the various homes, loops through the forest, and connects to the stone circle, wind turbine sites, and retreat house. Once away from the road, it is easy to feel as if you are far from the industrialized world, as little road noise or other sounds can be heard.

Although the proximity to Amherst makes working there a viable option, most members of the Core Group work at Sirius or in the nearby town of Shutesbury. Other members have jobs in Amherst, often associated with the University of Massachusetts campus there. Although Sirius hosts and runs a number of educational and other programs, the non-profit is not able to provide employment for the whole community.

[24] Map Data: Google

4.2 Homebuilding and Neighborhood Development

All of the buildings at Sirius, except for original farmhouse and garages, were built by community members and apprentices using locally harvested wood that was milled and stored on the land. The designs prioritized the use of non-toxic materials, including citrus-based paint thinners and cellulose insulation. All of the homes were designed to use passive solar energy and were constructed using post and beam techniques. The results of these practices are homes that are generally small and energy efficient and seem to fit with the surrounding landscape.

Although some of these homes were started by community members, they are all owned by the community. If a family that builds a home leaves Sirius, they are paid back for the home through the rent that is gathered from their home. Several of the homes at Sirius, including Kailasha and the Light House, were built in this fashion.

Figure 4.2-A The Light House at Sirius

Sirius has had to work with and around local government requirements to build Sirius in the way they wanted. By structuring the community as a non-profit corporation and having that corporation own all of the buildings, Sirius was exempted from zoning requirements. This allowed them to cluster the buildings and to build multiple homes without having to subdivide the land. One of the members of Sirius also sits on the local planning board, which provides some protection for the community and helps them to influence the development of the local community.

Figure 4.2-B The Cob House at Sirius

In at least one case, however, the local government declared that one of the Sirius buildings, the Cob House, was unsuitable for habitation. The Cob House was featured in several magazines after it was built, which led the local government to pay more attention to it. Its construction did not meet the requirements of several building codes and so it was deemed unfit for habitation. It is now used primarily for meetings and parties, but cannot be used as a residence.

The following photos show many of the other major buildings and homes at Sirius. Currently there is housing for approximately 30 residents at Sirius, and the Community Center includes another 6 guest rooms. There was only one additional home built during the several years that I visited, and I was told that there are few places suitable for building on the site that haven't already been used, so it is unlikely that the housing stock will increase significantly.

Figure 4.2-C Phoenix House at Sirius

Figure 4.2-D The Sirius Community Center

Figure 4.2-E The Long House at Sirius

Figure 4.2-F A yurt at Sirius

Figure 4.2-G New home under construction at Sirius

4.3 Village Commerce

Sirius is more centrally organized than the other two ecovillages. While Earthaven is a homeowners association, and EVI is a collection of different entities, Sirius is a single non-profit, and as such it organizes most of the village commerce. The Sirius Community Center is used for small conferences and educational programs year round, with guests staying in the guest rooms at the Community Center and eating at the kitchen there. These activities provide employment for community members, as do the gardens. Whereas the other ecovillages included farms and CSAs that were on village land but not necessarily run by the village, Sirius's gardens are run by Linda, one of the community founders and a member of the Core Group, and the gardens costs and revenues are part of the non-profit's budget. The village store is another endeavor that operates as part of the non-profit. Sirius buys bulk goods which are then made available to community members through the village store. The store operates primarily on the honor system, with members recording what they take from the store in a computer and being billed for it monthly. Thus, most of the economic activity at Sirius is mediated by the non-profit, rather than individual businesses or co-ops.

Sirius has also functioned as a fostering organization for other non-profits and businesses. Living Routes, a non-profit that educates and arranges study abroad experiences for students to learn about eco-communities started out under the umbrella of Sirius, but it is now a part of University of Massachusetts. A small business that manufactures and sells kombucha also began at Sirius but has now moved off-site so that it can expand. In many ways, Sirius functions as a core from which other communities and endeavors can grow, but it does not try to expand into a community that can contain those activities.

Figure 4.3-A Sirius community store

5. Social Institutions and Local Culture

5.1 Decision Making and Organization

The decision-making process at each ecovillage has a powerful influence on the development of social norms and culture. The details of Sirius's decision-making process are discussed above, but the biggest difference between Sirius and the other ecovillages studied is that at Sirius it is consensus by the Core Group, rather than consensus by all full members. One of the major complaints about consensus decision-making at the other ecovillages is the difficulty of getting a large group of people with diverse opinions to all agree on a particular proposal. At Sirius, only the Core Group may block a decision, so only eight people have to agree. Even with fewer people, some issues can be difficult and divisive, as I witnessed in a debate about whether to cook meat in the Community Center kitchen. However, in general, consensus decision-making does seem to progress more swiftly at Sirius than at the other two ecovillages.

However, the Core Group system also creates some tension in the community. When I spoke to younger members of Sirius and to former members of the community, I was often told how frustrating it was to try and make any changes at Sirius. The Core Group is made up mostly of the older members of Sirius who have lived there the longest, and many younger members felt they weren't open to new projects and proposals to change the way Sirius functions. I spoke to one of the community founders and members of the core group about this, and he said that often young members will propose an idea that members of Sirius had attempted years before that hadn't worked. He felt that the Core Group represented the accumulated wisdom at Sirius while the younger members felt that the Core Group stifled their creativity and ability to experiment.

This tension will continue to play out as the members of the Core Group continue to age and eventually step down from their role as decision-makers. Many members of the Core Group are in their late 60s or 70s, making the transfer of leadership to younger members a key concern for many members of Sirius. Currently there is at least one younger member who is highly involved in the decision-making process at Sirius, but other young residents I spoke to were not interested in being involved in the decision making. When asked about her involvement in decision-making, one younger resident responded, “I'm not. If they decide to build a new building, cool, but I don't have to be at the meeting to talk about it.” For these residents the requirement to attend weekly consensus meetings was actually one of the reasons not to go from resident to member.

Despite the frustration expressed by some of the younger members, most residents and members of Sirius seemed satisfied with the decision-making process and the decisions that had been made. Sirius was formed in 1978 and has had decades to work out most of its processes, so the main decisions that have to be made center around keeping the community going. Much of their focus in the meetings I attended was on fundraising and budgetary issues, which most members and residents did not want to be involved with.

5.2 Sharing and Cooperation

Sharing of time and resources is common at Sirius. Although there are not as many formal sharing systems as at Earthaven or EVI, I witnessed numerous examples of informal sharing. I watched residents took time to help others with laundry, car maintenance, and food preparation. At least one resident told me that the insulation of her home was a community project, with many residents bringing different insulating materials and helping her to prepare for winter. Residents also work together to gather and transport wood for any house that starts to run low in the winter. Sirius is based on an ethic of cooperation, and it is readily apparent in the daily activities of the residents.

5.3 Village Service

Members of Sirius are expected to work eight hours a week for the community and residents are expected to work four. This service is essential to the functioning of the community, especially given its small size. Up to half of the work can be in committees, but the other half is expected to be physical work that the community needs. If any member has something that needs to be done, particularly a larger project that they cannot complete alone, they can propose it as a community project. If it is approved, then that project will count towards the required community service hours.

One member told me that the village service requirement is a challenge because so many of the residents and members are in their 60s or older, and these members are not as physically able as they once were. She feels that bringing in more young people is essential for the community. However, the high number of work hours required for members (the highest of the three ecovillages) is also a barrier to new members joining. Several residents and former members that I spoke to mentioned that the expected eight hours a week plus weekly meeting attendance was more than they could offer to the community, especially when they had children to care for.

5.4 Community Celebrations

Sirius has a variety of community celebrations that affirm their connections to each other, the natural world and the spirit. Each year on July 4, Sirius celebrates Interdependence Day instead of Independence Day. They gather together to focus on how much we need each other and how interconnected all parts of life are. There are also occasional sweat lodges, and a full moon ritual is held each month at the stone circle that honors connections to the spiritual and the natural.

While I was visiting I also took part in a World Healing Meditation, which is held each Saturday. The purpose of the meditation is to hold the wish for peace and healing throughout the world. The members of Sirius see themselves as offering education and assistance to the world, and these meditations are part of that work, and also serve to bring the members of the community together.

Another favorite celebration of many Sirius members is the cob oven pizza parties. These are held in the green behind the Community Center and include members of Sirius as well as people from Hearthstone Village, often including a hundred people or more. Everyone at these parties come to bake pizzas in the outdoor oven, eat, and celebrate being together.

Another tradition, which seems to encapsulate the focuses on healing, community, and personal growth present at Sirius, is the drawing of Angel Cards. Each year the members and residents of Sirius have a ceremony where they draw an Angel Card. Each card represents a lesson or virtue which is supposed to be focused on that year. One resident described his experience with the Angel Cards to me.

> "The one I drew last year was patience, and the accident is what it took to teach me that. This year I drew gratitude. I'm finding that much, much easier to learn.
> The cards represent lessons or virtues, and I suspect that all of them, whichever card you draw, has something that all of us need to get better at. The card is helpful because instead of trying to develop all virtues at the same time, you focus on one and really work on that. There are other people that think that is too pragmatic and not spiritual enough, but it works for me."

These celebrations and ceremonies help to bring the community together, to reinforce the values of the community, and to provide support and enjoyment to all the community members.

5.5 Attitude of Experimentation

I spoke with one of the founders of Sirius about how he would know if the community was living sustainably, and he answered,

> "You look at what you've created and ask, 'Is it harming the environment? To what degree? Can you do it better, or is it out of your grasp?' Then you make compromises. Okay, it's out of my grasp now but we'll lean toward this. It's not a simple and I don't know anybody that's living a completely sustainable lifestyle. So, the thing is to prioritize and say, 'Where am I doing the most damage and how can I change that?' Then do the things that are within your grasp."

As it is with the other ecovillages, Sirius is an experiment in attempting to live sustainably. They do not believe or act as if they have achieved their ideal. Each new project is an experiment that is part of trying to live more sustainably. Although Sirius is the oldest of the communities and was criticized by some members and former members for being a difficult place to enact change, the attitude of experimentation still pervades the community. They have installed multiple types of renewable energy, have experimented with a variety of building materials, and have fostered several non-profits and small businesses. The members of Sirius are striving to develop a more sustainable way to live, and see themselves as being in the midst of that work, not the endpoint.

5.6 Behavioral Shifts

Joining Sirius means becoming part of a close-knit community which believes in the sacredness of life. While the choice to join the community generally requires already sharing these values, living in such a community can reinforce these values, resulting in perspectives and behaviors that may not have manifested outside the community. One of the founders of Sirius explained the process to me.

> "The core experience that I have is life being sacred, and so what we try to teach people is to come into that experience themselves and understand the sacredness of it all. Once you invite that you don't have to talk about what you should be doing and what you shouldn't be doing, because you have this internal compass saying, 'Ok, if life is

> really sacred and interconnected, what am I doing with my life? How am I living that out? What am I going to be doing in my life? How am I going to be driving my car?' I drive using waste vegetable oil instead of diesel fuel because that's much better for the environment. That cost me a lot of money to do and a lot of time and energy, but it was so important to me that that is what I did."

Other members of the community described similar changes that they had made once they were connected in the community. An artist that was living there told me that she had completely changed the way that she chose the materials that she used. She was purchasing materials for a new project when she realized,

> "How can I buy something that isn't biodegradable and make something new out of it when I'm living in this place that is all about ecological consciousness? I live in a place where I make constant decisions about composting versus throwing something away in such a careful, deliberate way. So how could I even think about making something that is not 100% biodegradable?"

Yet another community member told me that he had switched to using biodiesel in his car and to eating primarily locally grown food after joining Sirius. Being part of the community with such clear norms has a pervasive effect on members, and even visitors like myself, which can lead to changes in habits and behavior.

Chapter 7. Case Study Conclusions

In many ways, the three case study ecovillages vary considerably. They range in size from 80 to 320 acres and in population from 30 to 260 residents. At EVI, most of the residents are professionals working in Ithaca or from home, while many of the residents at Sirius and Earthaven work in the ecovillage or nearby communities. At Earthaven, most of the planning and construction was handled by ecovillage members, while EVI made use of architects, contractors, and builders. Sirius has an explicit spiritual aspect, while EVI and Earthaven leave that up to their members.

However, despite these and other surface differences, these communities share a set of common practices and common goals. Interviews, community documents, and the mission statements all make repeated references to the ecovillages working to both foster community and to preserve and restore nature. These two goals are the core of ecovillage life, and the practices that support them form the common elements among the three ecovillages.

These shared principles are reflected in the ecovillages' structures. All three ecovillages structured their communities to protect nature and to foster community. At each ecovillage the homes and other village buildings were designed to minimize environmental impacts. Passive solar design, natural building materials, small building footprints, and high efficiency systems are common design elements among the ecovillages, all of which minimize energy and material use. Renewable energy is also used extensively in each village, making use of local resources and reducing the impact of energy use. Design elements are also used to foster community. Homes are oriented toward common spaces, and gathering places, both indoor and outdoor, in each village provide spaces for the community members to meet and interact. The principles of care for the environment and the community are woven through the physical structure of these communities.

The commitment to the natural world in these communities extends beyond minimizing negative impacts to actively promoting the health of the natural world. At each ecovillage, members spoke of the desire to not only protect nature, but to restore the local ecosystems to greater health and productivity. Each ecovillage developed on a site that had depleted soils and reduced biodiversity due to its previous agricultural use. The ecovillagers have set up programs to improve the soil, to selectively harvest trees, and to allow land to lie fallow so that it can recover. The vast majority of the land in each community is also being kept as natural space, forest or meadow, to allow the local ecosystems to recover and regain their former biodiversity.

The twin goals of care for nature and community in the ecovillages are not separate, but instead reflect the inclusion of nature as a member of the community. This integration can be seen in many of the village celebrations and events. The stone circle at Sirius is aligned to nearby mountains, the Sirius community center, and other important natural and social landmarks. EVI celebrates summer with a berry picking and pie baking event, and all of the ecovillages have harvest celebrations and events that occur on the equinoxes. Natural events are causes for celebration, bringing people closer to the land and to each other.

Food production is a common activity at all three ecovillages. Each community has acres devoted to farms and gardens, as well as many small personal gardens. While much of the food is consumed in the ecovillage, the goal of food production is not self-sufficiency: instead the ecovillages use food to build community and connect to surrounding communities. At EVI, the farm supplies much of the food used in the common meals, but also acts as a CSA that sells shares throughout Tompkins County. Picking up shares from the CSA is often how people first learn about and visit EVI. At Sirius, food from the gardens is available to all the members and is a major part of the Hearthstone Village meals that bring people into Sirius. Earthaven has multiple farms which sell food both to ecovillage members and to the surrounding community, and Earthaven has started a program to bring local farmers into the ecovillage to sell their produce. The act of growing and eating food from their land deepens the connection amongst the ecovillagers and between the ecovillagers and nature, and sharing the produce connects them to the surrounding communities.

Reuse, sharing, and recycling are ongoing activities within all of the ecovillages. Instead of disposing of food waste, almost all of it is composted so that food waste becomes the fertilizer for growing new plants. Used appliances, children's toys, clothing, DVDs, etc. are shared and reused throughout the community, passing from one family to another as they are needed or wanted. These acts of reuse not only make efficient use of resources, but also mirror the way that nature handles resources, where the output from one process is always the input for another and nothing is actually waste. There are formal co-ops in place that provide access to yard and wood-working tools, entertainment libraries, and technical equipment. There are also networks for sharing cars, child care, manual labor, etc. This sharing not only makes efficient use of local resources and provides needed goods and services within the community, but also strengthens the interactions and bonds among community members.

Forming these sharing networks is easier in ecovillages because of the conscious ethic of cooperation that is already present. There are comments and stories throughout the case studies that show that the members of these communities see working together as a basic aspect of life in community, whether it is the sharing of a painting ladder or the formation of a co-op for buying root vegetables. This ethic of cooperation makes it much easier to engage in cooperative activities in these communities than it is in mainstream America. Instead of having to search out a group of people that would be willing to trust each other and commit to a project, you have a ready pool of people who already trust each other and are used to working together. The formation of the photo printer co-op at EVI is a perfect example of this. One member became aware the printer was available, and he already knew other community members who would like to have access to such a printer. As a result, community members were able to pool their resources to purchase it very quickly, and now the whole community has access to a low-cost, high quality printer. The existing social fabric of cooperation in the ecovillages essentially lowers the transaction costs of cooperative action within the communities, and as has been shown by these communities, cooperative action often provides a good or service for a lower associated environmental impact than individual action.

These networks of reuse and sharing are examples of a trend amongst the ecovillages that I refer to as “replacing consumption with community.” In each of the examples above, a good or service that would often have been purchased by an individual is instead provided through the community, which reduces individual consumption and environmental impact. However, this trend extends beyond these examples. Many parents told me that they didn’t feel the need to drive their children from activity to activity as often because there are other children and many activities available within the village. Community dinners, celebrations, and spontaneous gatherings also led many people to make fewer trips into town to visit restaurants and bars. The communal nature of the ecovillages not only reinforces the values of the community, but also provides many of the goods and services that would otherwise have to be purchased.

A question that consistently arises in response to this analysis is, “How much of the reduction in environmental impact is due to the communal nature of the ecovillage, and how much could be done by individuals who are committed to reducing their environmental impact?” Many of the activities that reduce environmental impact among the ecovillagers can also be enacted by individuals who aren't in an ecovillage but are still devoted to living more sustainably: green homes and buildings that consume less energy are being constructed throughout the world, carpooling and car sharing programs exist in many cities and communities, and vegetarian and vegan diets are practiced by a multitude of people. However, a significant number of the practices that reduce waste and overall impact are difficult to replicate without the support of a community. The sharing of tools, appliances, entertainment, and other products is a powerful technique for reducing impacts that is difficult to replicate outside of such a community.

In addition, many practices which could work outside an ecovillage or similar community are generally not practiced as intensely elsewhere as they are in these communities. Car sharing and carpooling are good examples. In the ecovillages some people choose to completely give up their cars and instead rely on sharing rides with other community members. While many individuals might carpool to work, they would be unlikely to give up their cars entirely and rely on their neighbors whenever they need to run an errand. This is possible in an intentional community because of the pervasiveness of the sharing network, and because the community amenities also reduce the need for car trips. Thus the community enables a reduction in environmental impact beyond what individuals would typically achieve in two ways: 1) the community supports practices which would not be feasible in a typical neighborhood, such as comprehensive tool sharing, community meals, and communal renewable energy installations; and 2) the community creates an environment conducive to a more intense practice of activities that would be feasible elsewhere, such as extensive car sharing, near universal composting of food waste, and widespread adoption of vegetarian and low-meat diets.

The strong community norms of restoring nature and fostering community contribute to the ability of these communities to support these behaviors. In addition, these norms also contribute to behavioral change among the community members. Not only do these communities reinforce and make possible certain environmental practices, but they also influence their members to take up these practices. Each case study discusses behavioral shifts that occurred amongst the community members because this is a key part of the impact of ecovillages. Not only do they enable their members to reduce their environmental impacts more easily, but they also encourage them to do so.

Despite the achievements of these communities, members of all three ecovillages were quick to tell me that they “do not live in a utopia.” These communities do not claim to have developed an ideal society, nor to have solved every environmental and social problem. Instead, ecovillage members exhibited the attitude that their communities are experiments. They are not following a pattern for the perfect community, but are instead spending their lives together trying to develop a community that addresses the problems they see in mainstream society. What exactly those problems are and how best to address them are issues decided by the community, and these decisions vary from one ecovillage to another and change over time.

Members of these communities are constantly trying to improve while learning from their past successes and failures. In addition to their own experiences, their connection to other ecovillages through the Global Ecovillage Network provides a way to learn from experiments in other communities throughout the world. This experimentation is ongoing in thousands of ecovillages around the world, and it provides a rich pool of potential solutions to social, environmental, and other problems facing society, many of which may have applicability in other communities.

While the ecovillage model has allowed these communities to accomplish significant reductions in environmental impact, it also poses significant challenges. In each of these communities, the issues of decision-making and community commitment were under constant discussion. Determining the right form of decision-making and how to keep a high level of community commitment are essential parts of the ongoing experimentation in these communities.

Some form of consensus based decision-making is implemented in all of ecovillages in this study. Consensus is frequently criticized for taking a long time because one or two members can block the decision-making process. Many community members are frustrated with the process, which causes some to stop attending meetings and others to leave the community entirely. However, there are several reasons for the use of consensus in these communities. One of these is enforcement. One previous ecovillage member who has studied many intentional communities explained to me that

> "…it is rare for communities to work on simple majority vote. My theory around that is that it works in mainstream culture because we've got a police force that can back that up. They can say, 'these are the rules,' and there is not much you can do about that. In community if you carry a motion with 51% of the vote, a majority, it's not going to happen. You need a supermajority of people to make any decision happen. Because otherwise people will not give their energy or work, or will sabotage what's happening. So I find in community that either there is a supermajority or consensus model or people tend to defer to a core group or individual. To try to let half the group make the decisions by majority vote has not worked in community."

Another reason for the use of consensus is that it tends to result in decisions that the community can support over the long term. Because decisions must be supported by all, or nearly all, of the members, it is rare that a decision that only benefits a few or has only short-term benefits will be selected. Developing a decision-making process that maintains these benefits of consensus, while proving more efficient and less frustrating is a challenge in each ecovillage and efforts at process improvement are ongoing.

Commitment is a central challenge to all intentional communities. Kanter's (1972) book *Commitment and Community* develops this theme in detail, but in essence a community cannot survive without the commitment of its members. Community members must choose to give their time and energy to the community, and any frustration about its structure, decision-making, values, and other factors reduces that commitment. The meetings, communal work, social gatherings, projects, etc. that make the community work require the enthusiastic consent and investment of the members, and maintaining this commitment is a constant challenge.

Despite their variations, all of the ecovillages share a core set of goals, practices, and challenges. These communities have achieved large reductions in environmental impacts compared to their surrounding communities, and the common goals and practices demonstrate how some of those reductions were achieved. The physical practices of minimizing building impacts, protecting and restoring ecosystems, and the social practices of integrating nature into the community, developing formal and informal sharing systems, and generally replacing consumption with community all contribute to the reducing the environmental impact of ecovillagers. The linked goals of fostering community and restoring nature that define these communities support and enable these practices. Although the ecovillage model faces significant challenges, its accomplishments and continuing experiments offer insight into the development of sustainable community.

Chapter 8. Life Cycle Assessment of Ecovillages

1. Introduction

Life cycle assessment (LCA) is an analytical tool used to comprehensively quantify and interpret the flows to and from the environment (including emissions to air, water and land, as well as the consumption of energy and material resources) over the entire life cycle of a product or process (ISO, 2006b). LCA considers the entire life cycle from raw material acquisition through production, use, end-of-life treatment, recycling, and final disposal. By including the impacts throughout the life cycle, LCA provides a comprehensive view of the environmental aspects of a product.

This LCA compares the impacts of residents living in three ecovillages to the impacts of residents living in the surrounding counties and the US average. The ecovillages included are Earthaven in Buncombe County, NC; Ecovillage at Ithaca in Tomkins County, NY; and Sirius in Franklin County, MA. At each ecovillage data was collected on four fundamental categories: 1) home energy use, 2) transportation energy use, 3) food consumption, and 4) waste disposal. Previous studies have shown that home heating and cooling, transportation, and food are consistently the most important consumption categories when modeling an individual's environmental impact, supporting the choice of these activities (Bin, 2005; Hertwich, 2005). While waste disposal was not found to be amongst the most important categories in previous studies, those studies often focus only on global warming potential and energy demand (Hertwich, 2005). With the wider range of impact categories being employed in this study, waste disposal was included to assess its contribution to overall impact.

2. Materials and Methods

This section will describe the goal and scope of the study, the functional unit, the system boundaries, the assumptions and limitations, and the impact categories chosen. The goal and scope provide a description of the context of the study which explains to whom and how the results are to be communicated. The functional unit is quantitative and is the reference unit to which all flows in the LCA are related. Allocation is the method used to partition the environmental load of a process when several products or functions share the same process.

2.1 Goal

This LCA is intended to provide an understanding of the average environmental impact of residents of three selected ecovillages (Ecovillage at Ithaca, Earthaven, and Sirius Community) compared to the average environmental impact of U.S. residents and residents of the counties in which the ecovillages are located (Tompkins County, New York; Buncombe County, North Carolina; and Franklin County, Massachusetts), referred to as comparison communities. The residents of these ecovillage communities have made many decisions about the way they live in pursuit of reducing their impacts, and the results of this study will demonstrate the effects of these choices. This study will attempt to show the quantifiable results of those choices. This study is intended to provide information to members of these communities, to the academic community, and to anyone else interested in this subject.

2.2 Functional Unit

The functional unit of this study is the activity of an average resident for the time span of one year, specifically 2010. A person is considered a resident of the ecovillage if they lived there full-time (at least 10 months of the year). The specific activities that are included in this study are home energy use, transportation energy use, food consumption and waste disposal.

Home energy use includes all fuels and energy used within the home, including electricity from the grid, electricity from onsite sources, natural gas and other fossil fuels. Transportation energy use includes the fuels burned to power personal vehicles and commercial airplanes. Food consumption includes all food eaten by the resident over the course of the year, whether within the village or elsewhere. Waste disposal consists of all wastes disposed of while in the village, including recyclables, compost, and trash. All of the environmental flows and impacts have been normalized to a single resident for the time span of one year.

2.3 System Boundary

This project focuses on material and energy throughput, with the four primary aspects of analysis (home energy use, transportation energy use, food consumption, and waste disposal) encompassing the major flows of energy and material used by an individual. These aspects are approached from resource extraction through end-of-life, whenever possible, although some of these life cycles are abbreviated due to data and/or analysis constraints. Any such constraints are described in the following sections. Figure 2.3-A below shows a diagram of the system boundary.

Elements that are specifically excluded from the system boundary include building construction, energy use in village common facilities, energy use at commercial or industrial facilities by village members, the manufacture and disposable of durable goods, and the manufacture of disposable goods. The disposable goods in the village is captured in the waste disposal activity. This system boundary includes the vast majority of the energy and material that flows through the villages on a daily basis, but excludes many impacts associated with the production and disposal of goods with a long lifespan, including village homes and buildings and durable goods, such as cars, refrigerators, etc.

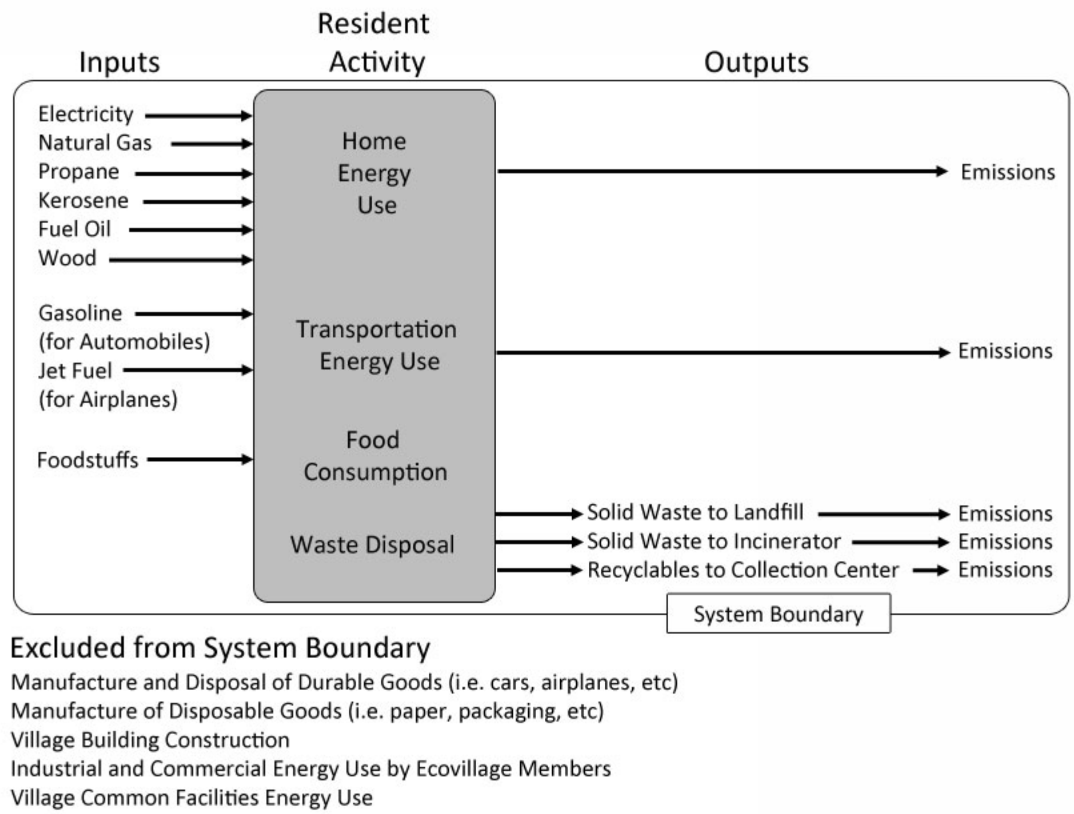

Figure 2.3-A System Boundary Diagram

A complete cradle-to-grave life cycle inventory (LCI) was developed for each energy source and for foodstuffs, covering all production steps from raw material extraction through to final end-of-life disposition. The study draws on primary individual consumption data for 2010 collected directly from ecovillage members via surveys and interviews. Results from the questionnaires are provided in Appendix A, and a copy of the survey questionnaire is provided in Appendix B. This project also relies on secondary LCI and meta-data sources, with no primary LCA data (other than individual consumption). The sources and treatment of these data are described in section 2.3.3.

All site-generated and purchased electricity is included in the system boundary. The extraction, processing and delivery of purchased primary fuels, and fuels used to generate purchased electricity, are also included within the system boundary. Purchased electricity consumed at various site locations is modeled to come from the appropriate eGrid subregion, based on the 2009 data, which is the most up-to-date eGrid data available (US EPA, 2012a).

2.3.1 Cut-off Criteria

The cut-off criteria for input flows to be considered within each system boundary are as follows:

- Mass – if a flow is less than 1% of the cumulative mass of the model flows it may be excluded, providing its environmental relevance is minor.
- Energy – if a flow is less than 1% of the cumulative energy of the system model it may be excluded, providing its environmental relevance is minor.
- Environmental relevance – if a flow meets the above two criteria, but is determined (via secondary data analysis) to contribute 2% or more to a product life cycle impact category (see below), it is included within the system boundary.

2.3.2 Initial Data Quality Requirements

Wherever secondary data is used, this study adopts critically reviewed data for consistency, precision, reproducibility, and to limit uncertainty. Wherever possible, the data source should be complete and representative of North America in terms of the geographic and technological coverage and be of a recent vintage, i.e., less than ten years old. Any deviations from these initial data quality requirements for secondary data are documented throughout the study.

2.3.3 Data Sources and Modeling Software

North America is considered as the geographic boundary of this study. The reference year for this study is 2010, with all of the ecovillage consumption data and the comparative data from the US EIA being for that calendar year. Comparative data for some activities is drawn from other years where necessary. However this is of minimal concern because, except for home energy use, consumption data should vary minimally from year to year. All comparative data is from 2002 to 2010. Table 2.3.3 details the data source and year for each of the comparative data sources used in this study.

Secondary LCI data and metadata are used throughout the study. Except for the ecovillage resident consumption and waste data, all other data are from secondary sources, including literature, previous LCI studies and life cycle databases. Three databases provide most of the data used in this study: the US LCI database[25], EcoInvent[26], and LCA Food DK[27].

Much of the LCI data residing in the US LCI database pertains to common fuels – their combustion in utility, stationary, and mobile equipment inclusive of upstream or pre-combustion effects. Generally, these modular data are of a recent vintage (less than ten years old), and this study draws on these data for combustion processes, as well as electricity generation and delivery on a regional North American basis. These data are free and publicly available. Thus they offer both a high degree of transparency and an ability to replicate the results of the study.

Another important data source is the EcoInvent LCI database. This database contains over 3,500 LCI modules for processes and products, all of which have undergone peer review. The basic assumption when using these data is that North American and European production processes are generally similar. Whenever Ecoinvent data is used, models have been adapted for North American circumstances (e.g., electricity grids, fuels, and transportation modes).

The LCA Food DK database is a collection of process-specific LCI models that detail the production of many common food products in Denmark. This data is necessary due to the limited data on U.S. food production. While some key food products are present in the USLCI database, many others are not. Thus the Danish food models were adapted to reflect U.S. energy use and transportation, as was done with the Ecoinvent models.

[25] http://www.nrel.gov/lci/
[26] http://www.ecoinvent.ch/
[27] http://www.lcafood.dk/

While ecovillage resident consumption data was collected directly from the ecovillage residents, consumption data for non-ecovillage residents was developed from several published sources. This data includes household energy consumption, vehicle miles travelled for ground and air travel, food consumption, and waste generation (Table 2.3.3-A). Published data was used for all aspects.

Table 2.3.3-A Data Sources for Comparison Models

Data Category	Source	Year
Home Energy Use	US EIA Residential Energy Consumption Survey[28] Tompkins County Community Greenhouse Gas Emissions Report 1998-2008	2010 2008
Transportation Energy Use	Ground Travel - National Household Travel Survey[29] and US Census Data[30] Air Travel - U.S. Air Carrier Traffic Statistics[31]	2010 2010
Food Consumption	USDA Agricultural Fact Book[32]	2002
Waste Disposal	The State of Garbage in America: The 17th Annual Survey of MSW Management in the U.S.[33] Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010[34]	2010 2010

SimaPro software v7.3.2 was utilized for modeling the complete cradle-to-grave LCI for both the decking and siding product systems. Within SimaPro, all process data including inputs (raw materials, energy and ancillary material use) and outputs (emissions and production volumes) are considered and modeled to represent each unit and system process. The analysis includes both measured and calculated data, and all unit and system processes have undergone a mass and energy balance to ensure consistency. The study's geographical and technological coverage has been purposely limited to the United States, representing average or typical technologies. SimaPro is also capable of generating life cycle impact assessment (LCIA) results, and the software was also used for this purpose. See section 2.5 for a description of the selected LCIA categories and characterization measures used in this study.

[28] http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption Table CE2.1
[29] http://nhts.ornl.gov/tables09/ae/TableDesigner.aspx (requires the use of the Table Designer)
[30] http://quickfacts.census.gov/qfd/states/00000.html (select individual counties to view)
[31] http://www.bts.gov/xml/air_traffic/
[32] http://www.usda.gov/wps/portal/usda/usdahome?contentid=agfactbook.xml&navid=AG_FACT_BOOK
[33] http://www.seas.columbia.edu/earth/wtert/sofos/SOG2010.pdf
[34] http://www.epa.gov/osw/nonhaz/municipal/msw99.htm

2.3.4 Data Exclusions from the System Boundary

This analysis is limited to the impacts associated with home energy use, transportation energy use, food consumption, and waste disposal. The creation of the infrastructure that supports this consumption (e.g., building homes, manufacturing cars, etc.) and the consumption of materials other than food (e.g., paper, clothing, packaging, etc.) were excluded. Consumption of energy outside of the home is also outside the scope of this study. While the inclusion of this consumption data would have created a more complete understanding of the impacts of individual consumption, collection and modeling of these additional data points was not feasible. Some studies suggest that home construction may contribute as much as home heating and cooling, but as this study is focused on energy and material throughput and it was not feasible to collect data on home construction, it was excluded for this analysis (Stephan, 2012). While the inclusion of the excluded materials and resources would have improved the analysis of the environmental impact of residents, the consistency of the data collected supports the primary aim of this study, which is the comparison of ecovillage residents to non-ecovillage residents. The models for non-ecovillage residents were designed to include the same data categories as ecovillage residents in all respects to maximize the comparability of the models.

2.4 Impact Categories/Impact Assessment

ISO 14040 states that the "impact assessment phase of LCA is aimed at evaluating the significance of potential environmental impacts using the LCI results" (ISO, 2006, p. 14). The LCIA phase involves modeling sets of selected environmental issues, referred to as impact categories, through the aggregation of resource usage and emissions to explain and summarize LCI results data. These impact categories are intended to characterize the relevant environmental flows to represent the potential or possible environmental impacts.

ISO 14044 does not specify any specific methodology or support the underlying value choices used to group the impact categories. The impact methodologies used in this study were selected to meet the goals of providing results in the most frequently examined impact categories, to provide the ability to compare to other studies conducted on ecovillage environmental impact and to avoid providing reproducing results by including impact categories that are all driven by the same processes.

The framework surrounding LCIA includes three steps that convert LCI results to category indicator results. These include the following:

1. Selection of impact categories, category indicators and models.
2. Assignment of the LCI results to the impact categories (classification) – the identification of individual inventory flow results contributing to each selected impact indictor.
3. Calculation of category indicator results (characterization) – the actual calculation of the potential or possible impact of a set of inventory flows identified in the previous classification step (ISO, 2006b).

2.5 Selected Impact Categories

While LCI enjoys a fairly consistent methodology, the LCIA phase is very much a work in progress, and there is not a generally accepted methodology for selecting and calculating the impact categories that might be included in an LCIA. Typically, LCIA is completed as a separate stage from the LCI. The LCI requires a complete mass and energy balance for each process under consideration. Once completed, the LCI flows are processed through LCIA impact methods and categories to determine possible impacts, but the choice of impact methodology has no effect on the LCI process.

Global warming and energy use are the most commonly used and easily understandable impact categories, but one of the limitations of the current body of LCA analyses is that very few studies consider impacts other than energy consumption and CO_2 emissions (Hertwich, 2005). The TRACI[35] (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts) LCIA methodology has been developed by U.S. Environmental Protection Agency, and it provides a full suite of impact categories with which to characterize the LCI flows. The impact categories used in TRACI v3.03 include Global Warming, Acidification, Human Health, Respiratory Effects, Eutrophication, Ozone Depletion, Ecotoxicity, and Smog. These impact categories are described briefly below.

- Global Warming Potential (GWP) – the methodology and science behind the GWP calculation can be considered one of the most accepted LCIA categories. Because this study also tracks an overall life cycle carbon balance, the carbon dioxide emissions associated with biomass combustion are included in the GWP calculation, but the sequestering of carbon (CO_2 from air) is treated as a negative emission in the calculation as per the IPCC methodology contained in SimaPro. GWP is expressed on equivalency basis relative to CO_2 – in kg or tonnes CO_2 equivalent.
- Acidification Potential (AP) – acidification is a more regional rather than global impact affecting fresh water and forests as well as human health when high concentrations of SO_2 are attained. Acidification is a result of processes that contribute to increased acidity of water and soil systems. Acid rain generally reduces the alkalinity of lakes. The AP of an air emission is calculated on the basis of the number of hydrogen (H+) ions that can be produced and therefore is expressed as potential H+ equivalents on a mass basis.
- Human Health – TRACI developers have computed Toxicity Equivalency Potentials (TEPs), which are characterization factors measuring the relative health concern associated with various chemicals from the perspective of a generic individual in the United States. For cancer effects, the TRACI system's TEPs are expressed in terms of benzene equivalents, while for noncancer health effects they are denominated in toluene equivalents.
- Eutrophication Potential – Eutrophication is the fertilization of surface waters by nutrients that were previously scarce. When a previously scarce or limiting nutrient is added to a water body, it leads to the proliferation of aquatic photosynthetic plant life, which can result in the death of fish and other aquatic life. The result is expressed on an equivalent mass of nitrogen (N) basis.
- Respiratory Effects – Particulate matter of various sizes (PM_{10} and $PM_{2.5}$) has a considerable impact on human health. The EPA has identified "particulates" (from diesel fuel combustion) as the number one cause of human health deterioration due to their

[35] http://www.epa.gov/nrmrl/std/traci/traci.html

impact on the human respiratory system – resulting in asthma, bronchitis, acute pulmonary disease, etc.

- Ozone Depletion – The stratospheric ozone layer acts as a filter absorbing harmful short wave ultraviolet light while allowing longer wavelengths to pass through. A thinning of the ozone layer allows more harmful short wave radiation to reach the Earth's surface, potentially causing changes to ecosystems and agricultural productivity. Effects on humans can include increased skin cancer rates and eye cataracts, as well as suppression of the immune system. The result is expressed on an equivalent mass of CFC-11 basis.
- Ecotoxicity – The ecological toxicity impact measures the potential of a chemical released into the environment to harm terrestrial and aquatic ecosystems. This assessment method measuring pollutant concentrations from industrial sources as well as the potential of these pollutants to harm ecosystems. TRACI characterization factors for potential ecological toxicity use 2,4-dichlorophenoxy-acetic acid (2,4-D) as the reference substance.
- Smog Formation Potential (POCP) – Under certain climatic conditions, air emissions from industry and transportation can be trapped at ground level where, in the presence of sunlight, they produce photochemical smog, a symptom of photochemical ozone creation potential (POCP). While ozone is not emitted directly, it is a product of interactions of volatile organic compounds (VOCs) and nitrogen oxides (NO_x). The POCP indicator is expressed as a mass of equivalent NO_x (US EPA, 2012b; Lippiatt, 2007).

The use of the TRACI impact methodology provides a more comprehensive understanding of environmental impact than could be achieved with a single impact category, but many of the impact categories in TRACI are directly related to combustion emissions, which results in a repetition of the patterns of results from category to category. To ensure that the results of this analysis provide a comprehensive understanding of environmental impact with a minimum of repetition, a correlation analysis of the results for each impact category in TRACI was conducted. Details of the correlation analysis are available in Appendix F.

The results of the correlation analysis suggest that all of the impact categories except for Eutrophication and Ecotoxicity are very highly correlated with Global Warming. Thus the tables and graphs in this report will include only Global Warming Potential (GWP), Eutrophication, and Ecotoxicity, although the results for other impact categories within TRACI are available in Appendix C.

While TRACI does provide a more comprehensive suite of impact categories than typically appears in published articles, it does not readily report cumulative energy use. The Cumulative Energy Demand v1.08 method was used to calculate this value. Cumulative Energy Demand (CED) is the sum of all energy sources drawn directly from the earth, such as natural gas, oil, coal, biomass, or hydropower energy.

Ecological Footprinting is a technique for measuring environmental impact, with the result establishing the amount of land in global hectares (gha) that the population requires to provide their resources and absorb their wastes, based on the Earth's biological capacity (Rees and Wackernagel, 1994). The ecological footprint was included for its ability to provide a single metric of environmental impact and to provide a basis of comparison with other studies of the Ecological Footprint of ecovillages (Tinsley, 2006; Moos, 2006). There was also a greater awareness of Ecological Footprinting than other impact categories in the ecovillages, making it an important metric for effectively communicating the results of the study.

As an additional point of reference, the overall results were also characterized using the Impact 2002+ methodology in Appendix C. IMPACT 2002+ is a methodology that was developed at the Swiss Federal Institute of Technology Lausanne, Switzerland. The life cycle impact assessment methodology IMPACT 2002+ uses a combined midpoint/damage-oriented approach. For IMPACT 2002+, new concepts and methods have been developed, including:

- Human Damage Factors are calculated for carcinogens and non-carcinogens, employing intake fractions, best estimates of dose-response slope factors, as well as severities.
- The transfer of contaminants into the human food is no more based on consumption surveys, but accounts for agricultural and livestock production levels. Indoor and outdoor air emissions can be compared and the intermittent character of rainfall is considered.
- Both human toxicity and ecotoxicity effect factors are based on mean responses rather than on conservative assumptions.
- Other midpoint categories are adapted from existing characterizing methods.
- Normalization can be performed either at midpoint or at damage level.

The IMPACT 2002+ method presently provides characterization factors for almost 1500 different LCI-results (Jolliet, 2003).

2.6 Limitations and Uncertainties

The findings in this research are limited by the inherent uncertainty of creating a representative model through LCA. Many assumptions were made in modeling the product system with representative processes and datasets. Uncertainty in modeling decisions has been addressed by conducting mass balance and sensitivity analyses as the LCI models were being constructed (data verification/validation relative to cut-off criteria and study goals). See Appendix H for the sensitivity analyses. While quality control was undertaken at each step in building the LCI and conducting the LCIA, uncertainty is still present in the results in non-quantifiable terms. For instance, the statistical distribution of numerous datasets is not provided and thus calculating confidence intervals around the inventory is impossible, let alone calculating the standard deviation of the impact assessment results. This is the case with all LCAs, however, and reliance on LCA results in decision making must reflect this.

In addition to these general limitations, there are some specific uncertainties and limitations that exist within this study, which are detailed below.

- Reliance on the LCA Food DK database ignores differences in agricultural techniques between Denmark and U.S.
- LCA models for some foods were unavailable, necessitating the use of proxies for some foods.
- Very limited data is available on food transportation distances, requiring the use of estimates.
- When respondents described their diets as vegan or vegetarian, some assumptions were made about the exact makeup of these diets.
- There is a lack of small scale data for diet and air transportation, requiring the use of national average data.

3. Results

Life Cycle Impact Assessment (LCIA) involves characterizing LCI data in terms of its potential environmental impact (e.g., Eutrophication, CED, GWP). The impact assessment phase of LCA is aimed at evaluating the significance of environmental impacts based on the LCI results. This evaluation is accomplished by sorting the LCI data and assigning it to specific impact categories. The LCI data is then characterized by converting it to common units and aggregating the converted data within the impact categories. This conversion relies on existing characterization factors, which are part of the impact methodology. The outcome of the calculation is a numerical indicator result, which is typically stated on an equivalence basis (e.g., kg carbon dioxide equivalents).

This section summarizes the LCIA results for the overall impact as well as each activity category (home energy use, transportation energy use, food, and waste disposal). Section 3.1 presents the LCIA combined results for each case study location and comparison community, and sections 3.2 through 3.5 provide the LCIA results for each activity category. The life cycle is analyzed via a contribution analysis by component for each activity category. The contribution analysis helps identify the significant components for each activity category.

3.1 Overall Environmental Impact

The LCIA results for the overall impact of one resident over one year by community are depicted in Table 3.1-A below. Figures 3.1-A – 3.1-E display the contributions of the four activity categories investigated in this analysis: home energy use, transportation energy use, food, and waste disposal. While each impact methodology provides an understanding of how these different categories affect the overall impact, the consistent difference between ecovillage and non-ecovillage residents in overall impact is striking. When the impact per ecovillage resident is compared to the comparison community resident, the ecovillage resident impact is between 43% and 76% lower across all impact categories and locations.

In terms of global warming, the reductions occur across all activity categories. Home energy use and transportation energy use are responsible for the majority of the GWP with food being of lesser import and waste disposal having a minimal impact. This global warming pattern of impacts is repeated with minor variation for Cumulative Energy Demand (CED) and Ecological Footprint, which tend to be heavily influenced by the fuel combustion. However, comparing the relative reductions of ecovillage residents in GWP to CED reveals that not only do the ecovillages have a lower GWP and CED, but they also have a lower carbon intensity, carbon emitted per unit of energy used. Thus, not only is less energy used per person in the ecovillages compared to the state averages, but the energy that is used generates lower global warming emissions per unit. The reduction in global warming emissions per unit is due to the an energy mix that relies heavily on low-carbon or no-carbon emission sources, including natural gas, renewable energy, and wood (which emits biogenic carbon that does not count towards global warming potential).

The Ecotoxicity and Eutrophication analyses show similar overall reductions, but with shifted relative importance of the categories. Eutrophication is dominated by the impact of food. As eutrophication is primarily driven by runoff from agricultural activity, this is to be expected. Ecotoxicity is similarly primarily influenced by waste disposal. As landfilling and incineration introduce many manmade compounds into the environment, it is sensible for waste disposal to be the dominant activity in for this metric. A more detailed exploration of each activity category can be found in the sections 3.2 through 3.5.

Table 3.1-A Overall LCIA Results

Impact Category	Global Warming (TRACI)	Eutrophication (TRACI)	Ecotoxicity (TRACI)	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	4,526.87	18.86	8,250.32	78,328	1.3731
EVI	5,677.58	13.25	6,744.68	79,103	1.4445
Sirius Community	5,211.57	16.34	7,995.88	104,299	1.5178
Buncombe Co., North Carolina	16,158.84	45.45	34,243.24	195,807	4.1630
Tompkins Co., New York	11,460.87	42.95	24,479.29	138,890	3.0072
Franklin Co., Massachusetts	15,256.69	43.28	17,751.90	194,246	3.9161
United Sates Average	15,887.22	45.58	33,012.12	197,072	4.0935

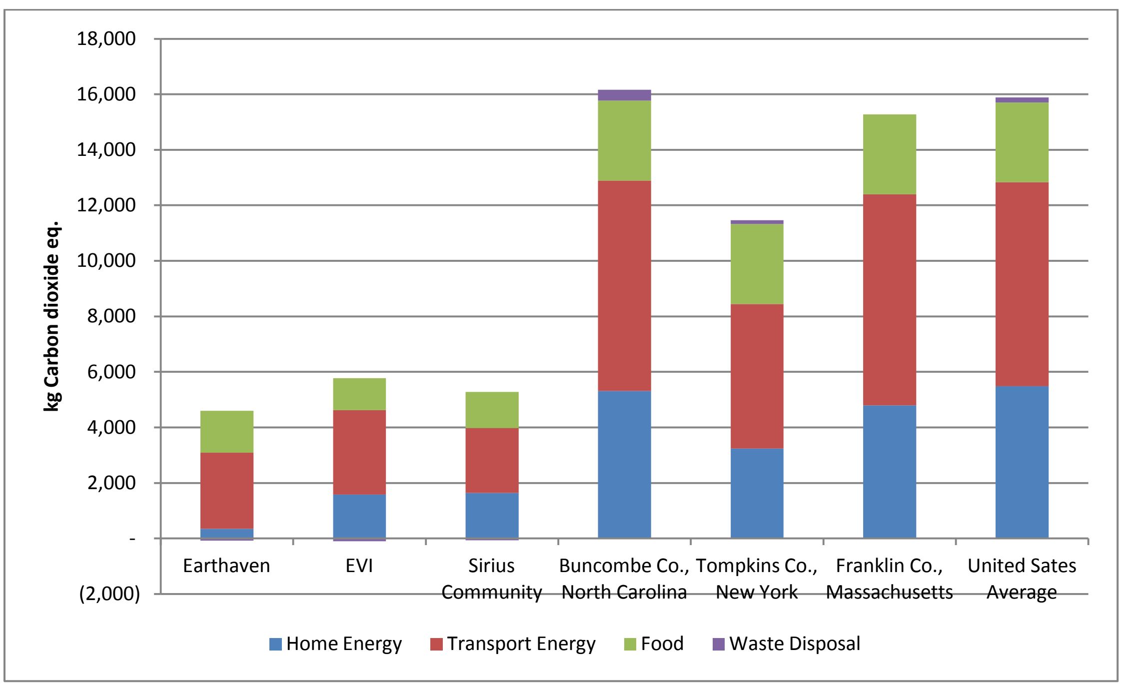

Figure 3.1-A Overall Global Warming Potential

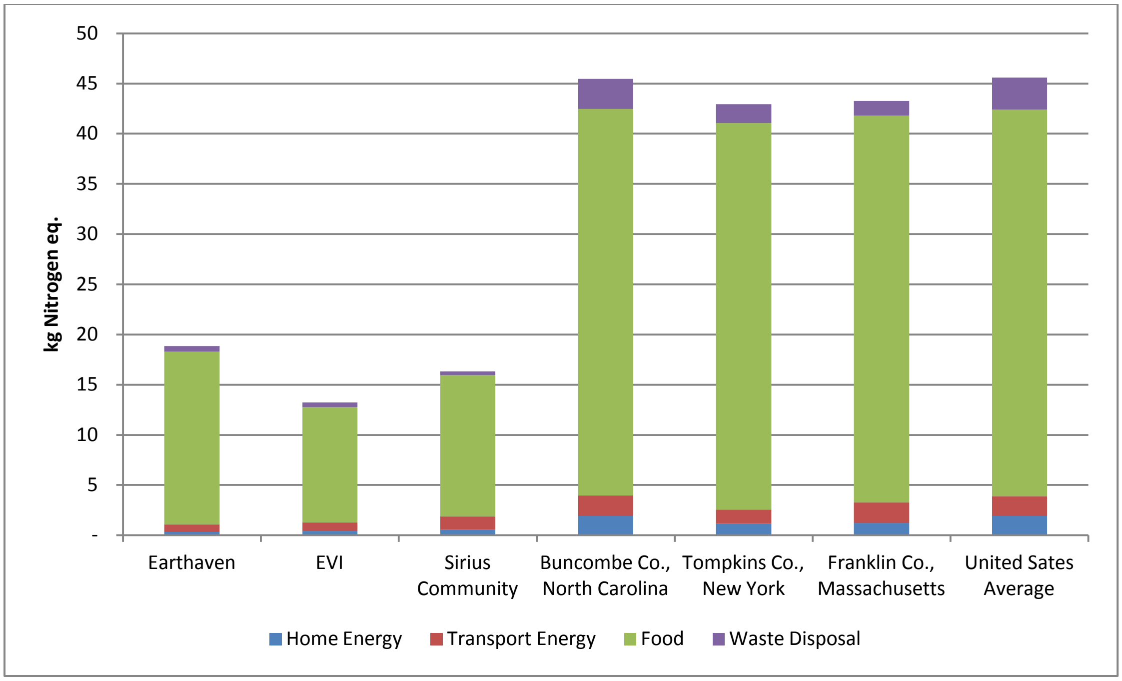

Figure 3.1-B Overall Eutrophication Impact

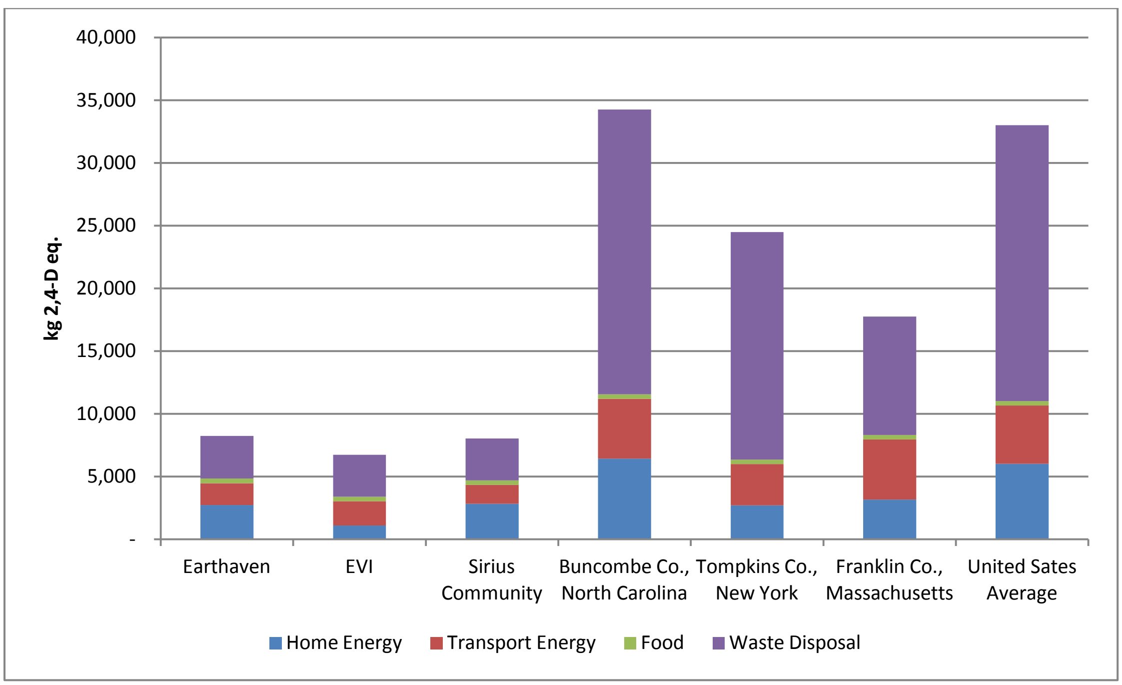

Figure 3.1-C Overall Ecotoxicity Impact

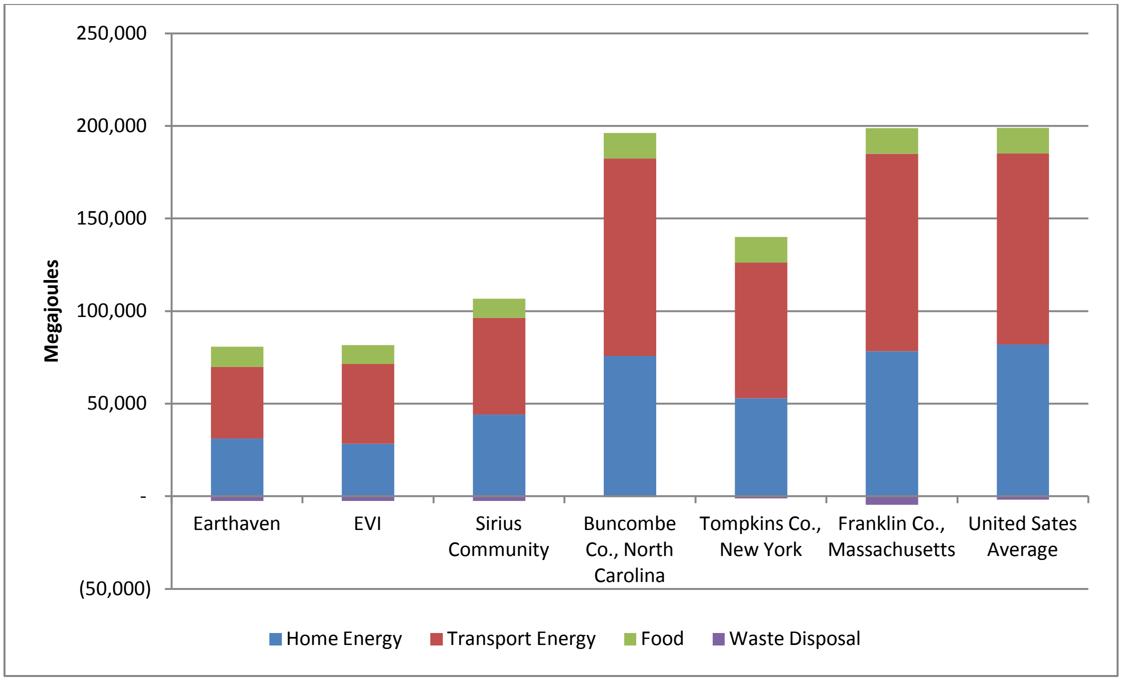

Figure 3.1-D Overall Cumulative Energy Demand

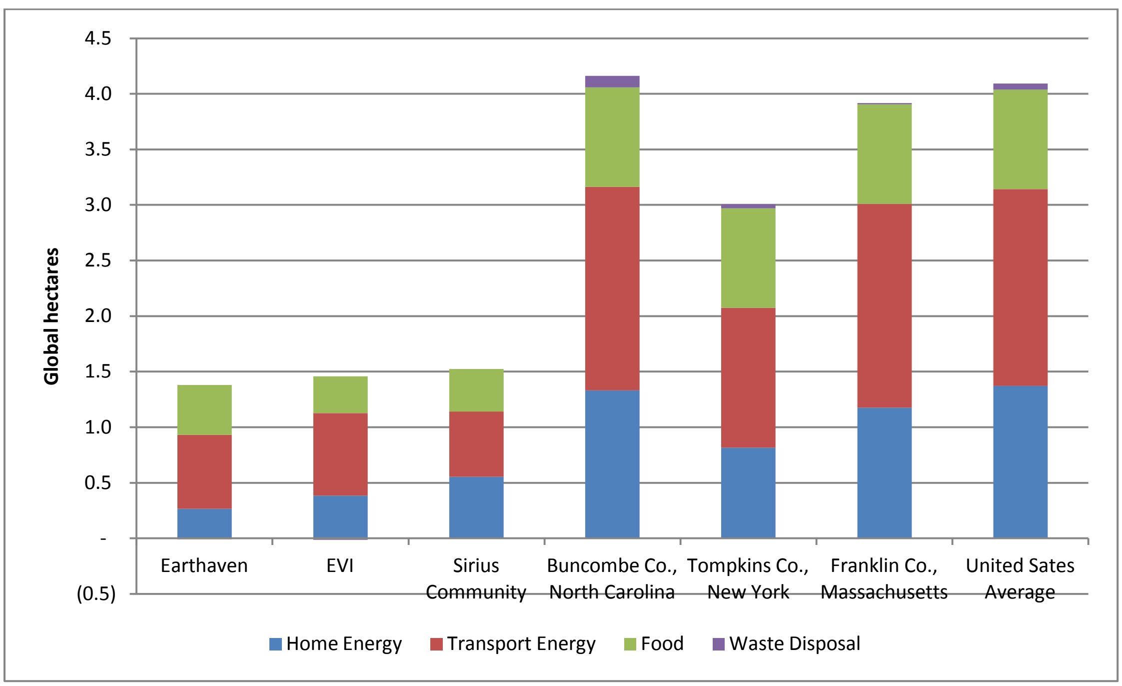

Figure 3.1-E Overall Ecological Footprint

3.2 Home Energy Use

The LCIA results for the average home energy consumption for one resident over one year by community are depicted in Table 3.2-A below. Figures 3.2-A – 3.2-E display the contributions of the different energy sources as well as total impact by community. Home energy use is heavily affected by climate and local energy infrastructure. By comparing the ecovillage results to the results of the surrounding county, these differences can be mitigated, leaving the differences due to construction practices, energy source, and consumption activities. When compared to the respective county average, the ecovillage average home energy use is considerably lower (59% lower for Earthaven, 46% lower for EVI, and 44% lower for Sirius).

A similar pattern of reductions exists across the other impact categories, with the exceptions being largely due to specific energy practices in each ecovillage and the variations in impacts from different energy sources. The exclusive use of electricity generated from on-site renewable sources coupled with a heavy reliance on wood for heating gives Earthaven a 94% reduction in GWP compared to the average Buncombe County, NC resident. This energy profile also results in an 83% reduction in Eutrophication, 57% reduction in Ecotoxicity, and an 80% reduction in Ecological Footprint compared to the average Buncombe County resident. The residents of EVI have a similar energy profile to Tompkins County residents, which is primarily made up of natural gas, used for heating, and electricity from the grid, although approximately 30% of EVI's electricity comes from on-site photovoltaics. Home energy use at EVI shows a 51% reduction in GWP, 63% reduction in Eutrophication, 60% reduction in Ecotoxicity, and a 53% reduction in Ecological Footprint compared to the average Tompkins County resident. Sirius residents rely more on fuel oil and wood compared to residents of Franklin County, and the lack of natural gas piping leads to the use of propane in its place. The use of wood for heating results in a more than proportional reduction in GWP (a 66% reduction in GWP compared to a 44%

reduction in total energy consumption), but mitigates Ecotoxicity reductions (11%). Disposing of the burned wood ash is the major contributor to Ecotoxicity.

Table 3.2-A LCIA Results for Home Energy Use

Impact Category	Global Warming (TRACI)	Eutrophication (TRACI)	Ecotoxicity (TRACI)	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	344.31	0.33	2,744.64	31,229	0.2640
EVI	1,580.82	0.42	1,095.47	28,481	0.3845
Sirius Community	1,636.61	0.55	2,824.22	44,185	0.5545
Buncombe Co., North Carolina	5,309.02	1.91	6,422.30	75,829	1.3319
Tompkins Co., New York	3,241.04	1.14	2,711.99	52,952	0.8146
Franklin Co., Massachusetts	4,799.35	1.23	3,167.00	78,288	1.1750
United Sates Average	5,487.13	1.91	6,031.84	82,011	1.3709

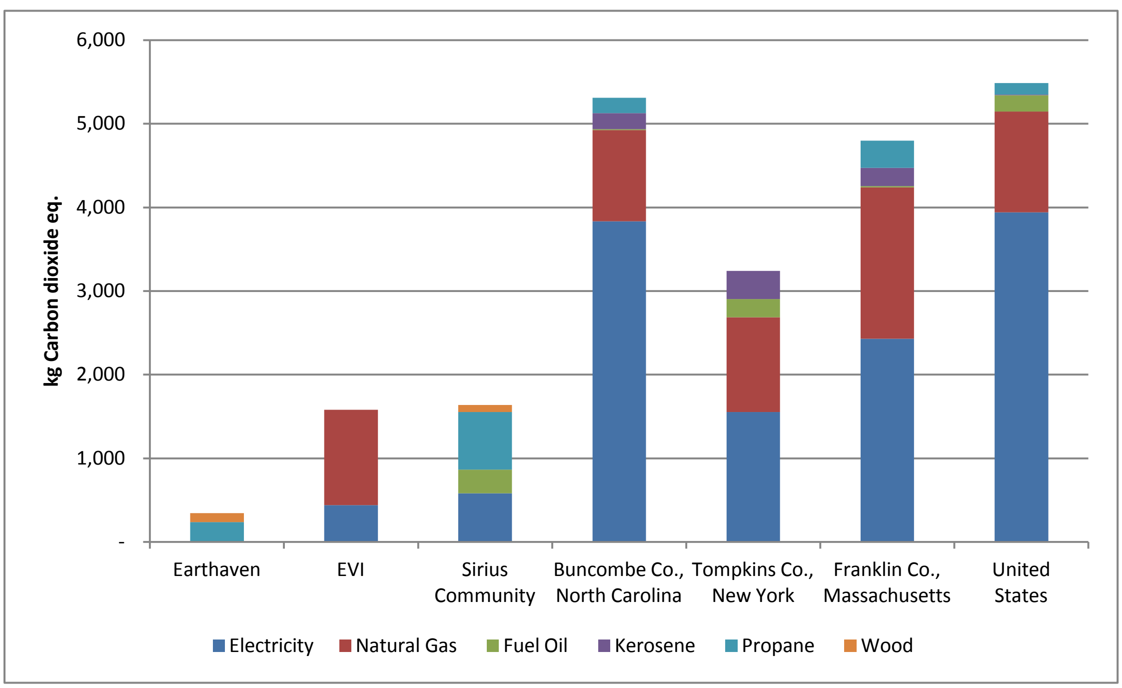

Figure 3.2-A Global Warming Potential of Home Energy Use

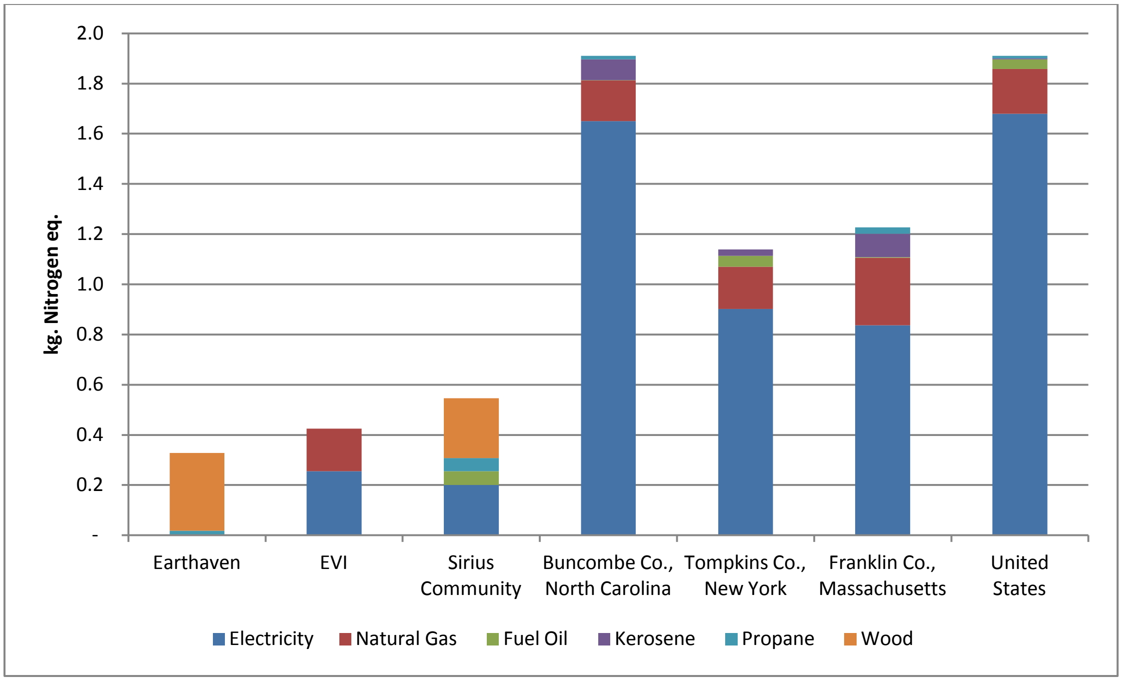

Figure 3.2-B Eutrophication Impact from Home Energy Use

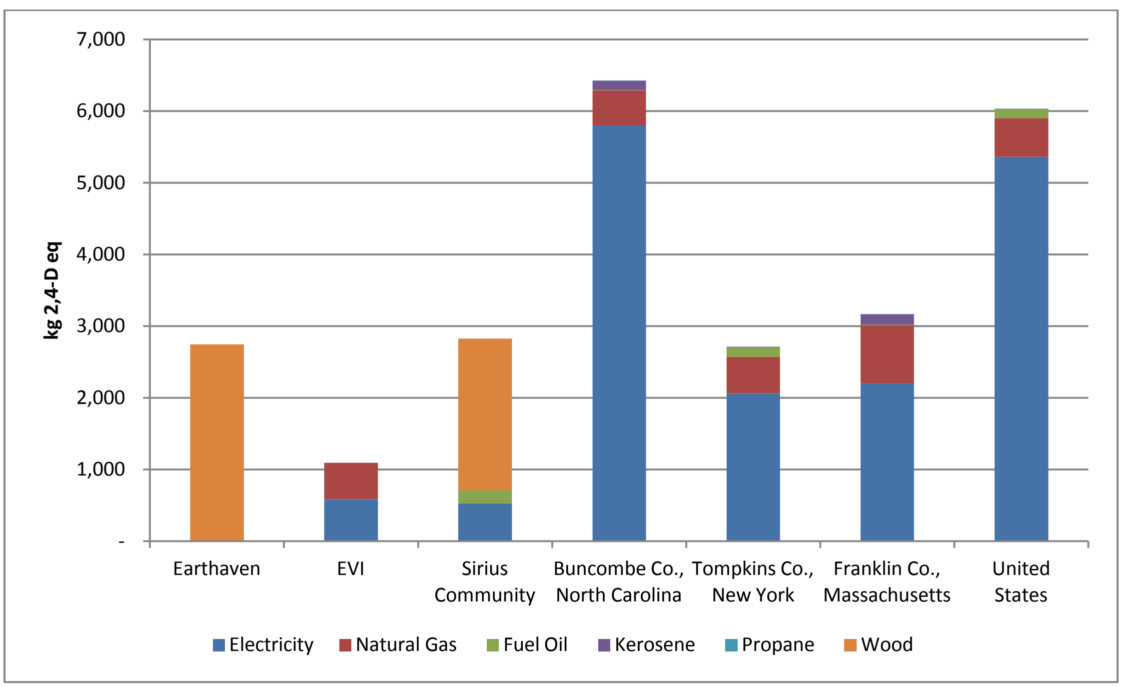

Figure 3.2-C Ecotoxicity Impact from Home Energy Use

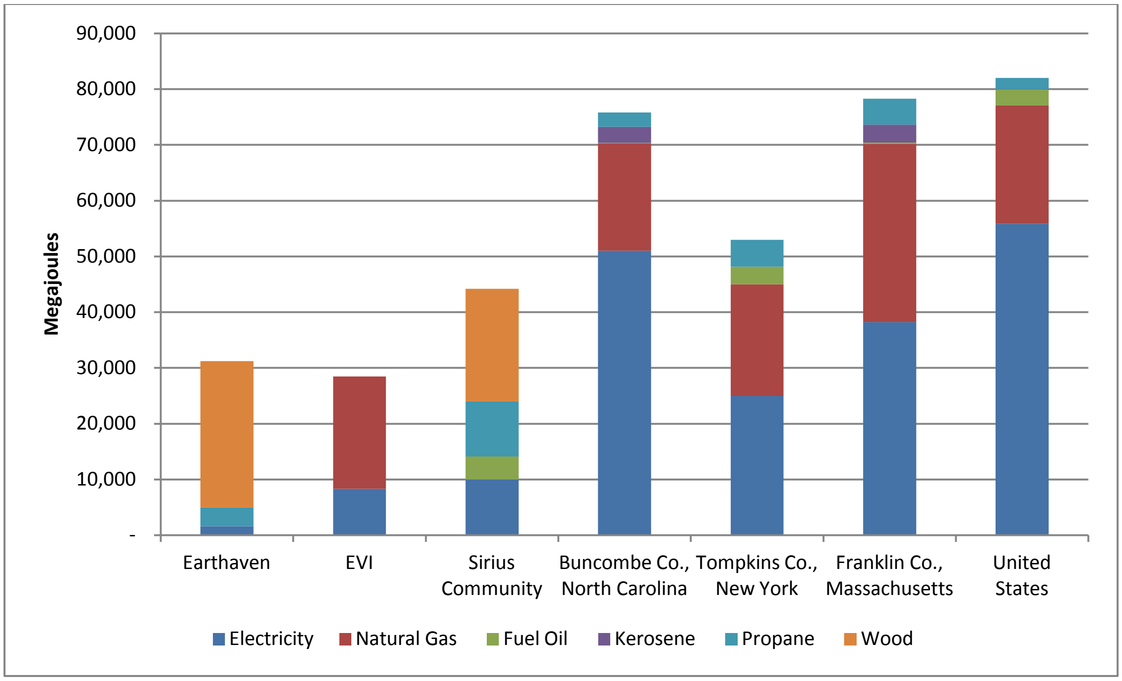

Figure 3.2-D Cumulative Energy Demand of Home Energy Use

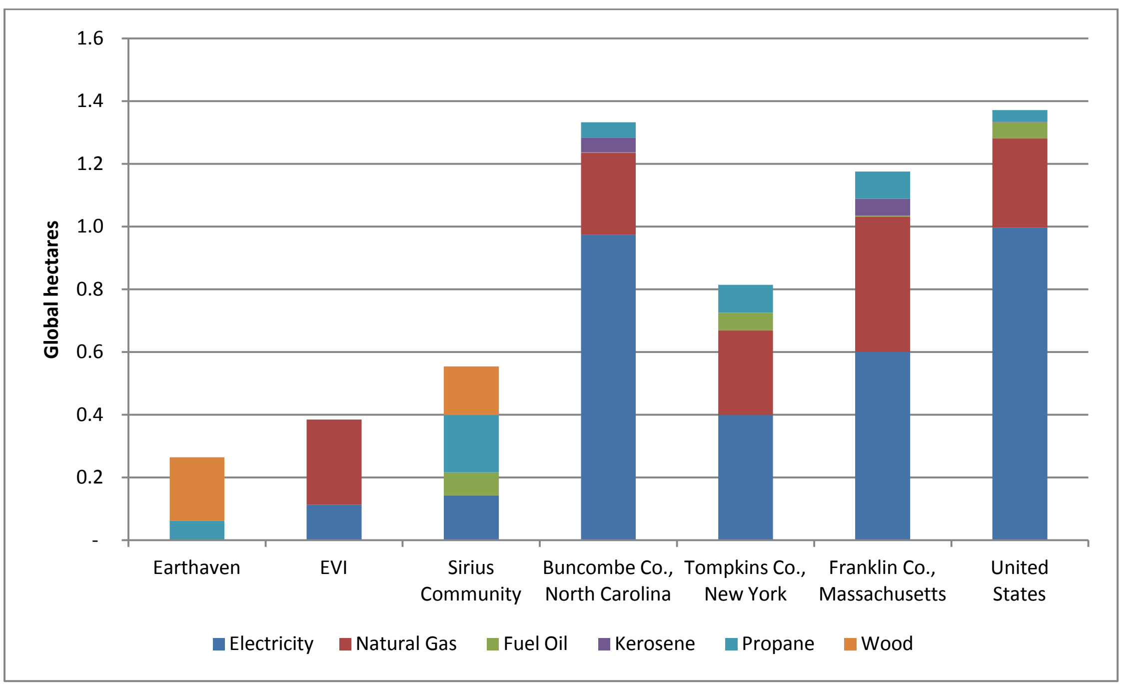

Figure 3.2-E Ecological Footprint of Home Energy Use

3.3 Transportation Energy Use

The LCIA results for the average transportation energy consumption for one resident over one year by community are depicted in Table 3.3-A below. Figures 3.3-A – 3.3-E display the contributions of the ground and air transportation as well as the total impact by community. Small scale data on air transportation was not available, so national average data is used throughout. Transportation energy use per resident per year ranges between 33,825 MJ in Sirius and 106,713 MJ for Franklin County, MA, and the ecovillage average is 63% lower than the U. S. average. While residents at all of the ecovillages had lower transportation energy use than the surrounding counties or national averages, EVI and Sirius both showed greater use of air travel than the national average. Thus the reductions in transportation energy use were achieved primarily through reductions in ground transport energy use. These reductions are due to fewer miles travelled per year, increased ride sharing, and the use of high efficiency vehicles. A similar pattern of reduced impacts for the ecovillages compared to the state and national averages can be found across all of the impact categories (average reductions: Earthaven 64%, EVI 41%, Sirius 58%). Sirius shows a higher eutrophication impact compared to the other ecovillages due to the use of used vegetable oil for fuel by some of the residents. Combustion of used vegetable oil results in higher emissions of nitrogen oxides than gasoline or petro-diesel.

Table 3.3-A LCIA Results for Transportation Energy Use

Impact Category	Global Warming (TRACI)	Eutrophication (TRACI)	Ecotoxicity (TRACI)	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	2,743.12	0.75	1,734.57	38,628	0.6656
EVI	3,045.18	0.85	1,933.49	42,999	0.7423
Sirius Community	2,340.45	1.36	1,493.57	52,199	0.5859
Buncombe Co., North Carolina	7,588.07	2.05	4,775.91	106,521	1.8315
Tompkins Co., New York	5,206.92	1.42	3,283.02	73,181	1.2593
Franklin Co., Massachusetts	7,601.82	2.05	4,784.52	106,713	1.8348
United Sates Average	7,343.11	1.98	4,622.32	103,091	1.7726

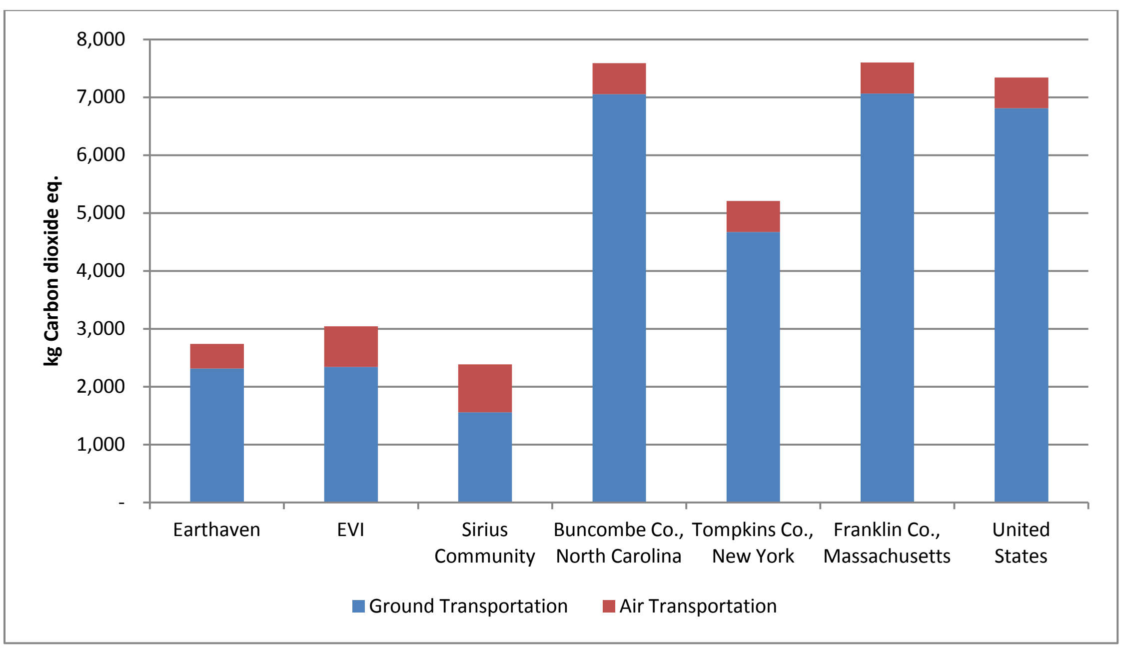

Figure 3.3-A Global Warming Potential of Transportation Energy Use

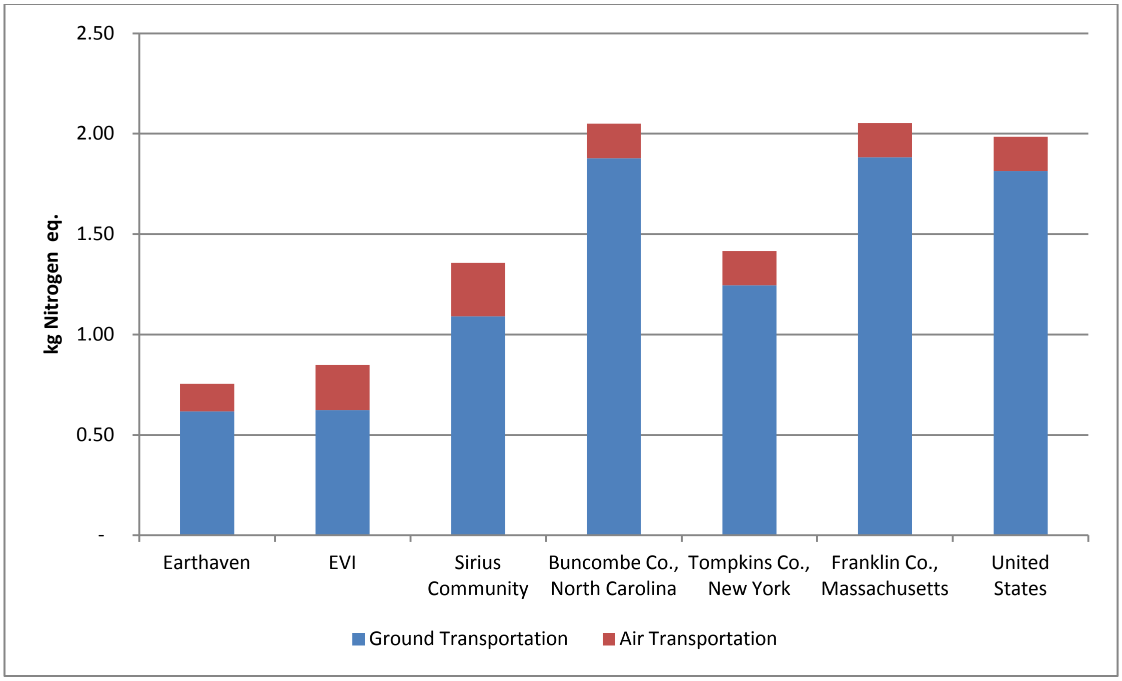

Figure 3.3-B Eutrophication Impact from Transportation Energy Use

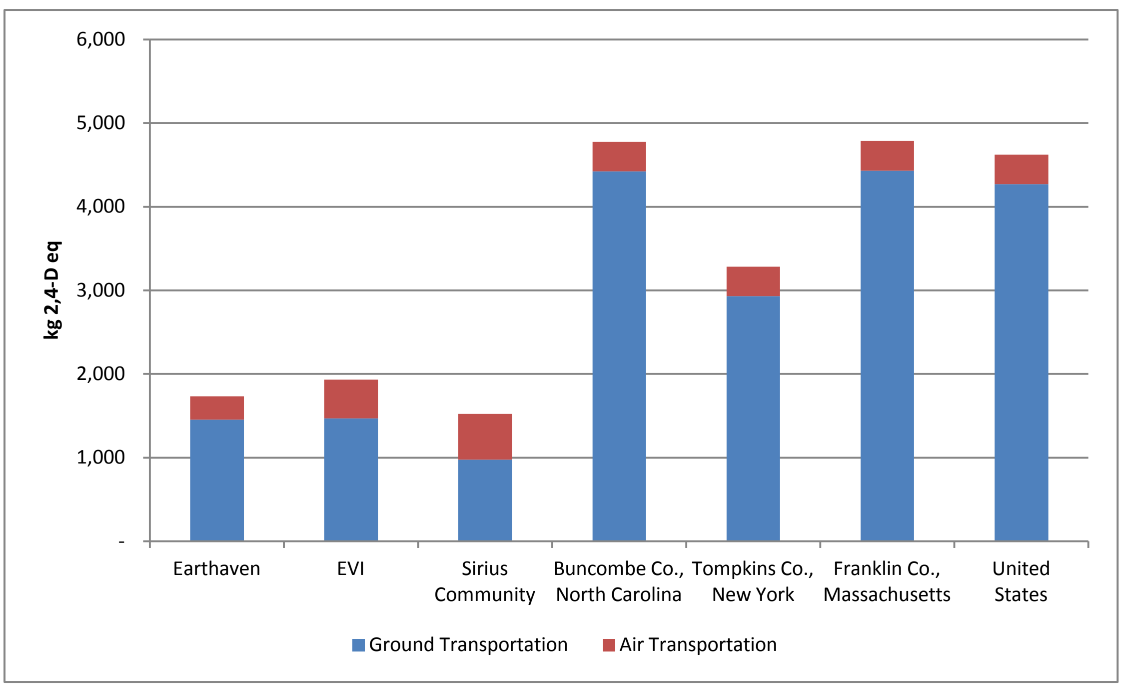

Figure 3.3-C Ecotoxicity Impact from Transportation Energy Use

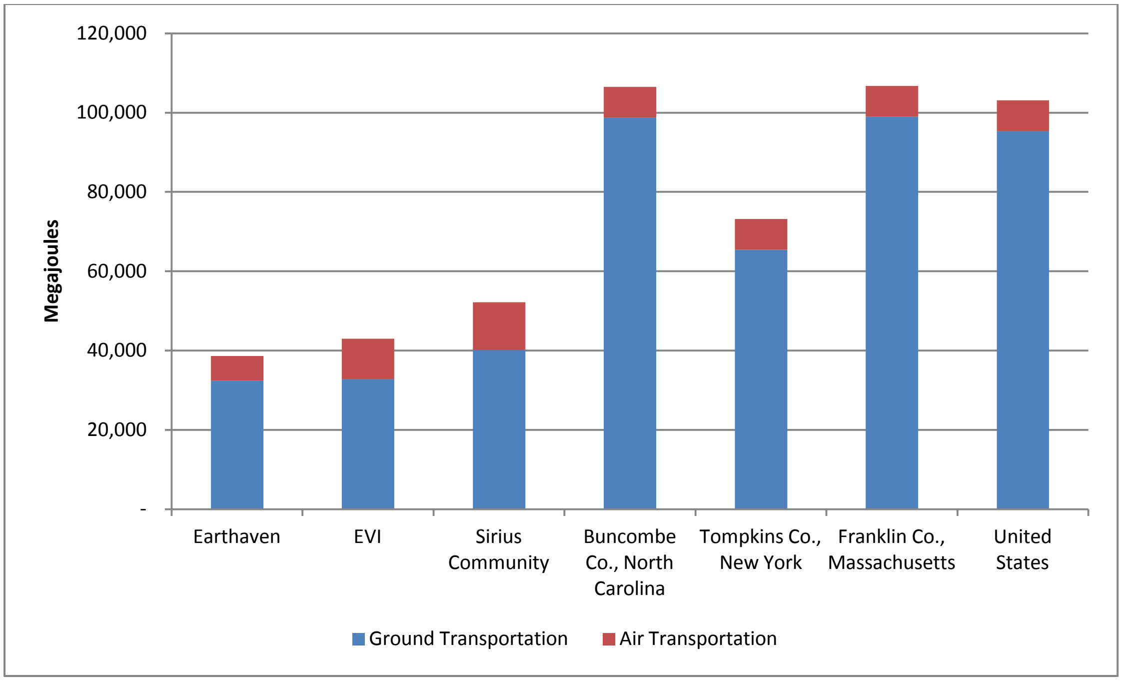

Figure 3.3-D Cumulative Energy Demand of Transportation Energy Use

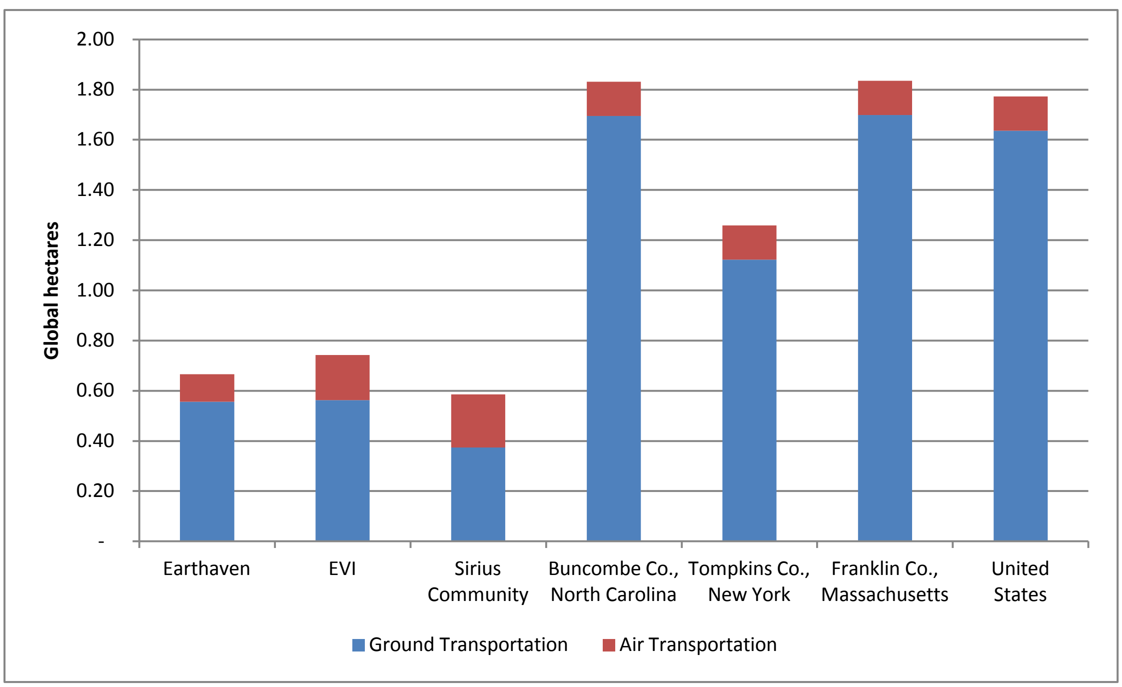

Figure 3.3-E Ecological Footprint of Transportation Energy Use

3.4 Food

The LCIA results for the average food consumption for one resident over one year by community are depicted in Table 3.4-A below. Figures 3.4-A – 3.4-E display the contributions of the different types of food as well as the total impact by community. Small scale data on food consumption was not available, so all comparisons are made to the U.S. average. The underlying assumption for the food analysis is that the total amount of food consumed per person does not vary by community, only the types and sources of food vary.

Global Warming, Eutrophication, and Ecological Footprint all show similar reductions in impacts compared to the U.S. average. Across these categories the ecovillage averages show reductions in impact between 47% and 70%. These impact categories are all strongly related to the amount of meat (beef, pork, veal, and lamb) consumed, which is considerably lower in the ecovillages than the U.S. average (65% lower in Earthaven, 83% lower in EVI, 75% lower in Sirius). The GWP of meat production has been well documented (Ogina, 2007; Pelletier, 2001; Peters, 2010), and the greenhouse gas emissions from meat production drive both GWP and Ecological Footprint. Animal wastes are also major contributors to Eutrophication, explaining that impact category's responsiveness to meat consumption. The proportional increase in other types of food (primarily vegetables, grains, dairy, and fruits) in ecovillage diets has relatively little impact on the GWP, Eutrophication, or Ecological Footprint. Food delivery is also a relatively minor impact for these categories, supporting Weber's conclusions that the impact of buying local food is outweighed by the effect of changing in diet to reduce meat consumption (Weber, 2008).

CED shows a more modest reduction in the ecovillages compared to the U.S. average, but in a similar pattern to that which exists in the other impact categories. The ecovillages show an average reduction of 24% in CED when compared to the U.S. average, which is due primarily to reduced meat consumption.

Ecotoxicity exhibits a very different pattern from the other impact categories. Ecotoxicity shows a two percent reduction at most in the ecovillages compared to the U.S. average. This is because this impact category is much more responsive to the production of fats, vegetables, grains, sweeteners, and food delivery. The primary drivers of the ecotoxicity impacts are the production of canola oil, corn, and corn syrup, as well as combustion emissions from food delivery.

Table 3.4-A LCIA Results for Food

Impact Category	Global Warming (TRACI)	Eutrophication (TRACI)	Ecotoxicity (TRACI)	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	1,512.59	17.21	368.30	10,928	0.45
EVI	1,147.95	11.49	365.36	10,082	0.33
Sirius Community	1,302.42	14.04	360.83	10,364	0.38
United Sates Average	2,875.18	38.52	369.21	13,841	0.89

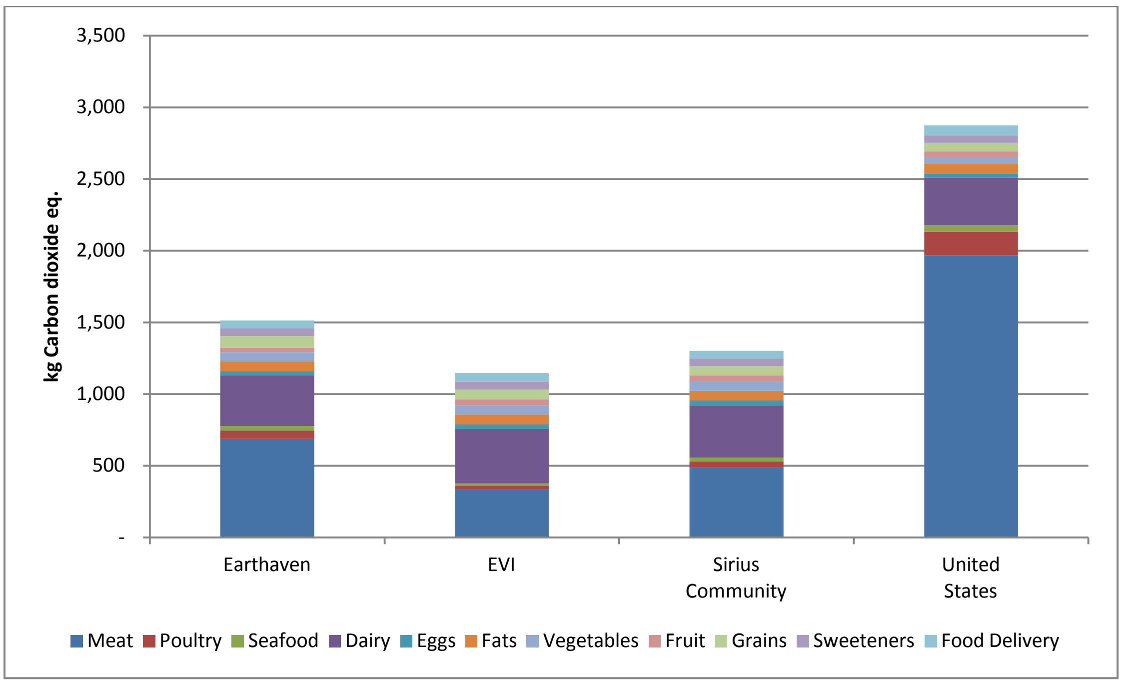

Figure 3.4-A Global Warming Potential of Food

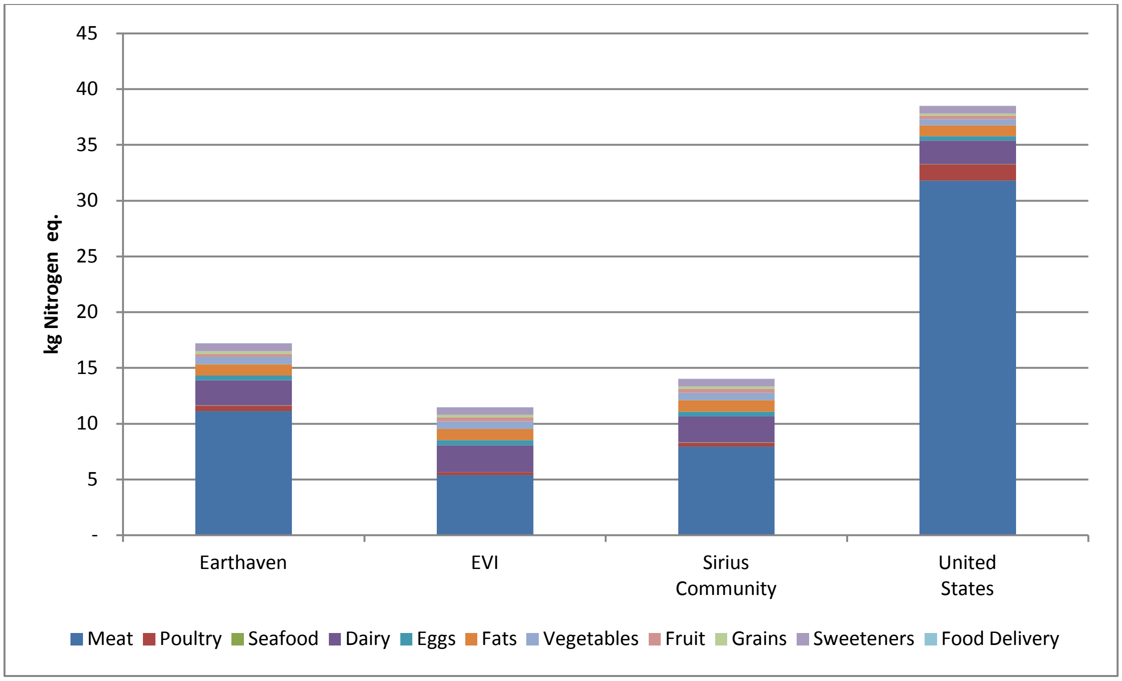

Figure 3.4-B Eutrophication Impact from Food

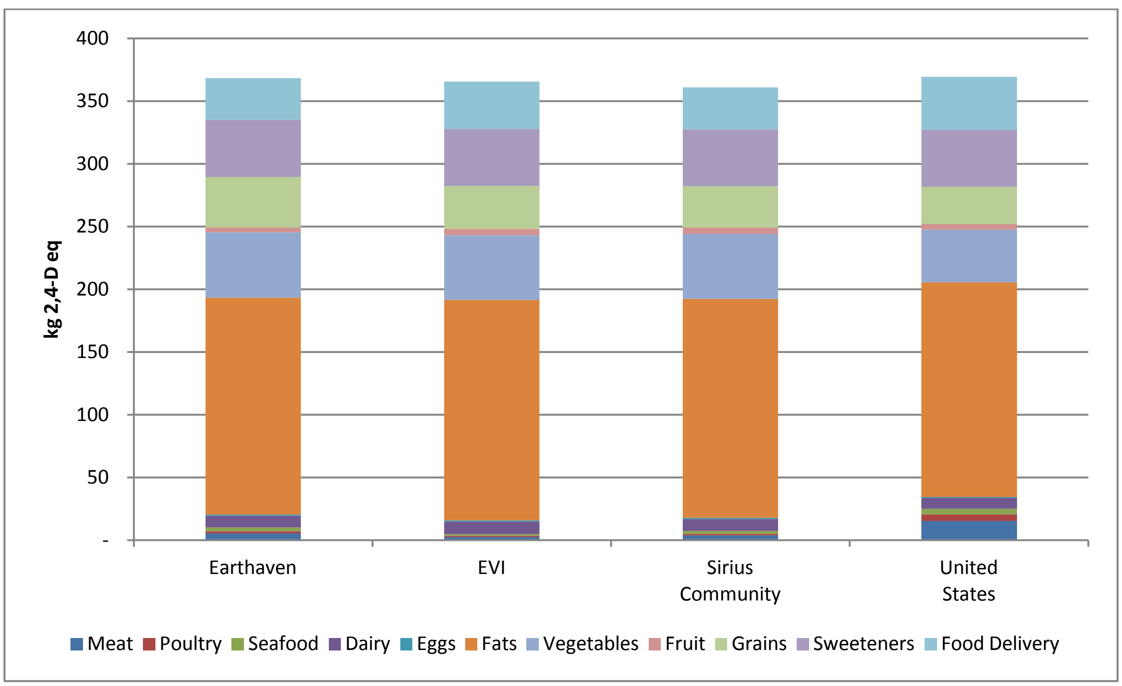

Figure 3.4-C Ecotoxicity Impact from Food

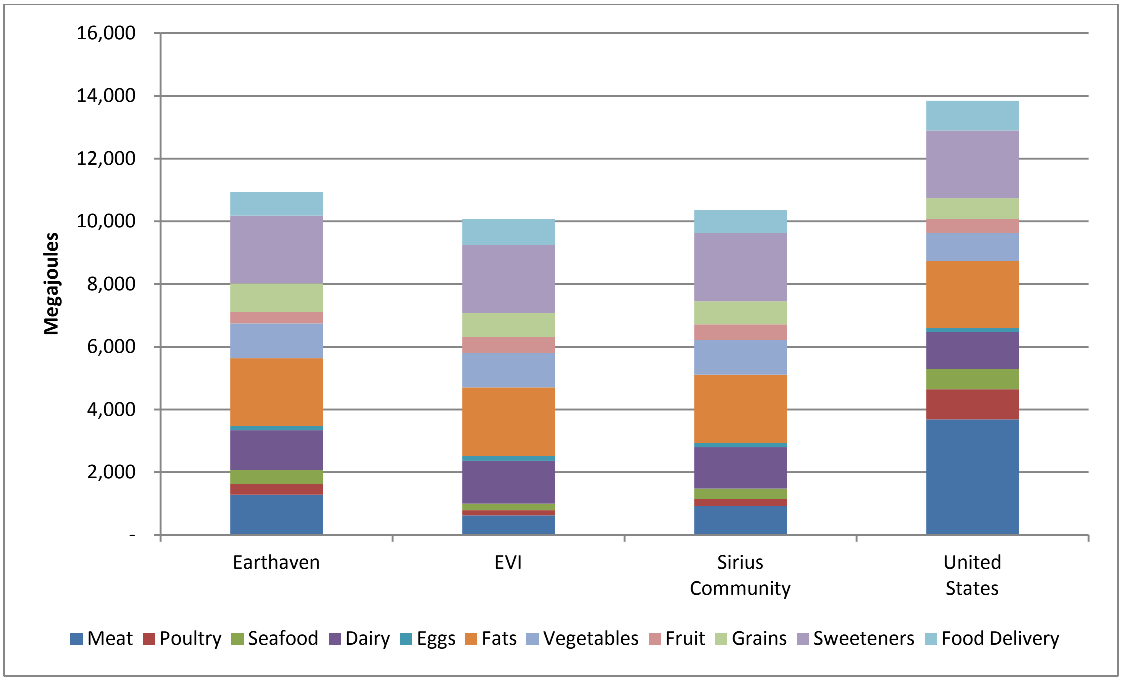

Figure 3.4-D Cumulative Energy Demand of Food

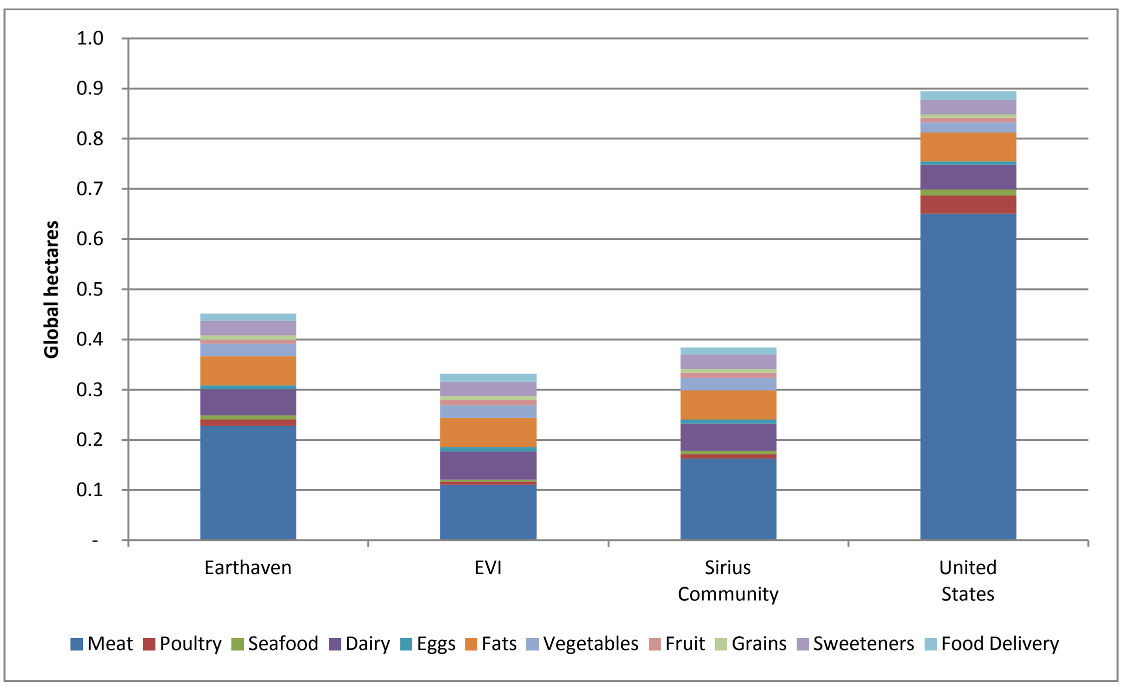

Figure 3.4-E Ecological Footprint of Food

3.5 Waste Disposal

The LCIA results for the average waste disposal for one resident over one year by community are depicted in Table 3.5-A below. Figure 3.5-A – 3.5-E display the contributions of landfill disposal, incineration, recycling, composting, and waste transportation as well as the total impact by community. Recycling and composting are the key factors in the low or negative results for waste disposal. When plastics, metals, and other products are recycled, they replace feedstock that would otherwise have to be manufactured from virgin resources. This replacement of manufactured feedstock creates a negative environmental impact. Composting creates a similar effect by being used in place of manufactured fertilizer. See Appendix E for more details on the composting models used in this analysis.

The reduced volume of waste at the ecovillages results in smaller (closer to zero) impacts for landfill and incineration across all of the impact categories. The high level of recycling at the ecovillages results in larger (further from zero) impacts for recycling than some of the county results, despite a lower overall volume of waste. The ecovillages also show larger impacts for composting due to its extensive for food and other organic waste.

The negative results associated with recycling and composting for GWP, CED, and Ecological footprint show the positive environmental impact that these activities can have. However, composting and recycling do not mitigate the impacts from landfilling and incineration for eutrophication and ecological toxicity. The ecovillage results demonstrate the reduced damage to the environment achieved by reducing the total amount of waste disposed. Incineration and the use of landfills have a wide range of impacts, (air emissions, soil contamination, surface water pollution, and groundwater pollution) which can be damaging to the environment (Christensen, 2010b).

When compared to the overall impact per resident, waste disposal is of minimal influence in most impact categories. Waste disposal comprises less than four percent of the overall impact for GWP, CED, and Ecological Footprint. Similarly, for Eutrophication, waste disposal makes up only 3% to 7% of the overall impact. However, for Ecotoxicity waste disposal is the single biggest factor, comprising between 41% and 74% of the overall Ecotoxicity impact. Waste disposal is the life cycle phase where materials are returned to the environment either through burial in a landfill or incineration. These activities result in releases of materials directly into the environment, which explains their strong impact on Ecotoxicity.

The disposal of aluminum, steel, and paper are responsible for more than 90% of the Ecotoxicity impact across all of the communities. Specifically it is the releases of aluminum and copper into the air, water, and soil that drives these Ecotoxicity results. Copper and aluminum both have negative effects on soils and aquatic ecosystems. These metals impair the uptake of nutrients from soils and can prove toxic to fish and other aquatic species (US EPA, 2008b; US EPA, 2009).

Table 3.5-A Waste Disposal LCIA Results

Impact Category	Global Warming (TRACI)	Eutrophication (TRACI)	Ecotoxicity (TRACI)	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	(73.16)	0.57	3,402.81	(2,457.00)	(0.01)
EVI	(96.37)	0.48	3,350.36	(2,459.33)	(0.01)
Sirius Community	(67.92)	0.39	3,317.25	(2,448.52)	(0.01)
Buncombe Co., North Carolina	386.57	2.97	22,675.82	(384.68)	0.10
Tompkins Co., New York	137.72	1.87	18,115.07	(1,083.92)	0.04
Franklin Co., Massachusetts	(19.66)	1.48	9,431.18	(4,596.90)	0.01
United Sates Average	181.80	3.17	21,988.75	(1,870.58)	0.06

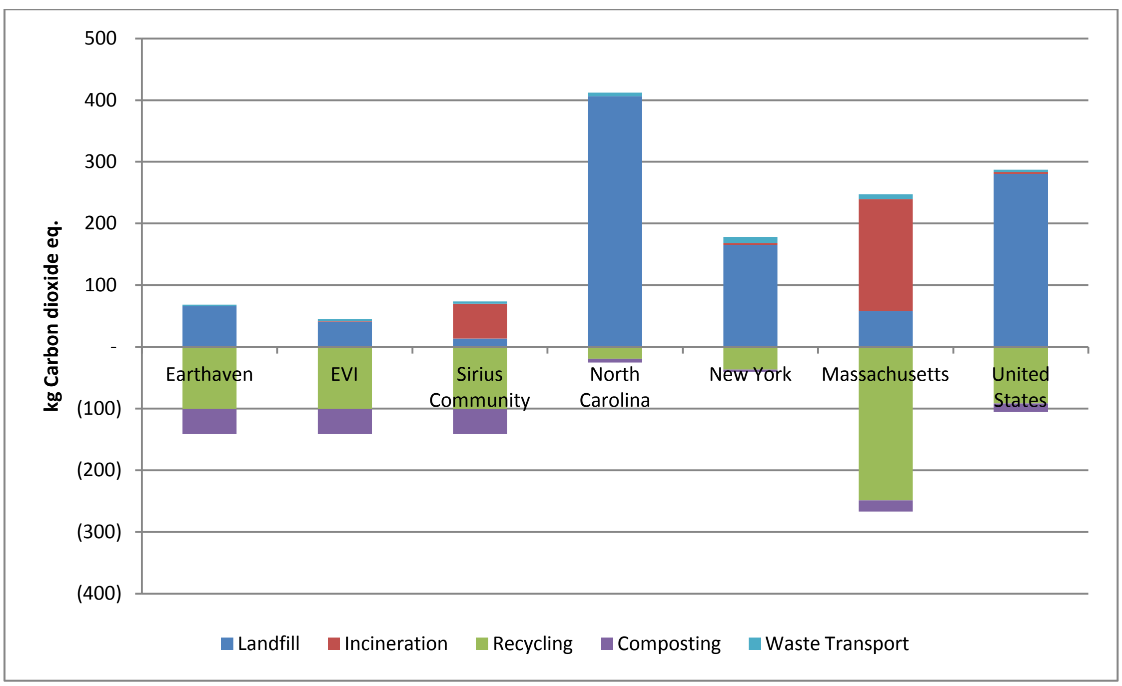

Figure 3.5-A Global Warming Potential of Waste Disposal

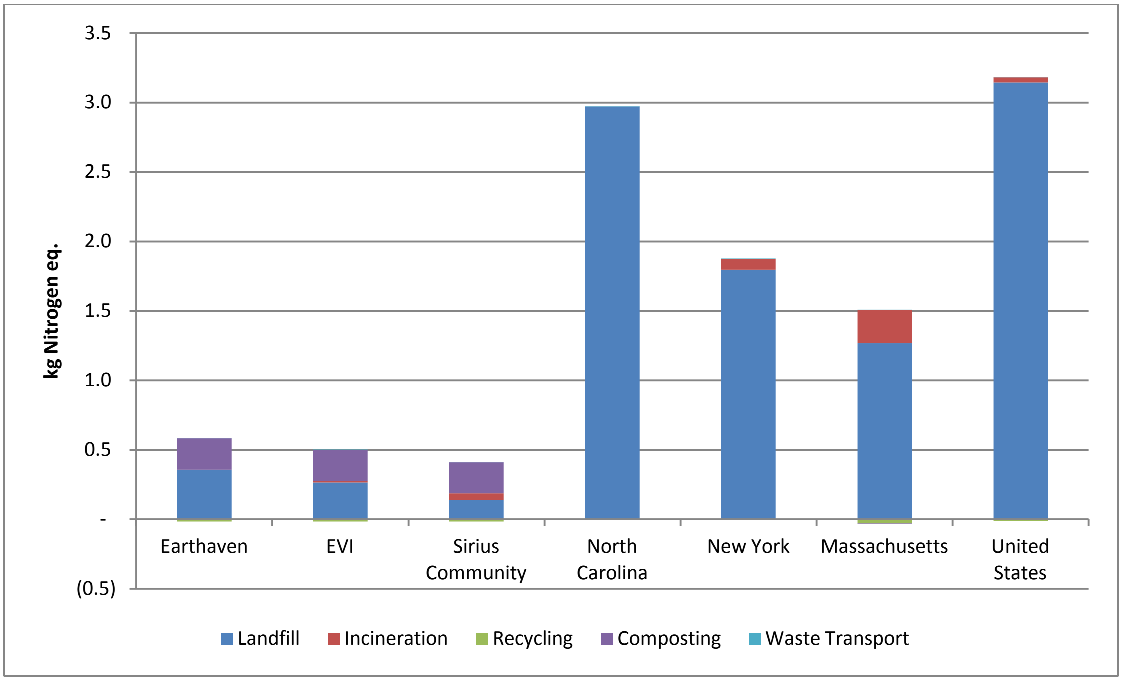

Figure 3.5-B Eutrophication Impact of Waste Disposal

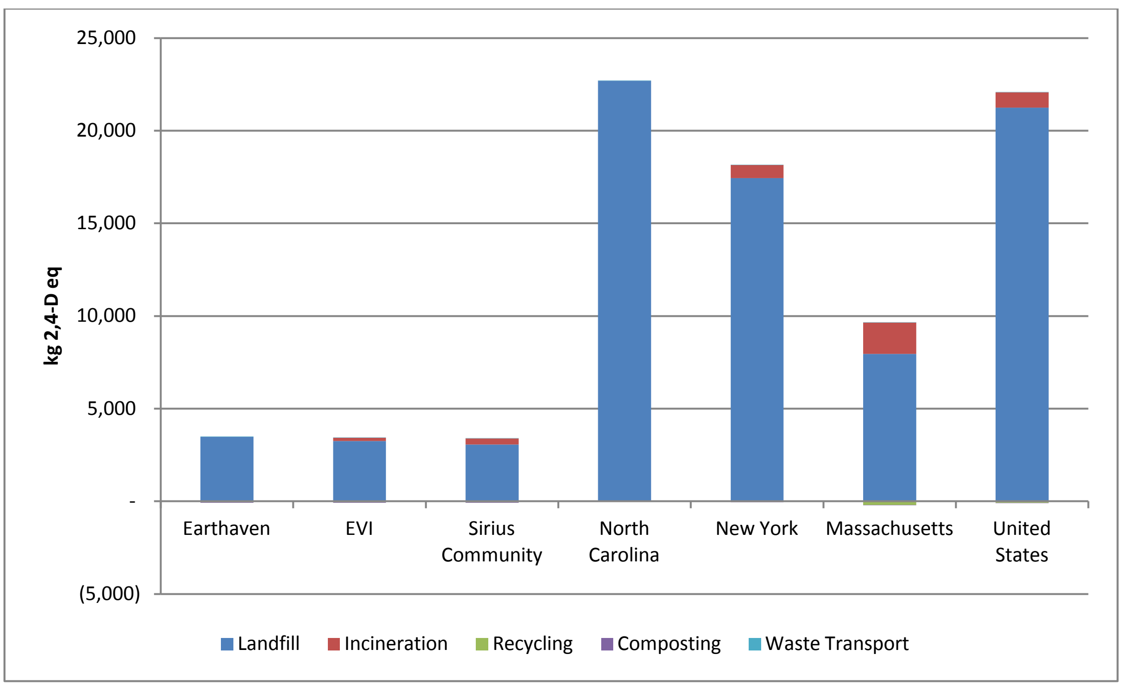

Figure 3.5-C Ecotoxicity Impact of Waste Disposal

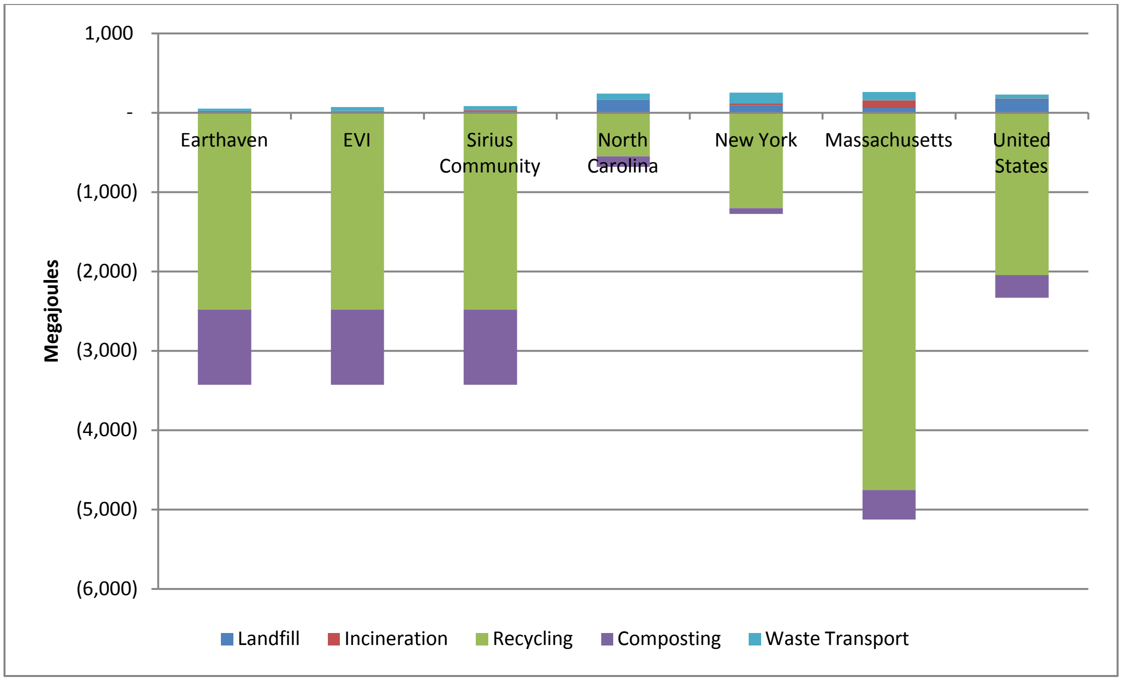

Figure 3.5-D Cumulative Energy Demand of Waste Disposal

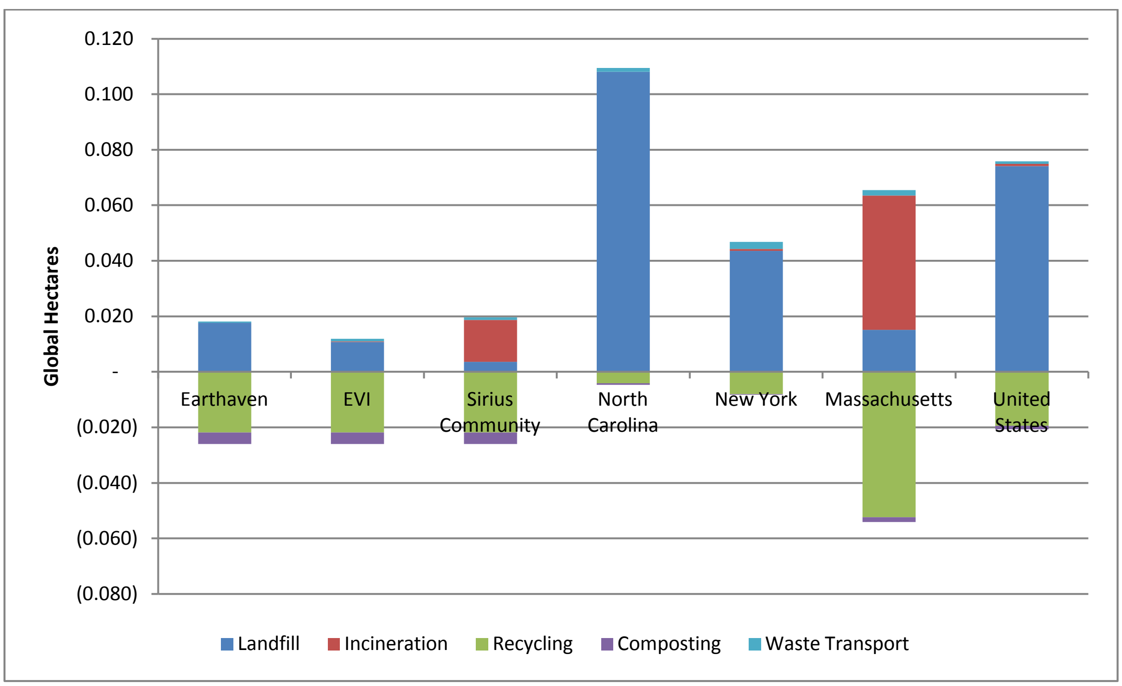

Figure 3.5-C Ecological Footprint of Waste Disposal

4. Discussion and Conclusions

The results of this analysis show a consistent pattern of reductions when comparing ecovillage residents to residents of the comparison communities. Table 4-A, below, shows the reduction in environmental impact for each category when comparing the ecovillage to its surrounding community. These reductions range between 43% and 76%, demonstrating that ecovillages are achieving substantial reductions in environmental impact across all the measured categories. Overall results for all TRACI categories and Impact 2002+ categories are provided in Appendix C.

Table 4-A. Reductions in Environmental Impact in Relation to Comparison Communities

Impact Category	Global Warming (TRACI)	Eutrophication (TRACI)	Ecotoxicity (TRACI)	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	72%	59%	76%	60%	67%
EVI	50%	69%	72%	43%	52%
Sirius Community	66%	62%	55%	46%	61%

Table 4-B, below, provides the average reductions across all of the TRACI categories, CED, and Ecological Footprint. These average reductions, with standard deviations between 7-12%, further substantiate the considerable reductions in environmental impact achieved by the ecovillages. However, there are some important variations that underlie this average data.

Table 4-B. Impact Reduction Means and Standard Deviations

Impact Category	Average Reduction	Standard Deviation
Earthaven	67%	7%
EVI	60%	12%
Sirius Community	58%	8%

One important variation is the difference in impacts between the comparison communities. While the US Average, Buncombe County, and Franklin County were similar in impact for most categories (all except Ecotoxicity), Tompkins County was consistently lower than the other communities. The Tompkins County data was not only more specific for home energy use (TCPD, 2010), but it also provides an example of a comparison community that is known to be focused on reducing environmental impact, as was confirmed by my interviews with EVI residents and other local residents. Thus, the comparison of EVI to Tompkins County provides some insight into the question of how ecovillage residents compare to environmentally-minded people living in more mainstream communities. While this data is suggestive, much more study would be needed to answer this question definitively.

Another key conclusion of this analysis is that Life Cycle Assessment provides an effective method for quantifying the types and magnitudes of environmental impacts of individuals, at least from a comparative perspective. The need to exclude disposable and durable goods as well as commercial and industrial activity from this analysis results in an analysis that cannot quantify the overall environmental impact per resident, but can provide an idea of comparative impacts of different residents. However, it is important to consider that excluded data may vary differently than the included data, so it is difficult to draw conclusions the results of a comparison of complete lifestyle impacts (all activities included). However, the ecovillage case studies developed in chapters 4 through 7 support the idea that reductions in the unmeasured activities would be similar in scope to the measured activities.

By including environmental impact categories beyond global warming and energy use in this analysis, as suggested by Hertwich (2005), the varied and complex impacts of certain activities can be better understood. Examples of this include landfilling providing a modest contribution to Global Warming Potential while being a large contributor to the Ecotoxicity impact, and food being by far the largest contributor to the Eutrophication impact while contributing more modestly in all other categories. Combustion and its emissions have a tendency to dominate energy demand and global warming measures, but other activities often drive other environmental impacts. These differences highlight the need to understand environmental impact from a more comprehensive perspective.

The reliance on government data for the comparison communities introduces one of the greatest limitations of this study. Government publications often did not provide data at a scale appropriate for the comparison of an ecovillage to the surrounding community. Even operating at the county level results in a level of aggregation of data that is not ideal. Directly surveying the surrounding community could provide a more precise comparison sample. However, even comparisons to national averages demonstrate that the residents of ecovillages have achieved significant reductions compared to non-ecovillage residents.

Chapter 9. Conclusion and Discussion

Two questions guided this research: 1) to what extent do ecovillage residents have a lower environmental impact than residents of nearby communities and the national average, and 2) how have ecovillage residents achieved these reductions in environmental impact? The first question is addressed in detail in the previous chapter, and the results are summarized in Tables 1 and 2 below. These tables show that the ecovillages have achieved environmental impact reductions between 43% and 71%, depending on village and impact category, compared to nearby communities. When compared to the national average these reductions ranged between 47% and 80%. These are large reductions, but are in line with the impact reductions of 50% for the ecovillage Findhorn seen in the Tinsley (2006) study, especially given the generally higher consumption per person in the U.S. as compared to Scotland, where the Tinsley study was conducted.

Table 1. Reductions in Environmental Impact in Relation to Comparison Communities

Impact Category	**Global Warming**	**Eutrophication**	**Ecotoxicity**	**Cumulative Energy Demand**	**Ecological Footprint**
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	71%	59%	76%	60%	66%
EVI	50%	69%	72%	43%	51%
Sirius Community	66%	62%	55%	46%	61%

Table 2. Reductions in Environmental Impact in Relation to US Average

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	71%	59%	75%	60%	66%
EVI	63%	71%	80%	60%	64%
Sirius Community	66%	64%	76%	47%	61%

One important question that occurs about these results is how much of the reduction in impact is due to the specific aspects of the ecovillages and how much of the reduction could be achieved by any community that is working to reduce their environmental impact. Although this question is beyond the scope of this work, the results for Ecovillage at Ithaca (EVI) compared to Tompkins County provide some insight. While the US Average, Buncombe County, and Franklin County were similar in impact for most categories, Tompkins County was consistently lower than the other communities.

The Tompkins County data was not only more specific for home energy use (TCPD, 2010), but it also provides an example of a comparison community that is known to be focused on reducing environmental impact, according to interviews with EVI and other local residents. Table 3, below, reproduces the life cycle inventory analysis (LCIA) results for home energy use for all the communities. These results show that for home energy use, the Tompkins County results are on average 35% lower than the other comparison communities (Buncombe County, Franklin County, and the US Average). However, the results for home energy use for EVI are on average 55% lower than Tompkins County (70% lower than the other comparison communities). This suggests that while a community that focuses on reducing environmental impact can make significant gains, ecovillages have the potential for even greater reductions. However, these results are only suggestive and further research would be needed to confirm these conclusions.

Table 3. LCIA Results for Home Energy Use

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven	344.31	0.33	2,744.64	31,229	0.2640
EVI	1,580.82	0.42	1,095.47	28,481	0.3845
Sirius Community	1,636.61	0.55	2,824.22	44,185	0.5545
Buncombe Co., North Carolina	5,309.02	1.91	6,422.30	75,829	1.3319
Tompkins Co., New York	3,241.04	1.14	2,711.99	52,952	0.8146
Franklin Co., Massachusetts	4,799.35	1.23	3,167.00	78,288	1.1750
United Sates Average	5,487.13	1.91	6,031.84	82,011	1.3709

The answer to the second question "How have ecovillage residents achieved these reductions in environmental impact?" is addressed through the ecovillage case studies in chapters 4 through 7. These case studies reveal that the members of the ecovillages consistently express two goals: fostering community and restoring nature. These two goals are the core of ecovillage life, and are enacted through a combination of physical and social practices that develop from the commitment to nature and community present in each ecovillage.

Ecovillages are intentional communities that embody the desire expressed by Beatley and Manning (1997, p1.) for a place to live where

> "…the land is consumed sparingly, landscapes are cherished, and cities and towns are compact, vibrant and green. These are communities in which the economic base is viable as well as environmentally and socially restorative. This vision of place emphasizes both the ecological and the social, where quantity of consumption is replaced with the quality of relationships."

This is a complex vision of community where the land is cherished, relationships are valued over the consumption of material goods, and human beings can live contentedly. Some form of this vision is expressed in the mission statements of each of the ecovillages included in this study and by the members of those ecovillages when they describe what they want for their home. Each case study ecovillage possesses a culture based on this vision, and it is this culture that leads to the emergence of the practices that have enabled such drastic reductions in environmental impact.

The origin of each ecovillage is different, but they all express a common theme. In each case, there was a group of people who were committed to the vision outlined above, and who were willing to commit their resources (time, labor, and money) to creating a community that reflected this vision. These communities all developed different cultures, and each struggled with different aspects of their vision. However, each of them includes their land as a member of their community, and cherishes and relies upon the relationships among the members to maintain the well-being of the community.

In her study of ecovillages Kasper highlights the role that the land ethic plays in the ecovillage paradigm, and points to it as a key aspect of a sustainable society.

> The ecovillage paradigm is not only different from the dominant western worldview, it is an understanding of the world that is consciously articulated and embodied in ecovillage practices, relations, and the physical setting itself. The land ethic is an essential mechanism through which all this takes place, beyond technology, laws, and economics. In regard to the question with which we began — what does a sustainable society look and think like? — ecovillages suggest the necessity of a paradigm that facilitates a sense of community wider than the traditionally human one. It means that not only do people have a more accurate understanding of the complex interrelations between themselves and the land, but also that they feel obligated to steward the land that gives them so much.

The ecovillages included in this study all reflect this inclusion of the land ethic, the focus on the inter-relations of the human community and the land, and the strong sense of stewardship that Kasper discusses. These are key aspects of why ecovillages exist and persist. The members of these communities want to live in a closer relationship with the natural world than can be found in most communities.

However, it is important to acknowledge the other main pillar of ecovillage life, the strong relationships among the human members of the community. These communities have worked hard to “replace the quantity of consumption with the quality of relationships,” and many members informed me that it was the strong human community that initially drew them to the ecovillage, while their relationship with the land developed and deepened during their tenure there. Thus the strong sense of community draws new members, with many members only becoming aware of the land as a member of the community after they have joined.

The practices which reduce the negative impacts to the environment and efforts to restore and improve the health of the land in these communities all emerge from the strength of the relationships among the members of the community, both human and non-human. While many of these practices can be transplanted to other communities and settings, it is the commitment of the ecovillagers and their particular worldview that makes these practices so effective. Kanter’s (1972) book *Commitment and Community* has as its thesis the idea that the health of an intentional community is directly related to the commitment of its members. This is true not only for the health of ecovillages, but also their effectiveness in terms of environmental impact. The commitment of members to each other and the land, and to the ecovillage paradigm, is what leads them to search out new ideas and techniques for living lighter on the land, what causes them to share in community labor when it would be easier to stay home, what makes these communities effective.

How transferrable or replicable the reductions in environmental impact achieved in these ecovillages are is a major question. While the practices related to green building and village planning could be used in other communities, most of the practices rely on the social fabric, the commitment of the members to succeed. As mentioned earlier the established trust and ethic of cooperation among the members of the community essentially reduces the difficulties associated with establishing cooperative action within the communities. This makes the many co-ops, car shares, and community projects easier to achieve, and the commitment within the ecovillages to all members—human and natural—ensures a high level of participation by the members. It is unclear whether these sorts of cooperative actions would succeed in other types of communities. It is also unclear whether and how the land ethic that is so integral to the ecovillage paradigm would develop in other communities. Studies of other environmentally-oriented communities will enhance our understanding of these topics

One direction for future research is to conduct similar studies at communities that are being developed based on what has been learned from ecovillages. In New York, the Tompkins County government is using the lessons learned at EVI and a grant from the U.S. Environmental Protection Agency to support two new developments. These include an urban pocket neighborhood in Ithaca, NY, and a "sustainable village using 26 acres of County-owned" land that will include "densely clustered, walkable neighborhoods of 37-45 homes, while maintaining open space and easy walking distance to public transportation and community services" (USEPA, 2013). These communities are attempting to apply the physical practices and some of the social innovations developed at EVI. Studying whether a similar ethos develops, and how effective these communities are at reducing their environmental impacts would improve our understanding of the transferability of the ecovillage practices.

Similar studies could also be conducted on other environmentally-oriented communities to better understand the differences in ethos, practices, and environmental impact reductions between communities and how these aspects influence each other. LEED-ND neighborhoods, private communities like Serenbe Farm, and other attempts at sustainable communities would all provide data points for a better model of the nature and potential achievements of sustainable communities.

The mix of methods used in this study provides a powerful set of tools for analysis of potential sustainable communities. The life cycle assessment (LCA) provides a quantifiable measure of the achievements of the communities. This measure can be used for comparisons across communities and provides an understanding of the strengths and weaknesses of the community in terms of environmental impact reduction. While the LCA provides these quantifiable results, it does little to answer the questions of how and why a community is effective at improving their relationship with the environment. The qualitative case study approach used in this study provides an understanding of the experiences and motivations of community members and provides essential context to the results of the LCA. Combining these two methodologies gives a rich understanding these communities in our efforts to better understand the nature of sustainable community.

The ecovillages in this study have proven successful in reducing their environmental impact. If all of the homes in the United States reduced their energy consumption to the level of homes in these ecovillages more than 300 million tons of coal, 60 million barrels of oil, and 4 trillion cubic feet of natural gas would be saved each year, which would reduce carbon dioxide emissions by almost one billion tons per year. The multiple and varied techniques that have been used to achieve those reductions and the communities that have developed them are a rich source for examination in the continued efforts to make our development patterns and society more sustainable.

The more technical methods employed in the ecovillages, including green building techniques and renewable energy systems, are widely used already. However, social and ethical facets, including the co-ops and other community practices, the replacement of consumption with community, and the adoption of the land ethic are aspects of ecovillage life that have not been adopted by society at large, but which are equally, if not more, responsible for the accomplishments of the ecovillages. This research supports the idea that the development of a sustainable society depends not only on what we do, but on how we think, and the understanding that these mutually influence one another, and ecovillages are examples of this principle in action.

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Appendix A. Survey Results

Below are the responses to the surveys that were distributed in each ecovillage. All identifying information has been removed, including name, address and make and model of vehicle. Grey squares designate missing data. The averages of these survey responses may not exactly match the averages used for the ecovillages due to supplementary data which was acquired outside of the survey, such as energy bills for the entire ecovillage. Waste data, which was requested in the survey, is not provided below because of the very low response rate. Data on waste management was collected through site observations and interactions with administrative personnel at each ecovillage.

	Location	Electricity	Natural Gas	Wood	Fuel Oil	Propane	Car MPG	Car Travel	Air Travel	% Vegan	% Vegetarian	% Meat	% Garden	% Local	% Other Source
		kWh	MMBTU	cords	gal	gal		VMT	VMT						
1	EVI						23	3750	2235	0%	88%	12%	20%	60%	20%
2	EVI	533	27.8	0	0	0	22	2180	5455	0%	61%	39%	0%	60%	40%
3	EVI	1908	32.8	0	0	0	55	4500	0						
4	EVI						34	10000	0	0%	100%	0%	0%	5%	95%
5	EVI	1200	21.6	0	0	0	36	2000	3200						
6	EVI	2300	13.6	0	0	0	21	6000	2090	0%	34%	66%	0%	0%	100%
7	EVI	1440	23.5	0	0	0	29	17000	12900						
8	EVI	330	9.9	0	0	0	46	4250	5080	0%	86%	14%	0%	70%	30%
9	EVI	214	24	0	0	0	55	7500	0	0%	70%	30%	7%	40%	53%
Average		1132	22	0	0	0	36	6353	3440	0%	73%	27%	5%	39%	56%

	Location	Electricity	Natural Gas	Wood	Fuel Oil	Propane	Car MPG	Car Travel	Air Travel	% Vegan	% Vegetarian	% Meat	% Garden	% Local	% Other
1	Sirius	1892	0	0.75	0	64	22	7000	0	0%	100%	0%	20%	30%	50%
2	Sirius	512	0	0.75	0	86	25	10000	5596	0%	20%	80%	10%	20%	70%
3	Sirius	512	0	1	0	86	30	4500	5224	0%	100%	0%	30%	30%	40%
4	Sirius		0	1	133	90	19	5500	7264	0%	100%	0%	15%	35%	50%
5	Sirius	503	0	0.5	0	207	26	12000	10224	0%	100%	0%	10%	15%	75%
6	Sirius	512	0	1	0	86		0	789	100%	0%	0%	20%	20%	60%
7	Sirius	1011	0	1	0	79	16	7000	5224	10%	30%	60%	30%	25%	45%
8	Sirius	512	0	0.75	0	86		0	0	0%	35%	65%	35%	35%	30%
9	Sirius	503	0	0.75	0	207	49	2000	4456	0%	20%	80%	25%	40%	35%
10	Sirius	503	0	0.5	0	207	49	12000	5989	0%	25%	75%	20%	20%	60%
11	Sirius	1892	0	0.5	0	64		0	0	0%	20%	80%	15%	20%	65%
Average		835	0	0.77	12	115	30	5455	4070	10%	50%	40%	21%	26%	53%

	Location	Electricity	Natural Gas	Wood	Fuel Oil	Propane	Car MPG	Car Travel	Air Travel	% Vegan	% Vegetarian	% Meat	% Garden	% Local	% Other
1	Earthaven	0	0	1.5	0	30	26	3000	5278	0%	55%	45%	20%	30%	50%
2	Earthaven	0	0	1.5	0	28	26	5500	0	12%	53%	35%	20%	30%	50%
3	Earthaven	0	0	1	0	92	21	5000	0	9%	51%	40%	25%	35%	40%
4	Earthaven	0	0	0.5	0	20	21	1080	16119	5%	75%	20%	20%	40%	40%
5	Earthaven	0	0	0.75	0	0	25	7500	3133	13%	62%	25%	30%	35%	35%
6	Earthaven	0	0	0.75	0	0	26	600	683	10%	70%	20%	40%	30%	30%
7	Earthaven	0	0	0.83	0	20	34	3700	909	5%	57%	38%	15%	61%	24%
8	Earthaven	0	0	1.5	0	75	23	6600	1878	0%	100%	0%	0%	20%	80%
9	Earthaven	0	0	1	0	24	31	1500	2026	0%	100%	0%	34%	31%	35%
10	Earthaven	0	0	0.5	0	25	25	7500	3595	25%	60%	15%	0%	100%	100%
Average		0	0	1.0	0	31	26	4198	3362	8%	68%	24%	20%	41%	48%

Appendix B. Environmental Footprint Questionnaire

Your Name:		**Email:**	

Instructions:

Thank you for taking the time to complete this form. Note that you can choose a different time period for home energy and transportation, so enter data in the form that is the easiest for you. For home energy use you also have the option of simply including a copy of your energy bill instead of estimating electricity and natural gas (specifically I only need the page showing the graphs of usage). If you would like a report on your carbon footprint please also include your email address below your name, so that I can send you your analysis. Thank you again for participating in my research. It is my hope that this project will demonstrate the many benefits of ecovillage life.

Home Energy Use

Time Period		*You can enter dates, or simply put 1 month , 1 year, etc. (a full year is preferable)*

Please provide information on your energy use below, please don't use dollar amounts, but instead units of consumption, such as kWh.
I have provided common units, but please change them to match whatever units your data is in.

	Amount	*Unit*	*Notes*
Electricity		kWh	
Natural Gas		ccf	

Other Fuels (provide estimate of yearly use)

	Amount	*Unit*	*Notes*
Wood		cords of wood	
Propane		gallons	
Heating Oil		gallons	
Other			

Renewable Energy	*Wind*	*Photovoltaic*	*Geothermal*	*Other*
Which sources of renewable energy do you have onsite?				
Please provide the percentage or amount of your energy comes from:				

Number of People	*Number of People*
How many people are responsible for this energy use (how many living in the home)?	

Transportation Energy Use		
Time Period		*You can enter dates, or simply put 1 month , 1 year, etc. (a full year is preferable)*
To estimate miles per gallon I need information on your vehicle:		
Make		
Model		
Year		

*Usage Data: Fill in miles driven **OR** odometer reading **OR** gallons of gasoline purchased (choose the easiest for you to answer)*

Miles Driven	

OR

Gallons of Gasoline Purchased	

OR

	Start of Period	*End of Period*
Odometer Reading		

Number of People	*Number of People*
How many people use this vehicle as their primary vehicle?	

Air Travel	
Please provide the number of miles you travelled OR origin and destination for each flight:	Flight 1:
	Flight 2:
	Flight 3:
	Flight 4:

Food Consumption	
Please fill out the table below based on a typical week. For each meal you will be asked to enter the source and type.	
The options for source and type are included below. In general, please choose the description that best matches the mean.	
However, if a meal is balanced between two sources, feel free to put both in with a slash between them (e.g. garden/local).	
For Source please enter:	
Garden:	If most of the food came from your personal garden, a community garden, or animals you raised
Local:	If most of the food came from a farm attached to your community or within about 100 miles of your home
Store:	If most of your food came from a grocery store or other large store
Restaurant:	If your meal came from any type of restaurant, unless it specifically uses local foods, then put local
For Type please enter:	
Vegan:	No animal products (meat, cheese, milk, etc)
Vegetarian:	No meat, fish, poultry, etc
Meat:	Meal included a portion of meat

	Monday	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*	*Sunday*	
Breakfast (Source)								
Type								
Lunch (Source)								
Type								
Dinner (Source)								
Type								

Organic Food		
In general what percentage of the vegetables you eat are organic (produced without pesticides or herbicides)?		
In general what percentage of the poultry you eat is free range, hormone and steroid free?		
In general what percentage of the beef you eat is grass-fed, hormone and steroid free?		

Waste Disposal

Please do your best to estimate the amount and type of waste for each question.

How much general trash do you throw out each week (answer in lbs, cans, bins, gallons, etc.)?
If you answered in cans, bins, or other unusual units, can you estimate the size or weight of one unit?

What do you typically throw out? (e.g. paper, food waste, yard trimmings, wood, leather and textiles, plastics, metals, glass, etc).

List Materials:							

What types of materials do you recycle? (plastics, aluminum, steel, and cardboard are common answers) and how much?

List Materials:							
Amounts:							
Units:							

How do you dispose of food waste (e.g. compost, trash, garbage disposal)?

Appendix C. Additional LCA Results

Table C.1 TRACI Overall Results

	Units	Earthaven	EVI	Sirius Community	Buncombe Co., North Carolina	Tompkins Co., New York	Franklin Co., Massachusetts	United Sates Average
Global warming	kg CO2 eq	4.44E+03	5.63E+03	6.33E+03	1.55E+04	1.12E+04	1.51E+04	1.53E+04
Acidification	H+ moles eq	1.53E+03	1.86E+03	2.61E+03	5.35E+03	3.81E+03	4.92E+03	5.30E+03
Carcinogenics	kg benzene eq	1.50E+01	1.83E+01	1.87E+01	6.73E+01	4.07E+01	4.53E+01	6.68E+01
Non carcinogenics	kg toluene eq	3.15E+05	4.24E+05	3.61E+05	1.91E+06	1.11E+06	1.24E+06	1.90E+06
Respiratory effects	kg PM2.5 eq	4.24E+00	4.17E+00	6.93E+00	1.12E+01	6.71E+00	1.00E+01	1.15E+01
Eutrophication	kg N eq	1.89E+01	1.32E+01	1.98E+01	4.54E+01	4.29E+01	4.33E+01	4.56E+01
Ozone depletion	kg CFC-11 eq	1.99E-04	1.95E-04	2.34E-04	4.91E-04	4.60E-04	4.99E-04	4.92E-04
Ecotoxicity	kg 2,4-D eq	8.25E+03	6.74E+03	1.07E+04	3.42E+04	2.45E+04	1.78E+04	3.30E+04
Smog	g NOx eq	1.99E+01	1.84E+01	3.99E+01	5.61E+01	3.46E+01	5.76E+01	5.09E+01

Table C.2 Impact 2002+ Overall (Impact Categories by Unit)

	Units	Earthaven	EVI	Sirius Community	Buncombe Co., North Carolina	Tompkins Co., New York	Franklin Co., Massachusetts	United Sates Average
Carcinogens	kg C2H3Cl eq	1.63E+02	1.92E+02	2.52E+02	1.76E+02	1.79E+02	1.78E+02	1.78E+02
Non-carcinogens	kg C2H3Cl eq	3.96E+02	3.87E+02	4.12E+02	7.26E+02	5.76E+02	7.94E+02	7.29E+02
Respiratory inorganics	kg PM2.5 eq	6.17E+00	3.82E+00	8.45E+00	1.09E+01	7.49E+00	9.84E+00	1.06E+01
Ionizing radiation	Bq C-14 eq	2.29E+03	2.82E+03	2.78E+04	3.69E+03	5.81E+03	4.12E+03	4.57E+03
Ozone layer depletion	kg CFC-11 eq	1.99E-04	1.95E-04	2.36E-04	4.91E-04	4.60E-04	4.99E-04	4.93E-04
Respiratory organics	kg C2H4 eq	1.87E+00	1.83E+00	4.04E+00	7.42E+00	4.65E+00	1.08E+01	6.10E+00
Aquatic ecotoxicity	kg TEG water	1.76E+06	1.59E+06	1.79E+06	3.99E+06	2.87E+06	3.87E+06	3.80E+06
Terrestrial ecotoxicity	kg TEG soil	2.28E+05	3.64E+04	2.03E+05	4.03E+04	4.03E+04	4.05E+04	4.08E+04
Terrestrial acid/nutri	kg SO2 eq	1.96E+02	1.69E+02	2.85E+02	4.91E+02	3.87E+02	4.59E+02	4.77E+02
Land occupation	m2org.arable	1.69E+03	1.05E+03	1.39E+03	3.37E+03	3.37E+03	3.37E+03	3.37E+03
Aquatic acidification	kg SO2 eq	2.87E+01	3.55E+01	4.84E+01	1.02E+02	7.29E+01	9.40E+01	1.01E+02
Aquatic eutrophication	kg PO4 P-lim	7.26E-01	4.96E-01	8.45E-01	5.61E-01	5.27E-01	5.52E-01	5.52E-01
Global warming	kg CO2 eq	3.78E+03	5.06E+03	5.72E+03	1.79E+04	9.69E+03	1.35E+04	1.37E+04
Non-renewable energy	MJ primary	4.66E+04	7.35E+04	7.84E+04	1.93E+05	1.34E+05	1.93E+05	1.94E+05
Mineral extraction	MJ surplus	-4.80E+00	-6.87E+00	-3.32E+00	1.03E+01	3.07E+00	-2.43E+01	6.93E-01

Table C.3 Impact 2002+ Overall (Impact Categories by Points)

	Earthaven	EVI	Sirius Community	Buncombe Co., North Carolina	Tompkins Co., New York	Franklin Co., Massachusetts	United Sates Average
Carcinogens	6.44E-02	7.60E-02	9.94E-02	6.94E-02	7.06E-02	7.04E-02	7.04E-02
Non-carcinogens	1.56E-01	1.53E-01	1.63E-01	2.86E-01	2.27E-01	3.13E-01	2.88E-01
Respiratory inorganics	6.09E-01	3.77E-01	8.34E-01	1.07E+00	7.39E-01	9.71E-01	1.05E+00
Ionizing radiation	6.79E-05	8.35E-05	8.23E-04	1.09E-04	1.72E-04	1.22E-04	1.35E-04
Ozone layer depletion	2.95E-05	2.89E-05	3.49E-05	7.27E-05	6.82E-05	7.39E-05	7.29E-05
Respiratory organics	5.61E-04	5.48E-04	1.21E-03	2.23E-03	1.40E-03	3.25E-03	1.83E-03
Aquatic ecotoxicity	6.45E-03	5.81E-03	6.56E-03	1.46E-02	1.05E-02	1.41E-02	1.39E-02
Terrestrial ecotoxicity	1.32E-01	2.10E-02	1.17E-01	2.33E-02	2.33E-02	2.34E-02	2.35E-02
Terrestrial acid/nutri	1.49E-02	1.28E-02	2.17E-02	3.73E-02	2.94E-02	3.48E-02	3.62E-02
Land occupation	1.34E-01	8.34E-02	1.10E-01	2.68E-01	2.68E-01	2.68E-01	2.68E-01
Aquatic acidification	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aquatic eutrophication	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming	3.82E-01	5.11E-01	5.78E-01	1.40E+00	9.79E-01	1.36E+00	1.38E+00
Non-renewable energy	3.07E-01	4.84E-01	5.16E-01	1.27E+00	8.80E-01	1.27E+00	1.27E+00
Mineral extraction	-3.16E-05	-4.52E-05	-2.19E-05	6.80E-05	2.02E-05	-1.60E-04	4.56E-06
Total	1.81E+00	1.72E+00	2.45E+00	4.44E+00	3.23E+00	4.33E+00	4.40E+00

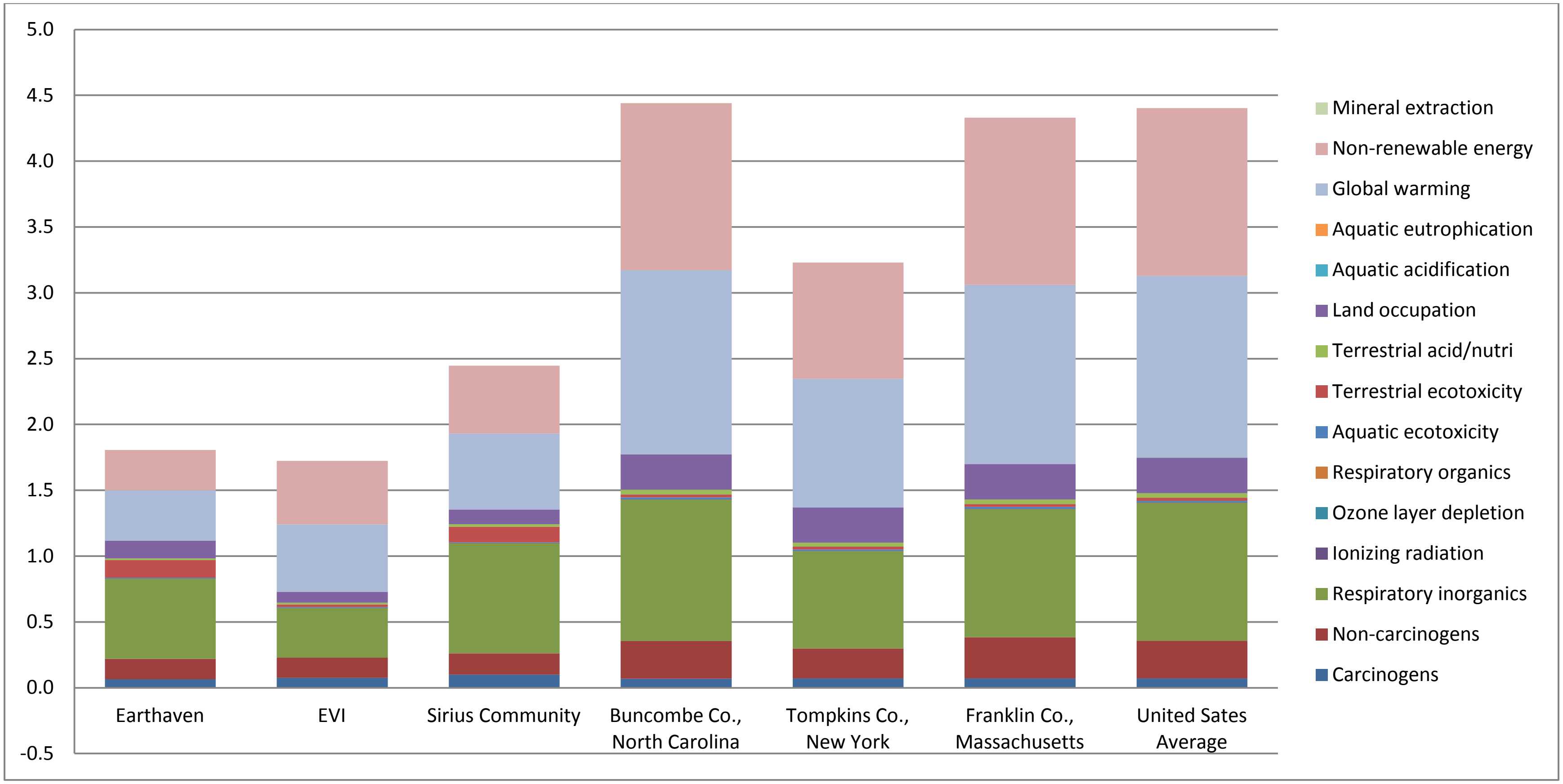

Figure C.1 Impact 2002+ Cumulative Graph

Appendix D. Discussion of Renewable Energy Infrastructure

In this analysis the infrastructure used to produce electricity was not included within the system boundary. While this is common practice for electricity produced at large plants, the non-inclusion of on-site photovoltaic panels requires some justification. Figure D.1 below helps to demonstrate the fact that the impact of photovoltaic panels are negligible to this analysis and well below the 1% cutoff established in section 2.3.1 of the life cycle assessment. This figure compares the impact of producing one square meter of photovoltaic panel to the impact of the electricity that panel can produce, if the electricity had been obtained from the electric grid. The electricity that could be produced by the panel in each location was estimated using PV Watts (http://rredc.nrel.gov/solar/calculators/pvwatts/version1/), a tool produced by the National Renewable Energy Laboratory which includes the insolation values for many locations in the United States, along with default values for panel and inverter efficiency. Figure D.1 and Table D.1 show that the impact of producing the photovoltaic panel is never more than 3% and generally less than 1% of the impact associated with obtaining the equivalent electricity from the grid for one year. The electricity models used in this appendix are the same as those used in the LCA. The photovoltaic panel model is taken from the Ecovinvent Database and is based on the report *Life Cycle Inventories of Energy Systems: Results for Current Systems in Switzerland and other UCTE Countries* (Dones, 2007)

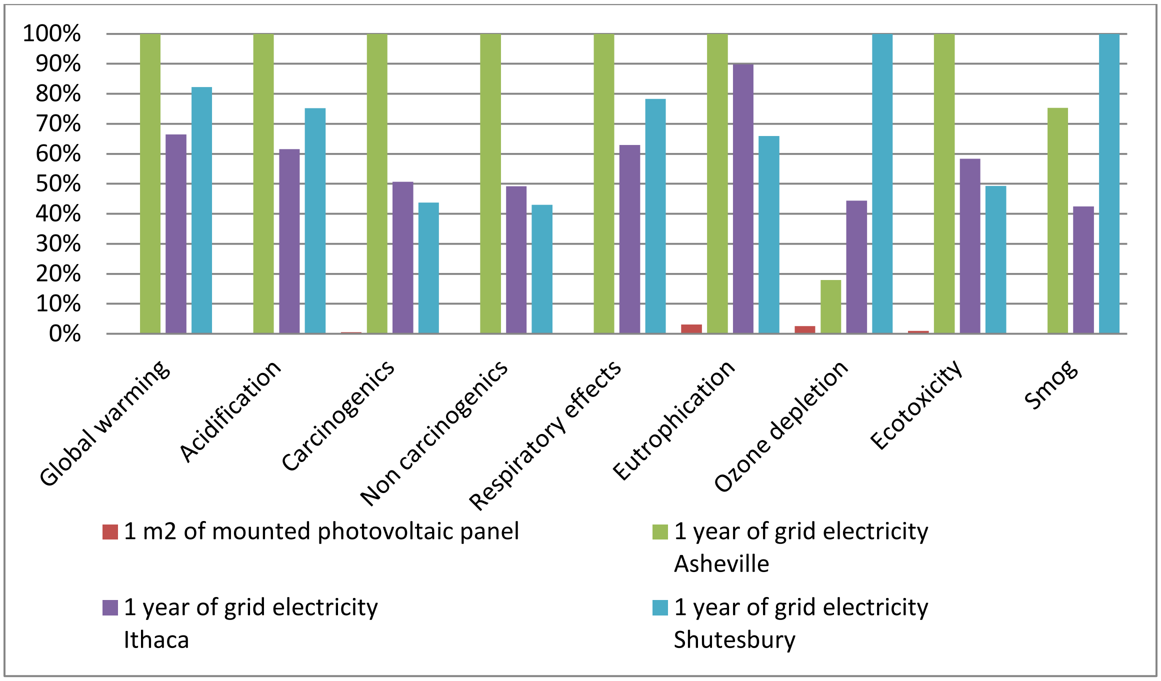

Figure D.1 TRACI Environmental Impacts of 1 square meter of photovoltaic panel and equivalent grid produced electricity

Table D.1 TRACI Environmental Impacts of 1 square meter of photovoltaic panel and equivalent grid produced electricity

Impact Category	Unit	Earthaven	EVI	Sirius Community	North Carolina
Global Warming	kg CO2 eq	2.60E+02	1.06E+05	7.07E+04	8.75E+04
Acidification	H+ moles eq	7.50E+01	4.69E+04	2.89E+04	3.53E+04
Carcinogens	kg benzene eq	4.07E+00	7.13E+02	3.62E+02	3.12E+02
Non Carcinogens	kg toluene eq	2.51E+04	2.04E+07	1.00E+07	8.79E+06
Respiratory Effects	kg PM2.5 eq	4.24E-01	1.75E+02	1.10E+02	1.37E+02
Eutrophication	kg N eq	1.41E+00	4.58E+01	4.11E+01	3.02E+01
Ozone Depletion	kg CFC-11 eq	4.90E-05	3.39E-04	8.41E-04	1.89E-03
Ecotoxicity	kg 2,4-D eq	1.54E+03	1.61E+05	9.39E+04	7.93E+04
Smog	g NOx eq	5.83E-01	4.60E+02	2.59E+02	6.10E+02

Based on the analysis above, an estimated GWP of 2.7 g CO2 eq./kWh was calculated for photovoltaic panels. This is the result of dividing the GWP for producing the panel by the electricity it is calculated to produce over 20 years, the estimated life of the panel. Two other sources suggested a range of 12-24 g CO2 eq./kWh (Fthenakis, 2011; Sherwani, 2010). To ensure that the impact of the photovoltaic panels is not being underestimated, the higher value of 24 g CO2 eq./kWh was tested as the high estimate. Table D.2 below shows the overall increase in GWP that would occur from the inclusion of the production of the photovoltaic panels based on both the low estimate and high estimate.

Table D.2 Increase in GWP from the Inclusion of PV panel production

		Low Estimate (2.7 g/kWh)		High Estimate (24 g/kWh)	
	Electricity from Renewable Sources	kg CO2 eq.	% Increase in Overall GWP	kg CO2 eq.	% Increase in Overall GWP
Earthaven	448.74	1.21	0.03%	10.77	0.24%
EVI	353.86	0.96	0.02%	8.49	0.15%
Sirius Community	242.32	0.65	0.01%	5.82	0.11%

Appendix E. Composting LCI models

In order to account for the environmental impact associated with composting, models for home composting and municipal composting were developed based on several literature sources (Andersen, 2010a; Andersen, 2010b; Andersen, 2011; Andersen, 2012; Hepperly, 2009). The home composting model, detailed in Table E.1 below, is based on a home composting pile that is kept outside and is turned every 6th week. This model best represents the typical composting practices at the ecovillages, where compost is generally produced by residents for personal gardens or by small-scale farmers. This model accounts for the air and water emissions from the compost pile as well as the estimated final product (about half the mass of the inputs). There are no energy inputs included in this model because all work is modeled as being done by manual labor. This model also includes the replacement of manufactured nitrogen fertilizers by compost.

Hepperly (2009) provides a comparison of the available nitrogen in compost (40%) compared to manufactured fertilizer (100%). Thus it takes 2.5 kg of compost to provide the same amount of available nitrogen as 1kg of manufactured nitrogen fertilizer. In addition, produced compost does not always directly replace purchased fertilizer. In many cases compost may be used (as it is a “free” product) in situations where a person would not purchase fertilizer, such as the restoration of forest soils. Due to this usage pattern, a utilization factor of 50% was set for ecovillages based on my observations of composting practices and discussions with ecovillage residents. The utilization factor means that 50% of the compost was used to directly replace fertilizer, while the other 50% was used for other purposes. Thus, of the 500g of compost produced, 250g are used to replace fertilizer, and due to the available nitrogen that 250g replaces 100g of manufactured nitrogen fertilizer.

Table E.1 Home Composting LCI

Inputs		
Household and Garden Waste	1	kg
Air Emissions		
Carbon Dioxide (biogenic)	236	g
Methane	1	g
Carbon Monoxide	0.55	g
Nitrous Oxide	0.13	g
Water Emissions		
BOD	3.5	g
COD	9.9	g
K	6.4	g
P	0.08	g
As	2.40E-05	g
Cd	2.50E-06	g
Cr	3.20E-05	g
Cu	2.90E-04	g
Hg	2.80E-07	g
Ni	8.70E-05	g
Pb	9.90E-05	g
Finished Product		
Compost	500	g

The municipal composting model, detailed in Table E.2 below, is based on windrow composting, a process where compost is produced in long rows instead of small piles. This model best represents the composting practices at used large-scale composting facilities, such as those used to compost municipal waste. This model accounts for the energy, fuel, and material inputs, as well as air emissions. Leachate from the compost is modeled as being treated by a wastewater treatment plant. The amount of estimated final product is higher for municipal composting due to the different process. This model also uses a higher utilization rate for the compost of 70% because much of this compost is purchased by individuals specifically to replace fertilizer. Thus, of the 600g of compost produced, 420g are used to replace fertilizer, and due to the available nitrogen that 420g replaces 210g of manufactured nitrogen fertilizer.

Table E.2 Municipal Composting LCI

Inputs		
Household and Garden Waste	1	kg
Electricity	0.0002	kWh
Diesel	3.04	ml
Lubricating Grease	0.013	ml
Motor Oil	0.005	ml
Hydraulic Oil	0.005	ml
Cleaning Fluid	0.001	ml
Air Emissions		
Carbon dioxide	86	g
Methane	1.9	g
Nitrous Oxide	0.05	g
Carbon Monoxide	0.12	g
Water Emissions		
Leachate (modeled as treated at water treatment plant)	130	ml
Finished Product		
Compost	600	g
Other Outputs		
Wood to Incineration	68	g
Waste to C&D	4.8	g
Waste to Incineration	6.5	g

Appendix F. Correlation Analysis of Impact Categories

The use of the TRACI impact methodology provides a comprehensive understanding of environmental impact, but many of the impact categories in TRACI are directly related to combustion emissions, which results in a repetition of the patterns of results from category to category. To ensure that the results of this analysis provide a comprehensive understanding of environmental impact with a minimum of repetition, a correlation analysis of the results for impact category was conducted. A description of the correlation analysis and its results are listed below.

The correlation analysis was conducted using the overall results for the each of the seven groups studied (Earthaven, EVI, Sirius, Buncombe County, Tompkins County, Franklin County and the US Average). Given the small sample size, dispersion of the data, and the desire to focus on the relationship of the impact categories, the data was transformed using the log base 10 to enhance linearity. The correlation matrix for the transformed data is below in Table F.1. There is a high degree of correlation amongst all of the impact categories, but two of the categories, Eutrophication and Ecotoxicity are considerably less correlated with global warming than the others. An examination of the 99% confidence intervals (Table F.2 and Figure F.1) shows that the confidence intervals for these two categories are also much larger than the other categories, again suggesting that they are less correlated with global warming.

These results demonstrate that all of the impact categories except for Eutrophication and Ecotoxicity are very highly correlated with Global Warming (correlation coefficients > 0.97, confidence interval <0.3). Thus the tables and graphs in this report only display Global Warming Potential (GWP), Eutrophication, and Ecotoxicity, although the results for other impact categories within TRACI are available in Appendix C.

Table F.1. Impact Category Pearson Correlation Matrix

	Acidification	Carcinogens	Non-carcinogens	Respiratory Effects	Eutrophication	Ozone Depletion	Ecotoxicity	Smog
Global Warming	0.996	0.984	0.987	0.976	0.875	0.972	0.935	0.982
Acidification		0.984	0.989	0.971	0.899	0.974	0.936	0.978
Carcinogens			0.998	0.980	0.832	0.922	0.942	0.968
Non-carcinogens				0.969	0.840	0.932	0.925	0.966
Respiratory Effects					0.844	0.929	0.973	0.963
Eutrophication						0.937	0.892	0.903
Ozone Depletion							0.905	0.961
Ecotoxicity								0.962

Table F.2. Impact Category Pearson Correlation 99% Confidence Interval Matrix

		Acidification	Carcinogens	Non-Carcinogens	Respiratory effects	Eutrophication	Ozone Depletion	Ecotoxicity	Smog
Global warming	High	1.000	0.999	0.999	0.998	0.990	0.998	0.995	0.999
	Low	0.953	0.807	0.843	0.721	0.066	0.690	0.384	0.783
Acidification	High		0.999	0.999	0.998	0.992	0.998	0.995	0.998
	Low		0.805	0.862	0.672	0.176	0.705	0.397	0.741
Carcinogens	High			1.000	0.998	0.986	0.994	0.995	0.998
	Low			0.970	0.766	-0.093	0.303	0.437	0.648
Non-Carcinogens	High				0.998	0.987	0.995	0.994	0.997
	Low				0.661	-0.067	0.367	0.325	0.630
Respiratory effects	High					0.987	0.994	0.998	0.997
	Low					-0.052	0.346	0.692	0.607
Eutrophication	High						0.995	0.991	0.992
	Low						0.405	0.143	0.196
Ozone Depletion	High							0.992	0.997
	Low							0.207	0.586
Ecotoxicity	High								0.997
	Low								0.593

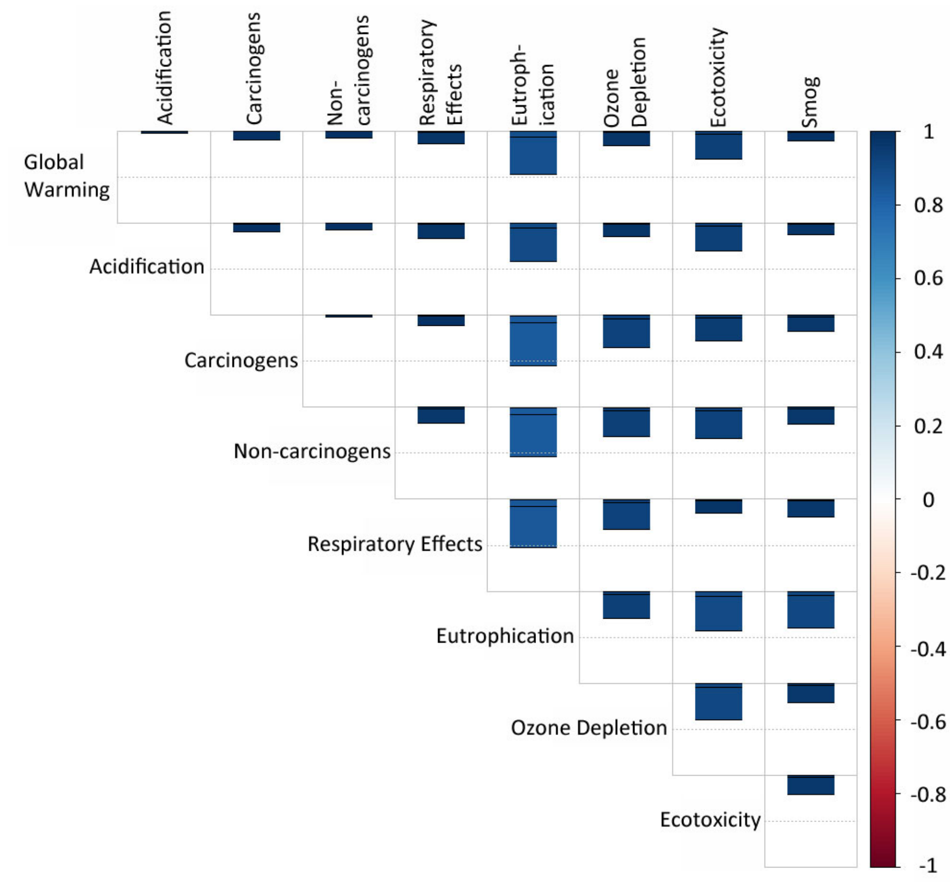

Figure F.1. Impact Category Correlation Confidence Intervals

Appendix G. Life Cycle Inventories

In the inventory analysis, a flow model is constructed using data on inputs and outputs. This model is the Life Cycle Inventory (LCI). The LCI consists of the inputs (natural and technological resources) and the outputs (emissions and wastes). In this analysis the functional unit (the consumption and waste generated by one person over one year) consists of four components: home energy use, transportation energy use, food consumption, and waste generation. Each of these components is examined in detail in the following sections.

G.1 Home Energy Use

This section describes the cradle-to-grave life cycle inventory for home energy use. Electricity, natural gas, fuel oil, kerosene, liquid propane gas (LPG), and wood are the energy sources used in the homes surveyed. The models created for these energy sources are described in detail below. A majority of this is drawn from the USLCI and Ecoinvent databases, but other published sources are used where needed.

Data on energy consumption by ecovillage residents was collected directly from the residents via survey and interviews. Energy consumption for non-ecovillage residents was obtained from the Residential Energy Consumption Survey (RECS) and the Tompkins County Community Greenhouse Gas Emissions Report, 1998-2008 (US EIA, 2012; TCPD, 2010). Tompkins County, NY where the Ecovillage at Ithaca (EVI) is located, published a report which detailed residential energy use. This report provides the energy use the comparison data for EVI, however there is a difference in year between the two data sources. The ecovillage resident consumption data is for 2010, while the Tompkins county report data is for 2008. However, a comparison of the heating degree days between the two years showed a minor (4%) variation. This suggests that the two years are sufficiently comparable for the purposes of this study. For Sirius and Earthaven, the best available comparison data was based on climate zone averages obtained from the RECS. In each case household energy use was divided by the average number of persons per household based on census data (US Census Bureau, 2012).

Table G.1-A Energy Usage per Person

	Electricity	**Natural Gas**	**Fuel Oil**	**Kerosene**	**LPG**	**Wood**
	kWh	1000 cubic feet	gallons	gallons	gallons	cords
Earthaven	450	-	-	-	34	1.0
EVI	1182	17	-	-	-	-
Sirius Community	1215	-	23	-	99	0.77
Buncombe County, NC (Climate Zone 4)	5,589	16	1	17	26	-
Tompkins County, NY	2,922	17	18	-	49	-
Franklin County, MA (Climate Zone 5)	4,066	27	1	19	47	-
United Sates Average	4,883	18	16	0.67	20	-

Electricity

Electricity is a very versatile energy medium which is used extensively by ecovillage and non-ecovillage residents. Electricity purchased from the electric grid (i.e. not produced on-site) is produced from a mix of sources, including oil, coal, natural gas, geothermal, solar, and wind. The EPA's Emissions & Generation Resource Integrated Database (eGRID) divides the country into regions and subregions and provides a breakdown of the energy sources used to produce the electricity available from the electric grid in each subregion (US EPA, 2012). The map below shows the eGRID subregions in the United States, and Table G.1-B shows the energy sources for the eGRID subregions containing the case study ecovillages. Models of the electric grid in each were created using models from the USLCI database for the production of electricity from the appropriate source.

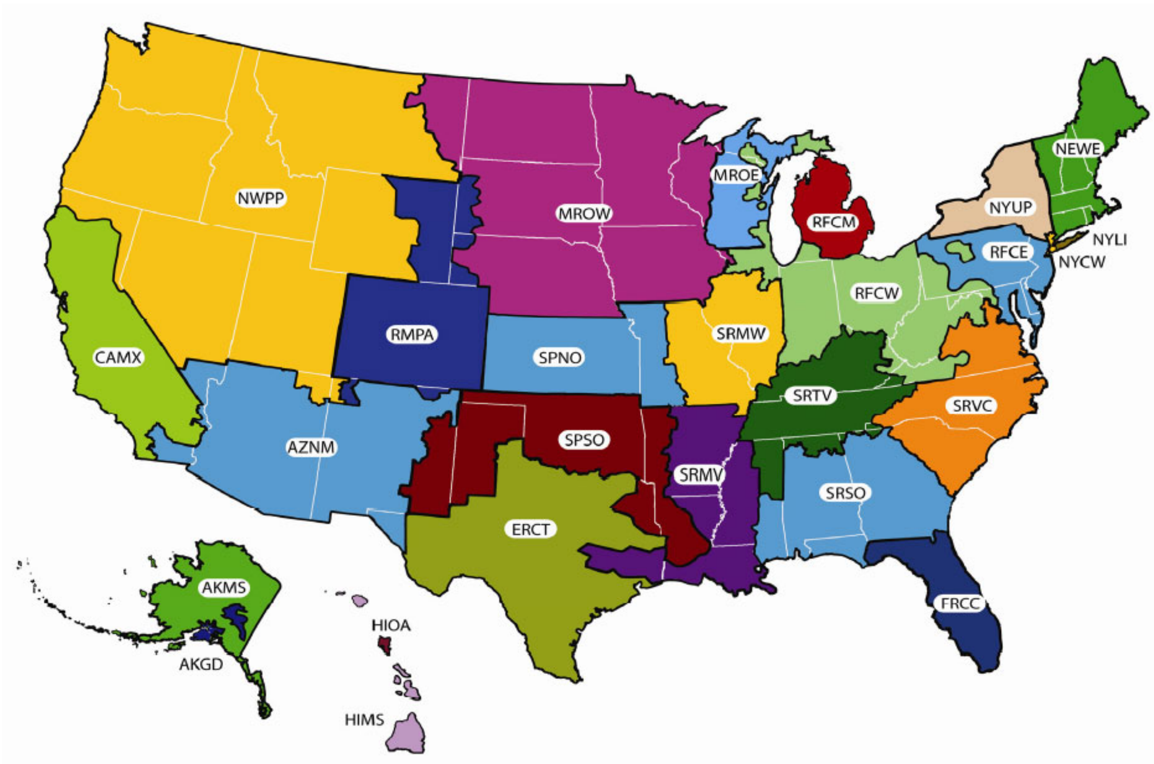

Figure G.1-A Map of eGRID Subregions

Table G.1-B Electricity Breakdown by eGRID Subregion

	Earthaven	**EVI**	**Sirius Community**	**U.S. Average**
City, State	Black Mountain, NC	Ithaca, NY	Shutesbury, MA	
eGRID Subregion	SRVC	NYUP	NEWE	
Energy Sources				
Coal	51.0%	25.4%	14.5%	50.2%
Oil	1.7%	6.6%	9.4%	3.0%
Natural Gas	3.8%	13.2%	36.7%	17.4%
Other Fossil	0.2%	0.3%	1.0%	0.5%
Biomass	2.0%	1.3%	5.7%	1.4%
Hydro	1.7%	26.0%	5.1%	6.6%
Nuclear	39.5%	27.1%	27.6%	20.0%
Wind	0%	0.1%	0.01%	0.34%
Solar	0%	0%	0%	0.015%
Geothermal	0%	0%	0%	0.3%

In addition to purchased electricity, ecovillage residents also made use of solar, wind, and micro-hydro technologies to generate electricity on-site. As infrastructure is not included in this LCA and maintenance inputs for these technologies are minimal, electricity generated from these sources was modeled as having no associated environmental burden (see Appendix D for more details). Data on the usage of electricity in EVI and Sirius was collected directly from copies or records of utility bills, providing a high degree of accuracy. In Earthaven, electricity use is provided completely through the use of on-site renewables and use is not measured, so consumption estimates are based on the electrical appliances used and average hours of use. As there is no modeled environmental impact associated with on-site renewable, inaccuracy related to these estimates has little impact on the results. The USLCI models used for electricity cover the full life cycle, including extraction, processing, transportation, combustion and emissions of the fuels, as well as line losses due to resistance and other factors. Line losses were estimated at 9.91% based on existing USLCI electricity models.

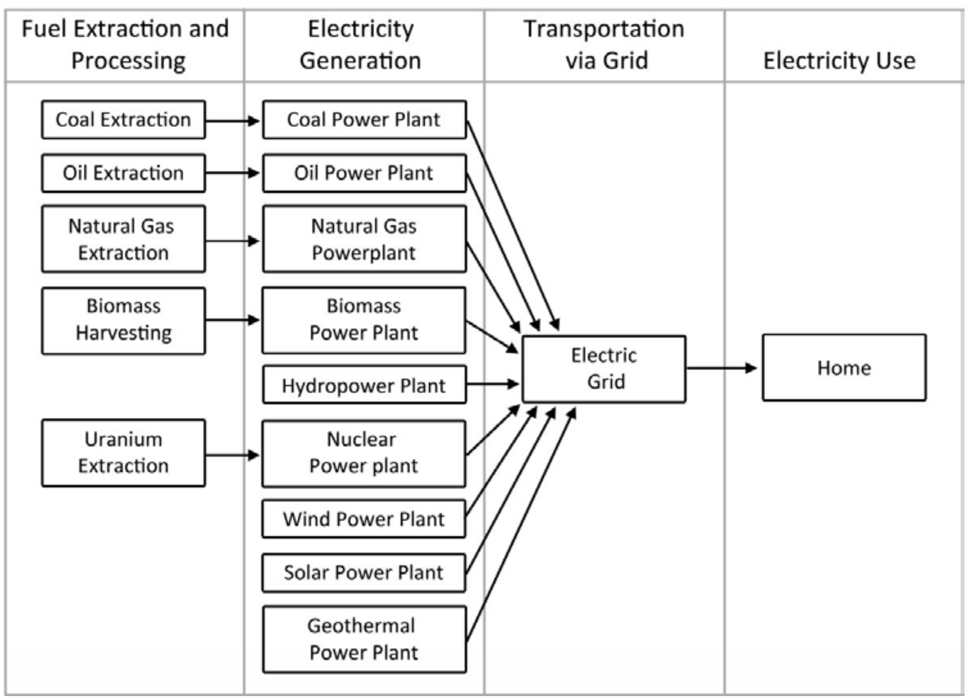

Figure G.1-B Electricity Flow Diagram

Table G.1-C LCI Data Sources for Electricity

Model	Data Source	Geographic Area	Time Period
Electricity from coal	USLCI	North America	2000's
Electricity from oil	USLCI	North America	2000's
Electricity from natural gas	USLCI	North America	2000's
Electricity from unspecified fossil	USLCI	North America	2000's
Electricity from biomass	USLCI	North America	2000's
Electricity from hydropower	USLCI	North America	2000's
Electricity from nuclear	USLCI	North America	2000's
Electricity from wind	USLCI	North America	2000's
Electricity from photovoltaic	USLCI	North America	2000's
Electricity from geothermal	USLCI	North America	2000's

Natural Gas Heating

Natural gas is used primarily for home heating, but also for cooking and water heating. The homes in Ecovillage at Ithaca and many other residences throughout the U.S. have natural gas supplied directly to homes vie underground pipes. Data on the usage of natural gas in the ecovillages was collected directly from utility bills, providing a high degree of accuracy. The USLCI model used for natural gas heating covers the full life cycle of the fuel including extraction, processing, transportation, combustion, and emissions.

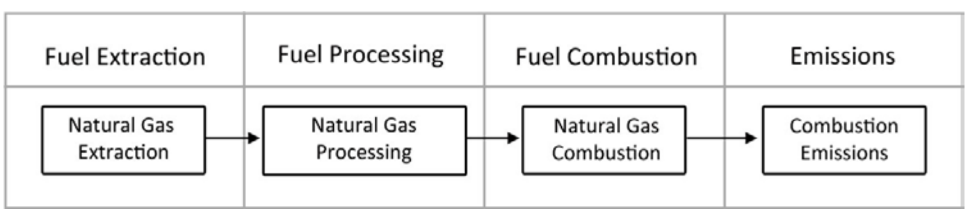

Figure G.1-C Natural Gas Combustion Flow Diagram

Table G.1-D LCI Data Sources for Natural Gas Combustion

Model	Data Source	Geographic Area	Time Period
Heat from natural gas	USLCI	North America	2000's

Wood Heating

Wood is used extensively for home heating at Sirius Community and Earthaven and is also used for heating homes throughout the U.S. The type of wood that is used for home heating can vary based on region and time period, being largely dependent on availability. Wood for home heating is typically measured in cords, which consist of 128 cubic feet of stacked wood (Crown, 2012). Based on a selection of widely used woods, Slusher (1995) estimates that one cord of wood can provide a minimum of 14.7 and a maximum of 30.7 million BTUs of heat, with an average value of 22.3 million BTUs. This average value was used when modeling the heat obtained from wood combustion. Data on the usage of wood in the ecovillages was based on estimates of consumption by the residents, which was the best available source of information. A sensitivity analysis of the amount of wood used is provided in Appendix H. The Ecoinvent model used for wood heating covers the harvesting, processing, transportation, combustion and emissions. This model was also modified so that any electricity used would reflect the makeup of the U.S. electricity grid, rather than the European grid.

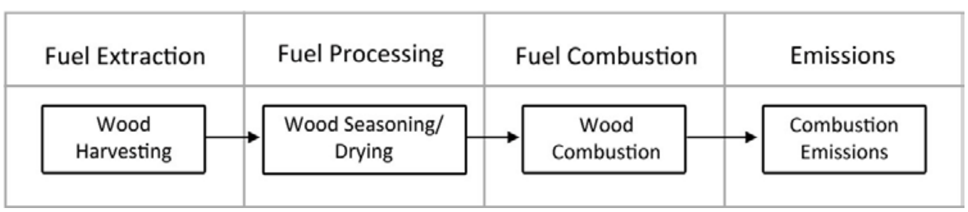

Figure G.1-D Wood Combustion Flow Diagram

Table G.1-E LCI Data Sources for Wood Combustion

Model	Data Source	Geographic Area	Time Period
Heat from wood	Ecoinvent	Europe, modified to U.S. conditions	2000’s

Liquefied Petroleum Gas (LPG) Heating

Liquefied petroleum gas (LPG) is used primarily for home heating, cooking, and water heating. The homes in Earthaven and Sirius, and many other residences throughout the U.S., make use of LPG, which is usually delivered to homes via tanker trucks or portable tanks. Data on the usage of LPG in the ecovillages was collected directly from copies or records of bills, providing a high degree of accuracy. The model used for LPG heating covers the full life cycle of the fuel, extraction, processing, transportation, combustion and emissions.

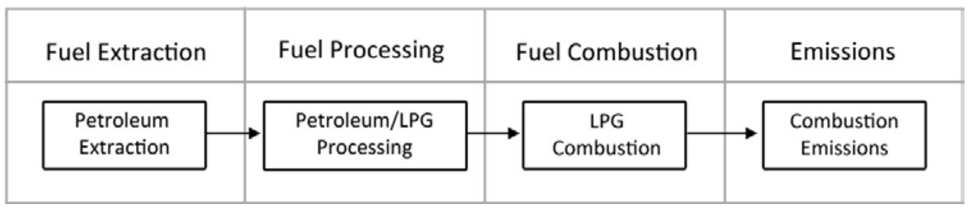

Figure G.1-E LPG Combustion Flow Diagram

Table G.1-F LCI Data Sources for LPG Combustion

Model	Data Source	Geographic Area	Time Period
Heat from liquefied petroleum gas	Franklin Associates	North America	Late 1990’s

G.2 Transportation Energy Use

This section describes the cradle-to-grave life cycle inventory for transportation energy use. Personal automobile use and air travel are the transportation methods surveyed. The models created for these transportation methods are described in detail below. A majority of this is drawn from the USLCI and Ecoinvent databases, but other published sources are used where needed.

Data on transportation usage by ecovillage residents was collected directly from the residents via survey and interviews. The annual vehicle miles travelled for non-ecovillage residents was calculated based on data from the National Household Travel Survey (NHTS) and the Census Bureau (US DOT, 2009; US Census 2012). The NHTS provided average vehicle miles travelled (VMT) per person, while the US Census data provided average commutes at a state and county level. These commuting distances were used to modify the state VMT to better reflect driver activity at a county level. VMT was converted into gallons of gasoline burned using the fleet-wide average fuel economy of 22.4 miles per gallon for passenger cars (Sivak, 2009). The annual air miles travelled for non-ecovillage residents was calculated by dividing the total passenger air miles travelled in 2010 by the total population in 2010, resulting in a nation-wide average (RITA, 2012; US Census, 2012). A sensitivity analysis of the range of air travel impacts is provided in Appendix H.

Table G.2-A Transportation Usage per Person

	Annual Ground Vehicle Miles Travelled	**Annual Air Miles Travelled**
Earthaven	4,598	2,090
EVI	6,353	3,440
Sirius Community	5,455	4,070
Buncombe County, NC	13,910	2,620*
Tompkins County, NY	9,215	2,620*
Franklin County, MA	13,938	2,620*
United Sates Average	12,888	2,620

*Values for the counties are the same as the U.S. average because smaller scale data was not available.

Ground Travel

The vast majority of privately-owned passenger vehicles (i.e. cars and light trucks) in the U.S. are powered by gasoline, with less than 0.5% of cars and less than 2% of light trucks being diesel-powered (US EPA, 2008). Diesel-powered vehicles in the non-ecovillage fleet were modeled as gasoline powered based on being under the 1% of energy cutoff. In the ecovillages surveyed, all of the vehicles were gasoline powered, except for a small number converted to run on used vegetable oil. Data on passenger vehicle use was collected in terms of number of miles travelled in the previous year and number of adult drivers making use of the vehicle. Many of the vehicles in the ecovillages were shared through informal car-shares, resulting in several adult drivers per vehicle. The accuracy of the vehicle miles travelled data varied from highly accurate, where the owner kept written records, to estimates based on typical driving habits.

Multiple data sources were used to develop the LCI models for gasoline and vegetable oil fuels. A USLCI model provided data on gasoline production, covering extraction, processing, and transportation. Data on the average combustion emissions per gallon of gasoline was obtained from EPA data (US EPA, 2008). Production of used vegetable oil was considered to have no impact, as this would otherwise be a waste product. Data on the combustion emissions for biodiesel was obtained from published articles comparing the combustion emissions of vegetable oil, biodiesel, and petroleum-based diesel (Krahl, 2009; Liu, 2010).

To convert data from vehicle miles travelled to gallons of gasoline, a miles per gallon (mpg) factor was needed. The United Sates fleet-wide average is 22.4 mpg (Sivak, 2009). For ecovillage residents, the mpg value for each vehicle was determined using the Fuel Economy Guide for that make, model, and year (US DOE, 2011).

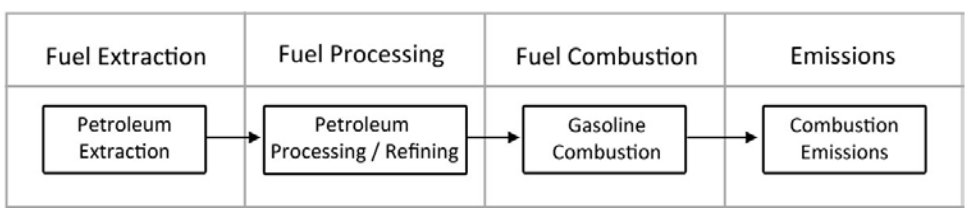

Figure G.2-A Gasoline Combustion Flow Diagram

Table G.2-B LCI Data Sources for Gasoline Combustion

Model	Data Source	Geographic Area	Time Period
Gasoline Production	USLCI	North America	2000's
Gasoline Combustion Emissions	U.S. EPA	United States	Late 2000's
Biodiesel Combustion Emissions	USLCI; Liu, 2010	North America; North America	2000's; Late 2000's

Air Travel

Air travel is a highly utilized method of transportation, particularly for long distance trips. Data on the average air miles travelled for non-ecovillage residents was only available as a nation-wide average. Ecovillage residents provided a list of all of the flights that they had taken in the past year, including origin and destination. The air miles travelled for each flight were calculated using a web-based tool which uses the great circle distance formula (Travel Math, 2012). The Ecoinvent model used for air travel covers fuel extraction, processing, transportation, combustion and emissions. This model was also modified so that all electricity used would reflect the makeup of the U.S. electricity grid, rather than the European grid.

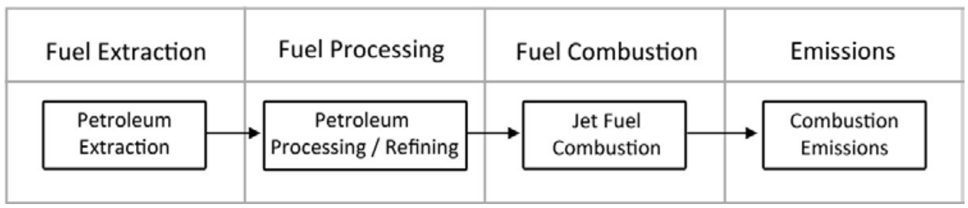

Figure G.2-B Jet Fuel Combustion Flow Diagram

Table G.2-C LCI Data Sources for Air Travel

Model	Data Source	Geographic Area	Time Period
Operation, Aircraft Passenger Transport	Ecoinvent	Europe, modified to U.S. conditions	2000's

G.3 Food

This section describes the cradle-to-grave life cycle inventory for food production, processing, and shipping. The models created for these activities are described in detail below. A majority of this is drawn from the LCA Food DK, USLCI, and Ecoinvent databases, but other published sources are used where needed. Data on diet and food source (garden, local, store, or restaurant) for ecovillage residents was collected directly from the residents via survey and interviews. The average annual food consumption by non-ecovillage residents was taken from the USDA Agricultural Factbook (USDA, 2003). This same source also provided data on typical spoilage and waste rates for food between production and consumption. Sensitivity analyses on possible diet variations between regions are provided in Appendix H.

Models for vegetarian and vegan diets were developed by modifying the average U.S. citizen's diet based on discussions and observations of residents identifying as vegetarian and vegan. These modifications included keeping the total amount of food, fats, and sweeteners constant while removing the food categories not consumed and proportionally increasing other food categories. This is likely to provide a conservative estimate of the impact of vegetarian and vegan diets because my observations suggests that the individuals following these diets often also have a lower total food consumption. Table G.3-A below shows the models that were developed for these diets. Individual models were also created for residents who followed other dietary patterns, such as not eating red meat.

Table G.3-A Components of Average, Vegetarian, and Vegan Diets

Food Category	Average U.S. Diet	Vegetarian Diet	Vegan Diet
Meat	9.6%	N/A	N/A
Poultry	5.2%	N/A	N/A
Seafood	1.0%	N/A	N/A
Eggs	2.0%	2.4%	N/A
Dairy	16.9%	20.6%	N/A
Fats (Meat)	0.2%	N/A	N/A
Fats (Dairy)	0.3%	0.3%	N/A
Fats (Vegan)	4.7%	4.9%	5.2%
Fruit	15.4%	18.8%	25.7%
Vegetables	24.2%	29.6%	40.4%
Grains	12.0%	14.7%	20.1%
Sweeteners	8.7%	8.7%	8.7%

The average distance that foodstuff travelled from the point of production to the point of consumption was estimated by for each food category through the use of several published sources (Weber, 2008; Pirog, 2003; USDA, 2007). These articles and reports provide a range of delivery distances for various food types and the locations where the foodstuffs are produced in the United States. Based on this data average delivery distances were estimated. These distances are provided in Table G.3-B, below. Where ecovillage residents identified their food as coming from their garden or the onsite CSA, no transportation is modeled.

Table G.3-B Estimated Delivery Distance by Food Category

Food Category	Estimated Delivery Distance (km)
Meat	1800
Poultry	1200
Seafood	1600
Eggs	1200
Dairy	340
Fats (Meat)	1800
Fats (Dairy)	340
Fats (Vegan)	1000
Fruit	900
Vegetables	1000
Grains	1000
Sweeteners	1400

The models for food production cover the production of fertilizers, animal feed, and other precursors, energy and material use during crop/animal production, food processing (e.g. grinding grain into flour), and shipment of food product to customer. Any energy used in cooking or preparation at any location outside of the home is not included. Cooking and preparation at home are captured in home energy use, detailed above. All of the models based on European data were modified to reflect U.S. energy sources. There were also a number of food categories for which LCI models were not available. These categories were represented by a proxy food or group of foods. These proxies represent the best available data, accounting for similar agricultural techniques to the foods without available models. Table G.3-C below shows each food category and the model or models that were used to represent it.

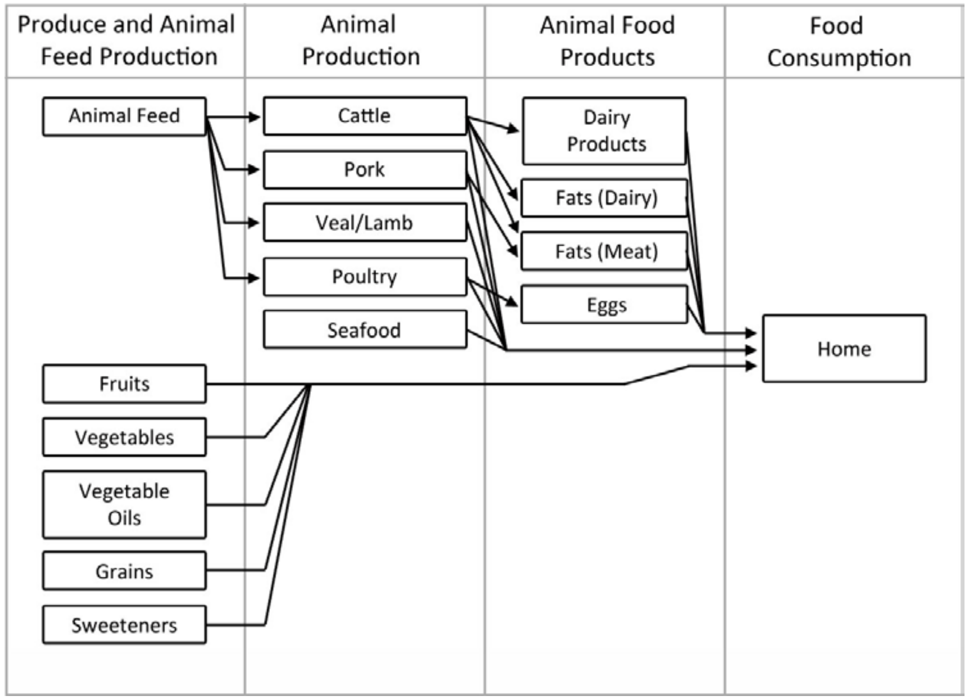

Figure G.3-A Food Flow Diagram

Table G.3-C LCI Data Sources for Food

	Food	Model	Database	Geographic Area	Time Period
Meat	Beef	Beef, at supermarket	LCA Food DK	Europe	Late 1990's
	Pork	Pork, at supermarket	LCA Food DK	Europe	Late 1990's
	Veal/Lamb	Sheep, at farm	Ecoinvent	United States	2000's
Poultry	Chicken	Chicken, at supermarket	LCA Food DK	Europe	Late 1990's
	Turkey	Chicken, at supermarket	LCA Food DK	Europe	Late 1990's
Seafood	Fish/Shellfish	Shrimp, at supermarket (50%); Cod, at supermarket (50%)	LCA Food DK	Europe	Late 1990's
Eggs and Dairy	Eggs	Eggs, at supermarket	LCA Food DK	Europe	Late 1990's
	Milk and Cream	Full Milk, at supermarket	LCA Food DK	Europe	Late 1990's
	Cheese	Cheese, at supermarket	LCA Food DK	Europe	Late 1990's
	Frozen Dairy	Cream, at supermarket	LCA Food DK	Europe	Late 1990's
	Evaporated and Dry Milk	Milk Powder, at supermarket	LCA Food DK	Europe	Late 1990's
Fats	Cooking Oil	Rape Oil, at regional storage	Ecoinvent	Europe	2000's
	Shortening	Soybean Oil, at oil mill	Ecoinvent	United States	2000's
	Lard/Tallow	Tallow, at plant	Ecoinvent	Europe	2000's
	Butter	Butter, at supermarket	LCA Food DK	Europe	Late 1990's
	Margarine	Palm kernel oil, at plant (20%); Rape oil, at regional storage (80%)	USLCI; Ecoinvent	United States; Europe	2000's; 2000's
Fruit	Fresh Fruit	Tomato, at farm	LCA Food DK	Europe	Late 1990's
	Frozen Noncitrus	Tomato, at farm	LCA Food DK	Europe	Late 1990's
	Dried Noncitrus	Tomato, at farm	LCA Food DK	Europe	Late 1990's
	Canned Noncitrus	Tomato, at farm	LCA Food DK	Europe	Late 1990's
	Fruit Juice	Tomato, at farm	LCA Food DK	Europe	Late 1990's
Vegetables	Dark Green	Potato, at farm	LCA Food DK	Europe	Late 1990's
	Legumes	Fava beans, at farm	Ecoinvent	Europe	2000's
	Orange	Carrot, washed and packed	LCA Food DK	Europe	Late 1990's
	Starchy	Potatoes, at farm	Ecoinvent	United States	2000's
	Other	Onion, at farm; Tomato, at farm	LCA Food DK	Europe	Late 1990's
Grains	Wheat	Wheat flour, at mill	USLCI	United States	2000's
	Corn	Grain maize, at farm	Ecoinvent	Europe	2000's
	Rice	Rice grain, at field	USLCI	United States	2000's
	Oat	Oat flakes, at farm	LCA Food DK	Europe	Late 1990's
Sweeteners	Cane/Beet Sugar	Sugar, at refinery;	Ecoinvent	Europe	2000's
	Corn Sweeteners	Maize starch, at plant	Ecoinvent	Europe	2000's
	Honey	Sugar, at refinery	Ecoinvent	Europe	2000's
	Other Caloric Sweeteners	Sugar, at refinery	Ecoinvent	Europe	2000's

G.4 Waste Disposal

This section describes the life cycle inventory models for waste disposal. The models used for these activities are described in detail below. A majority of this is drawn from the USLCI and Ecoinvent databases, but other published sources are used where needed. Data on waste disposal by ecovillage residents was collected directly from the ecovillages. Ecovillage at Ithaca had recently conducted a waste study which determined that they dispose of 75% less waste than the national average (US EPA, 2011). This reduction is achieved through extensive reuse, recycling, and composting. While detailed records were not available at the other ecovillages, observation of similar reuse, recycling, and composting practices resulted in the use of the EVI model as the basis for the waste disposal models at the other two ecovillages. The average solid waste disposal by for the comparison counties and United States average was taken from studies conducted by the U.S. EPA, Columbia University, and state MSW data (US EPA, 2011; Biocycle, 2010; MADEP, 2010; NYDEC, 2012; NCDWM, 2003). Table G.4-A below shows the modeled waste disposed (to landfill and incinerator) of by ecovillage and U.S. residents by waste stream.

Table G.4-A Waste to Disposal per Person per Year by Waste Stream

Waste Stream	U.S. Resident	Buncombe Co., North Carolina	Tompkins Co., New York	Franklin Co., Massachusetts	Ecovillages
Paper	118.87	124.98	83.81	100.50	19.40
Glass	23.38	19.33	16.30	12.07	3.14
Metals	40.73	41.75	34.44	0.96	6.10
Plastics	79.37	60.75	54.42	78.36	8.45
Rubber, leather and textiles	49.78	34.11	30.18	49.94	28.43
Wood	40.16	29.27	27.62	38.27	1.44
Yard Trimmings	56.06	51.87	55.74	51.55	3.03
Food Scraps	94.20	69.61	64.60	94.50	3.15
Other	23.71	17.32	16.07	17.12	6.00

Data on the percentage of solid waste sent to landfills and incinerators was obtained from a variety of published sources (MA DEP, 2010; NY DEC, 2012; NC DWM, 2003). The average distance of 59 kilometers that waste travels to an in-state landfill or incinerator comes from a report published by the Federal Highway Administration (US FHWA, 2009). Distance for waste shipped to an out-of-state landfill was assumed to be 400 miles. A sensitivity analysis of the effect of the out-of-state landfill shipping is provided in Appendix H. Table G.4-B below shows the disposal scenarios for each state.

Table G.4-B Waste Disposal by Destination

	Landfilled in State	Incinerated in State	Landfilled out of State
Massachusetts	26%	55%	19%
New York	41%	17%	42%
North Carolina	90%	0%	10%

The models used for final disposal include both landfill and incineration. Composting was modeled at both the municipal level (as large-scale windrow composters) and at the ecovillage level (as garden compost piles). Both of these models were developed for this analysis based on published data. Detailed descriptions of these models are available in Appendix E. Recycling was modeled using existing LCI models which include the collection and processing of materials as well as the avoided feedstock that the recycled materials replace. These models are based on European data and were modified to reflect U.S. energy sources. Table G.4-C below provides more details on the recycling models.

The models used for landfill disposal include landfill gas flaring and landfill leachate, which incorporates both short-term leachate to wastewater treatment and long-term (after lining failure) to groundwater. These models were also modified to include updated data on the production of biogenic carbon dioxide and methane (Christensen, et.al., 2010a; EPA, 2013). The models for incineration disposal include waste-specific air and water emissions from incineration, auxiliary material for flue gas cleaning, and the disposal of residual materials to landfill. All of the models based on European data were modified to reflect U.S. energy sources. The waste streams for which LCI models were not available are represented by a proxy waste stream, which closely resembles the appropriate waste processing technology. Table G.4-D and G.4-E below show each waste stream and the model used to represent it for both landfill and incineration.

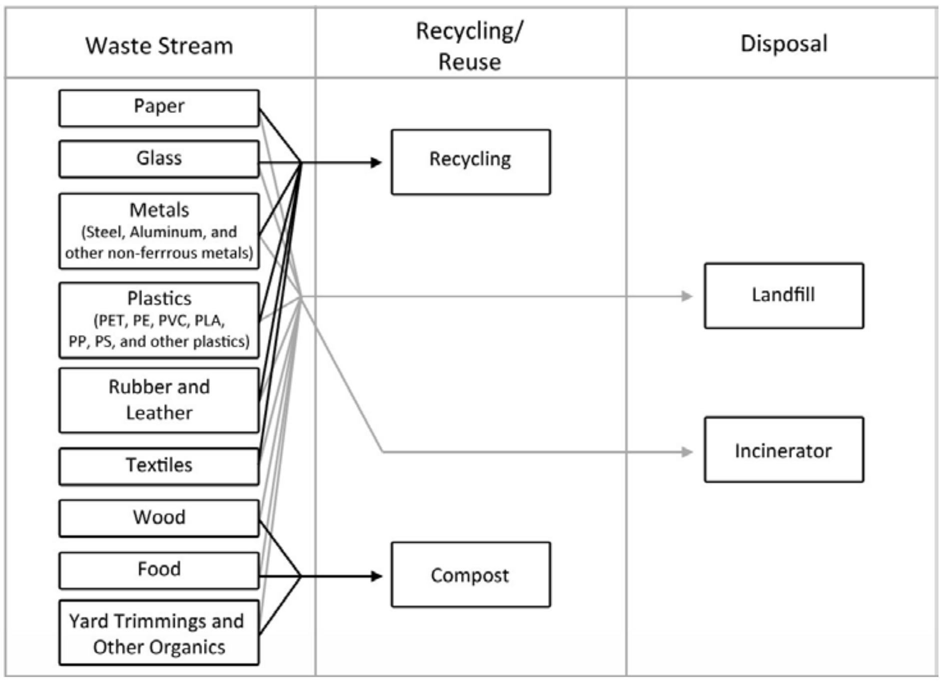

Figure G.4-A Waste Flow Diagram

Table G.4-C LCI Data Sources for Waste to Recycling

Waste Stream	Model	Data Source	Geographic Area	Time Period
Paper	Recycling paper	Ecoinvent	Europe	1990’s
Glass	Recycling glass	Ecoinvent	Europe	1990’s
Metals	Recycling steel/ Recycling aluminum	Ecoinvent	Europe	1990’s
Plastics	Recycling Plastics	Ecoinvent	Europe	1990’s

Table G.4-D LCI Data Sources for Waste to Landfill

Waste Stream	Model	Data Source	Geographic Area	Time Period
Paper	Paper to landfill	Ecoinvent	Europe	2000's
Glass	Glass to landfill	Ecoinvent	Europe	2000's
Metals	Steel to landfill / Aluminum to landfill	Ecoinvent	Europe	2000's
Plastics	Plastics, mixture to landfill	Ecoinvent	Europe	2000's
Rubber, leather, and textiles	Rubber to landfill	USLCI	United States	2000's
Wood	Wood to landfill	Ecoinvent	Europe	2000's
Food Scraps	Wood to landfill	Ecoinvent	Europe	2000's
Yard Trimmings	Wood to landfill	Ecoinvent	Europe	2000's
Other	Municipal solid waste to landfill	Ecoinvent	Europe	2000's

Table G.4-E LCI Data Sources for Waste to Incinerator

Waste Stream	Model	Data Source	Geographic Area	Time Period
Paper	Paper to incinerator	Ecoinvent	Europe	2000's
Glass	Glass to incinerator	Ecoinvent	Europe	2000's
Metals	Steel to incinerator / Aluminum to incinerator	Ecoinvent	Europe	2000's
Plastics	Plastics to incinerator	Ecoinvent	Europe	2000's
Rubber, leather, and textiles	Rubber to incinerator	Ecoinvent	Europe	2000's
Wood	Wood to incinerator	Ecoinvent	Europe	2000's
Food Scraps	Wood to incinerator	Ecoinvent	Europe	2000's
Yard Trimmings	Wood to incinerator	Ecoinvent	Europe	2000's
Other	Municipal solid waste to incinerator	Ecoinvent	Europe	2000's

Appendix H. Sensitivity Analyses

H.1 Sensitivity Analysis of Diet Models

Many of the residents of the ecovillage communities described their diets as either vegetarian or vegan. Follow-up questions and observations of their eating habits were then used to develop models for these diets. Observations suggested that those eating a vegetarian or vegan diet did not increase their consumption of all other food categories to make up for their lack of consumption of meat, eggs, and/or dairy. Specifically they did not increase the amount of fats or sweeteners, but did increase their intake of the other food categories. The models used throughout this analysis have been based in this data, and it is important to test the effects of this modeling decision.

Table and Figure H.1-A show the results for the current vegetarian and vegan diets as well as a model where all categories are increased equally (equal weights model). Table and Figure H.1-B show the result of these equal weight models on the overall LCIA results. The variation between the current model and the equal weights model is consistently low for the vegetarian model, with no more than 7% variation across all of the impact categories. The vegan models show more variation, particularly in Eutrophication (17%), Ecotoxicity (17%), CED (19%), and Ecological Footprint (19%). The sensitivity analysis results for overall impact shows a low degree of sensitivity to equal weights diet models, with the variation between the equal weight diet models and the current diet models ranging between 0.3% and 2.0%.

Table H.1-A Vegan and Vegetarian Model Sensitivity Results

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Vegetarian Model	819.57	6.08	374.38	10,072	0.12
Vegetarian Model (Equal Weights)	823.50	6.34	403.10	9,474	0.12
Vegan Model	468.40	3.57	418.55	10,859	0.09
Vegan Model (Equal Weights)	493.86	4.29	501.79	9,135	0.10

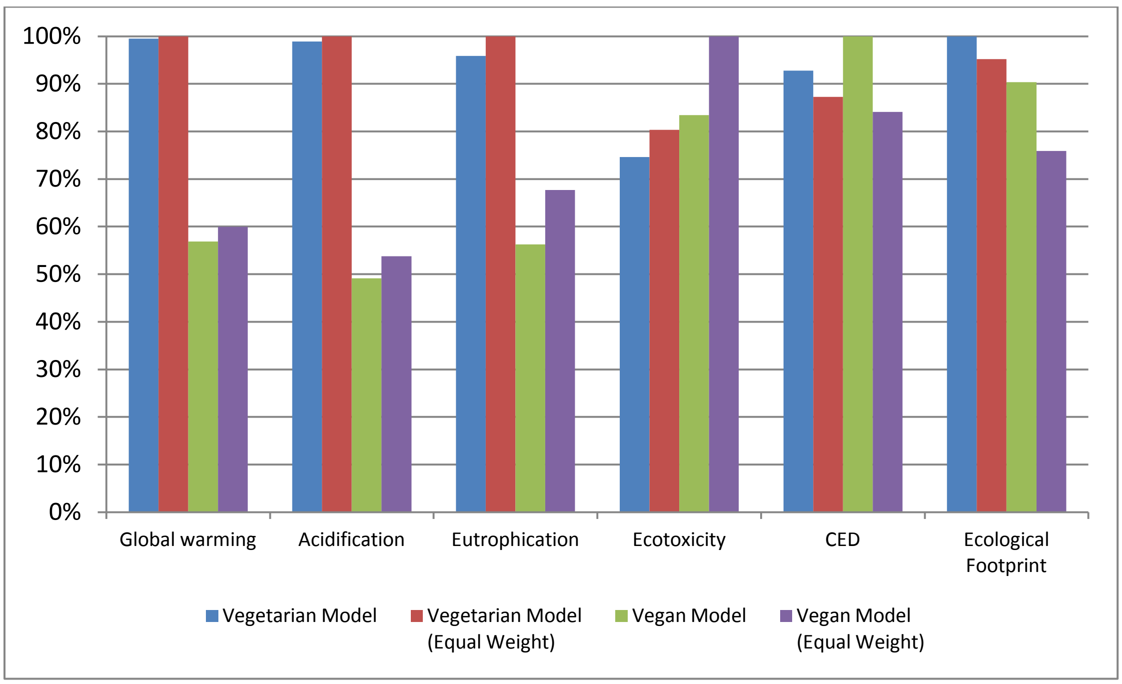

Figure H.1-A. Vegan and Vegetarian Model Sensitivity Results

Table H.1-B Overall Sensitivity Results (Equal Weights Food)

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven Average	4,652.77	19.03	9,298.36	80,840	1.38
Earthaven Average (Food Equal Weights)	4,694.37	19.38	9,320.10	81,487	1.40
EVI Average	5,834.97	13.39	8,257.54	81,657	1.46
EVI Average (Food Equal Weights)	5,865.43	13.69	8,288.94	82,377	1.48
Sirius Average	5,396.95	15.65	10,421.60	88,460	1.54
Sirius Average (Food Equal Weights)	5,439.95	15.97	10,454.54	89,243	1.55

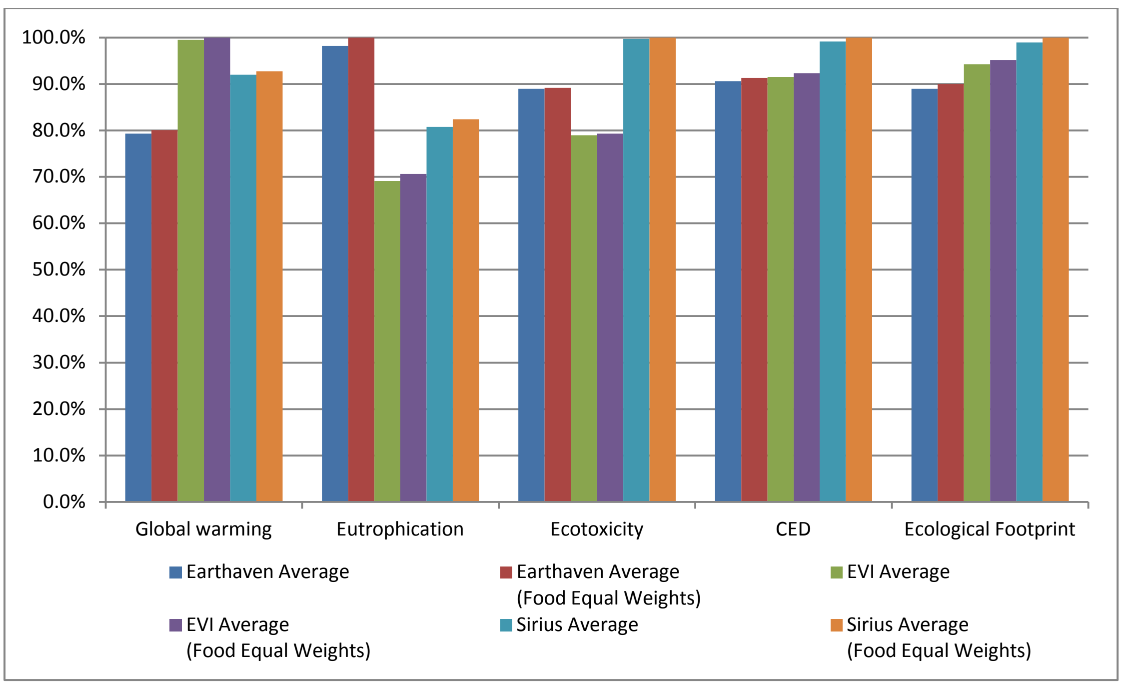

Figure H.1-B. Overall Sensitivity Results (Equal Weights Food)

H.2 Sensitivity Analysis of Wood Use

Earthaven and Sirius communities make extensive use of wood for heating, but few residents in either community had precise records of how much wood they burned. Estimates in Earthaven were provided on a per person basis and were generally rounded to the nearest half a cord. Sirius was able to provide an estimate of the entire community's use that was supposed to be off "by no more than 10% in either direction." The wood use for each community was first cut by 20% and then increased by 20% to determine how sensitive the total home energy use and overall LCIA results are to wood use. Twenty percent was chosen to be outside the range of estimates provided by the community members.

The sensitivity analysis results for home energy use show a high degree of sensitivity to changes in wood use, particularly in the Ecotoxicity impact category. An increase of 20% in wood use results in an increase in global warming of 1%, an increase of in Eutrophication of 10%, an increase in Ecotoxicity of 15%, an increase in CED of 10%, and an increase in Ecological Footprint of 6%. The sensitivity analysis results for the overall impact show a moderate degree of sensitivity to changes in wood use. An increase of 20% in wood use results in less than a 1% increase in global warming and Eutrophication, a 5% increase in Ecotoxicity and CED, and a 2% increase in Ecological Footprint.

Table H.2-A Home Energy Use Sensitivity Results (Wood Use)

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven (20% less wood)	322.67	0.27	2,195.74	25,982	0.22
Earthaven (current model)	344.31	0.33	2,744.64	31,229	0.26
Earthaven (20% more wood)	365.95	0.39	3,293.54	36,475	0.30
Sirius (20% less wood)	1,619.95	0.50	2,401.57	40,145	0.52
Sirius (current model)	1,636.61	0.55	2,824.22	44,185	0.55
Sirius (20% more wood)	1,653.27	0.59	3,246.87	48,225	0.59

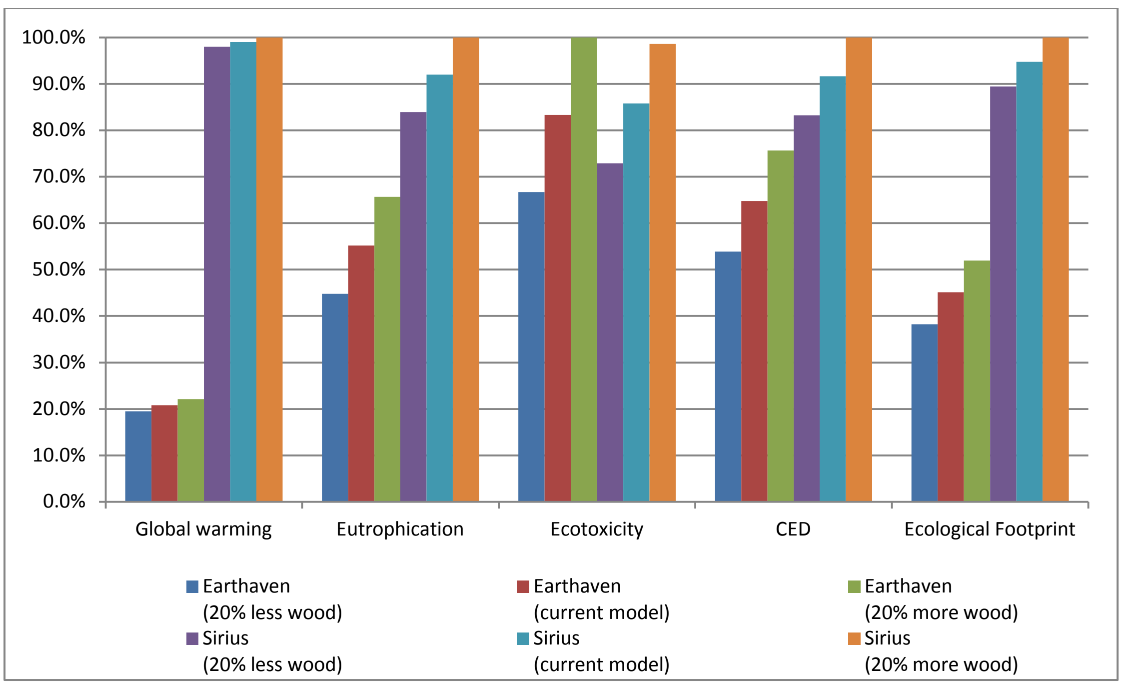

Figure H.2-A. Home Energy Use Sensitivity Results (Wood Use)

Table H.2-B Overall Sensitivity Results (Wood Use)

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Earthaven (20% less wood)	4,631.13	18.97	8,749.46	75,594	1.34
Earthaven (current model)	4,652.77	19.03	9,298.36	80,840	1.38
Earthaven (20% more wood)	4,674.41	19.09	9,847.25	86,087	1.42
Sirius (20% less wood)	5,380.29	15.61	9,998.95	84,420	1.51
Sirius (current model)	5,396.95	15.65	10,421.60	88,460	1.54
Sirius (20% more wood)	5,413.61	15.70	10,844.25	92,500	1.57

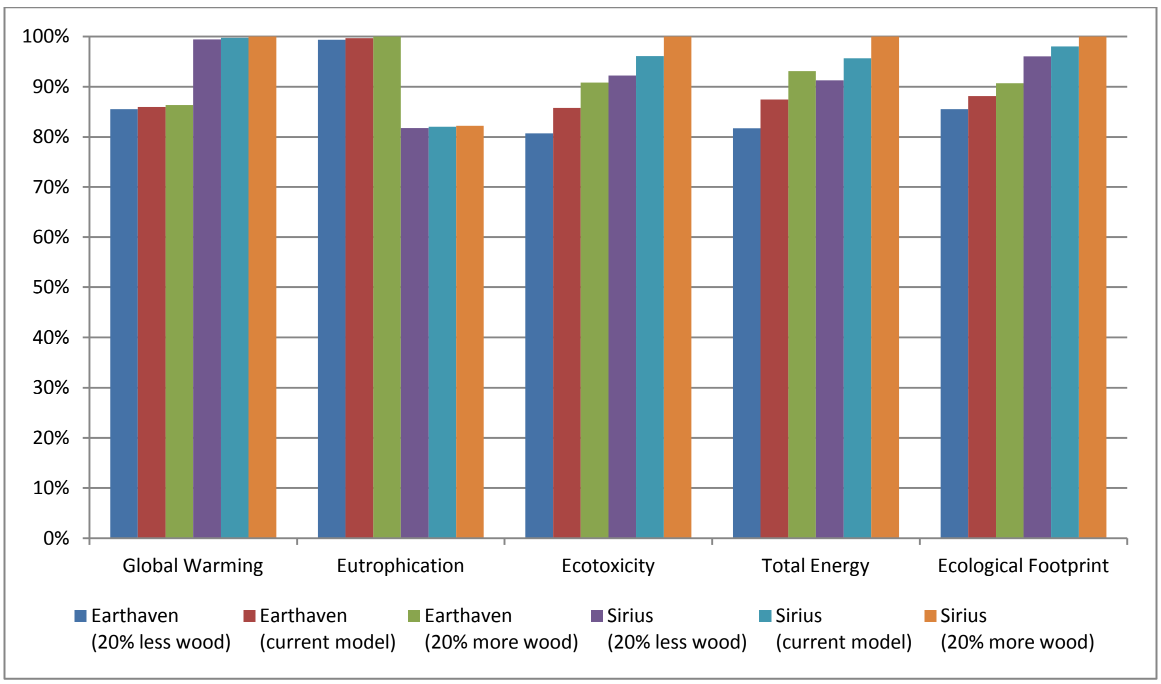

Figure H.2-B. Overall Sensitivity Results (Wood Use)

H.3 Sensitivity Analysis of Out-of-State Landfill Distance

Massachusetts and New York both ship some of their landfill waste out-of-state. Records from the appropriate state departments provided the percentage of landfill waste shipped out-of-state, but not the distance that this waste travels. A geographic analysis of states that accept landfill waste resulted in an average distance of 400 miles for landfill waste shipped out-of-state. The waste was assumed to travel by truck, as this is the highest impact mode available. Rail and ship may be used for longer distances, but these modes have relatively lower impacts per mile. The transportation distance of the waste shipped out of state was first cut by 50% and then increased by 50% to determine how sensitive the total waste and overall LCIA results are to out-of-state landfill distances.

The sensitivity analysis results for waste disposal show a low degree of sensitivity to changes in out-of-state landfill distances in all categories. When the changes in out-of-state landfill distances are considered in relation to the overall impact, they have a very minor impact (less than 1% across all impact categories).

Table H.3-B Waste Disposal Sensitivity Results (Out-of-State Landfill)

Impact Category	Global Warming (TRACI)	Eutrophication (TRACI)	Ecotoxicity (TRACI)	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
EVI (-50% Out of State Distance)	-0.245	1.22E-03	8.445	-8.495	-3.60E-05
EVI (current model)	-0.243	1.22E-03	8.445	-8.464	-3.54E-05
EVI (+50% Out of State Distance)	-0.234	1.22E-03	8.447	-8.344	-3.32E-05
Sirius (-50% Out of State Distance)	-0.175	9.93E-04	8.361	-8.488	-1.71E-05
Sirius (current model)	-0.171	9.94E-04	8.362	-8.436	-1.61E-05
Sirius (+50% Out of State Distance)	-0.167	9.95E-04	8.363	-8.385	-1.51E-05

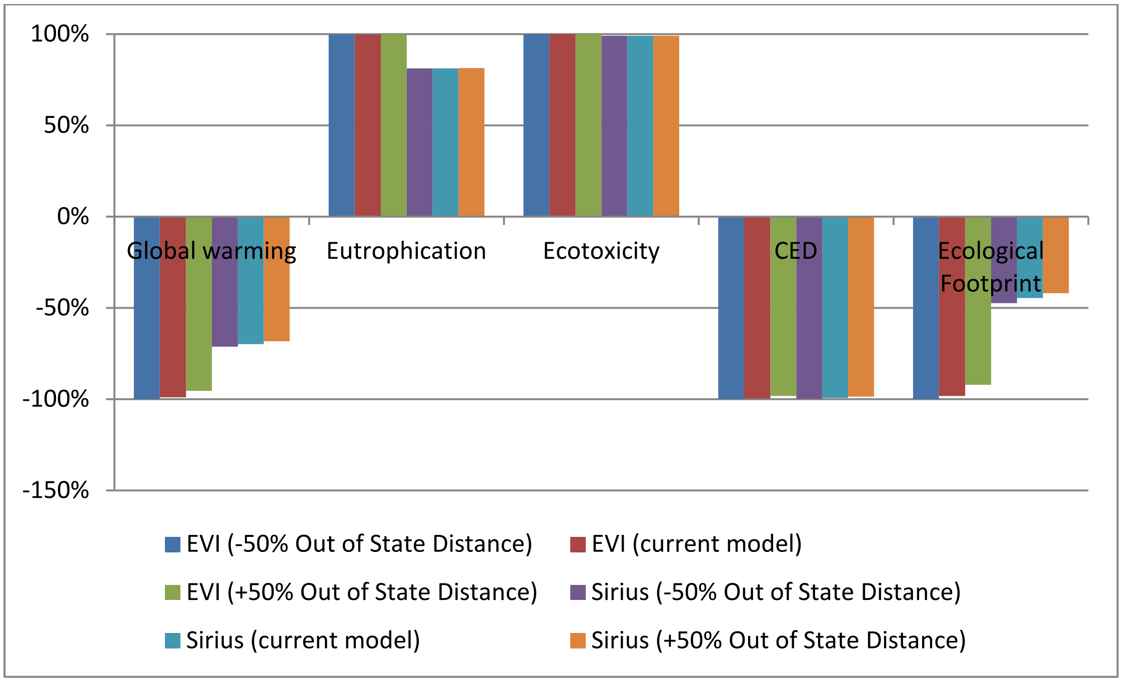

Figure H.3-A. Waste Disposal Sensitivity Results (Out-of-State Landfill)

Table H.3-B Overall Sensitivity Results (Out-of-State Landfill)

Impact Category	**Global Warming**	**Eutrophication**	**Ecotoxicity**	**Cumulative Energy Demand**	**Ecological Footprint**
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
EVI (-50% Out of State Distance)	5,676.67	13.25	6,744.51	78,192.45	1.46
EVI (current model)	5,677.58	13.25	6,744.68	78,204.80	1.46
EVI (+50% Out of State Distance)	5,681.09	13.25	6,745.35	78,252.37	1.46
Sirius (-50% Out of State Distance)	5,210.07	16.34	7,995.60	103,380.52	1.52
Sirius (current model)	5,211.57	16.34	7,995.88	103,400.78	1.52
Sirius (+50% Out of State Distance)	5,213.06	16.34	7,996.17	103,421.04	1.52

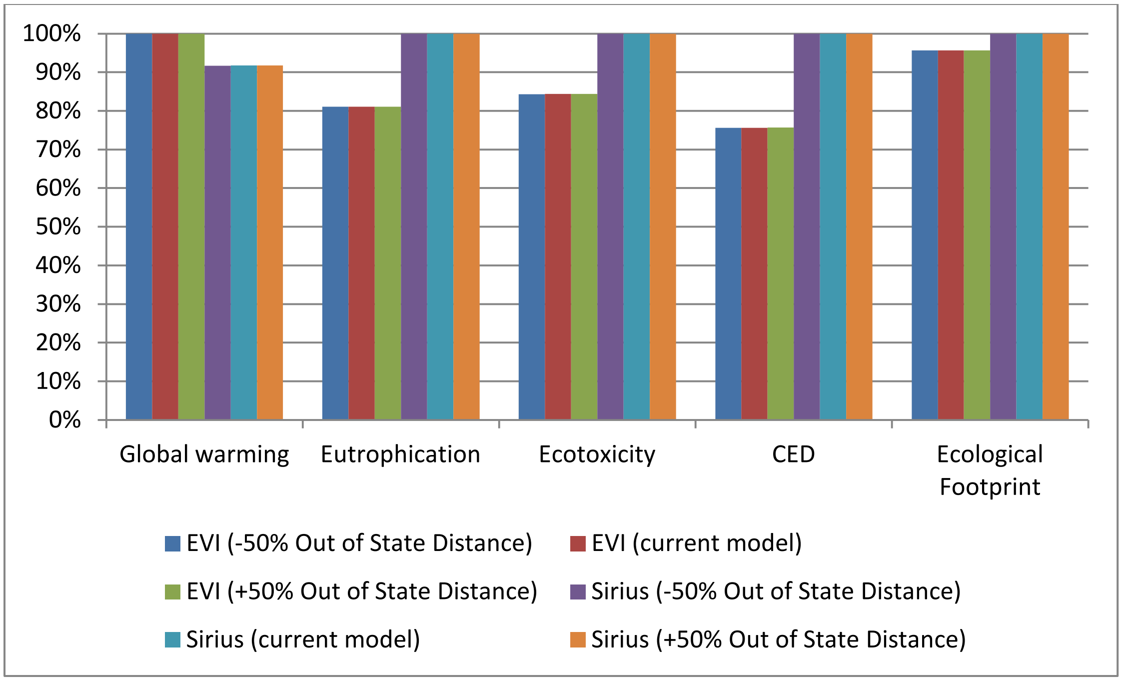

Figure H.3-B. Overall Sensitivity Results (Out-of-State Landfill)

H.4 Sensitivity Analysis of Air Transportation

Data on air transportation at a state or local level was not available, so national averages were used in this analysis. Based on the ranges of air transportation at ecovillages, a 50% increase and decrease in air travel beyond the national average should cover the range of likely values. An analysis of the impact of these variations on the overall impact for each comparison community is below. The sensitivity analysis results show a relatively low degree of sensitivity to changes in air travel in all categories. The largest variations occur in GWP, CED, and Ecological Footprint, with about 3% difference in impact between the +50% scenario and the -50% scenario. Eutrophication and Ecotoxicity show 1% or less variation between the scenarios. These variations are the same across all three comparison communities.

Table H.4-A. Overall Sensitivity Results (Air Travel Variations)

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
Buncombe Co., NC (-50% Air Travel)	15,211.87	45.36	34,066.52	191,929	3.88
Buncombe Co., NC (current model)	15,478.99	45.45	34,243.24	195,807	3.95
Buncombe Co., NC (+50% Air Travel)	15,746.11	45.53	34,419.96	199,684	4.02
Tompkins Co., NY (-50% Air Travel)	10,891.85	42.86	24,302.57	135,013	2.84
Tompkins Co., NY (current model)	11,158.97	42.95	24,479.29	138,890	2.91
Tompkins Co., NY (+50% Air Travel)	11,426.09	43.03	24,656.01	142,768	2.91
Franklin Co., MA (-50% Air Travel)	14,826.38	43.19	17,575.18	190,368	3.80
Franklin Co., MA (current model)	15,093.50	43.28	17,751.90	194,246	3.87
Franklin Co., MA (+50% Air Travel)	15,360.62	43.36	17,928.62	198,124	3.93

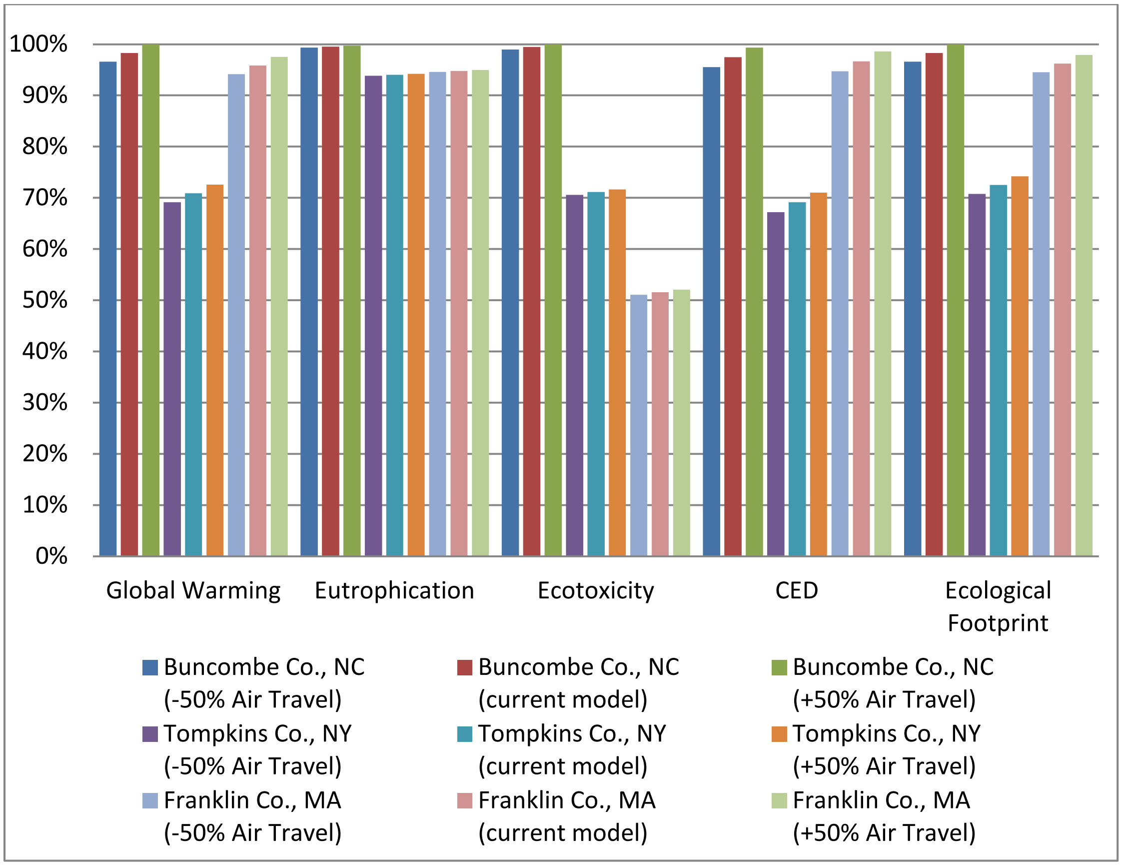

Figure H.4-A. Overall Sensitivity Results (Air Travel Variations)

H.5 Sensitivity Analysis of Regional Diet Variations

Data on diet variations between regions was very limited. The Community Nutrition Mapping Project (USDA, 2013) contains a state by state analysis which percentage of people who are meeting the USDA recommended portions for grains, dairy, fruits, vegetables, and meat. This data shows that the variations among states for these categories is relatively slim, with the largest being a 10% increase in grain consumption in Massachusetts compared to the US average. The examination of the impacts of various food categories shows that meat consumption has by far the largest influence on the environmental impact of diet. While the USDA data showed only a 2-4% variation in meat consumption from the US average in the various states, this sensitivity increases the range to 10% to account for a wider range of possible diets.

An analysis of the impact of these variations on food impacts and overall impacts is below. The overall impact results show a modest degree of sensitivity to changes in meat consumption, except with Eutrophication. The food impact results show more sensitivity with a range of 1-7% variation between the current model and the +/- 10% cases. For the overall results, GWP, Ecotoxicity, CED, and Ecological Footprint show no more than 2% variation between the current model and the +/- 10% cases. Eutrophication, however, shows a 6.8% variation between the current model and the +/- 10% cases. This is because food impacts make up the vast majority of the eutrophication impacts, and meat consumption strongly influences the food impacts. These results suggest that the overall Eutrophication impact will be influenced if meat consumption is over or under estimated by more than a few percent. Given that the USDA data suggests no more than a 4% variation in overall meat consumption, it is unlikely that this analysis is being overly influenced.

Table H.5-A. Food Sensitivity Results (Meat Consumption Variations)

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
-10% Meat	2,657.42	35.19	366.70	13,313.16	0.82
Current Model	2,875.18	38.52	369.21	13,841.26	0.89
+10% Meat	3,092.95	41.85	371.72	14,369.36	0.96

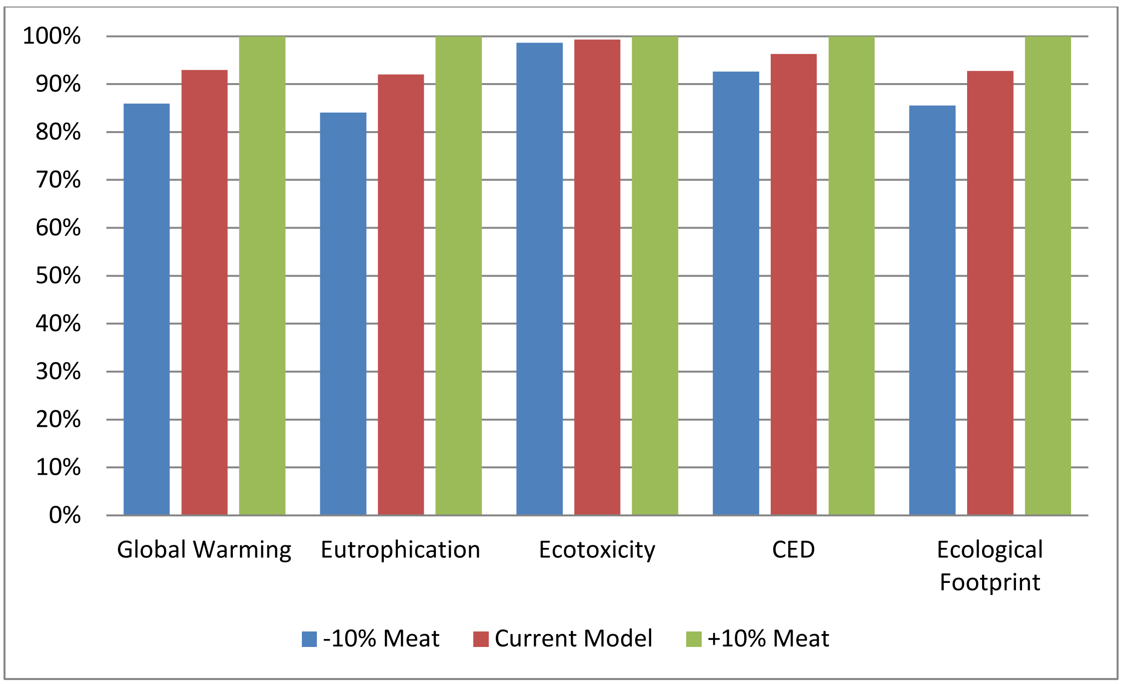

Figure H.5-A. Food Sensitivity Results (Meat Consumption Variations)

Table H.5-B. Overall Sensitivity Results (Meat Consumption Variations)

Impact Category	Global Warming	Eutrophication	Ecotoxicity	Cumulative Energy Demand	Ecological Footprint
Unit	kg CO_2 eq.	kg N eq.	kg 2,4-D eq.	megajoules (MJ)	global hectares (gha)
-10% Meat	15,088.79	42.26	33,009.61	196,544.35	3.85
Current Model	15,306.55	45.58	33,012.12	197,072.45	3.92
+10% Meat	15,524.32	48.91	33,014.63	197,600.55	3.99

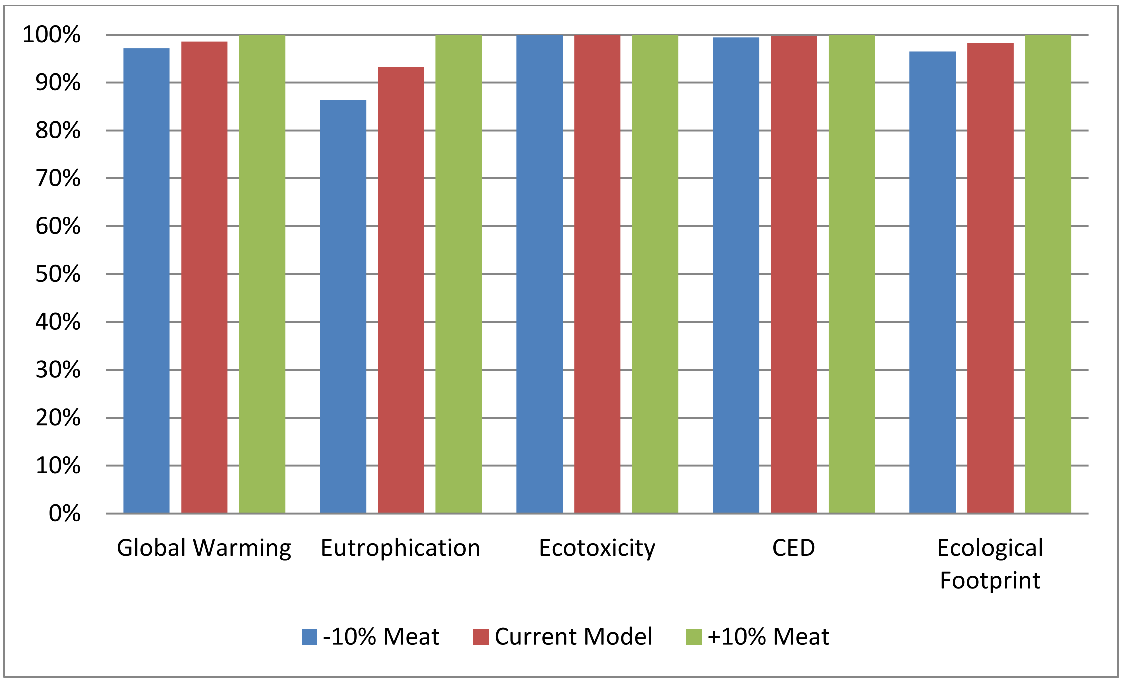

Figure H.5-B. Overall Sensitivity Results (Meat Consumption Variations)