Ecovillage Residential Energy Systems:

How ecovillages are contributing to a residential energy transition in the United States

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Abstract

This report assesses the residential energy systems of two ecovillages in the United States (Ecovillage Ithaca, New York and Twin Oaks Community, Virginia) in an effort to determine how these developments can contribute to an overall energy transition in the country. The report finds that both ecovillages studied are living more sustainably with regards to their residential energy systems. EVI consumes about 46% less residential energy per resident than the average New York resident, and produces approximately 11% of all residential energy consumed. Twin Oaks consumes about 31% less residential energy per resident then the average Virginian, and produces approximately 41% of all the residential energy it consumes.

Interviews with residents suggest that the social and economic institutions at each ecovillage - which allow for different forms of communal investment and agency – enable many built form investments and behavioral changes to improve residential energy systems. 'Built form' improvements are found to be more easily replicated in broader society than behavioral changes, due to the ease of implementation and the compatibility with the current regime. External interaction with the local, state, and federal governments as well as the private market is seen to be greatly dependent on the specific ecovillage in question – including the institutions established within the village, the community's relationship with local authorities, and the methods of adaptation used. The report concludes that these two small-scale community energy systems offer many lessons for broader society and other emerging intentional communities. However, their contribution to an overall energy transition is minimal due to a lack of cohesive policy towards such a transition from the national government.

Key Findings

- Empirical evidence suggests that the residential energy systems of both ecovillages are in fact more sustainable than surrounding areas.

    - Residents at Ecovillage Ithaca consume approximately 46% less residential energy per person than the NY state average, and the community produces approximately 11% of the residential energy it consumes.

    - Twin Oaks consumes approximately 31% less residential energy per resident than the surrounding state of Virginia, and the community produces approximately 41 % of all residential energy that it consumes in a given year.

- The residential energy system of Ecovillage Ithaca can be seen to interact extensively with both the government and the private market, while Twin Oaks interacts considerably less with these external forces than conventional communities.

- Built form improvements implemented at Ecovillage Ithaca were seen as replicable by many residents, while the institutions which allowed for communal investment and consumption reductions were seen as harder to replicate in broader society. Twin Oaks residents felt that the residential energy system may not be replicable piecemeal, but that the energy savings accomplished were replicable within the broader context of the egalitarian structure of Twin Oaks.

- Many residents at Ecovillage Ithaca offered specific, pragmatic changes in regulatory frameworks in order to encourage residential energy improvements. Most residents interviewed at Twin Oaks did not feel that the government would want to help replicate their egalitarian model of community.

- Ecovillage Ithaca has taken a pragmatic, incremental approach to communal living by trying to offer an alternative to suburban lifestyle. Many implemented changes at Ecovillage Ithaca do not challenge the incumbent regime, but in fact work in cooperation with explicitly stated goals of the regime. Twin Oaks energy reductions come from wholesale reductions in overall consumption through the sharing of products and minimal consumption.

- The replicability of both models depends on the success of the incumbent regime.

- Whether a residential energy transition will occur in the United States depends greatly upon the incumbent regime and its ability to decouple fossil fuel energy consumption/production from economic growth.

- What is feasible is small, local change driven by grassroots movements and citizens who are searching for more sustainable ways of living

Acknowledgements:

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Definitions:

There are several terms used throughout this report which must be defined in order to lend clarity to the paper and its analysis. These terms are defined below.

British Thermal Unit (BTU): The energy required to heat 1 pound (0.454 kg) of water, from 39 °F to 40 °F (3.8 °C to 4.4 °C)

Energy Systems: can be considered socio-technical systems, which are "the linkages between elements necessary to fulfill societal functions" (Geels, 2004; Kern and Smith, 2008). For the sake of this paper, an energy system includes the provision (and production, if applicable) of heat, light, and power.

Transitions: are described as social transformation processes causing structural change to systems over time (Kern and Smith, 2008).

Ecovillages: are intentional communities with a focus on ecological sustainability. For further definition, see section 2.3.

Institutions: The formal and informal rules of the game (regulations, laws, markets, infrastructures, shared perceptions and expectations of power relations, knowledge networks) which govern system transitions (Hischemoller, lecture Feb 2012).

Regimes: A regime consists of three interlinked dimensions: 1) networks of actors and social groups, 2) institutions, 3) material and technical elements (Verbong and Geels, 2007).

Niches: The micro-level 'locus' areas where novelties emerge. This can include market niches or technological niches. (Verbong and Geels, 2007)

Intentional Housing Communities: "communities that were specifically designed to enhance their resident's quality of life by balancing concern for interpersonal relationships (social capital), personal growth and development (human capital) and connection with nature (natural capital) with needs for physical subsistence (built capital and income" (Mulder et al, 2005).

Co-housing Communities: "private living units with communal living areas" (Thomas and Blanchard, 2009).

Net Consumption: energy consumption excluding electrical system energy losses.

Primary Consumption: "refers to the direct use at the source, or supply to users without transformation, of crude energy, that is, energy that has not been subjected to any conversion or transformation process" (OECD, 2012).

Decentralized Generation: the production of energy from small-scale energy systems that produce electricity and/or thermal energy at or near the point of use.

Built Form Reductions: energy savings gained through physical adaptations/investments (insulation, double-pained windows, etc.).

Abbreviations:

Term	**Acronym**
British Thermal Unit	BTU
Decentralized Generation	DG
Environmental Protection Agency	EPA
Ecovillage Ithaca	EVI
Greenhouse Gases	GHG
Heating, Ventilation, Air Conditioning	HVAC
Leadership in Energy and Environmental Design	LEED
Liquid Propane Gas	LPG
National Renewable Energy Laboratory	NREL
Old Dominion Electric Cooperative	ODEC
Renewable Portfolio Standard	RPS
Residential Energy System	RES
Return on Investment	ROI
Solar Renewable Energy Credits	SREC
Twin Oaks Community	TO
United States Department of Energy	US DOE (or just DOE)

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1. Introduction

The need for a transition from fossil fuel energy is recognized as necessary by most of the 'developed' or 'western' world. This move is necessitated not only to reduce greenhouse gas (GHG) emissions and thus curb the effects of climate change, but also to increase energy independence among western nations - many of whom are heavily dependent upon fossil fuel imports (Bodansky, 2010; Deutch, 2004). Despite the apparent consensus among developed nations of the urgency of a sustainable energy transition, the United States has shown little success in transitioning away from fossil fuels (Carlarne, 2010).

Not waiting for top-down changes, many grassroots movements have sprouted which are attempting to develop independent solutions to the challenges of sustainable energy production and consumption (Loezer, 2011; Wight, 2008). A prime example of such a grassroots movement in the United States is the ecovillage movement. This movement started in the early 1960's as part of the environmental movement through the creation of environmental communities, in which local citizens began creating social and environmental solutions on the community level (Wight, 2008). Since that time, the ecovillage movement has grown significantly in the United States and globally, with each community creating its own set of solutions for living a more sustainable lifestyle *(Ibid)*.

As part of this effort, each ecovillage must assess its residential energy system: how it will produce, consume, and store energy. A residential energy transition in the United States would significantly impact overall energy consumption and production. Such a transition would reduce each community's reliance on imported energy, fossil fuels, and possibly even centralized generation. This residential energy transition would necessitate an increase in residential production, drastic decreases in consumption, or both.

This paper will study the residential energy systems of two ecovillages – Ecovillage Ithaca (EVI) in Western New York, and Twin Oaks Community (TO) in central Virginia - in an effort to determine what lessons these communities can offer to broader US society regarding a transition to a more sustainable residential energy system.

The method of evaluating 'energy systems' within ecovillages as niche developments is inspired mostly by the energy transition theory and practice in the Netherlands. This unique approach to system transition through the development and fostering of 'niches' has been analyzed extensively in the literature (Hisschemöller 2010; Kern and Smith, 2008; Kemp 2008). The method of this paper is novel because it uses the theoretical framework of energy system transitions and 'niche development' as applied to the United States, where no such strategy explicitly exists. In this way, the paper analyzes community energy system developments within ecovillages as niche developments and assesses how these developments have interacted with local, state, and national policy during their formation.

1.1 Research Question

In order to perform this study, the paper will seek to answer the following research question:

To what extent can the residential energy systems of ecovillages contribute to an overall residential energy transition in the United States?

This main question will be answered by the investigation of the following sub-questions:

1) How do the residential energy systems of Ecovillage Ithaca and Twin Oaks differ from mainstream society (Are they really more sustainable)? With regards to:

- Energy consumption
- Energy production
- Energy storage

2) How do the institutions of Ecovillage Ithaca and Twin Oaks support, enable, or hinder their residential energy system development?

3) How does the interaction between internal institutions and external forces affect the residential energy system?

4) How can the residential energy systems of Ecovillage Ithaca and Twin Oaks be seen as 'niche' developments, and what is their potential for replication?

5) What steps (if any) can be taken by the government (local, state, and Federal) to aid the development of these niches?

1.2 Structure of Report

This report will proceed in Chapter 2 by offering background about the US energy system, transition theory, the ecovillage movement, and a brief description of the two ecovillages studied in the report. Chapter 3 will describe the methodological framework of the paper. Chapter 4 will detail the results of the empirical analysis of residential energy consumption at both villages, thus answering sub-question 1. Chapter 5 will analyze these results. Chapter 6 will detail residents' opinions gathered through qualitative interviews performed at Ecovillage Ithaca with regard to its institutions, the interaction of these institutions with external factors, the replicability of the residential energy developments, and government involvement with the energy system. Chapter 7 will describe these same elements for Twin Oaks Community. Chapter 8 will discuss the results of these interviews and elucidate the insights they reveal. Chapter 9 will conclude the paper by using the data and analysis to explicitly answer all 5 sub-questions and the overall research question.

2. Background

This Chapter will briefly describe the historical and current energy system in the United States, as well as residential energy's contribution to this overall system. It will then describe transition theory in order to establish the theoretical basis for the report's analysis. It will continue with a description of the ecovillage movement, and the two specific ecovillages studied in the report.

2.1 US Energy: a brief history and current trends

United States energy production and consumption consists of (in order of magnitude) petroleum, coal, natural gas, nuclear, and renewables. The United States has consumed more energy than it produced every year since 1960, making it a net importer of energy (EIA, 2010).

US Energy Production and Consumption

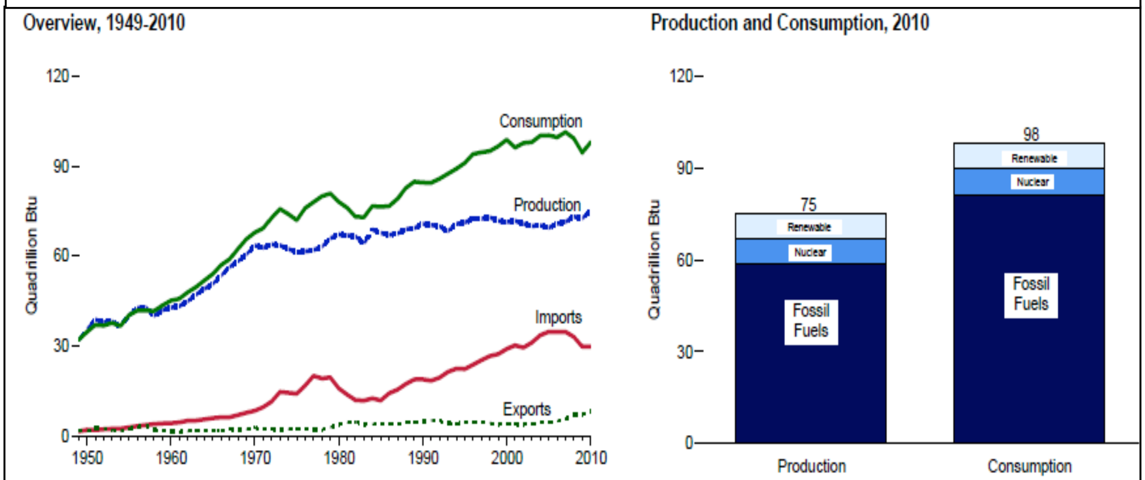

Figure 1: Historical overview of US energy (left) and a detailed overview of US production and consumption in 2010. Note that for the past 50 years, the US has been a net importer of energy. Source EIA, 2010.

Renewable Energy as share of Overall Consumption (2010)

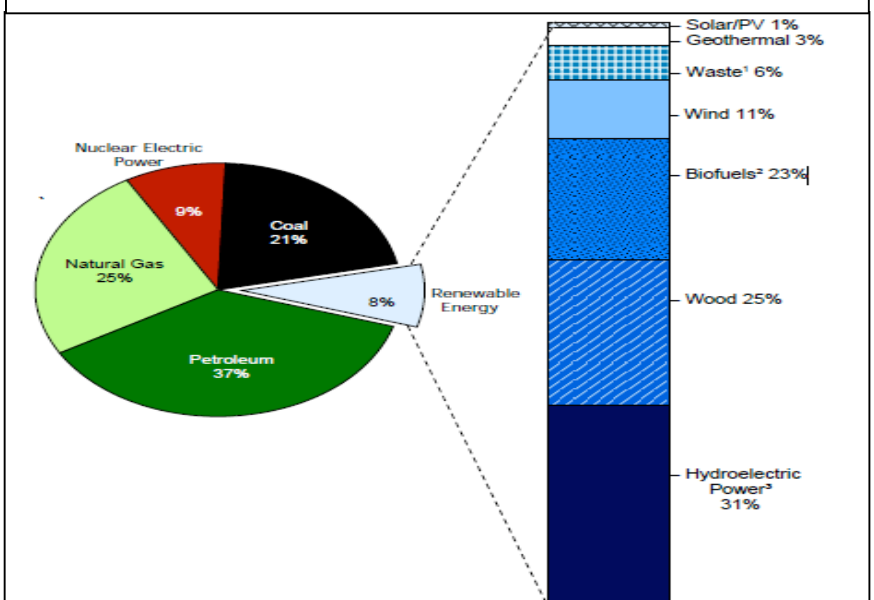

Figure 2: Source: EIA, 2010. Note: Renewable consumption equals production for all sources except biofuels.
[2]Total biomass inputs to the production of fuel ethanol and biodiesel.

US Energy Production

The vast majority of energy produced in the United States comes from large power plants utilizing centralized generation. This includes plants using coal, petroleum, natural gas, other gases, and hydroelectric (EIA, 2010). While there are an increasing number of centralized generation plants utilizing solar arrays and wind technology, hydroelectric plants and biofuels produce the majority of the country's renewables. (EIA, 2012).

Cogeneration and small power production – termed decentralized generation (DG) – have increased their contribution to the energy mix since the passage of the Public Utility Regulatory Policies Act (PURPA) in 1978. As of 2006, there were:

> "about 12 million DG units installed across the country, with a total capacity of about 200 GW. Most of these [were] back-up power units used primarily by customers to provide emergency power during times when grid-connected power [was] unavailable" (USDOE, 2007).

In 2003, these DG units generated approximately 250,000 gWh of electricity, less than 1 % of the United States energy production for that year (USDOE, 2007). In part because only a small fraction of DG capacity is used for continuous generation, the market is expected to increase to only 3 GW of power in 2025, or 0.25% of total estimated US capacity (Sovacool, 2008).

US Energy Consumption

The United States consumed 98 Quadrillion BTUs of energy in 2010, 30% more than it produced (EIA, 2010). While the consumption per capita of the United States decreased approximately 2% between 1990 and 2008, the gross consumption increased 20% over the same period (IEA et al, 2011). Since the early 1970s, there has been strong public pressure to increase energy independence in the country and thus reduce reliance on foreign imports for energy – most of which consist of petroleum (Krauss and Lipton, 2012). However, the dialogue of the regime focuses mostly on production, with little explicit focus on significant reductions in energy consumption. This focus has lead to the passing of many regulations attempting to transition the United States to a more self-reliant situation with regards to its energy supply. More on the national policies for energy will be detailed in section 2.1.5.

US Energy Storage

According to the DOE, "energy storage and power electronics hold substantial promise for transforming the electric power industry" (OEDER, 2012). The United States government has recently increased investment in energy storage alternatives. In addition, the private sector has taken an increased interest, due in part to the increasing investment in renewable technologies, and the need to store the periodical flows of electricity provided by these renewables. The U.S. energy storage market totaled $3.06 billion in 2011 (EBI, 2012).

The US Government has been investing in these technologies in the hope that rapid development will lessen the need for more expensive infrastructural investments (OEDER, 2012). The DOE has invested $1.25 billion for electric drive battery and component manufacturing facilities, and part of the American Recovery and Reinvestment Act (ARRA) includes $185 million in federal matching funds for DG technologies (*Ibid*). The resulting projects have generated 537 MW of storage systems to be added to the grid (EAC, 2011).

The United States electric power grid currently has a storage capacity of approximately 23 GW, of which almost all is provided by pumped hydro (EAC, 2011). The table below shows all existing technologies, and their contribution to total energy storage capacity.

Estimated Installed Capacity of Energy Storage in U.S. Grid (2011)

Storage Technology Type	Capacity (MW)
Pumped Hydro Power	22,000
Compressed Air	115
Lithium-ion Batteries	54
Flywheels	28
Nickel Cadmium Batteries	26
Sodium Sulfur Batteries	18
Other (Flow Batteries, Lead Acid)	10
Thermal Peak Shaving (Ice Storage)	1,000
Total:	**23,251**

Figure 3: Source, EAC 2011.

Many individual investors and communities are also interested in energy storage, due in many cases to its applicability for off-grid electricity potential. There is distrust among a minority of the population regarding electricity supply, and the capability of the US grid to handle the anticipated increases in demand. Thus, there is motivation in some areas/communities to increase energy storage and energy production in order to reduce dependency on the grid – both to avoid increasing energy costs and reliance on large electricity utilities, and also to be prepared for possible grid failures.

US Residential Energy

The residential sector accounted for approximately 23% of the total energy consumed by the United States in 2010 (EIA, 2012). Nearly all residences in the United States have electricity provided by the centralized electricity grid – even those in rural areas. ***While the residential sector required nearly a quarter of the country's energy demand in 2010, the sector generated less than 1% of total US energy production for the same year (Ibid). A residential energy transition in the United States would thus significantly impact overall energy consumption and production.*** This transition would necessitate an increase in residential energy production, significant decreases in residential consumption, or both.

Total Contribution of Residential Sector to US Energy Consumption (2010)

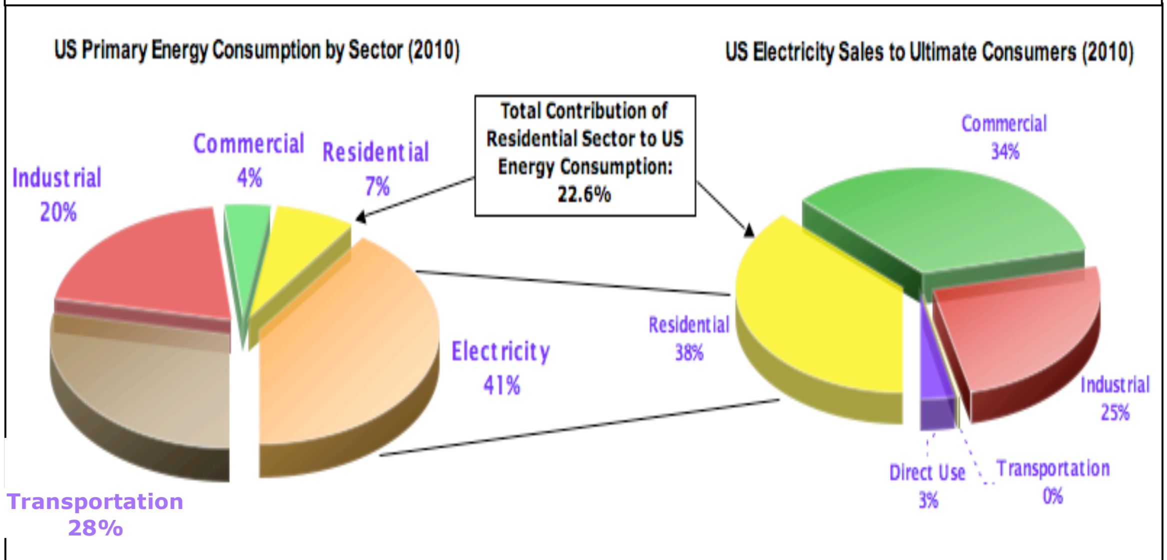

Figure 4: Percentage of total energy consumption from residential sector. The result is the combination of primary energy consumption from residential sector, and the percentage of electricity sales to residential sector (to indicate how much of primary electricity generation goes to residential use). Adapted from Source: EIA, 2010.

US Energy policy: a transition?

The United States has, since its inception, lacked a cohesive national energy policy[1] (Barnberger, 2004). The complexity of the division of powers both within the federal government and between the federal government and state governments makes a nationwide energy plan almost infeasible. However, some trends can be seen with regards to national energy policy. The Trias Energetica – a model developed in the Netherlands to describe sustainable building – can be used to describe one such trend. As characterized in the model, the first step of US energy policy is often to reduce energy losses (increase efficiency), the second step is to increase the use of renewables when possible, and the third is to make efficient use of fossil fuels when necessary (Hisschemöller and Bode, 2010). This can be seen clearly by the explicitly stated goals of the Energy Independence and Security Act of 2007, which are:

> "To move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government, and for other purposes." (Rehal, 2007).

Examples of energy efficiency measures began as far back as the Carter Administration, with the Weatherization Assistance Program, and can still be found in the most recent energy bills of 2007 and 2009 (US DOE, 2010; Rehal, 2007). More than two thirds of the $24 billion in energy subsidies from the federal government in 2011 went to conservation and renewables (Smith, 2012).

[1] Note: While the energy policy of the United States is, and has traditionally, been formed by national, state, and local authorities, this section will focus only on the national energy policy. More details about state and local policies relevant to the case studies can be found in Chapter 4.

President Obama's American Recovery and Reinvestment Act provided $3.2 Billion in grants for projects that reduce total energy use and fossil fuel emissions, and improve energy efficiency nationwide (US DOE, 2010). The use of financial incentives to encourage the aforementioned practices often comes in the form of tax breaks, tax reductions, tax exemptions, and loans (*Ibid*; Rehal, 2007).

Federal investment in renewables increased when President Obama took office, but has since decreased. Subsidies to clean energy amounted to $44.3 billion in 2009, but have since reduced to $16 billion in 2012 and will further reduce to $11 billion in 2014 (at which point, the subsidies will expire if not renewed) (NY Times, 2012). In addition, several tax credits are available for the development of renewable energies, including a 30% tax credit for homeowners who install solar electric systems, and up to $4000 tax credit for wind installations and $2000 for geothermal (US DOE, 2011). Furthermore, many states have passed a Renewable Portfolio Standard (RPS), although Congress has failed to pass a federal requirement.

Regarding fossil fuels, Washington has simultaneously supported fossil fuel extraction and use through subsidies. From 2002 – 2008, the Bush Administration's subsidies for fossil fuels totaled $72 Billion of taxpayer money, while renewables consisted of only $29 Billion over the same period (Adeyeye et al, 2009). The Obama Administration has drastically reduced fossil fuel subsidies - which amounted to $2.5 billion in 2011 (Smith, 2012). However, there are criticisms that the US Government offers many benefits to the oil and gas industry which are not recognized officially as subsidies and thus are not accounted for, and some organizations have estimated the actual subsidy valuation as high as $41 billion annually (Clayton, 2011)[2].

A Way Forward?

While recent policies from the Obama Administration have (arguably) helped renewable technologies become more competitive and shown the administration's commitment to reducing US dependence on fossil fuels, some studies have shown that efficiency gains and the contribution of more renewables to the energy mix will not be enough to eliminate or even substantially reduce US dependence on foreign suppliers, given increasing consumption (Smith, 2012; Deutch, 2005). In other words, along with increased renewable production and energy efficiency, large reductions in energy consumption are required both to achieve energy independence and reduce GHG emissions to a sustainable level (Princen et al, 2002). However, the priority of economic growth , and the difficulty of decoupling this economic growth from energy consumption, creates huge challenges for the nation's energy policy (*Ibid*). Thus, with top-down change from the regime restrained by vested interests, small-scale niche developments in both renewable and decentralized generation technologies, and as importantly, consumption reduction strategies, may be seen as vital to a US energy transition.

2.2 Energy Transition Theory and Sustainability

This report borrows from the analytical framework of transition theory, which studies the historical and current dynamics, patterns, and mechanisms through which system transitions occur (Kern and Smith, 2007; Geels, 2004; Kemp et al, 1998). Energy

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[2] This discrepancy potentially undermines the accuracy of previous numbers in this section, including renewable subsidies. However, the general trends mentioned should still hold true (assuming that unreported subsidies have not changed significantly during Obama's administration – which is impossible to know).

systems are socio-technical systems which “provide linkages between elements necessary to fulfill societal functions” (Kern and Smith, 2007; Geels, 2004). In the case of residential energy systems, this includes energy required for domestic living – including home heating, lighting, and power[3] (*Ibid*). A transition constitutes the processes of social transformation through which systems change structurally over time (Kern and Smith, 2007; Rothmans et al, 2001).

This study uses Geel’s multi-level analysis to describe interactions which lead to system transitions on three levels: landscape, regime, and niche (Geels, 2004). The landscape consists of changes which occur beyond the control of regime members, such as climate change. Regimes consist of the actors and networks that shape the discussion and proposed solutions to a given problem (Geels and Schot, 2007). The niche level, on which this paper will focus most, consists of the micro-level locus where changes develop (ibid). (See Appendix A for more about this framework).

The residential energy system ‘transition’ described in this paper would thus require structural transformation initiated by social and technical change. Therefore, an ecovillage can be considered more ‘sustainable’[4] than surrounding areas if it has created transition in three broad categories (most likely a combination of the three): increased residential (decentralized) production of electricity, significantly decreased residential consumption, and/or increased residential energy storage capabilities. While there are many ways in which the overall energy system could transition (through smart-grids, decentralized production outside the residential sector, etc.), this paper will only focus on change driven from within the residential sector. More specifically, it will focus on changes to the residential energy systems of two ecovillages, in order to assess how these changes can contribute both technically and socially to a broader residential energy system transition in the United States.

2.3 What is an Ecovillage?

Definition

Ecovillages are specific forms of intentional communities focused on social and ecological cohesion. Ecovillages are examples of small-scale, localized attempts to change patterns of production, consumption, and societal interaction. More officially,

> “Ecovillages are urban or rural communities of people, who strive to integrate a supportive social environment with a low-impact way of life. To achieve this, they integrate various aspects of ecological design, permaculture, ecological building, green production, alternative energy, community building practices, and much more” (GEN, 2012).

A key factor that defines an ecovillage is that the community “strives” to reorient social and environmental priorities from those of mainstream society. It should be noted that no ‘ideal’ ecovillage exists, and that each community, as well as the movement itself, is a “work in progress” (Jackson, 2004). The term ‘ecovillages’ is intentionally broad,

[3] Due to a lack of time and resources, aspects of residential living outside of home energy – i.e. transportation, food and water requirements, etc. have not been included in this report.

[4] This definition of ‘sustainable’ is only for the purposes of this study and its focus on residential energy system transitions. The report does not address CO2 equivalents, or other conventional methods of assessing ‘sustainability’.

encompassing many communities around the world, not all of whom have similar goals or focuses, even within the communities themselves.

Origins, Motivations, Philosophies

Origins:

Intentional communities were present in the United States since the beginning of colonial occupation, when pioneers joined together in search of religious, social, political, and/or economic freedom (Kanter, 1973). The term ecovillage became common in the 1990's, but the idea evolved from the environmental communes which sprung from the environmental and other social movements in the United States during the 1960's (Wight, 2008). There are an undetermined number of ecovillages around the world, with estimates ranging from several hundred to several thousand (Jackson, 2004).

Motivations:

Those who formed ecovillages were seeking social, political, and religious change (Kanter, 1972). The demonstration and construction of a community to create different ways of living was seen as the most effective form of social change by many ecovillage planners, who – like the builders of intentional communities before them – were frustrated with the ineffectiveness of individual dissent, gradualist reform, and revolution as methods for creating social change (Hayden, 1976; Kirby, 2003).

Studies show that the desire for social and/or ecological cohesion serves as the main motivations for joining an ecovillage (*Ibid*). Many ecovillagers express a feeling of "disconnectedness and alienation from conventional social patterns and mores (Kirby, 2003)". Some suggest that the individualistic, consumer-driven 'mainstream' society is leading to depression and discontent that cannot be easily solved within the current social constructs (Wight, 2008).

Thus, it is the desire for a more holistic, community-driven lifestyle that motivates many ecovillagers – although the motivations for each individual and each community vary greatly.

Philosophies:

The GEN network recognizes sustainability along three pillars: social, ecological, and spiritual (Kirby, 2003). The idea of a 'holistic' or 'systems approach' to community building is common among ecovillages, who tend to adopt the environmental sociological 'human exceptionalist' critique of conventional society (Wight, 2008)[5]. The holistic approach sees all aspects of daily life as integrated, and thus requires a rejection of the fragmented, individualistic lifestyle that constitutes 'western culture'. However, rather than simply rejecting this contemporary lifestyle, ecovillage communities are using their philosophies of social, ecological, and spiritual cohesion in order to actively demonstrate another way of living (Kasper, 2008; Wight 2008; Kirby, 2003).

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[5] Human Exceptionalism is a sociological theory which claims that many of the environmental and social problems of modern society stem from the philosophical alienation of humans as separate from the surrounding environment, rather than as a functioning part of the whole

Background of Ithaca Ecovillage


Source: EVI, 2012

Located about 5 KM from the city of Ithaca in western New York, Ecovillage Ithaca (EVI) was formed as a non-income sharing, intentional housing community with a focus on ecological sustainability in 1996. The mission statement of the community is:

> "To promote experiential learning about ways of meeting human needs for shelter, food, energy, livelihood and social connectedness that are aligned with the long term health and viability of Earth and all its inhabitants" (Walker, 2005).

The community consists of two separate neighborhoods – named FROG and SONG - making it the first co-housing community in the world to have more than one neighborhood (Chitewere, 2006; Holleman, 2011). It houses approximately 160 residents and 10 renters, but these numbers are expected to increase with the addition of a third neighborhood – TREE – which is now in the planning stages.


Source: Hasler, 2009.

The village was designed based on the co-housing model, which places all houses in close proximity. All houses are duplexes (sharing at least one wall with another house). This is in stark contrast to standard housing in the suburban United States, which usually consists of houses of individual units with space surrounding each. The EVI community is currently 176 acres (70.8 hectares), with a goal of 80% of all available land remaining undeveloped (Brown, 2004). Because EVI has condensed the houses into a relatively small area (5 acres for each neighborhood), they have been able to preserve 149 acres (60.3 hectares) as open space for the community, with 15 acres dedicated to an organic farm and berry farm. Each neighborhood also has a community house in which communal meals and meetings are held. Most people earn private income by working in Ithaca, or within the village.

Background of Twin Oaks Community

Source: FEC, 2007

Twin Oaks (TO) Community was founded in 1967 in central Virginia. It is an egalitarian, income sharing community whose stated purpose is:

> "to perpetuate and expand a society based on cooperation, sharing, and equality" (Twin Oaks Handbook, 2011).

TO began as an experimental attempt to create a utopian society similar to the one described by author B.F. Skinner in his book Walden II (Kinkade, 1994). While TO's mission is focused on egalitarianism, it also recognizes ecological concerns, and recognizes itself as an ecovillage on its website (www.twinoaks.com).

Source: Twin Oaks Tofu, 2012

Twin Oaks "assumes responsibility for maintaining the availability of natural resources for present and future generations through ecologically sound production and consumption" (Twin Oaks Handbook, 2011).

TO is situated on approximately 300 acres of land, on which there are 7 residential houses, which collectively house all 107 members. Thus, the houses are very compact in their spacing, and members have only a small private room, averaging 125 ft^2 (11.6 m^2) to themselves (Interviewee 1). TO has left a large percentage of the land undeveloped and forested, and uses some of the space for growing food for the residents. The community funds most its activities through its two main businesses, which produce goods sold to the private market: Twin Oaks Hammocks, and Twin Oaks Tofu.

3. Methodology

This section will describe the problem statement and the approach used to carry out this study. It includes discussion of the literature review used to contextualize the problem statement, methods of empirical data gathering within the two ecovillages studied, as well as unstructured interview and participant observation techniques used.

Problem Definition

Given the problem of an unsustainable residential energy system in the United States, this report explores the technologies, attitudes, and perceptions of residents living at EVI and TO in order to learn lessons and offer perspective from those who are currently participating in this transition. This report assumes that the current residential energy system in the United States is inherently unsustainable with regards to both supply of fuel sources, and the consequences of the combustion of these sources. It also assumes that a delineation can be made between the residential energy system - as measured by the regime as the 'residential sector' - and the overall energy system.

The problem is seen as the challenge of transitioning the residential energy system to a more sustainable system – one which can supply power from domestic (preferably local) sources, and that contributes less to environmental degradation (both through GHG emissions, and harmful harvesting practices). This problem widely affects the United States population, as well as citizens of the world who are affected by the United States' energy acquisition abroad. However, as there has been little progress with top-down initiatives from the regime in this regard, this study seeks to find contributions offered by niche developments that are replicable in broader society.

Problem Scope

The scope of this paper focuses mainly on the Niche level developments of the two ecovillages studied. However, it also discusses interactions between each niche and the overarching regime. During this process, it is assumed that the motivation for transitioning the residential energy system exists within the United States, particularly among those individuals living in the Ecovillages studied. Thus, the question of motivation regarding energy system transitions is not covered in resident interviews, which focus on technological investments, behavioral changes, and the institutional structures which have enabled them. Regarding future developments, this study has refrained from interviewing residents about their anticipations for the future of their residential energy systems. However, the topic did arise during conversation, and thus it is touched upon in the report.

It should be recognized that the each community studied, as well as the overarching regime in the United States, cannot be assumed to have cohesive motivation - particularly with regards to energy transition - given the multipolarity of actors and interests involved. Therefore, the problem scope is narrowed to the niche level: discussing how the regime could (presuming the motivation) assist the development of more niche residential energy transitions, as well as how these niches could be replicated without the assistance of the regime.

Literature Review

Most data gathered during this report was found through extensive literature review of three distinct areas of study: Energy transition theory in the Netherlands, sociological and empirical studies of ecovillages in the United States, and US state and local energy policy. All federal metadata was gathered through the use of the Energy Information Administration website, except where otherwise stated. Regional data was found from the Residential Energy Consumption survey (REC). State level data for New York was taken from NYSERDA documents (NYSERDA, 2012), the EIA (EIA, 2010), and the REC survey (EIA, 2007), while Virginia data was exclusively from the REC survey. Tompkins County information was gathered from a report on the sustainability of the county (TCPD, 2010). The paper seeks to combine this information at their nexus – the development of niches and alternative energy systems in the United States, viewed through the lens of energy transition theory against the backdrop of national and state energy policies and regulatory frameworks.

Empirical Data Gathering (On-site)

Structured interviews served to gather primary, empirical data: residential energy production and consumption in each ecovillage, and energy storage methods. The empirical research measured actual energy consumption and production in each Ecovillage using British thermal units (BTUs) as a measurement unit. The selection of these measurements is due to the potential availability of the data - in both the ecovillages of study and surrounding communities - as well as the feasibility of gathering this information in the limited time period available.

With regards to EVI, empirical data was taken from resident Francis Vanek, who tracked both natural gas and electricity use (the only two sources of fuel) for the year 2010. More about this process can be found in Appendix B. The production data was generated by totaling the size and number of solar panels in the neighborhood, and using PV Watts 2 (an estimator of solar production based on yearly averages of hourly thermostatic data developed by the National Renewable Energy Laboratory (NREL, 2012) (See Appendix C). Storage data was gathered through interview with resident Jeff Gilmore.[6]

At Twin Oaks, empirical data was provided by the community in the form of yearly electrical and liquid propane gas (LPG) bills. Estimates were made with forestry managers for wood production, while all solar power has been tracked through a metering system (Appendix D).

Interviews and Participant Observation

Once the empirical performance of each ecovillage was determined, interviews were conducted with residents to learn about the institutions within each community, the replicability of the successes of the community, and the ways in which residents see the regime as able to facilitate further transition.

[6] All measurements in ft^2 have not been converted to m2 because they are used for comparative purposes and it was thus deemed unnecessary. As a reference, 1 m^2 equals 10.76 ft^2.

Unstructured interviews were performed with members of the two ecovillages who are considered 'experts' in the field of energy. These experts were determined through recommendations of hosting and visit coordinators, who have extensive knowledge of the communities. After these recommendations, a 'snowball' method was utilized to find others recommended by the initial interviewees.

The study period involved time spent in each ecovillage, during which participant observation was also used. In order to further understand the institutional dynamics involved in the development of the energy systems in each ecovillage, it was critical to experience (as much as possible) life in those villages. This included participation in everyday activities such as work, meals, and social activities (participant observation). The participation in such activities also lent the opportunity to have casual conversations, some of which were relevant to the study at hand (unstructured interviews). The use of these techniques also helped strengthen more structured interviews by giving more legitimacy to the interviewer, and leading to further acceptance of the researcher by the communities.

Selection of Ecovillages

The decision to study Ecovillage Ithaca and Twin Oaks was made due to several factors, including the use of decentralized generation and reduced consumption techniques in each community, the ability to gather historical data for analysis, each community's location, accessibility, and willingness to accept visitors, and the financial implications for the researcher regarding travel and housing. It was decided that two villages would provide enough data for the purposes of the study, while still allowing enough time to 'live' in each community for a period.

Study period

The overall study period for this research was from April through July, 2012. The literary review of this study was performed during April and early May of 2012. The stay at Ecovillage Ithaca consisted of one week's stay, from May 8th through May 15th, 2012. The stay at Twin Oaks Community consisted of three weeks' stay, from May 18th through June 7th, 2012. The analysis of results and completion of the thesis was from June 8th through July 15th, 2012.

4. Results

4.1 Ecovillage Ithaca's Residential Energy

EVI Residential Consumption

Ecovillage Ithaca has a residential energy mix which consists of natural gas and electricity (Interviewee 2). This is in contrast to the surrounding county, state, and region, which all rely on other fossil fuel sources as well.. At EVI, use of natural gas is primarily for space and water heating, while electricity is used mostly for lighting and appliances (*Ibid*). The electricity and natural gas purchased by EVI is provided by the utility NYSEG. The electricity fuel mix of Tompkins county is shown in Figure 10 to give an estimate of the fuel sources used to provide EVI with electricity.

EVI Residential Energy Fuel Mix Compared with Surrounding Regions

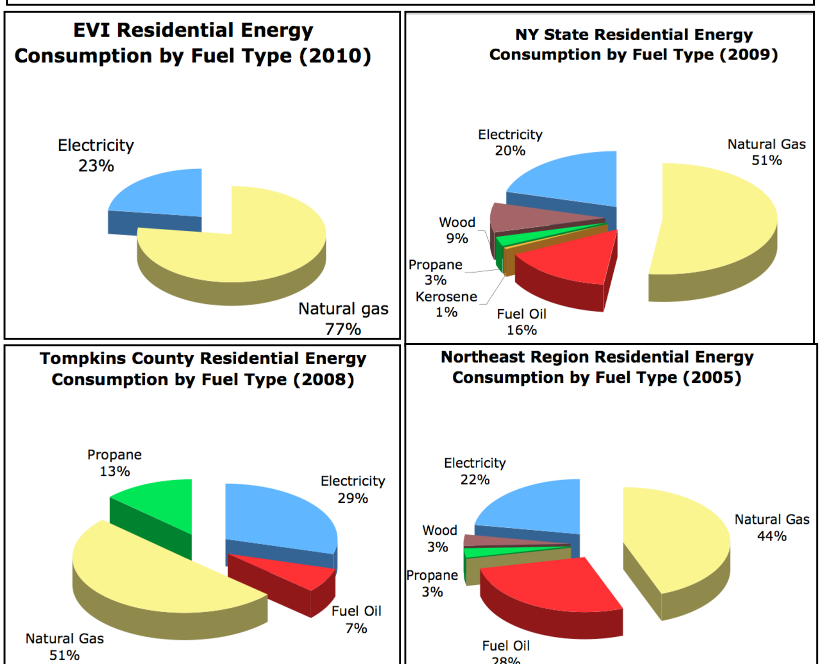


Figure 5: Shown above are the residential fuel mixes of all four regions studied. Source (in clockwise order from top-left): Vanek, personal communication, May 17, 2012; NYSERDA, 2011; TCPD,

Tompkins County Electricity Fuel Mix (2009)

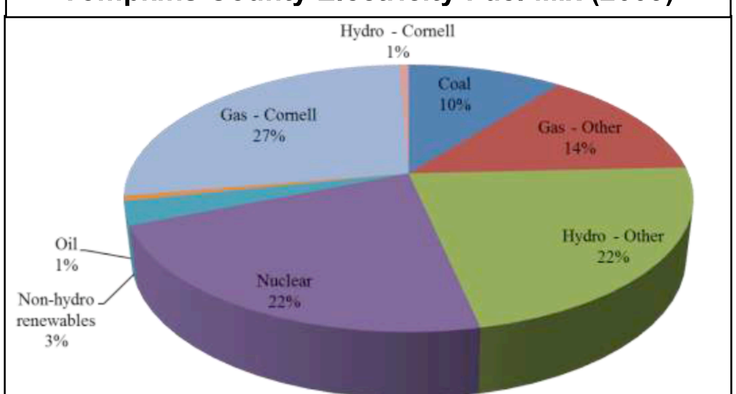


Figure 6: Estimates which fuel sources are used to produce the electricity in Tompkins County (data for EVI specifically was not known). Source: Nicklaus, 2012

Resident Francis Vanek has recently begun tracking residential energy consumption data. His results for 2010 are compared with the surrounding areas of Tompkins County, New York State, and the Northeast region in Figure 7. EVI uses somewhere between 30% and 60% less energy than surrounding areas, depending on which measurement is used, and to which area EVI is compared.

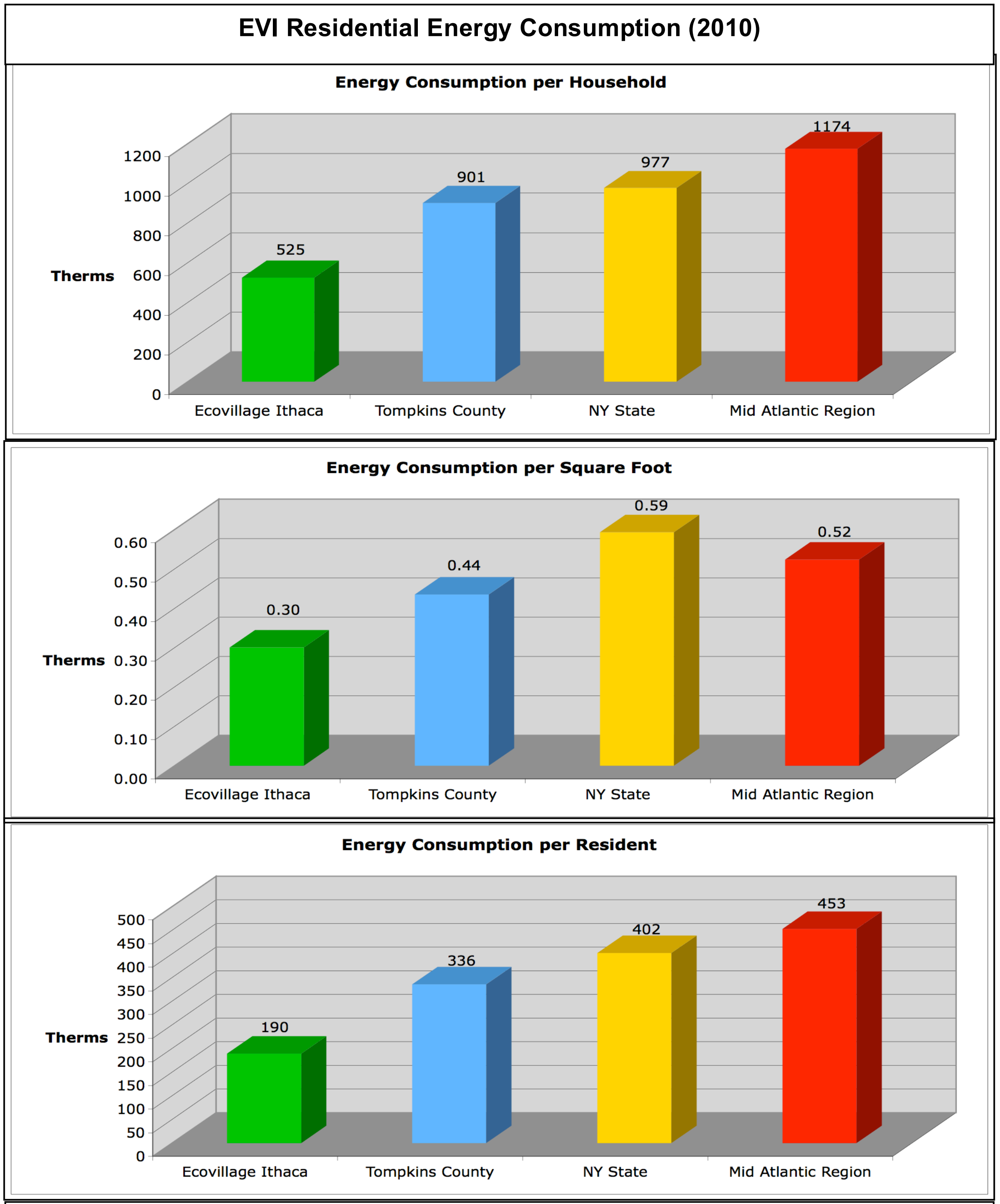


Figure 7: Residential energy consumption per household, square foot, and resident in EVI, Tompkins County, NY State, and the Mid-Atlantic Region. *The data have been adjusted for heating and cooling degree days, since the years in which data was gathered are inconsistent. For a more detailed description of calculation and assumption, see Appendix B. Sources: Correspondence with resident Francis Vanek, 2012; TCPD 2010; NYSERDA, 2011; EIA, 2007.

EVI Residential Production

Solar Arrays:

EVI generates significantly more decentralized electricity than surrounding areas - whose residential production is negligible (USDOE, 2007). The neighborhood of FROG has recently installed a 50 KW, ground-mounted, battery-less and grid-tied electric solar array. Resident Jeff Gilmore also created a way to track the energy production of this array, which has been installed since late December of 2011. According to these numbers, the array has produced approximately 63% of the electricity consumed by the FROG neighborhood (Interviewee 3). It is estimated that the arrays will generate approximately 57,000 KWH of electricity per year (See Appendix C).

The FROG common house also has a 6KW array on the rooftop, which can be estimated to produce approximately 6,777 KWH per year. This system is grid tied but also includes a battery system, which was installed due to residents' concerns of emergency preparedness (EVI, 2012). More on this system will be described in Chapter 4.1.

In the second neighborhood, SONG, 14 out of 30 houses have solar panels installed on their roofs. The panels are 140 W each, and total 224 for the entire neighborhood. The total generation estimate of this neighborhood is approximately 35,700 KWH per year (See Appendix D).

The total electricity production and consumption of the entire village has been estimated in Figure 8. It shows that approximately 47 % of electricity consumed in the village is produced by their solar panels.

EVI Residential Energy Consumption (2010)

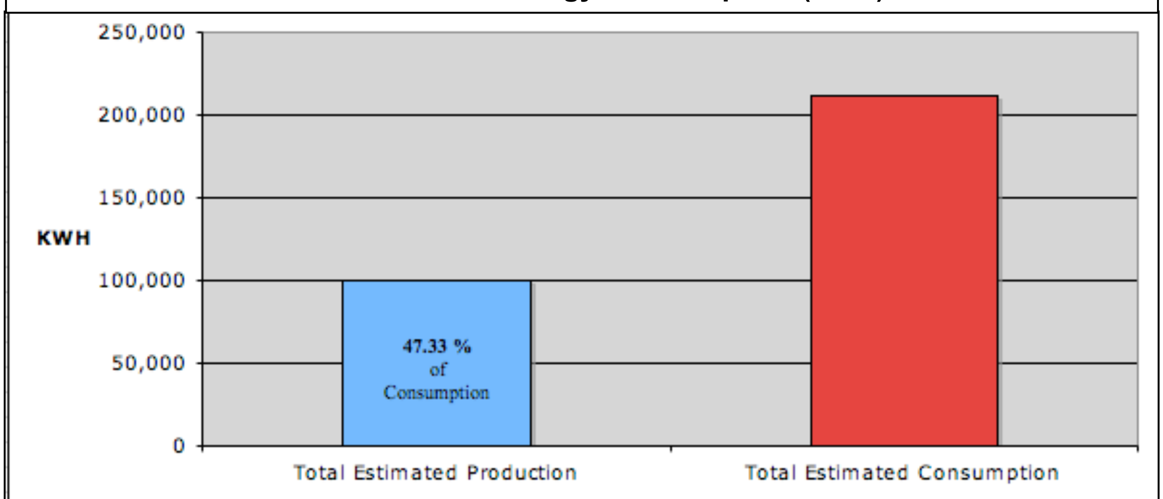


Figure 8: Source: Vanek, T., personal communication; NREL, 2012 (PV Watts 2 estimates).

Solar Thermal:

The neighborhood of SONG has two houses who installed solar hot water heaters. Their estimated combined production is approximately 17 million BTUs (170 Therms) per year (Interviewee 2). While the overall savings contributed to EVI's natural gas consumption is small (less than 1%), these solar heaters reduce the need for the use of natural gas to heat water for the two homes in which they are installed.

EVI Residential Energy Storage

At EVI, the FROG common house has a 6KW solar array on its roof, which is grid tied but also powers an emergency battery system. The system consists of 8, 225 Amp MK 8G8D batteries. According to EVI energy expert Jeff Gilmore, the system could provide emergency power to the village for 1-3 days, depending on the time of year and the electricity load drawn from the batteries (Interviewee 3). Thus, while this system could provide short-term emergency power, it is not equipped to allow the community to subsist without connection to the centralized electrical grid.

EVI Overall

Residents at EVI consume approximately 46% less energy per person than the NY state average, and the community produces approximately 11% of the energy it consumes. The electricity production at EVI is mostly decentralized generation from grid tied solar panels, and is noteworthy because the investment was provided by the community itself (Interviewee 3). The graph below shows the total estimated production of energy in EVI, as compared to consumption for the year 2010.

EVI Residential Energy (2010)

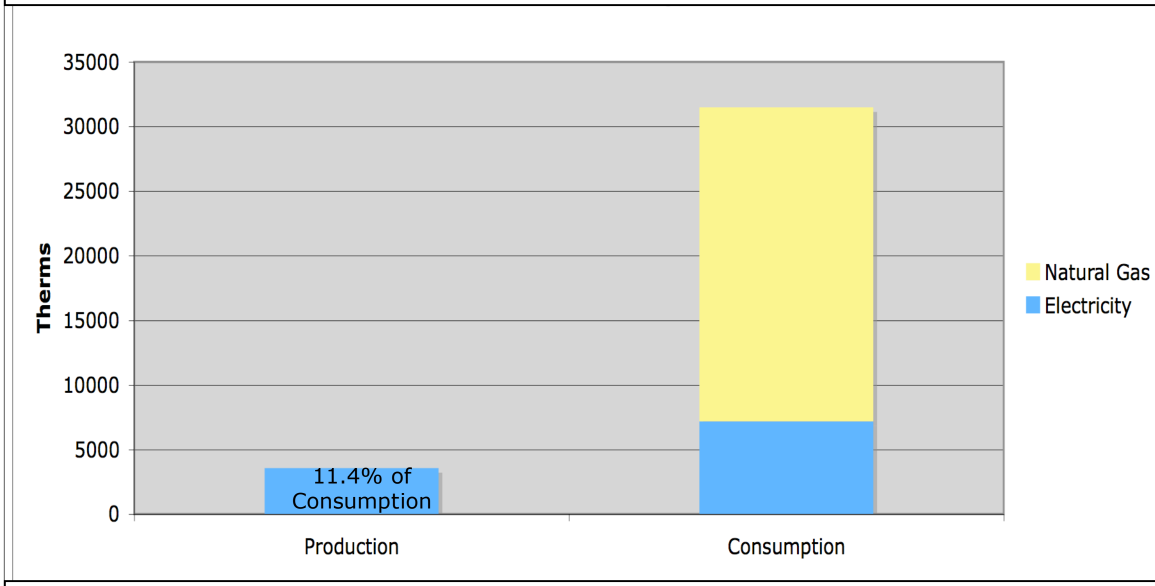


Figure 9: Source: Vanek, T., and Gilmore, J., personal communication; NREL, 2012 (PV Watts 2 estimates).

4.2 Twin Oaks Residential Energy

Twin Oaks Residential Consumption

Twin Oaks community uses wood, electricity, and LPG to supply energy needs to its residents. Virginia State and the South Atlantic region also use natural gas, kerosene, and fuel oil in their residential mix. Figures (X-Z) show the percentage of residential energy by source for each area. Twin Oaks uses large amounts of wood - all of which is gathered from the property - for space heating in its residential buildings (Interviewee 4). LPG is used for the gas stoves in residential kitchens and for hot water heating. Electricity is generally used for lighting and appliances, but also for heating hot water in some residential buildings (*Ibid*). The electricity and propane consumed by Twin Oaks is provided by a local distribution cooperative – Rappahannock Electricity Cooperative. Rappahannock purchases this electricity from Old Dominion Electricity Cooperative (ODEC), whose electricity fuel mix is shown in Figure 13.

Residential Fuel Mix of Twin Oaks and Surrounding Regions

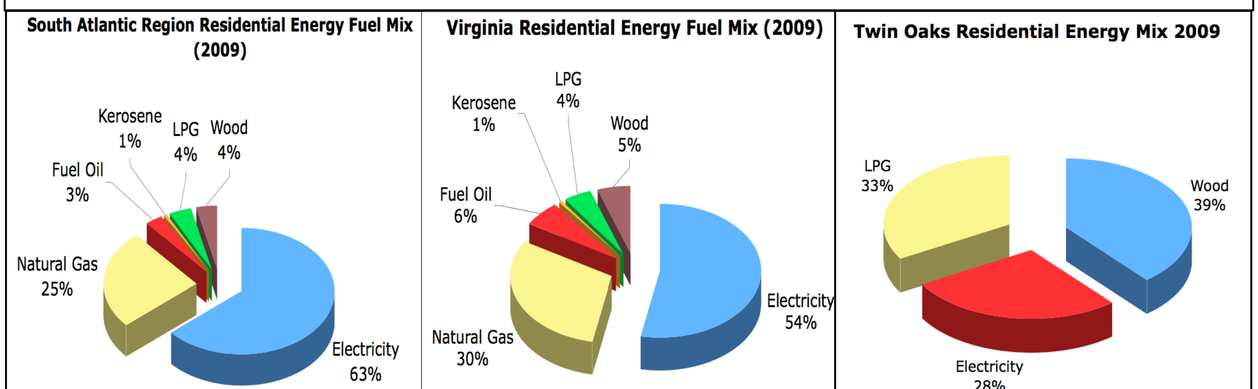


Figure 10: Residential energy mix of Twin Oaks and surrounding areas. Note: County data not available. Source: Pers Comm, Calvin, REC 2009.

ODEC and Virginia State Fuel Mix (2011)

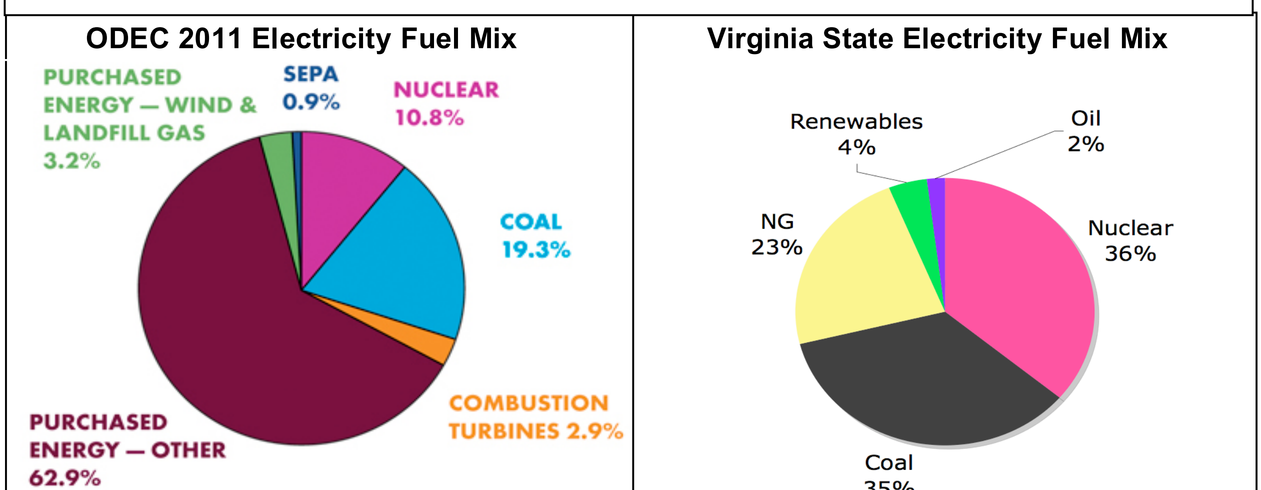
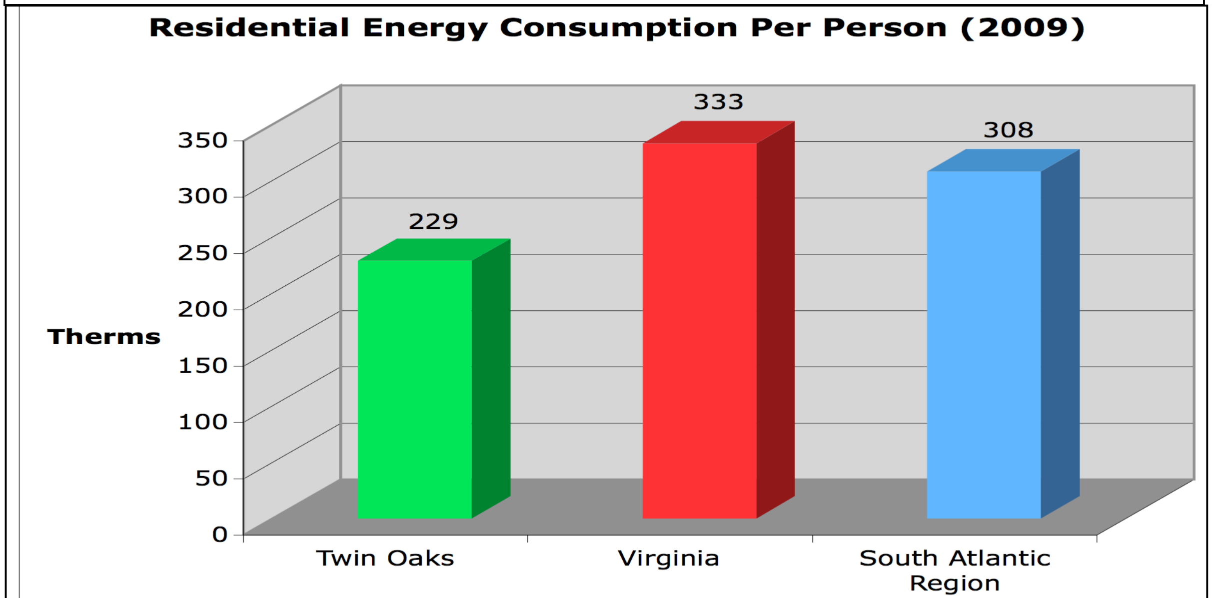


Figure 11: Shows the fuel mix used by ODEC to provide electricity to its customers (who include, indirectly, Twin Oaks). Note that information about the electrcitiy purchased by ODEC was not available, so the State of Virginia electricity fuel mix, representing a rough estimate of the fuel mix purchased by ODEC, is shown in the pie chart to the right. Sources (left to right): Rappahannock Electric Cooperative, 2012; GEA, 2012, adapted from U.S. Department of Energy, Energy Information Administration, Power Plant Report (EIA-920), Combined Heat and Power Plant Report (EIA-920), and Electric Power Monthly (2006 Preliminary).

The overall residential energy use per resident at Twin Oaks is considerably lower than surrounding regions - approximately 31% less than Virginia and 26% less than the South Atlantic Region. However, by area (square foot) TO uses almost 75% more energy than the State of Virginia. These data will be interpreted and analyzed further in Chapter 5.

Twin Oaks Residential Energy Consumption (2009)



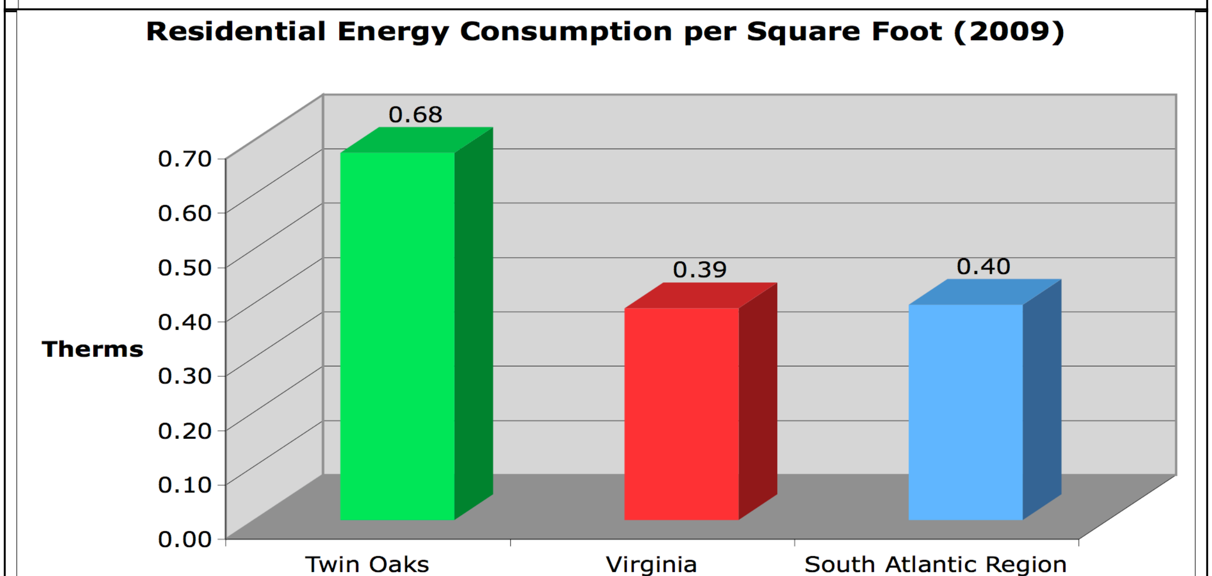


Figure 12: Residential Energy Consumption at Twin Oaks per person, and per square foot. Measurements in therms. 1 therm = 100,000 BTUs.

Twin Oaks Energy Production

Twin Oaks produces residential energy through solar arrays, solar thermal hot-water heaters, and through the harvesting of wood from the property (Interviewee 5). Each of these production methods will be explained below.

Solar Arrays:

TO has two solar panel arrays on the property. The first is a 10.8 KW grid-tied system, installed in 2010, which generates approximately 16,000 kWh of AC electricity per year. This production is tracked through a net-metering system which allows the community to subtract the kWh produced from the panels from their final bill (similar to the system in use at EVI). The second is an independent 750-watt system, which operates off the grid, and generates approximately 920 kWh of AC electricity each year. This system will be described in more detail in Chapter 5.2.

Twin Oaks Residential Electricity (2011)

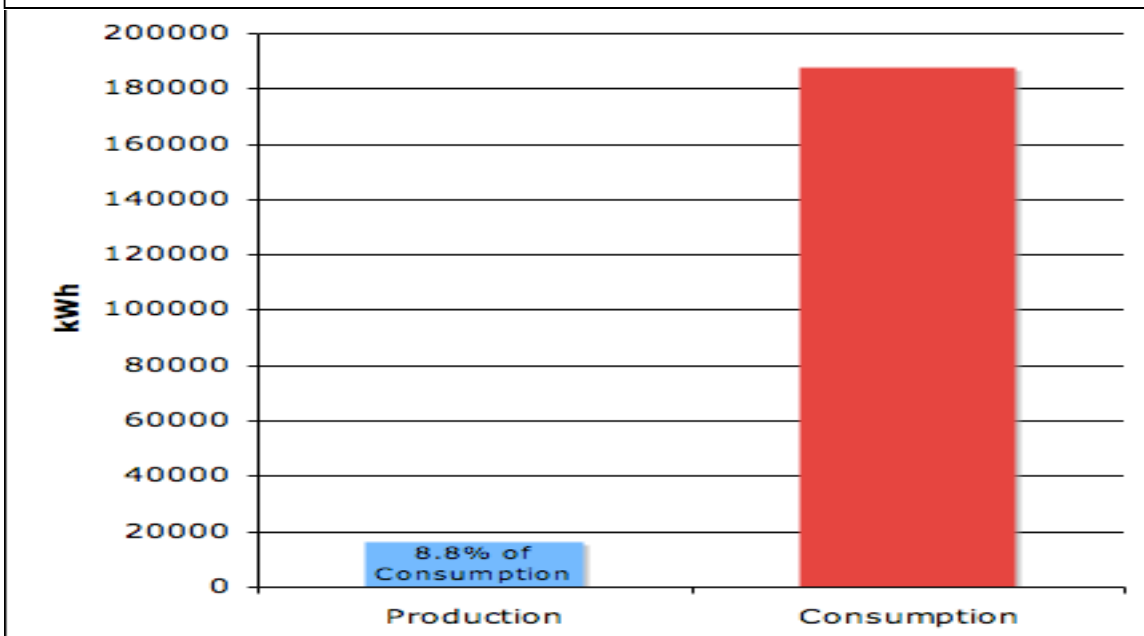


Figure 13: Sources: Personal communication; Community Data – see Appendix E, Appendix D

Solar Thermal:

While there are five solar thermal systems installed at Twin Oaks, only two of these are in operation due to failures caused by an earthquake, which occurred in Virginia in 2011 – the epicenter of which was only miles from TO (Interviewee 5). Due to the varying degrees of operability, efficiency, and size of these systems, as well as the difficulty in tracking the energy produced, they have been omitted from the quantitative analysis of TO. However, these systems deserve mention because they offer some residential energy production, and represent another effort of TO to live more sustainably.

Wood:

All wood consumed for residential energy at TO is harvested from the community's property. Thus, all 9000 Therms of residential energy (approximately 45 cords) consumed yearly by the residences of TO are produced within the community. This practice is sustainable because the forestry team harvests trees at a pace slower than the regrowth rate of the forest. In fact, only "dying, standing dead, or fallen dead trees are harvested" (Interviewee 6).

Twin Oaks Residential Energy Storage

As mentioned previously, TO has one system of electrical storage. This 750-watt solar array works in conjunction with 16 batteries with a capacity of 220 amp-hours each – leaving a total capacity of 3520 amp hours. The system generates approximately 920 kWh per year, all of which is used in one half of the residential building named Kaweah. In the solar half of Kaweah, called Sunrise, residents use only the electricity generated from these panels (although they still share a kitchen and laundry facility with the other half of the building, powered by utility provided electricity). This requires residents in Sunrise to use electricity extremely frugally to meet their self-imposed electricity restrictions (Interviewee 4).

This storage system uses proven battery technology and therefore does not represent a cutting-edge or revolutionary approach to storing electricity. However, what must be noted are the lifestyle changes required from residents in order to live with such low electricity consumption, and the notable effort this particular residence has made to live off the electricity grid.

Twin Oaks Overall

Twin Oaks consumes approximately 31% less residential energy per resident than the surrounding state of Virginia, and the community produces approximately 41 % of all energy that it consumes in a given year. Due to the limited nature of this residential study, the effects of TO's true sustainability are likely underestimated. Because people work and live in the same location in TO, their commercial, industrial, transportation, waste, and water usage energy requirements are probably even lower than broader society (Interviewee 7).

Twin Oaks Residential Energy (2011)

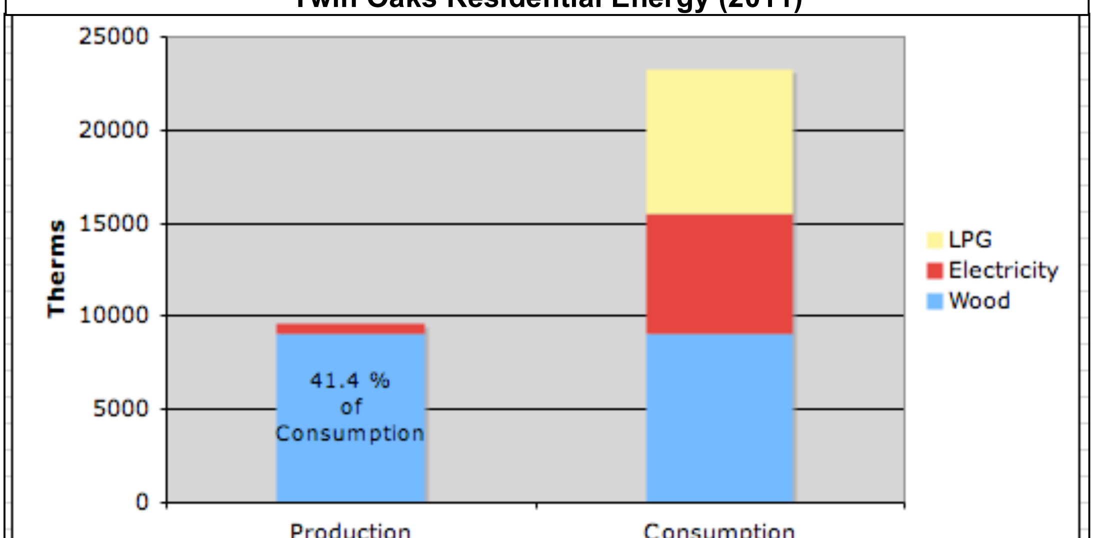


Figure 14: Sources: Personal communication; Community Data – see Appendix E, Appendix D

5. Discussion of Empirical Results

This section will discuss the results obtained from the empirical data at EVI and TO. It will make some interpretations of the data in order to establish an analytical base for the qualitative analysis, which will be detailed in chapters 6 and 7.

5.1 Ecovillage Ithaca

The results of the empirical data suggest that EVI's residential energy system is more sustainable than those of surrounding areas. This can be seen through their significantly reduced consumption and their production of renewable electricity using solar arrays.

Residential Consumption

EVI's reduced consumption comes from both behavioral change and from built form improvements (these topics were discussed at length with residents of EVI, and will be covered in more detail later in the report).

When comparing the historical results reported by Brown in a 2004 study of EVI's energy consumption with the results obtained in this study, it can be seen that EVI has reduced its consumption significantly in the past 10 years (Brown, 2004; See Table 1). This is to be expected, as the Brown study was performed before the construction of the second neighborhood (SONG), which has included more built form improvements (Interviewee 2).

Ecovillage Ithaca Consumption: Past/ Present

	Per Household	Per Resident	Per Square Foot
97-02 Average (Therms)	690	270	0.51
2010 (Therms)	525	190	0.30
Percent Improvement	23.9%	29.7%	41.1%

Table 1: Source: Interviewee 2; Brown 2004[1]

The reduction in consumption per square foot generally represents built form improvements which increase energy efficiency (Interviewee 2; Brown 2004). The consumption per household and resident has reduced as well; this suggests that there have probably been simultaneous behavioral changes resulting in consumption reduction.

When comparing EVI historical data to NY State averages, it can be seen that while NY residents have actually decreased their per capita residential energy consumption each year, EVI has done so at a faster rate (EIA, 2010; Brown, 2004). This suggests that EVI is a leader in their residential energy system development, and that they have many lessons to offer broader society with regards to consumption reduction.

Percent Less Consumption at EVI Than Surrounding Areas (2010)

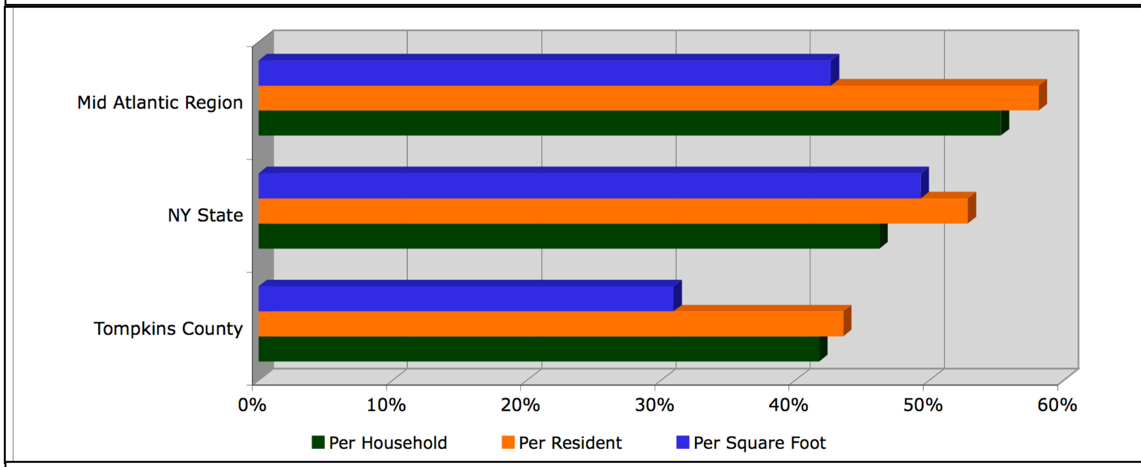


Figure 15. Source: EVI Resident data; NYSERDA, 2011; TCPD, 2010; EIA, 2007. This graph compares EVI's consumption to the regions identified on the X-axis. The bars represent the percentage less that EVI consumed as compared to each region.

Residential Production

EVI produces 100,000 kWh of electricity each year from its solar arrays. As there were very few solar panels installed during the years of Brown's study, almost all of this production has been installed in the past 8 years (Interviewee 2). This speaks to the community's commitment to creating decentralized energy generation through renewable technologies.

All surrounding areas have negligible or no energy being generated by residential users (some wood, and very small amounts of solar and wind) (EIA, 2010). This suggests that EVI is leading the way with regards to solar investment and decentralized generation.

Built Form and Behavioral Change

There is debate from those who have studied EVI energy consumption as to whether built form or behavioral change contribute more towards energy consumption reductions within the community (Mulder et al, 2005; Brown, 2004). It is extremely difficult to isolate these variables, especially considering that the institutions which support reduced consumption habits also allow for built form improvements within the neighborhood. These areas often overlap – for instance, the shared water heaters, which are a built form contribution enabled by the social construct of sharing within the community, or the investment in the FROG solar panels, which is a built form improvement facilitated by social behavioral change within the village.

Built Form:

The houses in EVI all have passive solar heating (south facing windows), super-insulation, a compact design (less square footage), and every house shares at least one wall with a neighbor (Walker, 2005). The solar windows provide heat gains from the sun in the winter, and feature trellises to block heat during the winter (the angle of the sun was carefully considered so that the sunlight would heat the home in the colder months, but not the warmer months when the sun's angle is higher in the sky) (Interviewee 8).

Each house features 6-7 inches (15-18 cm) of insulation between a double-walled structure in order to provide maximum energy storage and thus increase efficiencies

(Brown, 2004). In addition, the windows are all triple-pained glass to reduce heat transfer.

The duplex systems, each consisting of 3-4 housing units, reduce energy consumption compared to single-unit homes. This is because the shared walls reduce the surface area to volume ratio (Brown, 2004). Stated more simply, there is less heat lost through the shared walls, which act as insulation for one another. In the first neighborhood built, FROG, each group of houses also shares an energy center to take advantage of the economies of scale.

The houses are considerably smaller than the average home in the United States, allowing for efficient energy use (*Ibid*). The average square footage of a home at EVI is approximately 1500 ft^2 per resident, including the shared common houses. This is 57% less than the Northeast region average of 2,613 ft^2. (US Census Bureau, 2011; Interviewee 2).

EVI Neighborhood Energy

	FROG (1996-1997)	SONG (2002-2004)	TREE (2012-2013)
Type of design	Standardized, 5 house types, 3 accessible units	4 house types with major customized elements, 1 unit retrofitted for accessibility.	Standardized, 3 apartment sizes, 4 home sizes. Accessibility emphasized.
Building materials	Double wall, stick-built	SIPS, straw-bale	Double wall, stick-built
Insulation	Blown in cellulose, R-30 walls	SIPS or straw-bale	Cellulose & closed cell foam, R-60 walls
Heating system	Passive solar, district heating, hydronic air handlers	Passive solar, Mini water-heater shared between duplexes, radiant floors	Passiv Haus with solar hot water, electric baseboard back-up
Renewable Energy	Neighborhood 50 KW PV ground-mounted system serves 30 homes	14 homes with PVs, 4 homes w. solar hot water	30-40 homes with PVs & solar hot water.

Table 2: This table summarized the built form technologies of each neighborhood, including the TREE neighborhood (still in planning stages). Source: Walker, 2012.

Behavioral Change:

There are significant contributions to consumption reduction at EVI through sharing programs and consumption awareness by residents (Interviewee 3; Brown, 2004). This includes the sharing of neighborhood items, such as the common houses (which replace individual dining rooms), lawnmowers, tools, hot water heaters (joined between two houses), and even solar panels (the production from the 50KW array and 6KW common house array are shared).

An interview with one energy expert at EVI articulately summed up the opinion of many of the EVI residents interviewed:

“Sharing feels right to me, I find it really satisfying… How much it affects our environmental footprint is not as clear – but probably quite a bit” (Interviewee 3).

5.2 Twin Oaks

It can be seen from the empirical data gathered that TO is living more sustainably than surrounding areas with regards to their residential energy system - due mostly to their significantly reduced consumption and high levels of energy production. Data suggests that most of these accomplishments can be attributed to behavioral change, rather than built form.

Residential Consumption

Twin Oaks' residential energy consumption per resident is considerably less than surrounding areas. Less anticipated was the fact that Twin Oaks consumes 74% more energy per square foot than the State of Virginia average. This can be explained by the lack of built form improvements in the residences at Twin Oaks, and the use of wood as the sole means of space heating (Interviewee 5). The houses at Twin Oaks were built by the residents, some with little or no insulation – causing increased energy loss. Wood is an easy source of energy for Twin Oaks, but is relatively inefficient since the community utilizes traditional wood heaters (approximately 55%- 80% efficiency). Thus, burning wood requires more BTUs to heat the same space as compared to other space heating methods, like 100% efficient electrical space heaters (Stelzer, 2012).

The numbers at Twin Oaks reveal that nearly all residential consumption reductions come from behavioral change, since built form is actually increasing energy use compared to conventional housing, rather than reducing it (Interviewee 7). The fact that TO has reduced their energy consumption so much while still using inefficient buildings proves the extent to which behavioral change can drastically reduce consumption. However, it also makes the replication of this energy system much more difficult in broader society because historically, behavioral change has proven much more difficult to initiate than built form efficiency gains (more in Chapter 7.3) (Brown, 2004).

Residential Production

TO produces about 41% of the energy which they consume each year. The production of about 16,000 kWh of electricity from the 10.8GW solar array is a part of the total, but the majority of production comes from the sustainable harvesting of wood for space heating. The contribution of the solar panels highlights the community's commitment to decentralized generation, considering that TO did not get federal rebates when investing in the array. TO received approximately 20% of the investment from the State of Virginia, but since they do not pay federal income tax, there was no tax credit available from the national government (Interviewee 5). The installation of the 750-watt system, which powers half of Kaweah, shows that residents are becoming increasingly concerned about their residential energy production and consumption.

There are environmental and health concerns associated with wood burning, and it is unclear whether using this form of space heating is actually 'greener' than its alternatives (Level, 2012; Maron, 2011). However, considering the sparse population in the area surrounding TO, airborne pollutants from burning wood did not concern residents, who often highlighted the sustainable way in which it is harvested (Interviewee 6).

Built Form and Behavioral Change

As mentioned earlier, the bulk of energy savings at Twin Oaks comes from behavioral change leading to reduced energy consumption. Much of the production is facilitated by the site planning of the community, which allows for undisturbed forest on much of the property, from which the wood is harvested. This opportunity is available to Twin Oaks both because of their choice to live in small living groups (group housing), and because the community was able to purchase a (relatively) large plot of land. Recently constructed residences do have built form improvements incorporated into their design – including super insulation and passive solar heating. As older residences are modified and/or rebuilt, this should bring down the consumption per square foot within the community, assuming that more built form improvements are included.

Many residents expressed the opinion that behavioral change was the biggest adaptation that Twin Oaks made, and that this contributed most to their energy reductions (Interviewee 9).

> "When it comes to energy reductions, the most radical things we are doing include living with less personal space, and sharing things" (Interviewee 5).

The motivation to increase energy efficiency was low for some TO residents interviewed, due mostly to the inexpensive cost of space heating with wood. The cost of the investment in increased built form efficiencies was therefore, according to some residents, difficult to justify financially.

> "We could make housing investments to lower consumption, but wood is incredibly cheap. We already use less wood than we are able to harvest from dead or dying trees" (Interviewee 7).

6. Analysis of EVI through Resident Interviews/ Participant Observation

6.1 EVI Institutions

This section will briefly describe the institutions of EVI, and describe EVI residents' responses to unstructured interviews about the way EVI institutions have enabled or hindered improvements in the EVI residential energy system.[7]

Governance

Overview:

There is no hierarchical ruling structure at EVI, unlike contemporary society, except for legal proceedings, which require the election of a President, Vice President, and Secretary for the Cooperative and Non-profit organizations. All major decisions take place by consensus within the community. However, EVI has in place an 'adapted consensus' model, in which a 75% supermajority can pass an issue despite having opposition. While this is seldom used, it does allow for more flexibility than a purely consensus model (Walker, 2012).

Interview/Participant Observation Findings:

The political structure at EVI is very unique, and residents had strong and often contrasting opinions about the consensus process (Wight, 2008; personal communication). The consensus process was seen by some as the 'tyranny of the minority' which inhibits EVI from its experimental goals by allowing those opposed to certain technologies or building approaches to prevent the village from constructing them.

> "The consensus process is complicated, and inefficient. It's better to keep things simple" (Interviewee 10).

However, others saw the consensus process as allowing input from all members, and thus increasing the viability, community acceptance, and ultimately the overall success of all projects (Interviewee 3; Interviewee 11). Thus, there were contrasting opinions among residents about whether the institutions of governance at EVI helped or hindered the energy system development.

Social/Proprietary

Overview:

Many things are shared among the EVI community which are individually owned in contemporary society - including land, lawnmowers, ladders, and other commonly used items. Despite this sharing, the community operates predominantly within a private property system. Each house is a private space, with most residents earning private income, owning private cars, and purchasing private commodities (except community meals, which are held several times per week).

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[7] This section aims to present a balanced representation of differing opinions encountered throughout the community – it is not a comprehensive account of all opinions expressed, which were diverse and often not cohesive among residents.

The houses of EVI all open onto a central walkway to increase interaction between residents. Common houses are present for each neighborhood, where common meals are held twice per week, and shared laundry facilities are present. Community projects are completed through a voluntary work team system, in which community members volunteer for the work in which they are most interested or skilled (Walker, 2005). While there is no requirement for community work, it is recommended that each village member contribute 2-4 hours of voluntary work per week (Holleman, 2011).

Interview/Participant Observation Findings:

Social and proprietary constructs within EVI influence the interaction of the residents and their ability to reduce consumption. A struggle mentioned within the village, which is also seen in broader society, was the conflict between individual and community (Interviewee 11). This is a balance which has caused some tensions within EVI. This is reflected through the differences between the two neighborhoods: FROG, the first village built, is more communal in its energy production and consumption, and also in its overall structure; while SONG, the second neighborhood, allows for individual investments with regards to energy production and the building of houses in general (Interviewee 3). Regardless of the level of social cohesion among each neighborhood, the overall social cohesion at EVI greatly effects their ability to both reduce consumption and produce energy.

Reduced Consumption:

It was argued that the built form successes of EVI can be attributed to the social interactions and cohesion formed within the community, but also suggested that these built form contributions can be accomplished without the arduous social bonding that was required for the formation of EVI (Interviewee 11; Interviewee 10). Some residents saw social cohesion as essential for the formation of both neighborhoods – requiring hours of decision-making and meetings in order to organize all investors simultaneously. During this arduous process, many investors dropped out, and for some time it looked as though the formation of the first neighborhood would fail (Interviewee 11). However, as a result of the social interaction throughout this process (or in spite of it - depending on who you ask), the neighborhood was constructed (Interviewee 11).

With regards to consumptive habits, much of the reduction in consumption was attributed to the social and proprietary institutions of EVI. The sharing programs within EVI were seen as dependent upon social cohesion, but how much these programs actually reduced consumption was less clear to those interviewed (Interviewee 12). While the contribution of sharing to reduced consumption is difficult to determine, there was a perception among some in the community that it contributes significantly:

> "We rideshare about 2-3 rides per day via email. The communal meals occur 3 times per week, and have about 50% attendance. There is only one person shopping, 3 stoves instead of all those individual stoves, and group dishwashing. Having this kind of life reduces our footprint" (*Ibid*).

Others felt that a significant part of EVI's energy reductions stems from the ecovillage naturally attracting already environmentally conscious residents to join. This line of reasoning suggests that EVI residents are more energy conscious than average residents in Tompkins County, and thus that the social cohesion within the village impacts the RES less than it may seem (Interviewee 12).

The communal ownership of some items and spaces, including the common houses, was thought to reduce consumption because it reduced the amount of space 'needed' within each residence (Interviewee 11).

Production:

The communal investment in the 50KW array in FROG village was linked to the social institutions within the village (Interviewee 3). According to one resident,

> "Social cohesion was necessary for the solar project to be possible. It involved people trusting each other with large amounts of money" (Interviewee 12).

This trust came not only from the community - to accept the terms of the individual investors from within the community fronting the capital for the project - but also from the investors themselves, who trust that all individuals within the neighborhood will pay back the $21 a month required to finance the loan (Interviewee 3). Furthermore, the social cohesion allowed for the construction of the 6KW array on top of the FROG common house. Equally important is the trust placed in those who organize the bills and divide the payments and energy savings among the residents (Interviewee 11).

EVI provides an example of how two neighborhoods with different approaches to residential energy system transition can both be successful: the more individually driven approach used by SONG – in which each resident privately invests in decentralized generation and thus privately receives all energy production benefits (compensation from utility company, tax credits, etc), and the more communal approach used by FROG - in which benefits are divided among the neighborhood equally (Interviewee 3).

Internal Economics

Overview:

Incomes are not shared at EVI, and most residents support themselves through work done outside the community (mainly in the nearby city of Ithaca). 45% of residents work from EVI - either remotely from computer, or with community farms or businesses - or are retired (EVI, 2010). In general, the community consists of middle to upper-class individuals, a fact that has lead to criticism of EVI from surrounding communities (Interviewee 10). Despite this, there is some variability of wealth within the community, which has lead to complications and tensions about how to handle these inequities (Holleman, 2011).

Interview/Participant Observation Findings:

Reduced Consumption:

Some EVI residents suggested that the financial status of EVI residents played a large part in their ability to create built form energy efficiencies. In order to design built form improvements within the residences at EVI, the up-front costs were considerable in terms of time and money. This stemmed from both the increased material (for instance, super insulation and double-pained windows), and from the need to hire a developer to custom-build the homes (Interviewee 11). Having the financial ability to make the upfront payments, and the need for a coordinated effort of individuals to self-finance down payments together all at the same time (rather than incrementally, as traditional neighborhoods develop), made the comfortable financial status of the individuals involved with the formation of this community a necessity (Interviewee 10). This problem was compounded due to the difficulty of obtaining loans or outside financing from banks and lending institutions (*Ibid*).

With regards to social cohesion and reduced consumption practices, finances also played a large role. A lack of disposable income caused some residents to resist projects which involve financial investment (Kirby, 2003). Some residents felt that this resistance hampered the achievement of EVI's mission as an experimental community, while others encouraged the development of opportunities for lower-income families to join the community (including the formation of cheaper homes in the new TREE neighborhood) (Interviewee 10; Interviewee 11). Some residents argued that increased financial inequality could inhibit the development of social cohesion.

Production:

The availability of capital has enabled EVI to invest in decentralized generation technologies (Interviewee 10).The ability to invest in solar panel arrays was aided by the financial and economic status of the community. The 50KW array was funded by 10 private investors from within the community, all of whom had enough saved capital to invest, and were willing to accept a rate of return of 5% (Interviewee 3). Furthermore, the 6KW array on the FROG common house was paid for through contributions from all neighborhood residents, and the more than 30 KW of production capacity in the SONG neighborhood was all financed by individual investments (Interviewee 2). While the State of New York offers tax credits for these investments, and the production of electricity allows for the investment to be paid back, the payback time is long and the amount of up-front capital is intensive. One resident of SONG shared that his solar panels required up-front investment of $15,000 – although the state did offer $9,000 in credits after the purchase (*Ibid*).

6.2 Institutional Interaction with External Forces

This section will discuss residents' impressions of the interaction of EVI with the institutional structures that surround the community. This includes legal interactions with local, state, and federal government officials and regulations, and the economic environment on both the governmental and private level. ***The RES of EVI can be seen to interact extensively with both the government (through lobbying, regulatory challenges, etc.), and the private market (through the purchase of technologies).***

Legal (External Interactions)

Overview:

EVI is setup as a 501(c)(3) non-profit entity. The two neighborhoods within EVI are each cooperatives, and there is a separate non-profit that owns the roads, the pond, and other capital not including the land (which is owned by another non-profit entity) (Walker, 2012). When residents purchase a house at EVI, they do not actually own the house, but gain shares in the cooperative of the neighborhood instead. The complexity of the legal structure is necessary in order to protect the community from lawsuits, as well as circumvent many of the legal and regulatory frameworks which were major obstacles in the development of the community (Interviewee 10).

Interview/Participant Observation Results:

The legal framework for residential development is incredibly complicated in the United States due to a diverse and varying set of local, state, and national regulations and policies. This section will discuss the legal challenges faced by EVI during its inception and progression both with regards to energy consumption reduction and decentralized generation.

Reduced Consumption:

According to residents closely involved with the creation of EVI, the legal challenges to reduced consumption came mostly in the form of regulatory challenges to the built form of the neighborhoods. The zoning regulations were a significant challenge, because they restricted the high-density design of the FROG neighborhood (and thus, the resulting energy savings) during its inception (Interviewee 11). At the time, there were laws in place restricting the building of houses in such close proximity to one another in the area in which EVI was zoned. Since this high-density design violated local regulations requiring more space between houses, the inaugural citizens of EVI had to lobby the local authorities in order to get a zoning permit (*Ibid*). This involved great time and effort on the part of the founding members, many of whom devoted years to the process of the formation of the FROG neighborhood.

> “When we started with FROG in ’91, no one had heard of co-housing or ecovillages. These were wild, crazy ideas. We had to educate local authorities, and so it took a lot longer to get through the regulatory process. It took a year to get approval for the zoning of the neighborhood. Then we had the preliminary and final site plan approvals, during the process we had to prove to the planning and town boards that we were upstanding citizens, not tie-die hippies. So we lined up our kids and elders to show we were ‘ordinary’ citizens” (Interviewee 11).

After EVI became known locally and began to gain support from the planning board and local authorities, things became a bit easier.

> “The formation of the second neighborhood, SONG, was less difficult from that perspective” (*Ibid*).

However, this means that many communities throughout the country trying to establish high-density housing must battle local authorities, as well as state and national regulations. This requires time, effort and money to establish relationships with local planning boards, and unite a group of people together (Interviewee 10). More about how residents thought this process may be streamlined will be discussed in Chapter 6.4.

Production:

There were legal challenges associated with the installation and establishment of the 50 KW solar array relating to the metering classification of the neighborhood. Because the array generated power for many different families, the neighborhood had to switch to a commercial metering account, rather than the residential account they had previously (Interviewee 3). This increased the overall price the residents pay for energy, since the commercial accounts are charged higher fees for energy used during high-demand times (*Ibid*). Some states offer a multi-residential metering account which avoids this problem (*Ibid*). Other legal challenges included the lack of feed-in tariffs, and the lack of “virtual net metering” – these will be further explained in Chapter 6.4.

External Economics

The economic incentives provided by New York State and the United States Government for residential investment in energy reduction/efficiency, and energy production technologies will be discussed in this section. In addition, private market developments will be touched upon briefly.

New York State:

New York State offers financial incentives for both consumers and builders in the residential sector to invest in energy efficiency and renewable energy production technologies. These incentives include personal, corporate, sales and property tax incentives, rebates, low-interest loans, grants, and performance based incentives (DSIRE, 2012). This move is part of New York States' renewable portfolio standard, which aims to make 30% of electricity from renewable sources by 2015 (NYSERDA, 2012). New York State also offers financial incentives for investment in energy efficiency improvements. These include property tax credits, rebates, grants and loans on the State level, and loans and green building incentives on the local level (DSIRE, 2012a).

United States:

The US Government also offers many incentives for energy efficiency increases and renewables investment. This includes corporate deductions, depreciations, and exemptions for energy efficiency, federal grant and loan programs, and personal exemptions and tax credits. With regards to renewables, the federal government offers corporate tax credits, federal grants and loans, and personal tax credits (DSIRE, 2012b).

EVI used the financial incentives offered by both New York State and the Federal Government for investment in the 50 KW solar array. Specifically, the project took advantage of NYSERDA rebates, New York State tax credits, and Federal tax credits (See Table 3). The total incentive funding from government sources covered 66% of the total investment (Interviewee 3). It should be noted that the tax credits came afterward, and thus required an upfront investment from the community totaling $188, 552 (*Ibid*).

EVI 50KW Solar Array Investment Costs

Total Cost	$278,712
NYSERDA rebate	$90,160
Federal tax credits	51,355
State tax credits	42,796
Total Incentives	$184,311
Net Cost	$94,401

Table 3: The financial costs of the 50KW solar array, including government rebates and credits. Source: Gilmore, 2012.

The Environmental Protection Agency (EPA) has awarded EVI - in coordination with Tompkins County and the City of Ithaca - a grant of $375,450, with matching funds of $188,650 from County and partner organizations, as an investment in energy efficient neighborhoods (EVI, 2011). The grant will be spread over a period of three years, and will involve funding for empirical research, investigations into how to replicate the accomplishments of EVI consumption reductions elsewhere, and marketing and outreach funds to increase interest in surrounding areas for co-housing projects similar to EVI (Interviewee 11; Appendix F).

While the federal government lacks a coherent residential energy policy, there are many economic incentives at both the national and state level which are encouraging renewable generation, energy consumption reductions through efficiency, and the development of energy efficient neighborhoods. However, there are still many instances where local, state, and national regulatory policies inhibit residential energy system developments (Interviewee 10).

Private Market:

The prices of both energy efficiency and energy production technologies have decreased in recent years. According to residents at EVI, this has assisted communities in increasing their energy efficiency and production by making it more affordable for them to do so (Interviewee 3).

Energy Consumption:

The market for residential energy efficiency has been growing in recent years in the United States, driven by increased demand and reduced cost in technologies.
The energy efficient home improvement market is forecast to increase from $38.3 billion in 2009 to $50.2 billion by 2014 (Pike Research, 2010). This includes upgraded electrical systems, appliances and major equipment, HVAC systems, roofing replacements, and window/door replacements – encompassing most of the built form improvements seen at EVI. In past years, energy efficiency technologies lowered in cost, making them more feasible during the formation of the SONG neighborhood (Interviewee 2).

Energy Production:

The United States solar market has been booming, with a predicted 75% growth between 2011 and 2012 (Wang, 2012). This market growth has been fueled in part by a 50% decrease in the cost of solar panels during 2011 (ibid). While much of this growth can be attributed to large, centralized solar projects, the greatly reduced cost of panels, combined with government incentives, have made solar projects more affordable for small holders (ibid). Some residents credited the reduction in solar panel price as a significant factor in the communities' collective ability to invest in these DG technologies (Interviewee 3).[8]

6.3 Replicability

Built form improvements implemented at EVI (for both energy production, and consumption reduction) were seen as replicable by many residents. Meanwhile, the social, economic, and governmental institutions which allowed for communal investment and consumption reductions were seen as harder to replicate in broader society.

Consumption

Most residents expressed that built form contributions – including passive solar windows, high-density housing, super-insulation, double-paned windows – could be more easily replicated elsewhere than the behavioral changes which have enabled reduced

[8] While other renewable markets for production (including wind, microhydro, etc.) are also growing, they will not be included here because they were not in use by EVI.

consumption within the village (Interviewee 11; Interviewee 2). Some suggested that people in the 'mainstream' did not want to change their lifestyles by sharing common facilities and items, and making decisions communally, and that it would thus be easier to replicate built form improvements which require very little with regards to lifestyle adaptation (Interviewee 10). The institutions of EVI, while crucial to the village's development, were seen as difficult to replicate, mostly due to the time and energy they required from community members (*Ibid*). While many EVI residents enjoyed this aspect of living at EVI, they also seemed skeptical about its applicability in a broader context.

> "I don't think you have to have a large number of residents participate in the grueling process of design and development to help them reduce their energy consumption" (Interviewee 10).

In fact, residents suggested that many of the advantages offered by techniques such as passive solar heating and duplex design are being used increasingly in other homes throughout the United States (*Ibid*). Thus, while many at EVI felt that their institutions had increased community cohesion and overall happiness, most did not see these steps as necessary to replicate much of the energy savings and production that the community had achieved through built form improvements.

Production

The communal investments at EVI were seen as difficult to replicate by those involved closely with the projects (Interviewee 3). This is because of the trust and communal cohesion required for the group investments in the FROG neighborhood, and the difficulties in predicting the payback of the investment.

> "The solar project is not scaleable because outside forces make it more complex than necessary. For instance, NYSEG [the utility providing electricity to EVI] wouldn't tell us the details of the metering system and its implications for our investment until after we had decided to install it" (*Ibid*).

Residents saw the replication of decentralized production projects outside EVI as dependent upon the specific social and financial considerations of each specific community (Interviewee 13). Thus, it was suggested that while the system of communal investment worked at EVI, it would need to be adjusted significantly to work in broader society. Those involved in the community solar projects suggested that they could be replicated by utilizing the same investment model as EVI (a few investors loan the up-front capital for the system, and then those households receiving energy savings on their utility bills from the system pay the investors each month to recoup the loan). However, there were suggestions of attracting outside private investors (who would have to have trust in the community or households to repay the loans), or encouraging local government to make such investments (Interviewee 12; Interviewee 3).

Individual decentralized production investments made by the SONG neighborhood were seen as replicable as long as residents had enough private capital to purchase the solar arrays (Interviewee 2). The government rebates and tax credits were seen as vital to ensure the continuing replicability of these private investments. Meanwhile, it was recognized that despite government subsidies and recently lowered solar panel costs, the arrays were still prohibitively expensive to install for most income levels (*Ibid*).

Despite this, some residents saw the private investment model as more compatible and thus more easily scaleable to broader society than the communal investment.

6.4 Government assistance

This section will detail the responses of EVI residents asked about how the government could assist with replicating the success seen in the community with regards to their residential energy production and consumption.[9] ***Many residents at EVI offered specific, pragmatic changes in the regulatory frameworks at the local, state, and national levels in order to encourage residential energy improvements.***

Energy Consumption

When asked how the government could assist in encouraging replication of EVI successes with regards to residential energy consumption, most answers focused on built-form adaptations. These suggestions included improving green building codes and training, adapting zoning regulations, easing restrictions in the planning process, and increasing federal/state grants.

Green Buildings:

Several EVI members interviewed expressed the need for building code reform on a local and state level. Some residents felt that the current building codes were quite prohibitive with regards to green building, and that this was actually restricting the number of green buildings by simultaneously discouraging housing developers and home owners from making such investments (Interviewee 12).

Residents of EVI were hopeful that Tompkins County officials could be encouraged to work with Ithaca city planners to revamp the building codes – with help and emphasis provided by EVI and other communities at the forefront of green design (Interviewee 10). Meanwhile, some residents expressed interest in broader State or Federal reform in order to assist green builders in other communities by reducing the time and effort required to lobby local authorities (*Ibid*).

In addition, one resident mentioned that local or state governments could provide funding for green building training, which could assist developers and home owners in finding methods, funding green building construction, and raising awareness about its possibilities (Interviewee 12).

Adapting Zoning Regulations:

The adaptation of zoning regulations on a state level was something advocated widely among experts at EVI. The separation of commercial, residential, and agricultural zoning areas caused many problems for EVI, because it originally restricted their ability to build densely clustered houses while leaving large plots of land undeveloped. Because of this, it took a year just to complete the zoning process of the first 30 acres of land (Interviewee 11). EVI has worked with local planners to draft zoning regulation which would allow for, or even encourage, pedestrian-centered neighborhoods with densely clustered homes (*Ibid*). This would include 'mixed zoning' areas, or floating Pedestrian Neighborhood Zones which would allow for more sustainable housing, according to the residents. These newly drafted zoning regulations

[9] It is important to note that the questioning of residents did not specify which level of government might assist communities - leaving respondents free to discuss whatever they felt appropriate

> "Codify some of what we've done with densely clustered development, and give guidance on how this process could be streamlined" (*Ibid*).

Several residents were quick to credit the Tompkins County government and the EPA for the Grant described in Chapter 6.2, which has provided funding and assistance, part of which has been dedicated to developing new zoning laws. Some EVI residents seemed optimistic that the new zoning regulations would help other communities by streamlining the zoning process and reducing cumbersome regulatory hurdles.

Easing Restrictions in the Planning Process:

As mentioned previously, the planning process of EVI took an extremely long time, and almost led to the community's downfall before construction began (Interviewee 11). In particular, residents mentioned the local government processes of site plan review, the building permit process, and the aforementioned zoning regulations as areas which should be streamlined and reviewed.

> "Getting amateur developers together is a daunting process. They don't know the steps. Everyone must be on board at once to develop such a community, whereas developers of traditional neighborhoods can build houses as they go. Easing up on restrictions in the planning process could help amateur developers' chances of success" (Interviewee 10).

Increasing Federal/State Financial Assistance:

EVI residents were excited about the EPA grant received for dense housing development, and were quick to point out that more such grants were needed to provide the funding, motivation, and awareness in society of the need for residential energy adaptation. This grant came through the Climate Showcase Communities Program, which offered $20 million from 2009-2010. However, the EPA does not anticipate future funding for this program (EPA, 2012).

Residents also appreciated rebates received for Energy Star and Leadership in Energy and Environmental Design (LEED) certifications. However, funding for LEED rebates in New York State expired because funding ran out, leaving it unclear whether the third neighborhood, TREE, would receive rebates if they met certification (Interviewee 11). The certification would cost $30,000 up front, and the result would be a $5,500 rebate per house, if the funding for this area is approved for the next fiscal year. Thus, some residents expressed that not only should such certifications be further encouraged, but that the State government should ensure that it would have enough funding to enable it to meet demand with regard to certification rebates (*Ibid*).

Energy Production

These discussions were based solely around solar energy production, since this is the most significant means of energy production within EVI. The six areas mentioned which could assist in making solar investment more affordable for communities included renewing federal subsidies for alternative energies, refundable tax credit changes, requirement of feed in tariffs, metering account adaptations, community solar opportunities, and local government organization of solar projects.

Renewing Federal Subsidies:

According to one resident energy expert, the federal government should

> "Renew subsidies for alternative energies. This can help communities find these investments more economically attractive" (Interviewee 12).

More than 70% of federal clean energy programs will expire by 2014, many which came as part of Obama's 2009 economic stimulus bill (Smith, 2012). This leaves in doubt the future of the renewables industry in the United States, which relies heavily on the subsidies provided by the federal government and was one of only a few industries which showed growth throughout the current recession (*Ibid*). Proponents suggest that renewing the subsides and making renewable tax credits permanent (as proposed by President Obama) can help foster continued growth in this sector, and that longer-term subsidy programs could lengthen investment windows and increase attractiveness for renewable investments (Interviewee 12).

Refundable Tax Credit Changes:

The refundable tax credit, which is offered by New York State to individuals who invest in solar technologies, could improve investment in solar energy if it was a subsidy or tax rebate instead (Interviewee 3). This could apply to both state and federal tax credits for renewable energies.

If the tax credit was changed to a subsidy, investors would not have to front the initial capital and then apply to be paid back, but would instead just get the reduction up front. This could reduce the amount of financial capital needed for such investments. Changing the tax credit to a tax rebate would help for investments like the FROG solar array, which was made by a cooperative. Since the cooperative has very few earnings, it cannot get a full tax credit (which is only paid to offset taxes due), whereas it could get a tax rebate (which is paid regardless of the amount of tax owed). Due to this complication, the cooperative has had to funnel the tax credits to individual members, who then pass those credits back to the cooperative (*Ibid*). Obviously, this is a deterrent to cooperative investors who may have less social cohesion and trust among their members.

Feed-in Tariffs:

A feed-in tariff is a policy requiring utility companies to buy energy from renewable producers at a given cost - generally based on the generation cost of that specific type of energy. This mechanism has seen success in countries like Germany (Butler and Neuhoff, 2007), and according to some EVI residents, would also help the replicability of private and communal solar production. Feed-in tariffs have been initiated in six states throughout the US, but not in New York or Virginia (Barber, 2012). In New York, when the 50 KW solar array at EVI produces a kWh and sends it to the grid, the utility company (in this case, NYSEG) subtracts that production from the overall bill of energy consumption sent to the FROG neighborhood. With Feed-in tariffs, the electricity would go directly to the grid, and the utility company would be required to purchase it at the predetermined price.

This difference is significant for several reasons. The first is that when installing the solar array, the community had to run the electricity to the meters within the neighborhood so that NYSEG could read the influx and outflow of power (known as net metering). This significantly increased investment costs, because the array was located far from the meters and thus electrical lines had to be buried and connections made to transport the electricity to the meters – rather than simply connecting the array directly to the electricity grid. The second is that the generation is only beneficial until it reaches the level of energy consumption (that is, FROG will not receive any benefit for kWhs it produces beyond those it consumes). The third is that instead of getting paid a high, guaranteed price for their renewable energy, EVI only gets kWhs deducted from their bill at the current price of the energy they are purchasing. The price of the energy EVI purchases is often much lower per kWh than the cost of the energy they produce, due to the relative lack of renewable energy within the energy mix of New York State.

Feed-in tariffs also make the return on investment reliable and easy to calculate. In the case of EVI, it is difficult for the investors to know what their Return On Investment (ROI) will be - because the amount of money they are saving (which is subtracted from their energy bill, and thus their 'payback') is tied to the current price of energy, which is prone to fluctuations. Since the price of energy is not consistent, this makes ROI calculations particularly speculative for solar investments. Conversely, feed-in tariffs require a guaranteed rate, which allows investors to more accurately calculate when they will be paid back, since they know exactly what rate they will make for their electricity, and approximately how much they will produce (Interviewee 3more).

Metering Account Adaptations:

Several residents suggested that the government could require changes to the metering account classifications of utility companies. This action would likely be taken at the state level. Currently, there are two account types: residential and commercial. The residential accounts require individual meters for each house, which will not facilitate a cooperative investment in solar arrays or any other energy generation technology which feeds the electricity into more than one meter (thus, into more than one household). In order to facilitate the FROG solar array, the neighborhood had to switch to a commercial account in which houses were grouped to the same account.

This is a concern for several reasons. The first is that many investors would not want to combine accounts, because this requires an accountant to handle group bills and divide the usage and savings accurately. It also causes complications if some of the group is unable to pay their bills.

> "One of the most complicated parts of this investment process is the accounting –the bills" (*Ibid*).

Another concern is that commercial accounts are charged according to different usage characteristics, including demand charges. This means that commercial accounts are charged more for energy consumed during peak-demand hours. Naturally, EVI uses most of their energy during these peak hours.

> "Our bills are only 25% lower despite solar creating more than half of our electricity because of the demand charge on our commercial account" (*Ibid*).

Thus, a 'cooperative account' - or a revamping of residential/commercial rate structures - would allow customers to avoid paying commercial demand charges, would be greatly beneficial for the investment in solar and other renewables. In addition, if it was possible to allow individual residential accounts to distribute the benefits of cogeneration, it may make community investment in projects such as the FROG array more viable (*Ibid*).

Community Solar Opportunities:
Community solar farms are centralized solar installations which accept capital from individual investors, and then in turn provide credit for the power generation and tax benefits back to those investors (Galbraith, 2010). Essentially, residents invest in solar panels in a remote location, and then receive tax credits and net energy rebates for doing so. According to some at EVI, the state government could play a role in this cogeneration opportunity by “requiring utilities to allow customers to do community solar”.

Local Government Organization:
When discussing the possibility of replicating the FROG array, residents mentioned the possibility that local governments could facilitate group investments in renewables.

> “Investments like this one could be organized by local city governments, by tying the loan for the solar investment to the house, rather than the person living in the house” (Interviewee 12).

This would allow for capital to be compiled for the up-front costs of solar investments, and could help ensure that the loans would be paid off even if the current household owners were to move out.

7. Analysis of Twin Oaks through resident interviews/ Participant Observation

7.1 Internal Institutions

This section will give a brief description of the internal institutions which have influenced the development of Twin Oaks' residential energy system. Each section will include results from qualitative interviews of Twin Oaks residential energy experts. ***Many residents were hesitant to answer questions about the TO residential energy system in isolation of the community as a whole, and often suggested that its development was the effect of other more pertinent considerations such as social and proprietary norms.***

Governance

Overview:

TO community utilizes a "participatory form of government in which voting members have either a direct vote or the right of impeachment or overrule" (Twin Oaks Community Handbook, 2011). The community operates what is termed a 'planner-manager' form of governance, in which planners are elected to make long-term decisions, and these planners appoint managers to handle specific areas of work or authority (Kinkade, 1994). TO has many different planning areas, varying from land planning to childcare.

The Community Planning Board is the most powerful, and consists of three people who have the authority for making policy decisions for the community. Each board member serves for a period of 18 months. The board appoints a President (required to be a board member), Vice President, and Secretary to serve for the Twin Oaks Organization – each for a period of one year.

The community elects planners through a process known as the 'veto box' in which the members place their votes on paper in a sealed box. There is no campaigning allowed – there is simply a notice stating the candidate, position, and voting deadline - and a particular candidate cannot be appointed if 20% or more of the community votes 'no'.

The Governing body makes decisions, but:

1) It must act with the principles and policies of the community
2) Governance must be participatory to the fullest extent possible
3) Voting members always have right to recall governing body, or a member of it
4) Voting members have the right to overrule any decision within 3 weeks of its passing

(TO Handbook, 2011).

Interview and participant observation findings:

Many at Twin Oaks expressed that the governance process, while sometimes bureaucratic, is relatively efficient, and allows for decisions to be made more quickly and fluidly (Interviewee 14). In addition, because of the planner-manager format, planners are able to make decisions without gaining absolute majority or even supermajority, but are still unlikely to push through decisions which would be opposed by even a large minority of the community, since every decision can be vetoed (*Ibid*). Many believe that this governance system greatly assists the development of the community because it allows those who have knowledge or interest to invest time and energy into making changes, while not requiring any effort from those who are disinterested. In addition, many small-scale decisions are made without consulting the community, which saves time and energy from the residents (Interviewee 17).

Two examples were given by residents to illustrate the success of the decision-making system with regards to residential energy: the decision to invest in the 10.8 GW solar panel array, and the decision to construct Sunrise (the solar-powered half of the Kaweah residence) (Interviewee 1). The investment in the solar panel was brought by the planners to the entire community, since it was a large investment that may have faced opposition. During this process, those in the community who were interested in this decision became involved through discussion and debate about whether or not to invest in the panels, and at what scale. The costs and benefits of the solar panels were discussed publicly, and in the end the community showed no clear opposition, signaling for the planners to move forward (Interviewee 15).

The decision to construct Sunrise was a compromise achieved through a similar process. Many within the community were eager to construct an eco-friendly residence, while others were urging the need for a child-friendly residence to be constructed. The two camps found conflict because there was only enough money to construct one residence, and the reductions in consumption required to live off the grid seemed daunting for some of those trying to raise children. The planners involved the community, who eventually reached a compromise that half of the building would be solar-powered and off the grid, and the other half grid tied – with communal kitchen and laundry facilities being powered by the grid (Interviewee 4).

Proprietary

Overview:

The community can be viewed as using a mostly socialist model of property ownership (Interviewee 14). Each member's room is considered private, and possessions within each room are private property. Everything else in the community is considered common property, to be used by anyone.

Interview and participant observation findings:

According to residents, the sharing of communal spaces and property greatly reduces the individual energy needs of each member, which naturally contributes to reductions in energy consumption. Examples included communal meals, shared housing facilities (laundry, sitting rooms, kitchens, etc.), shared water heaters, and even shared clothing.

Furthermore, it was expressed that the communally owned Twin Oaks businesses, and communally owned profit they generate, greatly increases members' collective agency. This assisted Twin Oaks' residential energy system through investments such as the 10.8 GW solar array and the construction of Sunrise – both of which required significant amounts of up-front capital mobilized by the community's shared profit (Interviewee 9).

Many residents expressed that the proprietary and social structure of Twin Oaks was a key reason for their happiness and quality of life, as well as a defining aspect of their egalitarian community. This is important to note because while it leads to residential energy system improvements, it is a means in itself. One resident even became agitated when he heard Twin Oaks' website mentions the community as an ecovillage.

> "Twin Oaks is not an ecovillage. We are an egalitarian community first. The ecological benefit is a result of our lifestyle, not the other way around" (Interviewee 16).

Social

Overview:

Due to the requirement that members live and work within the community, the social structure of TO is very close-knit. Social interactions occur throughout the day, in the communal living areas, during labor hours (many jobs actively encourage social interaction), and during communal meals. The community serves two communal meals (lunch and dinner) each day. In addition TO has many social clubs and events which occur daily.

Interview and participant observation findings:

Residents felt that for their quality of life, the social structure was a significant contributor (Interviewee 9).). In addition, social norms were seen as encouraging reduced energy consumption. This included the sharing of goods, using minimal amounts of water when possible, reusing materials rather than throwing them away, turning off lights, hanging laundry, and many other examples (*Ibid*).

Internal Economics

Overview:

All income generated by the Twin Oaks Corporation is shared equally among its members, or invested back into the community. TO uses labor credits as their basic economic unit. Each member is required to complete a predetermined number of hours of labor (labor credits) every week. During the research period of this study, the required weekly labor requirement was 42 hours. Each hour of labor is equivalent, regardless of the type of work (i.e. administrative, gardening, construction, etc.). Through this system of labor credits, and careful and successful business management, TO is able to support members from varying socio-economic backgrounds and financial situations. Since all members have their rent, food, health care, and dental expenses covered by the community, up-front investment and financial mobility are not necessary to become a member at TO.

All residents work full-time at TO, and live within the community. In addition to their means being provided, members are given a small monthly stipend (about $80). Members are not allowed to spend money beyond this stipend, in an effort to keep the financial situation in TO as egalitarian as possible. However, members are allowed to work outside the community to generate 'vacation pay', so long as their required labor credits are fulfilled. This money must be spent when on vacation outside the community. In addition, any prior savings or assets from individual members must be 'frozen' when they join the community, and are not to be used while they maintain membership (Interviewee 14).

Interview and participant observation findings:

Many residents pointed to the Twin Oaks economic system as facilitating the collective capital needed to undertake investments such as the solar panels and Sunrise residence (Interviewee 5). Furthermore, the economic system encourages reduced consumption because it allows only $80 a month in free spending for each resident (Interviewee 9).). Thus, residents don't have the money to participate fully in consumer culture (*Ibid*). Using the labor credit as the main form of currency has significant effects on the lifestyle of the community by aiding in social cohesion and reducing the use of monetary currency – another factor which isolates TO from the consumer society.

Spiritual

Overview:

Twin Oaks claims in its Statement of Religious Beliefs the following religious philosophy:

> "Because we share a planetary unity we are one with each other. Whatever harms any of us harms us all. Therefore we endeavor:
>
> To eliminate hierarchy in relationships between people
> To practice non-violence in our personal, interpersonal and political lives
> To respect and preserve the natural environment for the use of our own and other species, now and in the future
> To eliminate classism, racism, ageism, patriarchy and other forms of oppression, both in ourselves and in other people
> To practice community of property, sharing all that we are and have and can produce with one another" (Twin Oaks Handbook, 2011).

Interview and participant observation findings:

Residents suggested that the common ideals which united some people at Twin Oaks were the spiritual philosophies of the community. However, how much this effected residential energy consumption was not clear through interviews. Most of these philosophies have already been discussed, including the political structure (no hierarchy), and the community property.

One area that deserves mention is the respect and preservation of the natural environment. There are many ways this can be witnessed at TO, including the practices of leaving many areas wooded, clearing only dead trees, living with little personal space, and consuming less. Of course, most of these things effect the consumption reductions that TO has achieved through lifestyle choices (Interviewee 9). However, as the spiritual aspects of the community are mostly implicit, and there is no religious or spiritual practice or center surrounding the philosophy, it is almost impossible to distinguish this institution within the community.

7.2 Institutional interaction with External Forces

Twin Oaks interacts considerably less with both the private market and the government than conventional communities than contemporary communities. The development of their residential energy system, while facilitated by a favorable tax status and a few private market technologies, evolved mostly independent of these forces through consumption reductions driven by the internal institutions of the community.

Legal System:

Overview:

TO is a 501(d) non-profit organization according to the Internal Revenue Service (IRS) tax code. This tax code is "for religious or apostolic organizations that have a common belief system and follow that system in their daily lives, have a primary activity of farming or manufacturing, have a common treasury that supports the needs of the members, have internally operated businesses, and have members who surrender almost all personal property upon joining and have no claim to the community resources upon leaving (Interviewee 17). The IRS sued Twin Oaks, challenging the status of TO as a 501(d) organization, suggesting that they were not qualified for this tax status because the community did not have a unified religion. However, TO won the lawsuit, and was able to continue in this tax bracket (Ibid).

Interview and participant observation findings:

Most residents at TO suggested that the interaction between the external legal system and the community was not generally a serious concern (Interviewee 9). TO managed to avoid the major challenge of zoning regulations, faced by many ecovillages and intentional communities, in part because some of the buildings were built before current zoning and construction laws/regulations came into place (Interviewee 5). In addition, each residential housing unit is isolated from the others, so there was little challenge with regards to 'high density' zoning violations faced at other Ecovillages.

When zoning regulations did come into effect in the 1970's, TO was labeled an agricultural zone. While this would seem to conflict with the zoning of the community, it has been a relatively easy process for the community to circumvent.

> "We just ask for a quote and a conditional use permit. Then the county says, well, as long as you do x,y, and z, you can build this structure despite being in an agricultural zone. So it hasn't caused much problem for us" (*Ibid*).

Initially, the community foresaw problems with the agricultural zoning, and went to the county planning board in the early 1970s to apply for 'planned unit development' zoning (Interviewee 5). The county rejected this proposal, and residents involved expressed a feeling that the government was trying to inhibit the spread of communities similar to Twin Oaks. Since then, the planned unit development zoning has been passed, but TO has not applied for rezoning, due mostly to the expenditure of time and money for the paperwork, and the fact that their current zoning status has not inhibited their development (Interviewee 5).

In the early 1970's, there were many interactions with what the members claimed were FBI agents, investigating the community. Members felt that these government agents were trying to make sure that the idea of communal life didn't spread around the country. This was confirmed, according to one resident, with an interaction with the county planning board in which a board member said – off the record -

> "We don't want communes sprouting up all over" (Anonymous board member).

While this may seem exaggerated, the 1970's were a tumultuous time in United States history, and the idea of communal life was spreading rapidly during this period. Regardless, the community overcame these obstacles and currently experiences few problems with regards to legal interactions (Interviewee 9).

External Economics

The economic environment within Virginia and the United States greatly effects the residential energy system of TO. This includes economic incentives and regulations enacted by the state and federal governments, as well as private market economic factors in the area. Each of these will be briefly discussed below.

Virginia State:

The state of Virginia offers financial incentives for renewables investment and for energy efficiency investments. The state government offers personal, sales, and property tax financial incentives for investment in energy efficient technologies (DSIRE, 2012c). In addition, utilities in Virginia offer extensive rebate programs for residential energy efficiency. There are several local government initiatives providing financial incentives for energy efficiency increase as well, although none in Louis County where Twin Oaks community resides (Ibid).

As a state, Virginia has only property tax incentives for investment in renewables, with no programs for personal, sales, or commercial taxes (Ibid). However, Virginia does offer loans for renewable energy investments at the state level. In addition, some utility programs are established for loans and performance-based incentives around the State. The Photovoltaic Manufacturing Incentive Grant Program, operated by the Virginia Department of Mines, Minerals, and Energy (VDMME), offers that:

> "Any manufacturer who sells solar photovoltaic panels manufactured in Virginia is entitled to receive an annual grant of up to 75 cents per watt of the rated capacity of panels sold" (DMME, 2012).

Furthermore, a short-term rebate for renewable investments was offered from 2009-2010. This grant was used by Twin Oaks community, and saved them approximately 20% on their investment (Interviewee 5). The rebate, which expired shortly after Twin Oaks successfully applied, allowed investors to receive up to $2,000 per kilowatt for solar panel systems up to 10 kilowatts in size (Standard Solar, 2009). The community also receives money each month (about $200) from the sale of Solar Renewable Energy Credits (SRECs) on the electrical grid (Interviewee 5). Twin Oaks receives money from utility companies both within and outside the state of Virginia who purchase SRECs to help meet the RPS required by their respective state governments (*Ibid*).

United States:

The interaction between the federal government and TO's institutions is considerably less than that of EVI. While many federal rebates and programs are offered which might benefit TO, because the cooperative pays little federal tax due to its tax status, it is unable to take advantage of many of these. Furthermore, because most residents claim an income well below minimum wage, residents also cannot receive the tax credits due to a lack of taxable income.

However, federal laws greatly influence the way that TO is able to operate. Thus, the federal backdrop described previously applies to TO, although the community operates more in isolation than EVI[10].

Private Market:

The economic trends for the United States have been described in section 6.2. However, these trends are less likely to impact TO because their energy system relies mostly on consumption reduction. In order to achieve this reduction, Twin Oaks is not dependent upon the market. However, if TO continues to seek built form improvements or the purchase of more decentralized production, then the private market will greatly influence their ability to afford these products. Furthermore, because the community, and thus its residential energy system, depend heavily upon private market sales of hammocks and tofu, the health of these industries is also relevant to the community's success[11].

7.3 Replicability

The discussion of replicability centered mostly on a systems (holistic) approach about the scalability of the egalitarian model, rather than the energy system specifically. An interview with one long-time TO resident articulately sums up this perspective:

> "There are several examples of wholesale replication of the Twin Oaks model, including Acorn and Eastwind. But this replication is difficult because it requires lifestyle changes. It is incredibly hard to replicate piecemeal, due to the cohesive nature of community " (Interviewee 9).

The replication of factors such as group living, shared eating facilities, and shared income are very difficult to assess without also taking into consideration the entire structure of all Twin Oaks institutions. For example, it is almost impossible to imagine the replication of the solar panel investments at TO in broader society, without the unique social norms which allowed the investment, including the income sharing, egalitarian business model which created the capital (Interviewee 5).

There is evidence that the entire model is quite replicable as a whole, as two communities in the nearby area (Acorn and Living Energy Farm) were started in a similar manner within the past five years. Twin Oaks encouraged these models through funding from the savings of the community, and also from members who moved to these

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[10] The total taxable earnings for each member equals the total profit from the cooperative, divided by the number of residents. Last year, this equaled approximately $4,500 per resident – well below the minimum wage. Thus, taxes paid federally are extremely minimal.

[11] However, they are well beyond the scope of this report

communities in order to assist in their development (Interviewee 9). Currently, Acorn is running a profitable seeds business as a 501(d), and is searching to start another community which can take on some of the excess business – since the community cannot keep up with the demand.

The replicability of Twin Oaks was seen by some residents as having an inverse relationship with the success of the capitalist economy. In this view, rising unemployment, decreased personal spending, and increasing debt would drive people to need another way to provide for themselves (Interviewee 9). In this instance, Twin Oaks and other egalitarian communities could offer an alternative that – while requiring lifestyle changes and social adaptation – requires considerably less money and consumption per person to provide an acceptable standard of living. Several residents voiced this, and a trend of increasing membership applications during times of economic recession was also observed.

Thus, while residents felt that the residential energy system may not be replicable piecemeal, the energy savings accomplished were seen as replicable within the broader context of the egalitarian structure of Twin Oaks (Interviewee 5).

7.4 Government Assistance

While residents had some suggestions for government assistance, most residents interviewed did not feel that the government would want to help replicate an egalitarian community like Twin Oaks.

Discussions with TO community members regarding government assistance, and how the local, state, or federal governments may assist communities in replicating some of the successes of Twin Oaks were often met with skepticism. When asked what the government might do to help Twin Oaks, some respondents felt that the Government was actively preventing the spread of egalitarian communities. One respondent said with a laugh:

> "Its hard to imagine that the government would want more of this" (Interviewee 18).
>
> "Many people want to live individually. This is great for capitalism. We are living communally, which means less consumption" (Interviewee 5).

Those who did not see the government as actively preventing the spread of communities like Twin Oaks felt that the community model was met by indifference from local and state officials.

Some residents discussed issues on the federal level, suggesting that federal subsidies to fossil fuel industries were delaying grid parody for renewables by keeping the price of conventional fuels unrealistically low. According to this theory, federal investment in things such as defense, fossil fuel exploration, and low cost land leases to large fossil fuel companies – all of which could be considered as subsidies to fossil fuel industries, although they are not explicitly listed by the government as such – keep the cost of fossil fuels much lower than they would otherwise be.

> "The government needs to level the playing field by removing subsidies to oil and gas. This even includes military spending, which assures our supply of cheap oil" (Interviewee 5).

There were some suggestions for how the government might better facilitate egalitarian communities overall. These included modifying zoning regulations, and creating more flexibility in government at local and state levels. The suggestion of allowing planned unit development zones at the local and state level was discussed previously. The local government has adopted this zoning option, and TO has not applied for this zoning category, making it difficult to determine how much this step would aide the development of other communities similar to Twin Oaks. However, emerging communities may benefit from this more suitable zoning regulation according to residents of Twin Oaks (Interviewee 5).

Allowing more flexibility in government at Local and State levels would reduce the logistical obstacles involved in forming an egalitarian community. While this may work, only the general idea was offered, and specific and pragmatic steps about how this may be accomplished were not suggested.

8. Discussion of Qualitative Results

The results of this study have shown how communities labeling themselves 'ecovillages' are incredibly diverse with regards to their approach to sustainable living. The responses of residents at both EVI and TO with regards to their residential energy systems elucidates the stark contrast in approach and philosophy between the two communities. ***It can be seen from these results that EVI has taken a pragmatic, incremental approach to communal living by trying to offer an alternative to suburban lifestyle, while TO has taken a more radical approach – more thoroughly rejecting contemporary society's social, economic, and proprietary norms***.

The differences in approach can be seen to both effect, and be affected by, the institutions within each ecovillage, and the way in which these institutions shape the residential energy system. Furthermore, the approach and philosophy can be seen to influence the way in which internal institutions interact with external institutions. This can be witnessed in the way that EVI has come to work with the government to enact incremental changes, while TO has sought less government policy change or assistance.

Both communities have encountered some contradictions when the vision of the community met practical circumstance. At EVI, and to a lesser extent at Twin Oaks, a contradiction exists in the purchase of goods in order to create reduction. While these purchases have decreased energy consumption overall, the products (especially solar panels) have environmental impacts and are often not made domestically. An interesting paradox for the community of TO is that, while fully embracing egalitarianism and social property, it simultaneously relies on the capitalist economy to generate revenue and provide for the financial needs of its members. However, on a daily basis, individual members of this community do not interact with the private market themselves, as most products purchased from the private market are brought in by one or two people, who travel to town to purchase goods. This interesting balance between the internal institutions of TO and the external institutions of broader society may reflect the struggle in the community between the individualistic notions of contemporary society (capitalism, private rooms), versus the communal philosophies upon which the community was founded (egalitarianism, common property, etc.).

From analysis of the data compiled in this study, the replicability of developments within each ecovillage is determined by two main factors: whether residential energy improvements stem from built form or behavioral change, and how differing the institutions of the particular ecovillage are from those in 'broader' society. The incremental approach used by EVI offers many pragmatic technological improvements, and generally includes ***adaptations which are acceptable from the perspective of the capitalist regime because they are commodifiable (consist of goods/services which can be marketed and/or sold)*** (Marx, 1844). ***Many implemented changes at EVI do not challenge the incumbent regime, but in fact work in cooperation with explicitly stated goals of increased renewable production and building efficiency.*** Meanwhile, TO's approach of egalitarianism yields a communal structure and lifestyle that makes piecemeal replication difficult in isolation of the institutions supporting it. The replicability of this model is made more difficult because it is, in many ways, against the interests of the incumbent regime. ***TO energy reductions do not come from***

investment in new commodifiable technologies (products which can be sold). Rather, they come from wholesale reductions in overall consumption through the sharing of products and minimal consumption. Not only are members of TO reducing energy with little purchase of commodifiable technologies, they are also drastically reducing their participation in the consumption of other goods which may be seen to 'drive' economic growth.

Reflecting on the theoretical framework and methodology used in this report, it can be seen that 'Ecovillages' is too broad a term to be considered a 'niche'. This is illustrated by the fact that Twin Oaks is clearly not a niche, while EVI is in many ways. EVI is currently offered some assistance by the regime, including finances to investigate their approach to green housing. Furthermore, many of the technologies allowing EVI's energy improvements are subsidized by the regime (including solar panels, and efficiency improvements). Meanwhile, Twin Oaks cannot be seen as a Niche because the regime is not intentionally assisting the development of the community. Interestingly, the regime is assisting the community through its tax status, but the regime's attempted dismissal of this benefit to the community reflects the incoherence of laws, actors, and interests within the regime, rather than an explicit attempt to help the niche develop.

Thus, EVI can be seen as a niche which has received some protection from the regime, although it was not with the explicitly stated goal of 'niche management'. However, it should be noted that the regime has only acted post hoc in this instance, deciding to assist the community after it had already succeeded - which is inconsistent with the approach of 'strategic niche management', which would seek to assist niches during their development. However, as further development is ongoing at EVI, it has been possible for the regime to support these progressions and thus assist the 'niche'. This successful assistance suggests that the regime could have more success with strategic niche management, if it was explicitly recognized and efficiently implemented. However, the current dichotomy in the political climate of the United States, and the federal government's inability to agree on even mild changes or reforms, leaves little hope in this regard.

Reflecting further on the methodology, this study elucidates the large gap between the regime and its explicitly stated goals, and the small-scale community developments on the niche level. Due to the complexity of the regime's federal and state governmental structures, and the vast number of diverse people, communities, and interests existent both within the regime and within the country, it becomes clear that explicitly managing niches would be a difficult task for the regime – particularly on a federal level. Furthermore, even were the regime capable of successfully managing such niches, it is difficult to imagine such a development in the US, due to the strong presence of free-market ideology and a wariness of government intervention (even from those within the government itself).

Further complicating the theoretical analysis of the application of strategic niche management techniques in the United States is the lack of cohesion or solidarity within the regime at the state level. In this way, each state government could be seen as a regime in its own right, with interests and motivations driven by actors whose concerns are not necessarily in line with the federal government (the larger regime). This analysis makes clear why top-down, explicit steering by the regime is difficult in a country as large, diverse, and dichotomized as the United States, while it may be more appropriate for a country like the Netherlands, which has a much smaller and (arguably) more homogenous population. These factors make local initiatives driven by grassroots change, such as the residential energy systems studied in this report, critical for a transition in the United States – a country unlikely to unite around a common vision for moving forward at the national level.

The conversation of the future of each village's RES did arise enough unintendedly during interviews that it warrants a brief discussion. Residents of both communities seemed to think that there were still more improvements that could be made to their residential energy systems. In particular, residents at EVI mentioned reducing natural gas usage, and residents at TO talked about upgrading their housing/insulation for greater energy efficiency. However, members of both communities were also focused on trying to make the established changes easier for future communities to replicate. It seemed that perceptions of future success lied as much in the development of similarly successful models of community as it did in the continued improvement of the current residential energy systems. This vision of the future, involving multitudinous, small-scale community development, suggests several recommendations for future research.

Recommendations:

According to the analysis offered in this report, the following recommendations are suggested for **areas of further research or policy development**:

- Investigate the possibility of requiring further green building code reform by the federal government
- Investigate the applicability of Tompson County zoning adaptations to other counties/ on the state level.
- Investigate how other states/counties have adapted zoning regulations to better facilitate sustainable building
- Investigate the applicability of cooperative investment models (at both EVI and TO) towards a broader energy transition
- Investigate the applicability of the cooperatively owned business model utilized by Twin Oaks for broader society (particularly poor regions/areas)
- Investigate the results of the EPA grant to EVI, and evaluate how effective this approach may be in the future with regards to green building developments
- Study more ecovillages to collect a more representative sample from this social movement
- Apply transition management theory to the residential energy systems of ecovillages or their equivalent (transition towns) in the Netherlands, where such a theory is used explicitly

- Study the demographic changes occurring within the US and the impact this might have on the populations and social acceptance of ecovillages

- Research the application of strategic niche management at the state or local level in the United States

- Work with utilities in the rate structure to develop and propose a rate for ecovillages that more clearly reflects actual usage and costs, includes metering charges and can be transferred to other similar communities

- Renew federal subsidies for decentralized generation (particularly solar technologies)

- Study the effectiveness of post hoc vs. pre hoc policy intervention (for instance, is it more effective to assist developments such as EVI's development scheme after it has shown itself capable of independent success, or to assist communities during or before such developments

9. Conclusion

This study has assessed the residential energy systems of two ecovillages in an effort to determine what lessons these developments can offer to ‘broader’ society. The two villages bridged the entire spectrum of social change: EVI offers a model for ‘making change from within’ the system, by incrementally shifting public perception and local political will, while Twin Oaks represents ‘system change’ by attempting to create an independent, egalitarian society.

The report began with a background description of the US energy system, including details about the residential sector and its contribution to the overall energy system. It then described transition theory in the Netherlands in order to connect the theoretical ideas of transition management to the United States. This was followed by a brief description of the two ecovillages (Ecovillage Ithaca and Twin Oaks) used in the study. After the background was established, the report set out to answer the first research sub-question.

Residential Energy Sustainability

“How do the residential energy systems of Ecovillage Ithaca and Twin Oaks differ from mainstream society (Are they really more sustainable)?”

In both cases, the ecovillages were found to be consuming considerably less energy than surrounding areas, and producing considerably more. Thus, it was seen that the residential energy systems of both ecovillages were in fact more sustainable than surrounding areas. EVI consumed approximately 50% less than NY State average, and produced about 11% of the total energy it consumed. TO consumed about 31% less than the State of Virginia average, and produced 41% of the energy consumed by the community.

With regards to energy storage, both communities provide examples of small-scale, temporary energy storage using batteries. EVI has made significant investments to allow for 1 to 3 days of backup electricity in the case of grid failure, while some TO residents have decided to live using only a small amount of solar generated and battery stored electricity. The communal investment structures and behavioral changes accompanying such systems are significant and were discussed at length, but the storage systems themselves do not utilize cutting edge storage techniques or technology. Still, the presence of such systems in both ecovillages shows residents’ eagerness to move towards energy autonomy, and prepare for possible failures in the central electrical grid.

Residential Energy and Institutional Structures

“How do the institutions of Ecovillage Ithaca and Twin Oaks support, enable, or hinder their residential energy system development?”

Residents interviewed about the institutional structures revealed very different opinions both between and within the two communities. At EVI, most residents agreed that the social and economic institutions of EVI aided the RES

development, but there was less agreement about whether the governing institutions enabled or inhibited development. While the communal, cooperative investments at EVI were evidence of unique developments with regards to the economic institution, it must also be noted that the availability of private income at EVI helped make investments in new technologies possible. ***At TO, most residents saw the institutions, which helped create their RES as inseparable from the entire egalitarian model of the community.*** Most of the energy improvements at TO were seen through behavioral changes leading to reduced consumption, and it was difficult to imagine this scenario without the strong institutional structure and support of the community. The social and proprietary institutions that encouraged sharing and communal property noticeably reduced consumption, and the communal, egalitarian economic model facilitated cooperative capital and agency.

Interaction with External Forces

"How does the interaction of institutions with the external forces around them effect the residential energy system?"

EVI interacted with both government and private market forces in order to develop its residential energy system. EVI, while at first facing opposition from local government, was able to overcome these obstacles and has since begun working with the government on the federal, state and local levels to try to push through legislative and regulatory change. EVI interacted extensively with the private market, and many of their residential energy system improvements have come with help from private contractors, developers, and businesses.

Since most of TO's RES improvements came in the form of reduced consumption, there was little need to interact with the government or private market in order to simply consume less. However, TO relied on the private market for purchasing solar technologies, and the sale of hammocks and tofu that generate the community's profits. TO has pushed for zoning adaptations in the past, and has representatives who interact with government to approve changes implemented within the community.

Niche Replicability

"How can the residential energy systems of Ecovillage Ithaca and Twin Oaks be seen as 'niche' developments, and what is their potential for replication?"

The residential energy system of EVI did receive some assistance from the regime in areas that were inline with the regime's explicitly stated goals for residential energy savings. In this way, EVI's RES may be viewed partially as a niche. Twin Oaks residential energy system was seen as conflicting with the goals of the regime, and thus received little support and cannot be considered a niche. However, as neither residential energy system received any type of 'protection', and the support for EVI came mostly post hoc, neither of these systems can be seen to have received 'niche management' from the regime. Instead, it seems the regime is more in support of assisting such niches *after* development, which is fundamentally different from the niche management strategy applied in the Netherlands. It can be seen from their success that these 'niches' do not need protection, as they have developed mostly without it. Still, the assistance provided by the regime to renewable technologies, as well as the grant provided by the

EPA to EVI, show that the regime can assist niche development in residential energy, and that the regime could theoretically increase and make more explicit this assistance. Furthermore, residents voiced concerns that the regime remove protections for the large, already profitable fossil-fuel companies and industries, and that this would in turn allow more opportunity for the development of niches in the residential energy system.

There were many potentially replicable aspects of EVI's RES, specifically with regards to built form improvements including passive solar heating, high density housing, shared water heaters, super insulation, and slightly reduced personal space. There were also replicable aspects of the communities' production investments, including communal investment in solar technologies. Meanwhile, ***Twin Oaks' RES was difficult to isolate from the strong institutions which supported it, and thus replication of the energy system piecemeal would prove very difficult. However, the egalitarian model as a whole offers a replicable model*** which has been imitated successfully several times, and which can help reduce energy consumption mostly through lifestyle change.

The replicability of both models was shown to depend on the success of the incumbent regime. The TO model was seen to improve when economic conditions in broader society worsen, since it requires no money to join and there is no outside income generation necessary once one becomes a member. Conversely, the EVI model of built energy savings will replicate well if people are employed, and have the money to invest in new homes which are built more sustainably, and new solar or other decentralized production technologies. However, the energy savings at EVI which come from behavioral change also become more attractive in times of economic downturn.

Government Involvement

"What steps (if any) can be taken by the Government (local, state, and Federal) to aid the development of these niches?"

Residents of EVI had many pragmatic suggestions, including the creation of feed-in tariffs, adaptation of green building codes, changes to zoning regulations, and the extension of subsidies to renewables energies. ***Many EVI members interviewed were actively involved in creating change and pushing for government assistance. Meanwhile TO residents were skeptical about the notion that the government may want to help their community. The institutions of TO were seen to be so different from broader society that they conflict with the incumbent regime in many ways.*** This included communal property, egalitarian (equal) wages, and the use of labor hours as an alternative currency. Due to these differences, it was seen that the government was unlikely to want to help TO, and thus residents did not have many incremental changes to suggest. Furthermore, the community's development in relative isolation from interaction with the government also contributed to the community's sense of autonomy.

Bringing it all together

"To what extent can the residential energy systems of ecovillages contribute to an overall residential energy transition in the United States?"

The development of ecovillage residential energy systems, and the extent to which they can contribute to an overall energy transition in the United States, depends greatly upon the specific ecovillage in question, and each village's unique interactions with external government and private market forces. Each ecovillage studied (and each ecovillage around the globe) has lessons to offer broader society in the quest to live a more sustainable life through the transformation of residential energy consumption and production. These small-scale changes driven by local initiative are likely to continue in the future, and to influence external forces in local and potentially subtle ways.

Whether a residential energy transition will occur in the United States depends greatly upon the incumbent regime and its ability to recognize and address an inherent incongruity within the dominant energy and economic paradigm: the decoupling of fossil fuel energy consumption/production from economic growth. Economic growth is the explicitly stated priority of the government in the United States. Yet this economic growth has historically been fueled in part by growth in the consumption and production of fossil fuel energy. Thus, the regime has many vested interests in fossil fuel industries and infrastructure. A residential energy system transition would require households and residents to produce energy, and/or to consume drastically less energy. Both of these goals may be seen to conflict with conventional means of economic growth, which rely in part on fossil fuel production and consumption. Using less energy means not only less consumption, but also eventually less domestic production (eventually, after imports of fuel are no longer needed). More decentralized production means less purchasing of energy from centralized producers. Thus, while the technology and financial capital may exist to implement a residential energy transition through decentralized generation and reduced consumption, it may not be in the government's interest (nor the large energy utilities who extensively lobby the government) to explicitly encourage such drastic changes due to the challenges such a transition may present with regards to vested economic and political interests in fossil fuels.

In any case, with a lack of top-down initiative from the regime, the effect of niche developments with regards to ecovillage residential energy systems can be seen to impact the country's overall residential energy system quite minimally. However, these ecovillages provide examples of ***feasible, small-scale, local change driven by grassroots movements and citizens who are searching for more sustainable ways of living.*** Each of the ecovillages created as a result offers its own lessons with solutions tailored specifically to that particular community. ***EVI provides an example of how an ecovillage can overcome regulatory and social hurdles while working within the current regime to make incremental, meaningful change. TO represents the establishment of a unique and institutionally distinct community which is making fundamental behavioral change with considerably less cooperation with the system.***

Ecovillages represent local alternatives to sustainable living, energy production, and energy consumption. The communal institutions in both cases presented in this study show how communal living can strengthen local investment and reduce consumption. Regardless of its status as a 'niche', or its replicability, each ecovillage studied offers an ideological contribution to an overall energy transition. In lieu of a lack of motivation from the regime, these communities are creating grass roots, self-driven, alternative ways of living, producing, and consuming regardless of the influence from external forces.

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Appendix A: Energy Transition Theory

This report borrows from the analytical framework of transition theory, which studies the historical and current dynamics, patterns, and mechanisms through which system transitions occur (Kern and Smith, 2007; Geels, 2004; Kemp et al, 1998). Energy systems are socio-technical systems which "provide linkages between elements necessary to fulfill societal functions" (Kern and Smith, 2007; Geels, 2004). In the case of residential energy systems, this includes energy required for domestic living – including home heating, lighting, and power[12] (*Ibid*). A transition constitutes the processes of social transformation through which systems change structurally over time (Kern and Smith, 2007; Rotmans et al, 2001).

This study uses Geel's multi-level analysis to describe interactions, which lead to system transitions on three levels: landscape, regime, and niche (Geels, 2004). The landscape consists of changes which occur beyond the control of regime members, such as climate change. Regimes consist of the actors and networks that shape the discussion and proposed solutions to a given problem (Geels and Schot, 2007). The niche level, on which this paper will focus most, are the micro-level locus where changes develop (ibid).

Out of transition theory has developed the practice of transition management, which has spawned the idea of strategic niche management (Kern and Smith, 2007; Kemp et al, 2007). This method for introducing change to technical regimes involves top-down protection or 'fostering' of 'niches' by large stakeholders (the government, businesses, NGOs) (Hischemoller et al, 2010; Kemp et al, 2007). These niche developments are local, small-scale developments that, if successful, can then be mainstreamed or up-scaled if they prove economically and technically viable (*Ibid*). The rationale behind the fostering of niches, specifically with regard to an energy transition, is that the creation of the current energy regime required huge public support, and that any niche competing for a transition must be temporarily protected from the market in order to establish competitiveness (Kemp et al, 2007).

> "The long development times, uncertainty about market demand and social gains, and the need for change at different levels in organization, technology, infrastructure and the wider social and institutional context-provide a great barrier (to the introduction of more sustainable technologies)" (Kemp et al, 2007).

Furthermore, there is little agreement on 'a solution' but rather a myriad of potential solutions, each of which requires different adaptations and benefits different actors. Thus, the fostering of small niche developments may 'prove' which areas, techniques, or technologies are most appropriate for up-scaling.

The success of this transition management strategy has been called into question for several reasons. Most importantly, the "approach risks capture by the incumbent energy regime, thereby undermining original policy ambitions for structural innovation of the energy system" (Kern and Smith, 2007). In addition, the strategy of dialogue has been criticized as undemocratic, because it allows the stakeholders who are invited to the

[12] Due to a lack of time and resources, aspects of residential living outside of home energy – i.e. transportation, food and water requirements, etc. have not been included in this report.

conversation to control what is discussed. This may result in cognitive impairment by limiting the possible options considered (Hischemoller et al, 2010; Lindblom, 1997).

For the purposes of this paper, however, the idea of niche development is particularly relevant. This report will assess how ecovillage residential energy systems can be viewed as ‘niche developments’ within the larger socio-political context of the United States energy policy, and how the government may foster (or hinder) the development of these alternative residential energy systems within ecovillages.

Appendix B: EVI Consumption

Data was gathered by Resident Francis Vanek. These numbers are included in the table below, which was sent to me as an excel file:

DataForSharing			Interim results			4/13/11
Year	2010		Units:	therms	(100,000btus)	
Summary of houses				kWh (for electricity		
Gas:	therms = 100,000 btu					
	Number	Avg per hse	Total SF	mbtu/SF		
Frog	30	432.42	38050	34.09		
Song	11	377.11	16972.4	24.44		avg sq ft
						added sqft for each house
Electricity: 7 houses combined from both neighborhoods						sq ft including common hs (assuming same size as frog common house
Avge per house:		3,524.1	Total SF	10638	kWH/SF:	2.32

Using these numbers, I extrapolated neighborhood-wide averages based on the energy consumption per square foot in each neighborhood (both electricity and natural gas). I then converted these numbers into BTUs.

The spreadsheet for calculating total energy for each area can be seen below.

	Per household	Per Resident	Per sq. ft
Ecovillage Ithaca	525	190	0.30
Tompkins County	901	336	0.44
NY State	977	402	0.59
Mid Atlantic Region	1174	453	0.52

Total energy consumption was adjusted for heating/cooling days, using 2010 as a base year (since this was the year EVI's data was gathered). In order to adjust, I found the percent change in heating days, and multiplied this by the % of square feet in the Northeast region heated by natural gas (50.11%). This newly created percentage was then multiplied by the total natural gas usage in order to 'normalize' the usage over different years. The same was done with cooling days, except this time I multiplied the percentage change in cooling days by the percentage of square feet in the US cooled by electric air conditioners. Using this new number, I adjusted the total cooling (electricity) usage to normalize the data over years.

Heating days	2010	2009	2008
heating days	5525	6004	5793
% change	1	1.086696833	1.048506787
adjustment factor nat gas		0.043446712	0.02430839
adjustment factor electricity		0	0
Cooling Days	2010	2009	2008

cooling days	944	540	698
% change	1	0.572033898	0.73940678
adjustment factor electricity		0.015889831	0.020539077
adjustment factor nat gas			

This method has shortcomings considering that electricity increases in ways other than air conditioning (for instance, fans) when cooling days increase. Additionally, the assumption that all natural gas is used for space heating limits the accuracy. Still, the overall numbers were adjusted less than 4%, and it does give a realistic normalization of the data, although the accuracy has flaws.

Appendix C: EVI Production

To calculate the total solar production of Ecovillage Ithaca, the first step was to calculate the total number of panels, and the watts of each panel. In the SONG neighborhood, this involved visually counting all 224 panels, and confirming through personal interview with resident Francis Vanek how many watts each panel was designed to generate. I then found the capacity of the FROG neighborhood based on personal conversation with Residents Francis Vanek and Jeff Gilmore. Then, I used the advanced system of PV Watts 2 (http://www.nrel.gov/rredc/pvwatts/grid.html), which uses recorded meteorological data for every region in the US, to predict the output of the total solar array. I did this because EVI had not tracked data for a full year, and it was more accurate to use PV Watts than to extrapolate the data they had gathered. I did check the meters in the FROG neighborhood and compare them to the estimates that PV Watts made for a similar time period, and the two numbers were very close (less than 2%). I used this as evidence of the accuracy of the PV Watts 2 program, which came recommended from an energy expert at EVI.

KWH/ Year Estimate using PV Watts 2				
	Panels	KW	Total KW	KWH/Year
FROG 50 KW			50	57,442
FROG COMMON 6 KW			6	6777
SONG Panels	224	140	31.36	35861
				KWH/Year
Total Estimated Production				100,080
Total Estimated Consumption				211,448.57

Production of energy from the solar thermal water heaters was tracked by Francis Vanek for his home. He made an estimate of the total energy saved each year, and I used this to extrapolate the energy production of the other solar thermal unit as well the total of the two.

Appendix D: Twin Oaks Production

Production estimates from Twin Oaks for solar electricity were taken directly from the inverters connected to the 10.8 KW solar array, which display real-time feed data from the panels. The panels had been installed exactly 2 years (730 days) when I read the data, which made it very easy to determine the yearly production of the panels (16,596 KWh).

The estimates for production of wood have already been explained in Appendix E. (Since Twin Oaks consumes all the wood they produce, the numbers are equivalent).

	Production	Consumption		
	9610	23203	41.4%	
	Wood	Electricity	LPG	
Production	9043	566		9610
Consumption	9043	6407	7754	23203

Appendix E: Twin Oaks Consumption

Twin Oaks consumption was estimated using the spreadsheets from the community, which were compilations of electricity and LPG usage during the past 5 years. To estimate the use of wood, extensive interviews were conducted with several experienced members of the Twin Oaks Forestry team, including Purl, McCune, and Valerie. From these conversations and the records of the forestry team, an average yearly chord consumption/ production was estimated.

Then I had to find the square footage of each residential building. This was done using a tape measure and graph paper. Attached to this appendix are the drawings I made of the buildings, which have been turned over to the community for their future use.

Energy consumption per square foot was then calculated based on square footage measurements made during the research period. Because some residences at TO also serve as commercial business areas, each building's energy consumption per square foot was used to separate residential from commercial energy use. This required the assumption that energy use is proportional by square foot in both the residential and commercial areas of each building. While this assumption is not likely to hold true, it was the most feasible, accurate way of determining residential consumption.

The total energy consumption was then calculated by finding a BTU/Square Foot estimate for each building (dividing total energy use – both electricity and LPG – by the area of the building), and then subtracting the energy use from 'commercial or industrial' areas – leaving only the 'residential' energy consumption. Wood was treated as though it was used equally (by area) among residences.

Years	Wood	Electricity	LPG	Total
2007	9043	6963	8286	24292
2008	9043	6998	9227	25268
2009	9043	7200	8233	24477
2010	9043	6773	8634	24451
2011	9043	6407	7754	23203

When comparing Twin Oaks to the surrounding State and Region (County data was not available), the electricity consumption from 2009 was used, since this was the year of data collection for both the state and region. In this way, no adjustments were needed for cooling/heating days.

Appendix F: EPA Grant

The Environmental Protection Agency (EPA) has awarded EVI - in coordination with Tompkins County and the City of Ithaca - a grant of $375,450, with matching funds of $188,650 from County and partner organizations, as an investment in energy efficient neighborhoods (EVI, 2011). The grant will be spread over a period of three years, and will involve funding for empirical research, investigations into how to replicate the accomplishments of EVI consumption reductions elsewhere, and marketing and outreach funds to increase interest in the community for co-housing projects similar to EVI (Walker, personal communication, May 14, 2012; Appendix F).

The funds will involve three pilot projects: TREE, EVI's planned third neighborhood, development of urban county land for a small co-housing community, and Aurora Pocket neighborhood (a renovation/rebuilding project). In this way, the project will test not only the creation of energy efficient neighborhoods from scratch, but also the modification of existing buildings (in-fill). The grant provides funding to install smart grids, monitor data, test energy consumption 1 year before and after move-in, and elicit surveys of quality of life before and after move in (Walker, personal communication, May 14, 2012). According to the grant writer Liz Walker there are three target markets for the marketing/outreach funds involved with the grant: the general public (to increase demand for such housing), development communities (to increase developer interest in such projects), and local governments (to increase local investment, and possibly ease regulatory restrictions) (*Ibid*).

Appendix G: List of Interviewees and Dates
(Presented in random order):

Purl, personal communication, May 30, 2012

Vanek, personal communication, May 17, 2012

Shal, personal communication, May 27, 2012

Mikey, personal communication, June 2, 2012

Calvin, personal communication, June 1, 2012

Gilmore, personal communication, May 12, 2012

Alexis, personal communication, June 2, 2012

John, personal communication, December 22, 2011

McCune, personal communication, June 4, 2012

Valerie, personal communication, June 5, 2012

Walker, personal communication, May 14, 2012

Franke, personal communication, May 10, 2012

Keenan, personal communication, June 1, 2012

Tony, personal communication, May 29^{th}, 2012

Gordon, personal communication, 5/22/12

Ethan, personal communication, May 28, 2012

Rick, personal communication, May 30, 2012

Goodman, personal communication, May 18, 2012