UNIVERSITY OF CALGARY

Community-Oriented Sustainable Energy Enterprises

by

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CERTIFICATE OF COMPLETION OF INDIVIDUAL PROJECT

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, the Individual Project Report entitled "**Community-Oriented Sustainable Energy Enterprises**" submitted by **Mitchell Douglas Hall** in partial fulfillment of the requirements for the degree of Master of Science in Sustainable Energy Development.

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ABSTRACT

Transitioning to a more sustainable energy paradigm requires a myriad of mechanisms and approaches. Based on current technology and resources, no one solution exists to replace fossil-fuels. Rooted in this transition is the idea of decentralizing energy production. This paper examines why our current energy paradigm is vulnerable and provides an in-depth analysis of how communities in developed regions can become more sustainable and resilient. The approach discussed utilizes the concept of a community-oriented sustainable energy enterprise. This enterprise seeks to implement renewable energy production within communities while maximizing social welfare and increasing local resilience. A proof-of-concept case study is presented to demonstrate how these implementations can be desirable from an environmental, social, and economic perspective.

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Glossary of Terms / Acronyms

COSEE - Community-Oriented Sustainable Energy Enterprise

COE - Community-Oriented Enterprise

EROEI - Energy Returned on Energy Invested

IOU - Investor Owned Utilities

PGEMC - Pitt and Greene Electric Membership Corporation

REPS - Renewable Energy and Energy Efficiency Portfolio Standard

RETs - Renewable-energy and Energy-efficient Technologies

RETScreen – Renewable-energy and Energy-efficient Technologies Screen

THE PROBLEM

As a world society sits astraddle between two eras: life continuing primarily reliant on fossil-fuels as it has for over a century or a new paradigm with a different energy portfolio strategy. Within these two eras exists 4 paradigms popularized by Robert Costanza and others: Star Trek, Ecotopia, Big Government, and Mad Max (Four Visions of the Century Ahead: Will it be Star Trek, Ecotopia, Big Government, or Mad Max, 1999). These scenarios factor in the impacts of technology, social change, and governmental participation with relation to the future state of humankind. This state ranges from a collapse of the environment and society to a perfect utopia in balance with nature. Historically, the public has been waiting for large private organizations and/or governments to provide and implement solutions (Star Trek, Big Government) while these organizations do not feel compelled to do so arguing public demand has not demonstrated this desire effectively (Ecotopia) (Costanza, et al., 2000). It is argued that the ongoing discussions over climate change and energy sources has stifled the level of commitment needed to incite the significant changes required for transitioning into a new stage of human existence (Costanza, et al., 2000). Granted efforts are being made but as discussed by the author of Consumption Opportunities and the policy on sustainable lifestyles for the UN Environment Programme, John Manoochehri; in comparison to other large endeavours society has successfully undertook such as space exploration, computer advancements, or urbanization; the sustainability movement is lagging (Manoochehri, 2009).

Supporting and implementing alternative energy systems has traditionally been perceived as sacrificial within our current economic and social model. Allowing for a generalization, many feel that utilizing renewable resources will ultimately create a strain on their life or business and can increase financial vulnerability (Porter & Linde, 1995) (Hall & Vredenburg, 2003). It must be noted that both the works by Porter & Linde and Hall & Vredenburg ultimately discuss strategies for moving past these perceptions. Energy is often viewed as security. Constant and relatively inexpensive energy-on-demand has allowed society to sustain the current way of life for the past century and it is believed by some that the transition to greater renewable energy reliance will require too much sacrifice (Walley & Whitehead, 1994). Unfortunately though these perceptions can reduce the likelihood that mankind will selflessly act unilaterally to create a sustainable future. One may say that this suggestion devalues the idealism of human compassion and progressive societal development, but in reality this essay conveys realistic optimism. As a whole it should be assumed that people desire to change for the better, but often as individuals demand minimal sacrifices to make these changes.

THE SOLUTION

One goal of this paper is to push communities to create a more balanced and sustainable mix of electrical energy sources for their members. This would promote the use of renewable energy and community ownership of their electrical energy portfolios, alleviating the heavy reliance on large private and public power production. It must be noted that the primary focus will be on developing a better energy portfolio in areas where there is already high energy usage rather than providing energy to those that do not have it yet. There will be several mechanisms presented to make this initiative feasible and successful.

This paper will review and build upon innovative approaches to subtly, but effectively drive society towards a more sustainable future through decentralized approaches. With the proper mechanisms in place during the transition, the traditional economic reward structures can be grandfathered in coupled with direct benefits at the local and individual level. Some of the ideas presented are not necessarily new, but are somewhat infantile in their permeation throughout the world.

OBJECTIVES

There are several objectives that will be met throughout this paper. The first objective will be focused on the question of why it is imperative that a new approach be used to change the energy paradigm. This is meant to engage the reader as to why there is a need for a shift in the paradigm. The second objective will consider the topic of sustainability and expand on previous concepts in order to highlight where the prevailing definitions are not complete. This part examines the aspect of sustainability in modern society. In order to be sustainable, it's important to factor in not only the needs of society, but also wants and salience. Building on the idea of sustainability, the next objective is to explore resilience, which this paper argues should be the ultimate goal for a community. The concepts proposed in this paper represent a crucial component for achieving resilience as a whole. Entering into the practical application part of the paper, a proof-of-concept will be presented for a community-oriented sustainable energy enterprise. Meeting this objective will demonstrate how communities can move in the direction of greater resilience without significant sacrifice. Lastly, strategies will be proposed for implementing and propagating this approach for communities and related sectors. More is discussed about these objectives starting the next sub-section. By meeting these objectives, the possibility for integrating community-oriented sustainable energy enterprises into society in general will become more realistic.

The Paradigm Needs an Adjustment

In order to spur communities – and ultimately society as a whole – towards a more sustainable future through community-oriented enterprises; it is important to demonstrate why there is a need for change. In the vulnerability section, the present and the future threats facing our modern civilization will be discussed. They include the concept of peak oil, energy return on energy invested (EROEI), environmental effects, and political/economic trends.

Awareness of the potential dangers must be established before any modifications in behaviours will occur. This section is meant to expose some of the underlying reasons why society must evolve past the way of existence established over the past century.

Modernize the Sustainability Concept

Although there are many definitions that exist for sustainability, this paper will examine some of the more popular as well as various interpretations. Then other factors to consider will be discussed, especially relative to this paper and initiative. This includes understanding what is important to sustain for individuals, communities, and society as a whole.

Resilience

While sustainability is important, the ultimate goal is resilience. This idea will be discussed further, but basically resilience provides an entity with the ability to survive and thrive in an ever-changing world. There are major initiatives worldwide that are investing heavily in resilience investigation and building such as the the Community and Regional Resilience Institute (CARRI) who states, "[the institute] believes that resilient communities are the foundation of a strong and resilient nation" (Community & Regional Resilience Institute, 2010). This group works closely with the US Department of Homeland Security and the US Department of Energy. Resilience is fundamental in the bigger picture for humanity's existence.

Community-Oriented Sustainable Energy Enterprise (COSEE)

The following section discusses the paper's core features for shifting towards a new paradigm going forward. While this is not a silver bullet solution right away, over time it can provide a means for transitioning to a more sustainable and resilient livelihood. There are many other external movements and factors that are vital contributions towards a sustainable future. This paper seeks to develop the idea of community-oriented energy enterprises not only as one medium for arriving to this desirable future, but actually providing a realistic and preferable way of sustaining it.

The paper will demonstrate the feasibility of implementing this model through a proof-of-concept case. Basing the research on a relatively typical community in North Carolina (United States), the RETScreen software (discussed below) will be utilized along with financial tools available in the US at the national, state, and local levels. The initial project will focus on producing energy to simply sell back to the grid at a premium. Through reinvestment, in all hopes, subsequent projects would be able to provide energy directly to the community instead of indirectly from the grid. Overtime, this would help the community become more locally independent and resilient. The objective in this approach therefore is to hypothetically create a sustainable project that achieves the following:

- Realizes enough income to payback the start-up costs in a reasonable time as well as produce a reasonable rate of return to entice socially responsible investors.
- Cover maintenance costs.
- Gain enough profits to contribute towards community endeavours and/or further sustainable energy development.
- Furthermore, it is important to demonstrate the environmental and social enhancements that are coupled with the projects. This can be analyzed using existing empirical data in comparison with the data produced from the hypothetical scenario.
- Qualitative social and environmental benefits will be included in the analysis.

STRATEGY

Going through the exercise of meeting the objectives mentioned above will provide a foundation to present a strategy for the energy industry, sustainable energy sectors, and local community-oriented energy enterprises. This section essentially describes the way forward in order to bring the ideas and plans discussed to fruition.

ASSUMPTIONS AND DEFICIENCIES

For each of the sections found in the methodology, assumptions will be highlighted where applicable and examine deficiencies in the process as well. In the results section, a summary analysis will also be presented for these two areas.

Interdisciplinary Aspects

This paper will cover many academic aspects related to sustainable energy development. In order to properly develop a ***sustainable energy*** paradigm for a community, technical research and analysis must be done on various ***energy systems*** and the RETScreen software discussed later (refer to *RETScreen* in Methodology section). Furthermore, while there are many intrinsic environmental aspects associated with the proposed model, it is also necessary to explicitly and numerically demonstrate ***environmental*** benefits and impacts where applicable. The ***social*** and ***economical*** arenas will play a major part in the roles of community participation and the social enterprise business structure. Strategies will be proposed for sustainable industries, the sustainable energy sector, and community-oriented energy enterprises. ***Political*** strategies will also be developed where relevant in accordance with regulations, subsidies, and environmental policies.

Understanding the Current Paradigm, Risks, and Associated Ideologies

"It's always going to be difficult to come up with sustainable ways to support our unsustainable lifestyle"

(Wyman, 2008)

Our heavy reliance on the fossil-fuel model is continuing to destabilize the economy, environment, and society. Experiencing the impact and discomfort resulting from polluted air, water, and land *should* incite discontent. Enduring difficulties on the economic rollercoaster *should* encourage civilization to slow down before being thrown from the track. Significant uneven distributions of resources in some regions causing disparities between those without basic needs and those with excess *should* compel us to recognize that there is a different way of doing things. So, why do people not do what they *should* do?

One of the reasons could be attributed to the fact that these circumstances did not develop instantaneously but were rather seductive in their permeation, similar to an addictive drug for a user. Often the user does not realize that they are addicted until it is too late to easily wean his or herself from the dependence. Due to the immediate benefits fossil-fuels provided and the ease in which their applications were proliferated, it's no wonder that it took little time before society found themselves completely reliant on these resources. In under a century society left behind the ability to live without heavy dependence on fossil-fuels for transportation, materials, and industry. This transition occurred so swiftly and indiscreetly that much of society came to accept this way of living perhaps without even realizing it, but still continue to support this addiction regardless. This is demonstrated all too often by the lack of effort to make sacrifice and the resistance to change imposed by industry and politicians. Complacency, denial of addiction, and continued reliance on fossil-fuels is exactly what the "dealers" want. Unfortunately the analogous drug supply is diminishing and the alternatives needed for the weaning process are not yet available. Can mankind sustain?

VULNERABILITY

Currently, the majority of most western communities depend on external resources for almost all their livelihood. Products used everyday come from all over the globe and are relatively easy to obtain from a logistical perspective. Energy is delivered directly to our houses and businesses through the power grid. This energy generally is produced from large centralized power plants. It is also comparatively inexpensive considering the amount of instantaneous energy delivered from sources such as oil, coal, and nuclear. But, imagine a world where fuel prices skyrocket due to diminishing supplies or political influence for instance. It no longer becomes easy and inexpensive to deliver food, energy, or even household matches across vast distances. Electricity from the larger plants, including alternative energy installations, will be increasingly directed towards the wealthy as well as vital operations for society such as hospitals. This leaves less energy for the common home or business. Yes this may seem overly dramatic, but as noted below, energy crises have occurred before with dire consequences.

There are many definitions of vulnerability and can relate to various levels and scales of society. Merriam-Webster defines it generically as "capable of being physically or emotionally wounded [or] open to attack or damage" (Merriam-Webster, 2010). While this definition can apply within the framework of this paper, it will need to be focused a little more to establish a working context specific to the topic.

For the purpose of this work, vulnerability refers to the susceptibility of a community's continued sustainability from the external influence of energy supplies and pricing. As mentioned, many aspects at the community level are vulnerable to these influences. Businesses rely on power and transportation fuels provided primarily from external sources. Increases in energy prices and decreases in availability will impact local economies directly. Scarcity of energy can cause social upheaval pitting neighbours against each other as well as neighbouring communities. Energy distribution disparity could cause a general breakdown of the economy and society. This has already been seen in some areas of the world as discussed by Rob Hopkins below.

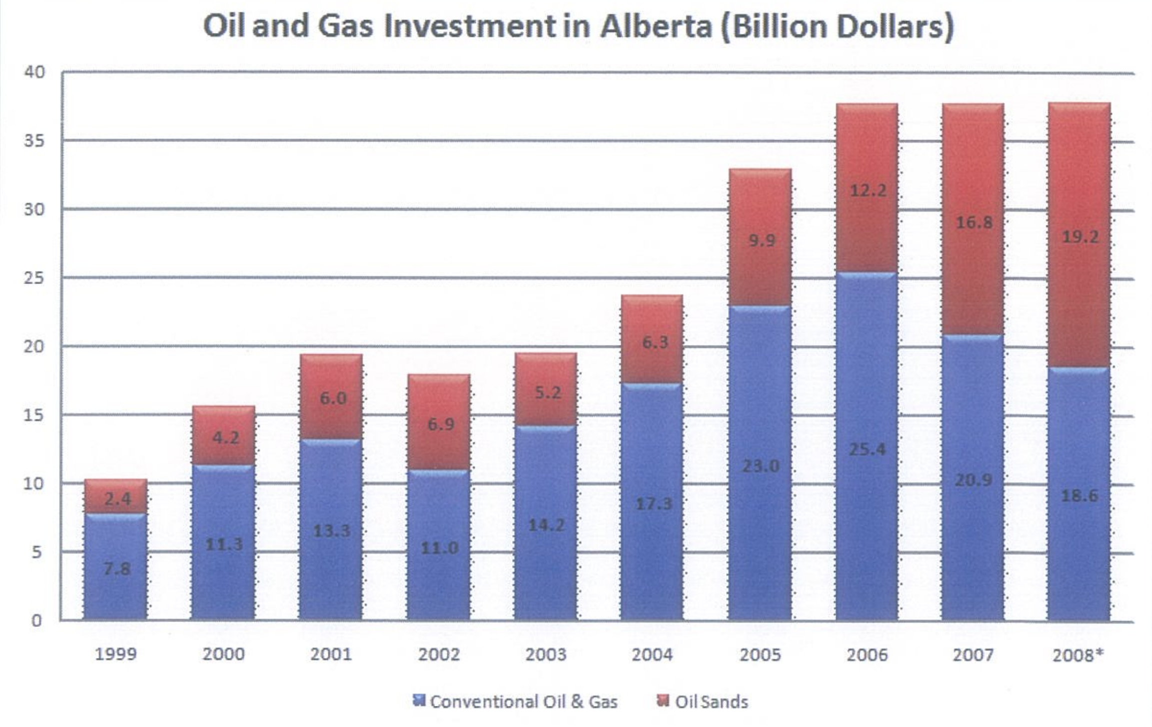
"Argentina is facing its worst energy shortage for twenty years, with widespread power cuts and natural gas shortages affecting public transport. Power cuts in Pakistan have led to riots, and in Iraq some provincial officials have begun disconnecting power stations from the national grid so as to keep the energy generated to themselves. Iran has introduced petrol rationing, and the UN recently warned the Sri Lankan Government that they will be unable to continue their humanitarian work in the country due to fuel shortages. In Uganda, grid power shortages have shut down the pipeline which brings diesel into the country from Kenya, a kind of peak oil 'feedback loop'.

In Nigeria only 19 out of 79 power plants work, and blackouts cost the economy $1 billion a year. Nicaragua is now running at a national energy deficit of 20-30%, with the national energy company having to shut down whole cities for 6-10 hours at a time. Costa Rica has regular blackouts, as does the Dominican Republic, where blackouts which originally only affected the poor barrio districts now extend to the exclusive residential districts."

(Hopkins, 2008, p. 40)

Furthermore, continued strains on traditional fuel supplies have forced governments and organizations to expand exploration and productions sites such as off-shore drilling and oil sands extraction. Figure 1 provides an example of this trend in Alberta, Canada. This continues to have a detrimental effect on the environment and these operations are increasingly encroaching on communities' "backyards".

FIGURE 1 - OIL AND GAS INVESTMENT IN ALBERTA



*Source: Statistics Canada, Public and Private Investment in Canada (*2008 data are preliminary actual)*

Governments and private energy companies have been incorporating energy vulnerability concepts into their policies and strategies for decades (Hirsch, 2005) (Progress Energy, Inc., 2010). Citizens of these countries, especially developed ones have generally relied on these organizations to ensure there is energy available and relatively affordable (State Energy Office, North Carolina Department of Administration, Appalachian State University Energy Center, 2005). As outlined below, there is good reason to believe that this model will encounter significant difficulties in the near future.

PEAK OIL

"Climate change says we should change, whereas peak oil says we will be forced to change."

(Hopkins, 2008)

The reality of peak oil seems to finally be permeating throughout mainstream society. The idea originally made public by Dr. M. King Hubbert around 1949 was used to estimate conventional oil production capabilities for the continental US, which he stated would peak somewhere between 1965 and 1970 (Hubbert, 1956). Although quite controversial initially, it came to pass that he was for the most part correct. He also estimated the world production based on proven and estimated reserves to peak about a half century later. Although the debate continues about world peak oil timelines, it is commonly accepted that petroleum is a finite resource (Hirsch, 2005).

The effects of dips in oil supplies and/or increases in petroleum prices have already been experienced in the past. The 1970's energy crisis came about due to two major events: the 1973 Arab oil embargo by OAPEC (Organization of Arab Petroleum Exporting Countries) and the Iranian revolution in 1979 (Hopkins, 2008). Furthermore, this decade was filled with tremendous shock and speculation related to the controversial peak oil period for the US. Many western countries fell into an economic recession during this decade, which most economists attribute to the energy situation. Many fear, including the authors of "The Coming Economic Collapse" (Leeb & Strathy, 2006), that the next energy crisis will be permanent due to the decreasing availability of easily accessible petroleum reserves.

More and more findings support the notion that humans are within the peak period currently. The US Energy Information Administration – notoriously reluctant to push peak oil ideas – released an eye-opening chart in their Annual Energy Outlook for 2009 Figure 2. The 2030 figure estimates 43 million barrels per day of world liquid fuel supply. This number is significantly lower than their own estimates for 2030 conventional oil production in their annual International Energy Outlook publications as summarized in Table 1.

FIGURE 2 - EIA ANNUAL ENERGY OUTLOOK 2009

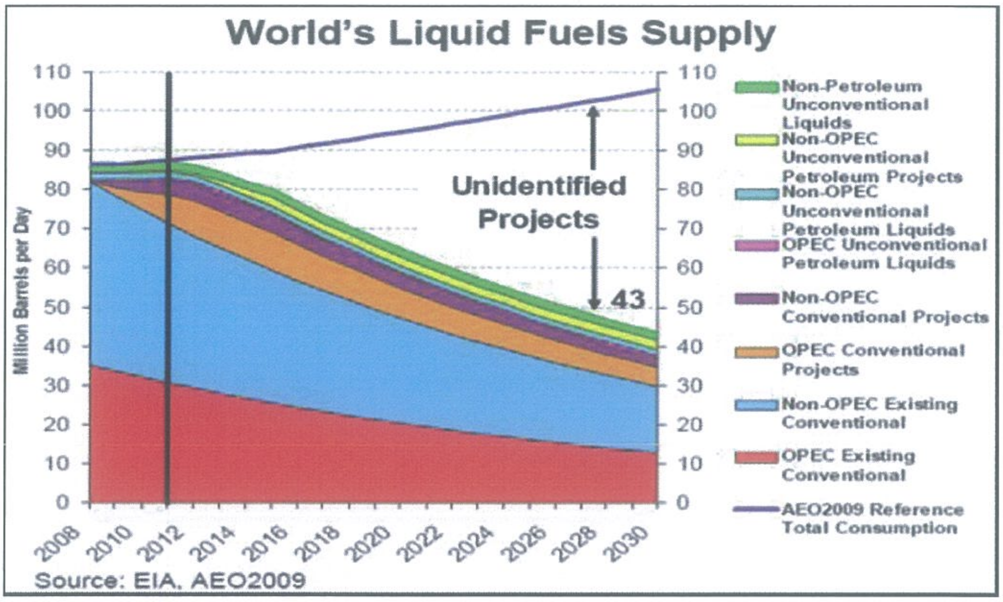
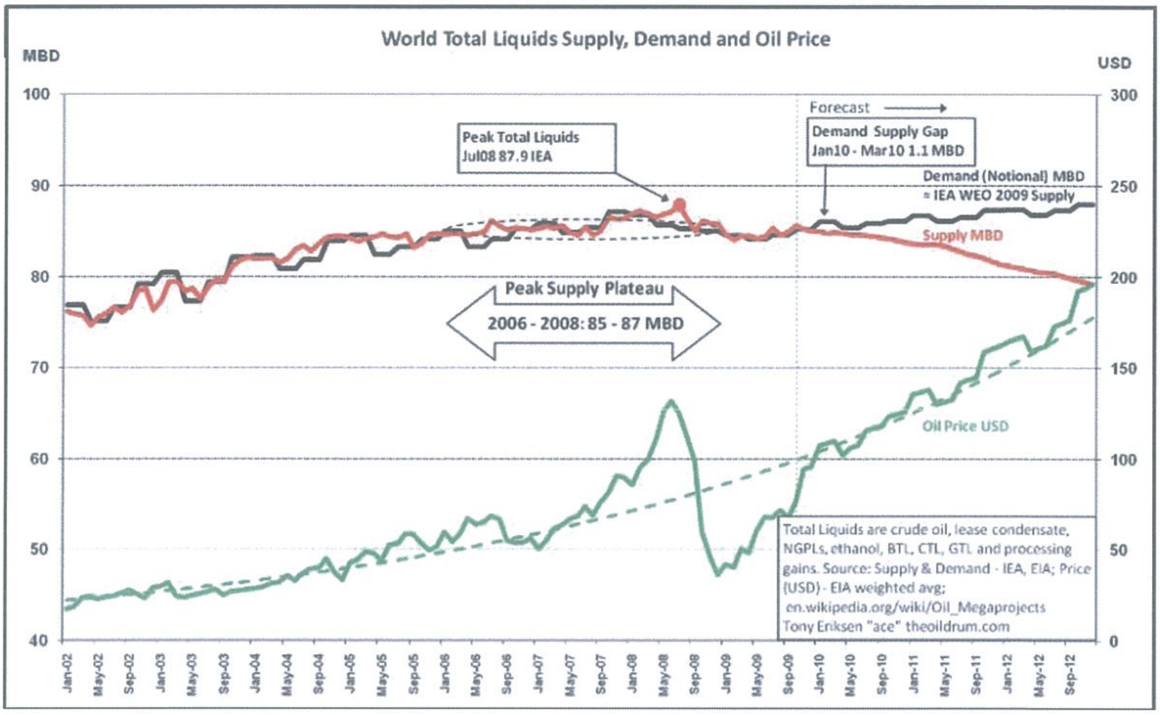


TABLE 1 – EIA INTERNATIONAL ENERGY OUTLOOK (CONVENTIONAL OIL PRODUCTION ESTIMATE FOR 2030)

Year	Amount (mil b/d)
2007	107.5
2008	102.9
2009	93.1

Obviously there are some significant differences in these estimates, but without exploring why these discrepancies exist, the primary point can be extracted still. Basically, liquid fuel production (especially conventional) will be decreasing over the next 20 years substantially while consumption demand will be increasing significantly. The chart below (Figure 3) reveals a condensed timeframe, updated as of November 2009. It demonstrates a more aggressive split between supply and demand starting around mid 2010. You can also see that even though there have been some fluctuations, the oil price trend line shows a steady increase over the 10 year period with an increasing rate projected after 2010.

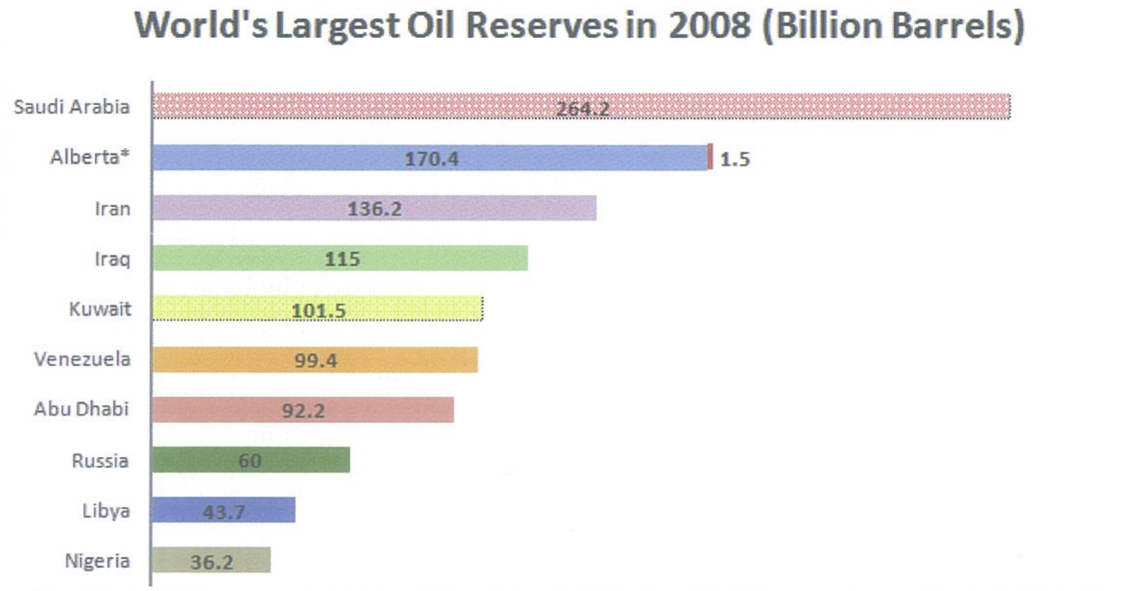
FIGURE 3 - WORLD TOTAL LIQUIDS SUPPLY, DEMAND AND OIL PRICE (HTTP://CANADA.THEOILDRUM.COM/NODE/5979)



Further evidence exists to support the trends discussed. The five year average size of oil fields found as of 1940 was 1.5 billion barrels. By 1960 it had fallen to 300 million barrels and by 2004, 45 million (Strahan, 2007, p. 62). The latest big find is the Canadian oil sands which have only recently become financially viable due to the decreasing supply of conventional sources. This oil is one of the most energy and water intensive approaches for extracting oil. It is estimated that the Alberta oil sands contains around 170 billion barrels of oil (Figure 4). World demand of liquid petroleum is about 86 million barrels per day (US Energy Information Administration, 2009, p. 126), or almost 32 billion barrels per year. Performing a little math, the oil sands supply is equivalent to about 5.4 years of fuel assuming no increase in demand, which is obviously not a correct assumption.

The more difficult and costly to extract oil the less private investors will be willing to take on projects. Some endeavours already approach exceeding the limit of energy input to energy extracted, with a similar cost/benefit relationship (Hall & Lambert, 2005) (Hopkins, 2008). This places a heavy burden on governments to subsidize efforts and ensure the energy demands of their citizens are met. As mentioned earlier, the current model of large private and government energy management that people have relied on over the last century seems to be threatened (Hirsch, 2005).

FIGURE 4 - WORLD'S LARGEST OIL RESERVES IN 2008



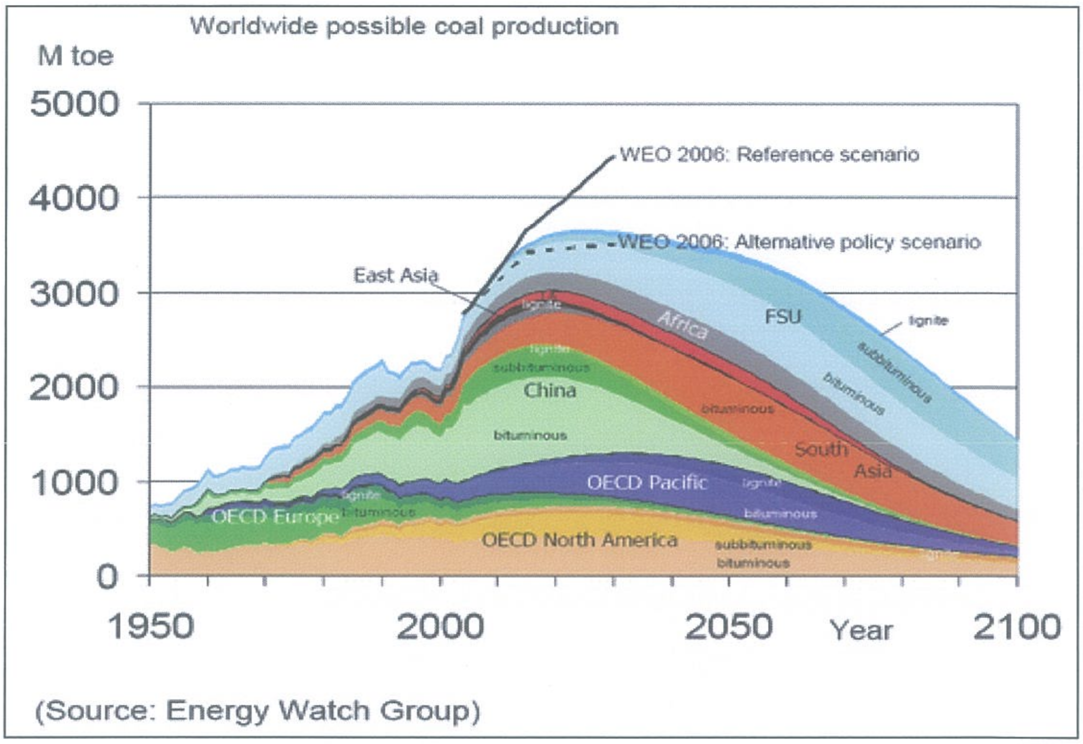
*Alberta's total oil reserves were 171.8 billion barrels, of which crude bitumen reserves accounted for 170.4 billion barrels and conventional crude oil reserves for 1.5 billion barrels (note: totals do not add up due to rounding)

Sources: ERCB 2009 ST-98 Report "Alberta's Energy Reserves 2008 and Supply/Demand Outlook 2009 - 2018" and Oil & Gas Journal "Worldwide Look at Reserves and Production. Special Report", December 22, 2008, Vol. 106, Issue 48

PEAK [FILL IN THE BLANK]

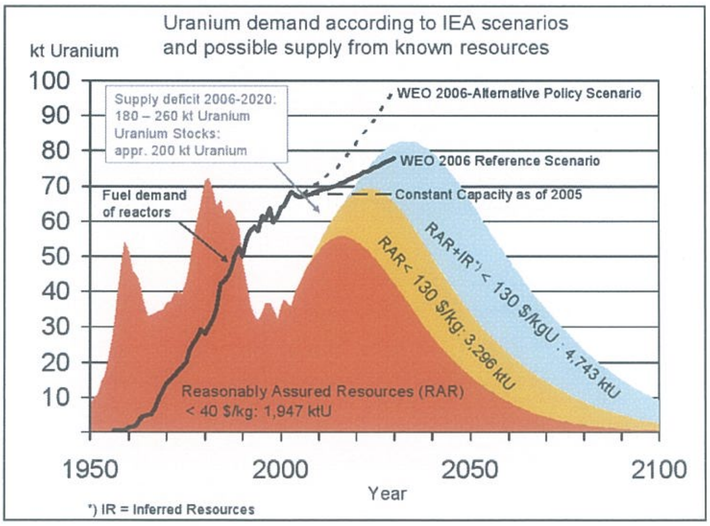
With the declining traditional oil supplies, many private organizations and governments are looking towards other fossil-fuels to fill the energy demand gap. Coal is still in high production even though it is one of the "dirtiest" fuel sources in the world. Its potential peaking must be considered as well. The Energy Watch Group released a report in 2007 saying that coal production could peak in 2025 (Figure 5).

FIGURE 5 - WORLDWIDE COAL PRODUCTION



Uranium supplies, which fuel the current nuclear technology, should also be examined. According to Figure 6 below, peak uranium should occur no later than 2040, but supplies will last beyond 2100.

FIGURE 6 – URANIUM DEMAND ACCORDING TO IEA SCENARIOS AND POSSIBLE SUPPLY FROM KNOWN RESOURCES (HTTP://WWW.THEOILDRUM.COM/NODE/2379)



The primary takeaway point related to peak oil and other fuels is that while it is debatable as to when the actual peak is and how long oil will be available after that, it is difficult to deny that supplies will be diminishing within the next 10-20 years (Hirsch, 2005). This will result in higher fuel prices and energy shortages in general making alternative energy plans not only more attractive, but necessary for sustaining society (Leitch, 2008).

NET ENERGY (EROEI)

Not only are overall fossil-fuel supplies and prices important in the consideration of energy models, the net energy and Energy Return on Energy Invested (EROEI or EROI) is equally significant. EROEI essentially represents the energy received from some source in ratio to the energy expended in obtaining that unit of energy.

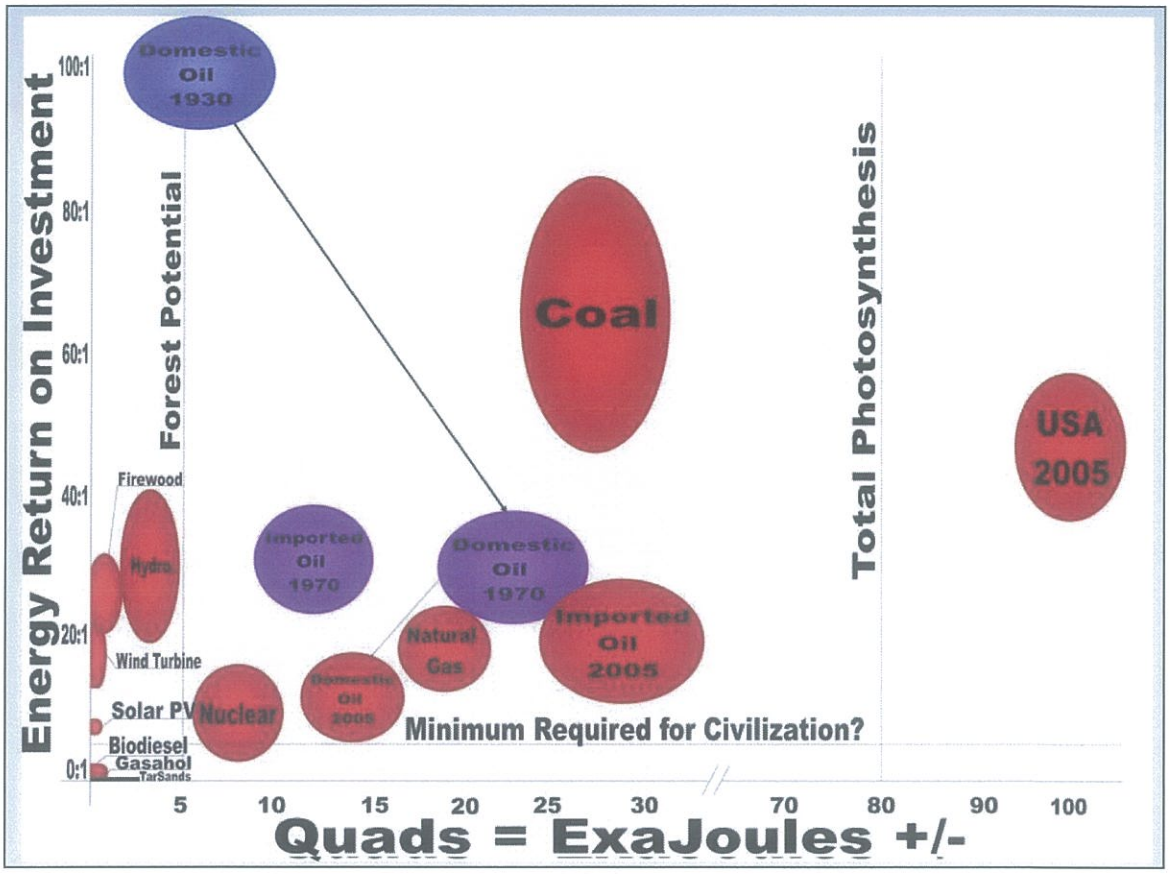
$$EROEI = \frac{Usable\ Output\ Energy}{Input\ Energy}$$

$$Net\ Energy = Usable\ Output\ Energy - Input\ Energy$$

As alluded to earlier, conventional energy sources are becoming more difficult to find and extract, thus requiring more input energy. Figure 7 represents the EROEI for the US as of 2005. This graph is frequently used in EROEI discussions and papers. Historically fossil-fuels have had the greatest EROEI with oil in the 1930's delivering a 90-100:1 ratio. This means that for every 1 unit of energy put into extracting and refining oil, about 90-100 equivalent units would be returned. It's no wonder oil became so prominent as the world's primary energy source. Keep in mind that one gallon of gasoline "has the equivalent energy of a man working for 600 hours; that would be 75 eight-hour days" (Visalli, 2006). In the 1970's oil and gas EROEI dropped to around 30:1 with it currently hovering around 10-22:1. Representing a major source for future energy supplies, the oil sands are around 2-4:1 depending on the reference source.

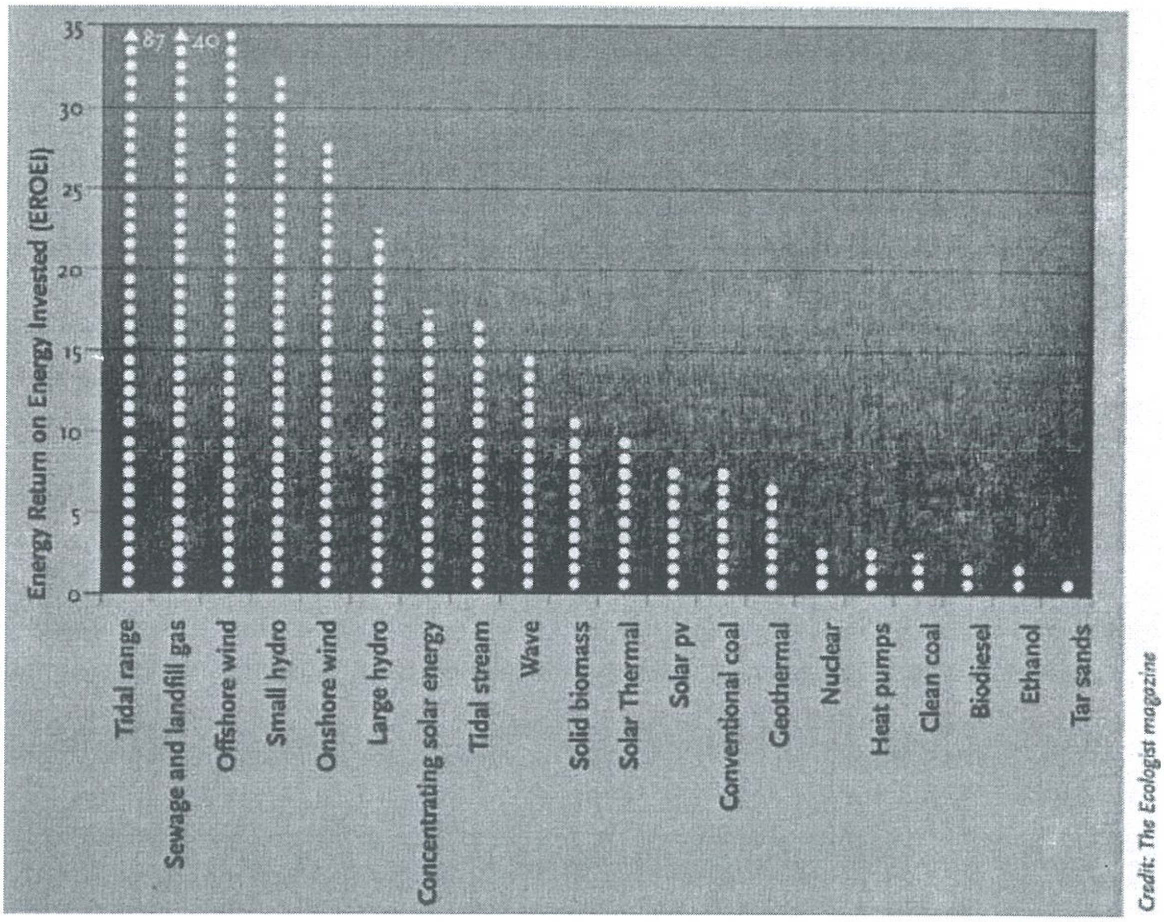
Comparing these figures with some of the more established renewable energy sources found in the same chart such as hydropower, wind, and solar; the gap has decreased considerably since the 1930's. Hydropower now holds one of the higher rankings for EROEI with 20-40:1. Wind turbines are equivalent or better than current oil and gas with an average 19:1 ratio as of 2005.

FIGURE 7 - POPULAR REPRESENTATION OF EROI FOR ENERGY RESOURCES IN THE US (HALL & LAMBERT, 2005)



Examining Figure 8, which is a more modern version of similar data, there are quite a few alternatives to oil and gas with reference to usable net energy. It also includes categories for Sewage and Landfill Gas, Concentrated Solar along much higher EROEI figures for wind farms. This should be expected due to improved technology and discovery of better areas for natural energy sources. Note there are some discrepancies such as the figures for Coal, but the numbers still generally reflect the same EROEI relationship when compared to oil and gas.

FIGURE 8 - ENERGY RETURN ON ENERGY INVESTED (HOPKINS, 2008, P. 51)



While these figures demonstrate vulnerability from a pure net energy perspective, they do not by themselves substantiate the argument for an immediate conversion away from traditional fossil-fuel sources. The attractiveness of oil and gas over the years has been its versatility. It can be used to power engines including automobiles and tractors, heat homes and produce electricity. Petroleum derivatives are involved in almost every item used daily either directly or indirectly. Thousands of years of stored solar energy can be used instantaneously. The return on energy is relatively immediate as compared to renewable energy resources. For example, take a wind farm with an EROEI ratio of 20:1 and a lifetime of 20 years. The construction and installation phase requires the most energy up front (1 unit) and it will take 20 years to get the other 19 units in total! This requires a significant upfront investment of not only finances, but energy as well. For this reason, it is important to ramp-up the use of renewable energy while there is still a cache of traditional instantaneous energy sources.

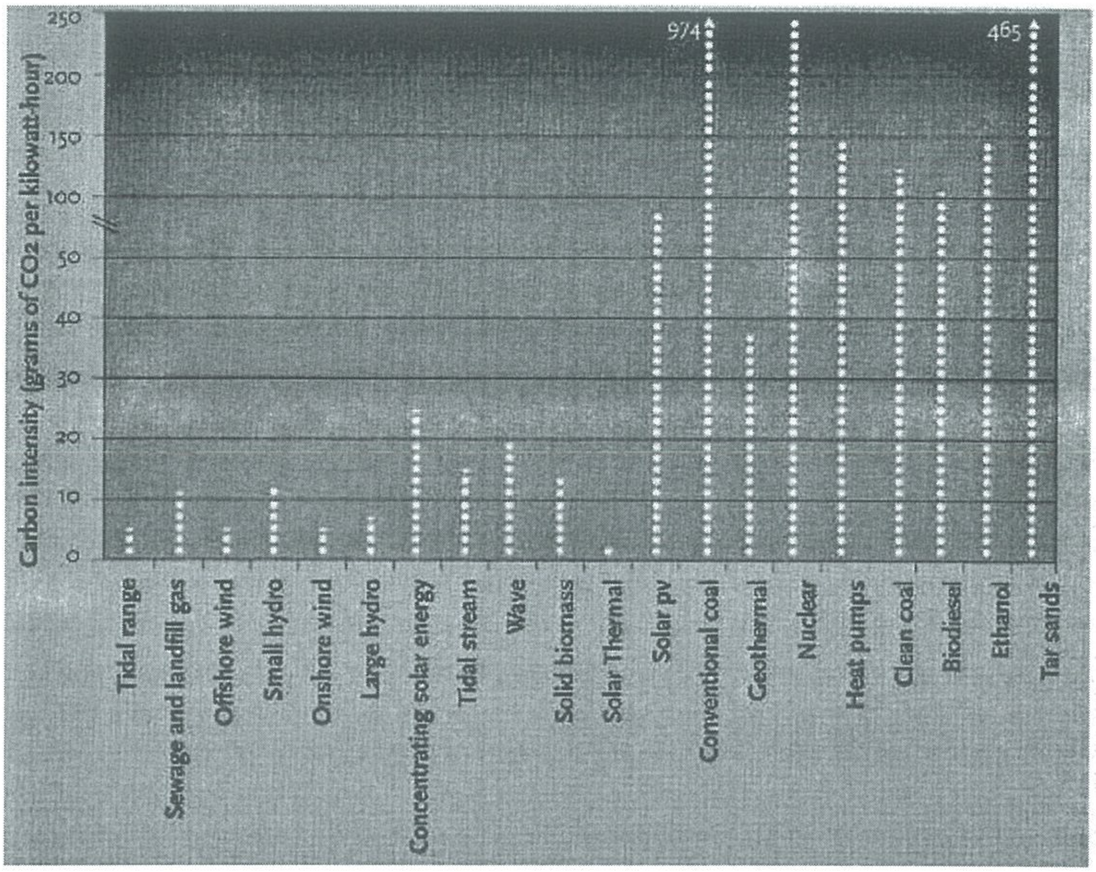
Conventional fossil fuels are indeed not easy energy sources to replace. Wind cannot be put directly into a gas tank and water cannot produce heat directly, but can be used for hydro power which can ultimately produce electricity. New energy models will need to rethink how to efficiently convert renewable resources into practical energy. This will require some restructuring of our lifestyle such as using electric cars instead of gas-powered. Covering every aspect of the new energy model is beyond the scope of this paper. Rather, the focus will be on replacing portions or all of the energy used by homes and businesses for electricity and temperature management.

ENVIRONMENT

Of course there is an environmental aspect related to vulnerability. This exists all along the continuum of broad and narrow perspectives. Without much argument, it is fairly safe to state that our choices for energy sources have an effect on the global ecosystem. The extent of the impacts will continue to be debated in classrooms, political arenas, and scientific forums for some time. As the reader has already seen in this paper, there are many contradictions within all areas of environmental sciences. Regardless, the primary point of the discussion is to emphasize that there are some generally accepted negative environmental impacts which can be managed better to create an improved way of life.

Taking for instance the energy sources used in Figure 8, a similar chart can be seen showing the carbon intensity for these different resources (Figure 9). As you can see here, coal has a large carbon footprint and considering its relatively lower EROEI, it does not seem to be the best solution to meet future energy demands from an environmental perspective.

FIGURE 9 – CARBON INTENSITY FOOTPRINTS (HOPKINS, 2008, P. 52)



For the most part, energy extraction production has traditionally been isolated from society as a whole. Communities surrounding large power plants or fuel extraction operations for the fossil-fuel industry may experience direct effects, but the vast majority of the populations do not live near these facilities or projects. Often the repercussions of the global energy demand are not realized in daily living. Sure many hear reports on television and may even see some direct effects occasionally. Electricity is used in our homes quite liberally, with the utility bill being really the only major thought of constraint. Conversely, producing energy locally can provide a more direct link between home usage, energy supply, and potential environmental effects. This link can create higher degrees of awareness and therefore improved behavioural adaptations.

This paper will demonstrate that along with the benefits of having energy resilience, a community can also directly reduce the negative environmental effects associated with many traditional sources such as fossil-fuels. These include harmful emissions, land and water pollution as well as natural resource preservation.

Government and Private Roles

"Other forms of vulnerability are less obvious. For example, in the 1970's, Middle Eastern nationalism, combined with the nationalization and appropriation of international oil company assets, as well as the formation of an international oil cartel (the Organization of Petroleum Exporting Countries, OPEC), resulted in oil embargoes. Also, the United States continued consuming more total petroleum while domestic sources provided a decreasing percentage. The 1970s reduced supply of petroleum in American markets appeared to happen suddenly but in fact, followed years of increasing vulnerability. That vulnerability was partially obscured by U.S. petroleum price controls. At the beginning of the 21st century, renewed political and military issues in the Middle East again increased vulnerability. However, American price controls are gone. Future supply shortages will be accompanied, and probably resolved, by higher petroleum prices. If price does not contain demand, curtailment and other mandatory controls may be needed"

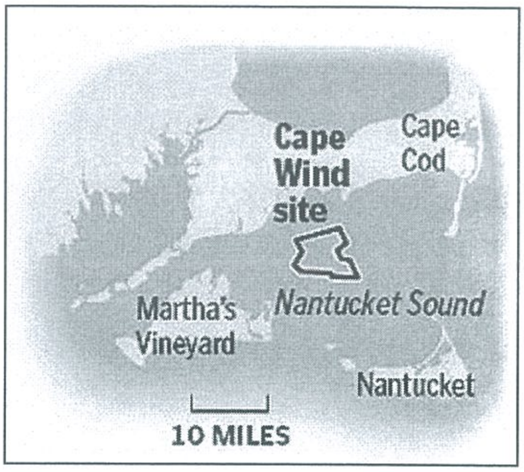
(State Energy Office, North Carolina Department of Administration, 2003, p. 11)

The transition to alternative energy production has not been a top priority for many governments and large energy companies in general (Costanza, et al., 2000). While the US will not be solely focus upon, it is worth noting that "in 1980, 10 percent of federal research dollars went to energy; today, it is just 2 percent" (Markey, 2009). It is also mentioned that "private investment from U.S. energy companies has dwindled to less than one quarter of one percent of revenues in R&D" (Markey, 2009). This is quite discomforting knowing that US utilizes about 25% of the world's energy with only 5% of the population (Markham, 2008, p. 4). According to the chief economist (Faith Birol) of the International Energy Agency (IEA), global subsidies for fossil-fuels totalled around USD 557 billion in 2008. He further went on to state that "This is the only single policy item that could make such a major change in the global energy and climate-change game" (Morales, 2010). The problem therefore is that society cannot wait for government and large utility companies to solve the approaching energy crisis alone. There must be another integrated approach in which communities take responsibility for producing and managing their energy supply.

There are significant barriers within governments and private industries for increasing the portion of alternative energy sources incorporated in the grand portfolio. Governments often have a tremendous amount of bureaucracy to navigate through. Various political agendas and substantial lobbying by industries often delays real progress. Frequently the opponents to alternative energy projects do not represent the majority in numbers, but rather have substantial resources to sway opinions or block legislation for instance (Costanza, et al., 2000).

The 420 MW wind project off the coast of Nantucket Island, MA (Cape Wind) has faced significant opposition since it was proposed in 2001. Really only a minority of stakeholders – generally representing more upper class members of society – provided the most resistance against the project. Several surveys have been done over the years and the majority of those residents in the vicinity of the area voted for the project. In November of 2008, a non-binding question was put on a voting ballot essentially asking if the person supported or objected to this wind project and future ones. The results showed that 87% of the respondents were for the projects. This was consistent with two other independent surveys conducted earlier in the year which both resulted in 86% support (Cape Wind - Energy for Life, 2008). In April of 2010, the U.S. Federal government approved the project. The point of this is that it has taken almost 10 years for this initiative to come to fruition, although there is continued legal contention and yet still there has not been any actual production installation made. While due process and impact assessment is always beneficial, this sets a bad precedent for larger alternative energy projects. The private organizations and government bodies involved seemed fairly inefficient in making this

FIGURE 10 – CAPE WIND PROJECT (THE BOSTON GLOBE, 2010)



successful in a timely fashion. Perhaps the next project will go more smoothly from the learning experience and the familiarity factor being introduced, but would sustainability be easier to accomplish on smaller, more distributed scales?

Government and private investment will be examined further in the Strategy section towards the end. At that point, it will be revealed how community-oriented sustainable energy enterprises can pierce and expand into the energy market.

WHAT IS MEANT BY SUSTAINABLE?

Many people throw the word or concept of "sustainability" around freely, attaching various meanings and implications. To establish vulnerability for a community's livelihood, it is important to discuss what exactly is meant by sustainability in the context of this paper. The famous Brundtland Commission report defined sustainability as:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

(United Nations General Assembly, 1987)

The US Environmental Protection Agency (EPA) notes how sustainability has evolved to recognize both the public and private sectors more specifically.

"A public policy perspective would define sustainability as the satisfaction of basic economic, social, and security needs now and in the future without undermining the natural resource base and environmental quality on which life depends. From a business perspective, the goal of sustainability is to increase long-term shareholder and social value, while decreasing industry's use of materials and reducing negative impacts on the environment."

(Environmental Protection Agency, 2010)

These are good general definitions but do not necessarily take into account quality of life completely. Different people and entities have differing views of what they desire in life, or even what is acceptable. In general, as one ascends the class levels of society, there are higher standards for material wealth as well as convenience. This paper makes no assertion that for a community to be sustainable, certain adaptations can be avoided all together.

A sustainable community should be one that provides, at minimum, a suitable supply of the basic needs to its members including access to food, water, shelter, and energy. This supply should enable the people to live healthy and happy in general without want for these necessities. Since this paper will in part focus on transitioning communities that have some levels of material wealth and convenience already established relative to the world's population, it is also important to incorporate these aspects into the sustainability definition. This may include continued use of computers or televisions or even a heated pool. Of course the prolonged availability of energy required to power these luxury items depends on the circumstances internal and external of the community.

It is not the intention to incorporate sustainable energy by substantially degrading the lifestyles of the participants. This entails maintaining a reasonable level of expectations of the community during and after the transition. For this reason, it is important to consider what is actually important to communities and individuals that will be more directly affected by the transition to a more sustainable lifestyle. It must be considered what is actually *worth* sustaining and then assign salience to these aspects of life. For instance, in the scenario of rationed solar electricity, some people may value being able to use their personal computers over a communal water pump. While this may sound selfish and unreasonable, the scenario must be considered especially if the ones demanding the computer usage are investing heavily in the community projects. Ideally a favourable situation could be reached to match the priorities of the community as a whole and on individual levels.

However, as mentioned, some adjustments along the way may be required, including some of the three R's for instance (Reduce, Reuse, Recycle) – but not to the extent where the resulting situation creates significant discontent within members' lifestyles. This paper discusses improving communities through participation, shared goals, and project ownership. Emphasis is placed on communal transformation scaled at the individual level to prevent certain members or class levels from bearing relatively inequitable loads of sacrifice than others. This means that the monetarily wealthy people of a community should not have to foot the entire bill without proper returns – financial, social, and environmental. Likewise the less affluent should not be burdened with sacrifice beyond their means of livelihood and recovery, such as regressive energy rates[1].

Why does this matter though...*really*? If fossil-fuels make our life easier and there is a substantial supply for at least another generation or two, why should society try to cease its heavy dependency? To respond, one can speak of the detrimental environmental effects associated with fossil-fuel production and consumption including greenhouse gas issues, toxic pollutants, and degradation of the planet's surface from exploitation of resources (Hopkins, 2008). One can also speak about the political, economic, and social problems that arise from the reliance on resources that are limited in total supply. Given our current direction, these general problems can only grow in quantity and significance as humankind moves into the peak fossil-fuel era. What must be considered then is the resilience of communities to respond and adapt to impending changes. This statement is supported by a strategic plan set forth by the International Human Dimensions Program recognizing resilience – encompassing vulnerability and adaptation – as important concepts that deserve more focus over the coming years (International Human Dimensions Program (IHDP), 2007).

RESILIENCE

As pointed out in one CARRI research report, summarizing Walker et al. along with Gunderson and Pritchard; resilience is "scale, context, and disturbance specific" (Moser, 2008, p. 20). This same CARRI report reviews a multitude of meanings and interpretations for resilience but ultimately states that "an easy synthesis of meanings and relationships is not possible" (Moser, 2008, p. 20). Tompkins and Adger state resilience involves a system's ability to absorb perturbations without being undermined or becoming unable to adapt and learn (Tompkins & Adger, 2004). Although there is much ambiguity in the nature of its definition, resilience is synonymous with words such as

[1] Regressive energy rates would be similar to regressive tax rates where a fixed amount is paid by all, but impacts the poorer income class more substantially.

flexibility, durability, and spirit (Hopkins, 2008). Since resilience encompasses adaptation and flexibility, its definition "is an emergent property that arises from the interaction of a particular system, its wider environment, and the forces that act on both (Moser, 2008).

In the context of this paper, locally supplying sustainable energy is not only environmentally and long-term financially sound, it is also a security measure. For example, having neighbouring sources of energy provides the option of contributing to the distributed grid, possibly earning money from feed-in tariffs and other subsidies. Furthermore, if needed, the energy could be redirected locally with some minor adjustments to the transmission lines where appropriate. Creating a self-sustaining social enterprise to finance and manage these projects only augments the resilience since decisions about usage and distribution can be made without the heavy control of a large organization or parental entity. These practices can ensure a community's survival and prosperity through times of external energy fluctuations or crises. This is resilience. Failure to embrace these notions and continue without engaging in local sustainability can lead to a vulnerable existence (Tompkins & Adger, 2004).

Community Driven Decentralization

Intrinsic to the idea of locally sustainable energy is the concept of decentralization. In order for communities to be more resilient, it is important that energy production shifts from large central plants to smaller distributed installations.

"In a decentralised energy (DE) system, electricity would be generated close to or at the point of use. Buildings, instead of being passive consumers of energy, would become power stations, constituent parts of local energy networks. They would have solar photovoltaic panels, solar water heaters, micro wind turbines, heat pumps for extracting energy from the earth. They might also be linked to commercial or domestic operated combined heat and power systems. The massive expansion in renewable capacity that this would represent, and the fact that when fossil fuels were burnt the heat would be captured and used, would lead to dramatic reductions in overall carbon emissions – at least half of all emissions from the power sector, or 15% of total UK emissions."

(Greenpeace, 2005, p. 2)

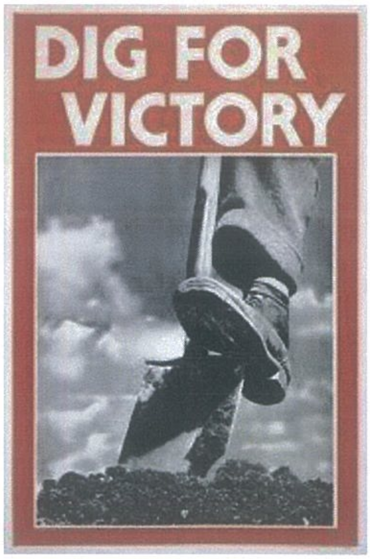
Furthermore, the paper goes on to say "In total, the energy wasted at the power station and on the wires is equal to the entire water and space heating demands of all buildings in the UK – industrial, commercial, public and domestic" (Greenpeace, 2005, p. 2). One goal of this paper is to demonstrate that decentralized energy production is not only viable, but represents a better energy paradigm for communities and the environment. It is also important the communities drive this decentralisation in their area.

Community Social Enterprise

History and Supporting Literature

Back in the late 1930's and early 1940's around the time of World War II, Britain implemented a "Dig for Victory" campaign to encourage local communities to grow their own food. Britain was importing over 55 million tons of food a year before the war. Once the war began, the Germans interrupted supply lines and the need for munitions, troops, and other war related shipments required the British to adjust their food sources. Rationing and promotion of trade within local markets ultimately proved successful for sustaining society and the economy. Food imports were halved during this period and land used for food production increased by over 80% (Simkin, 2010) (Hopkins, 2008). While this was primarily based on food production, the principles of the movement can be applied to the global energy situation. If the government and the people get behind something so critical, major change can take place very swiftly.

Figure 11 - Dig for Victory (Simkin, 2010)



The modern concept of members in a community working together to create a more sustainable way of living has really only gained momentum over the past decade or so. One of the recent pioneers was a permaculture designer and lecturer in Kinsale, Ireland by the name of Rob Hopkins. He worked with his students to develop an "Energy Descent Plan: a series of measures that the town could implement to anticipate declining oil supplies" (Leitch, 2008). The town ultimately adopted the proposal and Hopkins went on to write a book entitled *The Transition Handbook: From Oil Dependency to Local Resilience* which advanced the idea of community responsibility towards a sustainable future. This framework asks "for all those aspects of life that this community needs in order to sustain itself and thrive, how do we significantly increase resilience (to mitigate the effects of Peak Oil) and drastically reduce carbon emissions (to mitigate the effects of Climate Change)?" (Transition Towns - What is..., 2010). Hopkins' book and efforts went on to create a movement named the Transition Network.

A community according to the Transition Network can be a city, town, village, etc. but must meet certain criteria to be recognized as a transition community. In January of 2010, there were 278 in total throughout the world (Transition Towns - It's Official, 2010). As of August 2010, they numbered 323. What's relevant to this paper's topic is that some of the certified *Transition Towns* have formed their own companies to successfully implement community-scale sustainable energy production. Other cities around the globe have done something similar such as Craven in North Yorkshire, UK where a community-run hydro-electric plant was installed in 2009. This £420,000 project will produce 165,000 kWh/yr and "profits will be divided between the shareholders and the community. The community money will be used to fund other projects" (Craven Herald & Pioneer, 2009). This is a wonderful example of how people can come together on a local level to take ownership of their energy portfolio.

One US organization named Northwest SEED (Sustainable Energy for Economic Development) has devoted its efforts towards research and development to support community based sustainable energy projects. Their mission clearly exemplifies this movement: "Northwest SEED works to establish a clean, diverse, and affordable Northwest energy system based on efficient use of renewable resources, with maximum local control and ownership of energy assets" (Northwest SEED, 2010).

Building on the Past

This paper will adopt different aspects of these various communities and organizations in order to build a comprehensive model for locally funded and managed energy portfolios.

The economic devices for funding, implementing and managing community renewable energy projects can utilize the community social enterprise concept as the guiding foundation. Employing this approach is important so that the community can sustain the funding and development of projects. Embracing the methodology of a capitalistic profit-driven business compels the enterprise to be efficient and cost aware. Traditional non-governmental and not-for-profit organizations generally do not operate to maximize earnings and therefore often miss opportunities to create more income for social investment. The proposed community enterprise will always put social needs first so maximizing profits provides more funds for social reinvestment. A wonderful by-product of this structure entails that no venture or action will be accepted which compromises social advancement for profits. This vision has far too often been sidelined in traditional for-profit organizations (Elkington, 1998).

According to Peredo and Chrisman, Community Based Enterprises (CBEs) "characteristically arise in response to some combination of the following:

- economic crisis and a lack of individual opportunity,
- the processes of social disintegration,
- social alienation of a community or subgroup from mainstream society,
- environmental degradation,
- postwar reconstruction, and
- volatility of large business" (2006).

It can be argued that several of these can be encountered within communities throughout the world, including in developed nations. Economic crisis is relative, but as there are currently recessions throughout the world, this can apply to many areas. Discontinuing environmental degradation is also a driving force that has gained ground in the past decades (Hart, 1997). Volatility of large business is a threat as well since allocation of resources, salience of social interests, and political motivations are often beyond the control of the communities that large organizations serve. Seeing that the world is experiencing at least some of the factors listed above from Peredo and Chrisman, it can be surmised that a strong case exists for community-oriented sustainable energy enterprises.

Checkpoint

In review, the objectives that have been covered thus far have been important in creating the necessary foundation for examining the proof-of-concept in the next section.

- The reader should now have a better understanding of the current energy paradigm and the associated vulnerability in relation to peak oil, EROEI, the environment, and government/private roles. This helps clarify why there is a need to shift the paradigm and also begins to explain why the concept of community-oriented sustainable energy enterprises can be a change agent.
- The concept of sustainability was explored and expanded on in order to account for the values and perspectives of diverse societies. While general basic needs are obviously crucial, it is also vital to consider what is worth sustaining beyond these fundamental components and what priority of importance they have to a community.
- Resilience is fundamental in society's ability to adapt to an ever-changing world. It is important to limit the impacts of the potential consequences that could result from high levels of vulnerability. Community driven decentralization along with a social enterprise approach for business structuring provides a sustainable future and greater impact resistance to external effects.

Methodology

Transitioning from the research-based segments of this paper, a practical proof-of-concept will be examined for the model discussed thus far. The true reason for undertaking the exercise described in the following sections was to demonstrate how the core ideas presented in this paper previously can be successfully applied in a real-world scenario.

Community-Oriented Sustainable Energy Enterprise

Some major variables for developing this model are population, geographical location and resources, and the economic infrastructure of the community. The balance between scalability and maximizing renewable energy usage is important as well. Unfortunately, due to the costs and real *exergy* production (actual usable energy) (Dinçer & Rosen, 2007) associated with these types of energy sources; there is a tipping point relative to the amount of investment capital available and overall community energy demand.

Due to the multiple contributing factors mentioned above, multiple scenarios of potential project approaches implementation should be explored. For instance, in some cases it will initially be more beneficial to implement renewable energy solely for acquiring feed-in tariffs to build capital for reinvestment into future expansion allowing for more direct usage by members. In other instances, it may be favourable to implement an energy source which can be directly distributed to members without having to go into a large power grid. This latter situation would probably be more common in smaller communities with lower overall demand or in a distributed point-of-energy system such as solar panels on houses. Unfortunately due to the scope of this paper, all of the possible scenarios will not be covered. While not every factor will be accounted for obviously, the attempt has been made to create a "worst-case scenario". For instance, as will be discussed further in the *Financial Incentives* section, there are numerous grants available which cannot be factored in because they are on a case-by-case basis. Therefore, it is not feasible to determine how much would be available to apply so they have been left out of the calculations. This implies that if it is shown as possible in this proof-of-concept, it would probably have better odds of success in actual implementation. With that said, the model will be adjusted at times in order to emphasize the importance of certain variables and further discussion will take place in the analysis section in order to provide more coverage of the potential approaches based on certain factors.

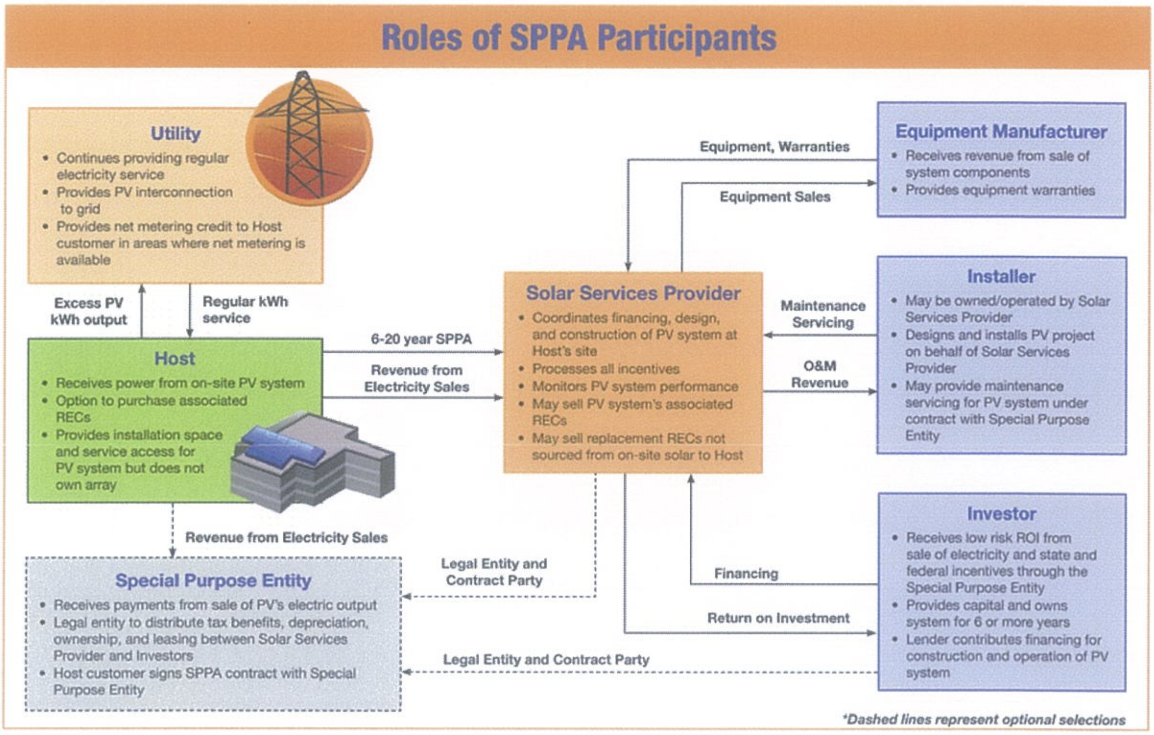
This proof-of-concept will be based on a for-profit enterprise created and managed at the community level. A for-profit structure was chosen over a non-profit for several reasons.

While non-profits benefit from tax exemption, a profit oriented enterprise can take advantages of numerous "green" tax credits, grants and incentives over time not available to non-profits. Furthermore, private investment and funding mechanisms can be integrated into the business alleviating the reliance solely on donations, charity, and/or public backing. It is beneficial that this enterprise is seen as an entity worth investing in; not solely relying on the goodwill of people. This is what bridges the gap between traditional economic mechanisms and sustainable endeavours.

With that said, it is important to maximize profits as well in order to provide more funding towards community projects. The driving-force is environmental and social good. Profits are a means to achieve these objectives, while enticing participants to become involved through goodwill and sound investment incentives. As stated before though, social enterprises should not compromise these core values and driving-forces to increase profits only for the sake of shareholder wealth.

Models exist which encapsulate the structure of what is being proposed as seen below in Figure 12. Examining this chart, the reader can see a diagram of a typical Solar Power Purchase Agreement. For this paper, the community will take on the roles of the Solar Services Provider and Special Purpose Entity in a combined fashion. It is also possible for the investors to be part of the company or external. This will be discussed further in the analysis section.

FIGURE 12 – ROLES OF SPPA PARTICIPANTS (POWERPURCHASEAGREEMENT.COM, 2010)



For this case, the business's financials will be based on the information found through research, manufacturer quotes, and the RETScreen outputs. The structure of funding will be solely based on shares sold to the public which will cover the upfront costs of the equipment and installation. The use of loans is not being factored in although this option will be discussed in the analysis section.

RETScreen

This project relies heavily on the *RETScreen Clean Energy Project Analysis Software* developed by Natural Resources Canada, which "can be used worldwide to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for various types of Renewable-energy and Energy-efficient Technologies (RETs)" (Natural Resources Canada, 2010). The free software is used by energy systems planners all over the globe, boasting 264,824 users in 222 countries as of September 29, 2010 (Natural Resources Canada, 2010). Although it is a very powerful tool, it has some shortcomings and opportunities for improvements. Many community members and even city planners may lack the requirements needed to use RETScreen which can discourage them from exploring an alternative energy portfolio. RETScreen also does not produce an energy matrix in order to recognize optimal combinations of production.

Ideally, future research and application would allow the development of an optimal energy portfolio based on the natural, social, and economic resources available in an area. This would require extending the functionality of RETScreen to produce a more personalized study. Unfortunately, this is not expanded on in this paper.

Proof of Concept

The proof-of-concept will use a region in eastern North Carolina as a case study for implementing community-oriented sustainable energy.

What's So Special About this Area?

The response to that question is "Nothing really." This area is meant to represent a typical community of the US consisting of subdivisions, suburbs, and rural communities. The idea is to demonstrate that an average community in the US has the capability of implementing a social enterprise with the purpose of locally producing energy. As discussed, this will provide more resilience in the face of future uncertainties surrounding energy.

While this will be explored further below, it is worth mentioning here that NC does have some renewable energy initiatives already operating. Along with some privately sponsored larger installations, the most notable program is NC GreenPower which accepts funding from NC residents and businesses to buy renewable energy production at a premium from small producers (often individual houses).

Although some initiatives exist, they do not necessarily contribute to local resilience from the perspective of many communities (Lerch, 2009). Often the renewable energy purchased by this program comes from individual houses or centralized facilities. This does not necessarily promote decentralization for community resilience. While a person providing a monthly contribution may be helping the environment and alleviating some of the state's reliance on outside fuel sources, the possibility exists that the person may not ever actually directly use any of the renewable energy produced (NC Green Power, 2010). What's more is that if there is an energy crisis, many communities may not have access to other methods of energy production even though they may have been contributing to NC Green Power for years. More on this topic will be discussed later (refer to *Background, Policies, and Programs* in Methodology section), but this short interlude can be concluded with the idea that the lack of resilience from these circumstances is quite common throughout the US due to the nature of centralized energy production (Greenpeace, 2005).

Returning back to the area of interest for this case study, the main focus is on the region detailed in Figure 13 and Figure 14 below. The first map shows the coverage area of the Pitt and Greene Electric Membership Corporation (PGEMC). It is a cooperative with 6,714 members as of June 30, 2010. It purchases electricity from different production units across the eastern US on behalf of its members. In 2009, they purchased around 205 GWh and sold 187 GWh in 2009 (Gray, 2010). In simplified math, this equates to around 28 MWh per household in a year (or 2.32 MWh per month).

As mentioned, this area is mostly made up of rural residents along with some suburban developments. There are some larger cities nearby which many people commute to for work including Greenville, Ayden, Winterville, and Farmville. These cities are serviced by their own utility companies. Table 2 below contains data on these cities since they have an effect on the further development of surrounding areas.

TABLE 2 - DEMOGRAPHIC DATA FOR AREA OF STUDY (CITY-DATA.COM, 2010)

City	Population (July, 2009)	Growth (%) since 2000	Median Household Income (USD) (2008)
Greenville	81,747	+35.2	32,836
Ayden	5,043	+ 9.1	29,321
Winterville	4,884	+1.9	45,337
Farmville	4,656	+8.2	35,594
North Carolina		+9.1(est.)	46,549
USA			52,029

FIGURE 13 – PITT AND GREENE ELECTRIC MEMBERSHIP COOPERATIVE: COVERAGE AREA (PITT AND GREENE ELECTRIC MEMBERSHIP CORPORATION, 2010)

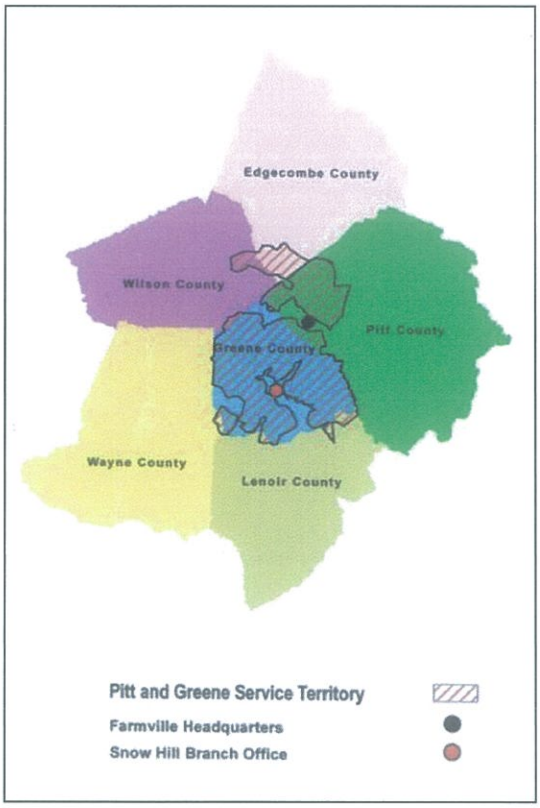
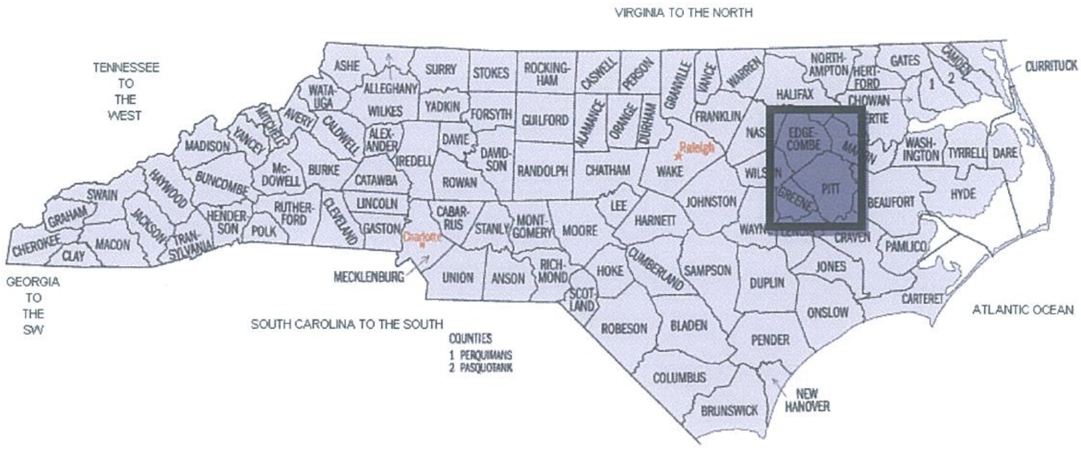


FIGURE 14 – NC MAP (CAROLINAYELLOW.COM, 2010)



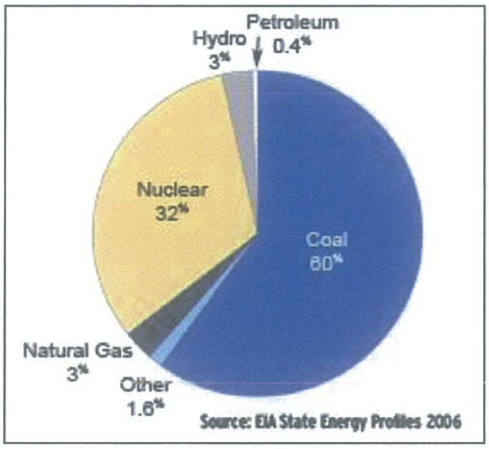
Before moving further into specifics for this particular community, it is important to examine the federal, state, and local renewable energy policies and financial incentives available as well as the general atmosphere.

Background, Policies, and Programs

North Carolina ranks 10th among states in population and 12th in energy consumption according to the US Census Bureau and the EIA respectively (U.S. Census Bureau, 2010) (U.S. Energy Information Administration, 2008). One would not necessarily expect this since it is not known for large cities such that are found in Texas, California, Florida, and New York who rank higher on the list. But, the state does hover around the 12 spot (± 2) in the four categories of classification (Residential, Commercial, Industrial, Transportation). It is worth mentioning here as well that "as is typical in the South, more than one-half of North Carolina households use electricity as their main energy source for home heating" (EIA State Energy Profiles - North Carolina, 2010) and most homes have air conditioners.

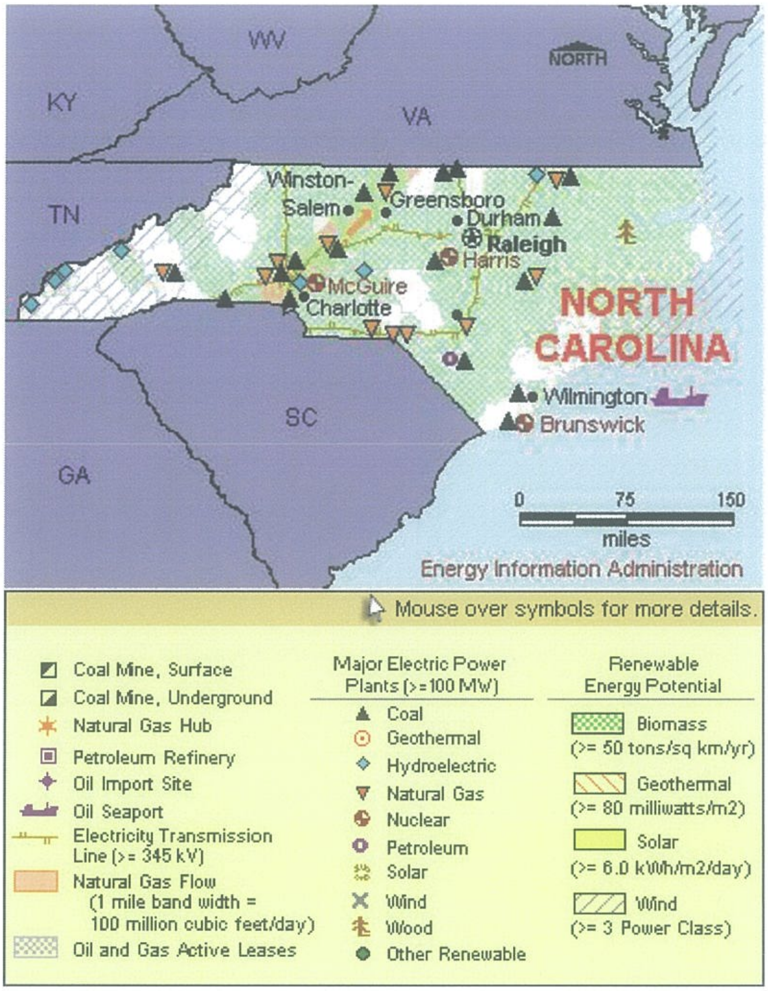
North Carolina imports all of its primary fuel sources except for the 3 nuclear plants (5 reactors) and renewable production installations. Not all of the nuclear energy produced is consumed in the state as some is exported to other states. NC has no significant reserves either as most of the fuel is delivered through just-in-time logistics (US Energy Information Administration, 2010). The state's fuel source mix is shown in Figure 15.

FIGURE 15 – NC SOURCES FOR ELECTRICITY (ENERGY INFORMATION ADMINSTRATION, 2010)



Currently, NC's electrical energy is provided by a mix of investor-owned utilities (IOU) (3), municipalities (76), and coops (32) (North Carolina Utilities Commission - Electricity, 2010). These organizations manage their areas with various types of legal structures, but generally obtain energy from the same production plants within NC with some energy provided from bordering states where more convenient (State Energy Office, North Carolina Department of Administration, Appalachian State University Energy Center, 2005). The map below (Figure 16) gives the reader an idea of the major production facilities in the state.

FIGURE 16 – NC POWER PRODUCTION PLANTS (US ENERGY INFORMATION ADMINISTRATION, 2010)



As you can see from Figure 15 and Figure 16, NC relies heavily on coal and nuclear power for electricity. It has about 67 operating coal-fired units at 25 locations (Source Watch, 2010). Due to the fact that two large plants are shared with SC through Duke and Progress Energy's operations, the mix is probably more 50-50 between coal and nuclear (Eldridge, Elliot, & Vaidyanathan, 2010). As mentioned there are no active coal extraction operations in the state. This high reliance on coal and nuclear, among other factors, has implications with respect to the state and local vulnerability.

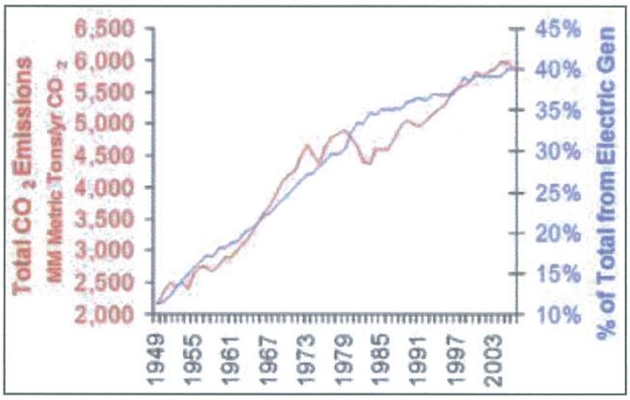
State and Local Vulnerability

In addition to the general vulnerabilities as discussed earlier in this paper, NC has some other vulnerabilities that should be discussed. These create a stronger foundation in the case for resilience in our case study region.

Coal & Natural Gas

As of January 1, 2008, the EIA estimated that there was about 489 billion short tons (1 short ton = 2,000 lbs) of coal left in the demonstrated reserve base (DRB) of the US. They also state that the US uses just over 1 billion short tons of coal annually (US Energy Information Administration, 2009). While there may be ample coal reserves in the US and the price has been relatively cheap compared to many other fuels, the actual fuel costs and environmental compliance expenses are ever-increasing due to its high levels of CO_2 mainly associated with electricity production (See Figure 17) (State Energy Office, North Carolina Department of Administration, Appalachian State University Energy Center, 2005) (Progress Energy, Inc. - AR, 2009).

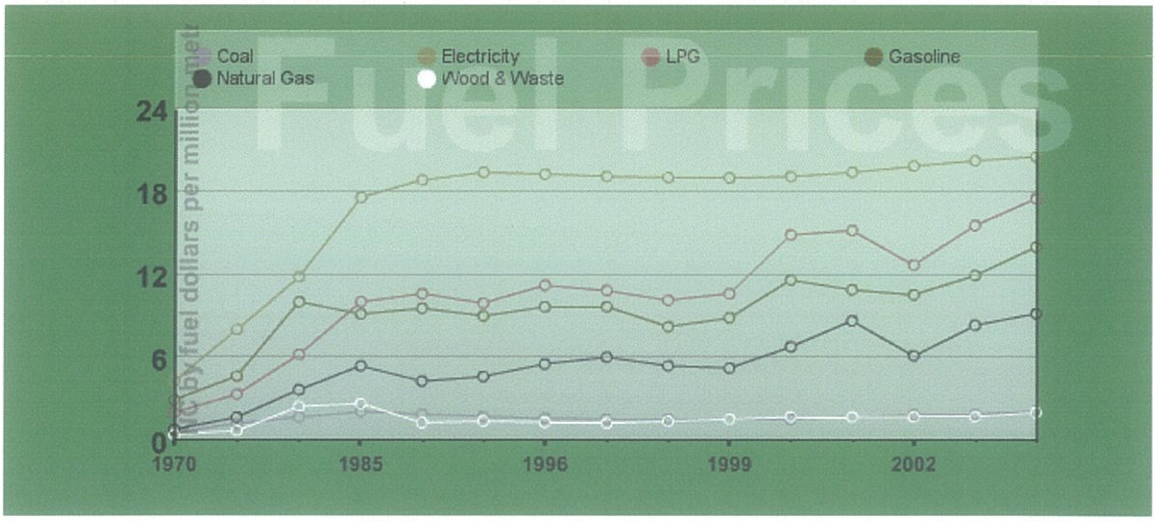
FIGURE 17 - US GHG EMISSIONS HISTORY AND PERCENT FROM ELECTRICITY GENERATION: 1949 – 2005 (CASTEN, 2008)



"The 1976 Clean Air Act (CAA) dramatically raised the cost of new coal plants, but grandfathered the existing coal plants out of compliance obligations. This essentially eliminated the economic logic for new coal plant construction -- and explains the absence of coal fleet growth over the past two decades" (Casten, 2008). Even these grandfathered-in coal plants will eventually need to be refitted or retired. At the end of 2009 Progress Energy Carolinas announced they would retire 11 coal-burning power plants in NC due to the expense of retrofitting for environmental compliance. Lloyd Yates, the president and CEO, stated in a press release "as emission targets continue to change, and as legislation to reduce carbon emissions appears likely, we believe in this case, it's in the best interest of our customers to invest in advanced-design, cleaner-burning generation for the future" (Progress Energy, Inc., 2009). The cost of replacing that power generation with natural gas was calculated to be about USD 1.5 billion while retrofitting the older coal plants would be in the area of USD 2 billion (Murawski, 2009). The president, chairman, and CEO of Duke energy stated that the Cliffside coal-plant under construction will be "the last coal-fired plate I will ever build" (Pooley, 2010).

Figure 18 shows the trends of fuel prices for NC between 1970 and 2008. As you can see, coal has been quite cheap over the years as compared to the other fuels.

FIGURE 18 – NC FUEL PRICES (US$/MMBTU) (APPALACHIAN STATE UNIVERSITY ENERGY CENTER, 2008)



Source:US Department of Energy, EIA, State Consumption, Prices and Expenditures (SEDS)

The realization that it is becoming more economical to move away from coal towards natural gas emphasizes the costs of making coal a cleaner fuel source. Either way, the costs for primary fuels are going up in NC. Since fuel costs are direct pass-through to the consumer in NC, these increases in prices will be reflected on the electric bills. Moreover, because NC has no reserves and employs just-in-time fuel delivery, these price changes will be implemented relatively rapidly (State Energy Office, North Carolina Department of Administration, 2003). Salaries and other income sources do not change in parallel spatially or temporally. This creates vulnerability for consumers trying to adjust their lifestyles to these price shifts.

NUCLEAR

As stated, the other major source of electricity in NC is nuclear with 3 plants (5 reactors) (see Figure 19).

FIGURE 19 – NC NUCLEAR INDUSTRY (US ENERGY INFORMATION ADMINISTRATION, 2009)

Report Updated: November 30, 2009

Nuclear Power Plants in North Carolina Net Generation and Capacity, 2008					
Plant Name	**Unit Number**	**Net Capacity MW**	**Net Generation Thousand Kwh**	**Capacity Factor (percent)**	**Operator/Owner**
Brunswick	1	938	7,031	85	Progress Energy Carolinas, Inc./Same
Brunswick	2	937	7,854	95	
Total		**1,875**	**14,885**	**91**	--
McGuire	1	1,100	8,357	86	Duke Power Company/Duke Energy Carolinas LLC
McGuire	2	1,100	8,713	90	
Total		**2,200**	**17,070**	**89**	--
Shearon Harris	1	900	7,821	99	Progress Energy Carolinas, Inc./Same
Source: Form EIA-860, "Annual Electric Generator Report," and Form EIA-906, "Power Plant Report."					

The last nuclear plant built in NC was the Shearon Harris facility in 1987. In 2008, Progress Energy filed an application with the Nuclear Regulatory Commission (NRC) to build two more reactors at this same site. It was certified by the NRC but will take another 3 years for review. It is estimated that the reactors would not be operational until 2018 if they decide to build them (World Nuclear News, 2008). Progress estimates that by 2016 they will have an additional 300,000 new customers (Progress Energy, Inc., 2010). In 2007 they put current nuclear development on hold to focus on a USD 50 million dollar energy efficiency program. Even with its success, the company realizes that future power plants will need to be built for meeting the growing demand of its customers (World Nuclear News, 2008).

Looking at Figure 19 again, the 5 reactors are operating on a 93% average capacity which means that there is not much more room to expand their output. Building new reactors are very expensive and time-consuming. There is a large outlay of investment but with a small demand for the first several years of operation. Companies wish to delay building large power plants – especially nuclear – as long as possible so that a larger demand will exist when coming on line for a faster rate of return. In the meantime, these costs can get passed onto the consumer. For example, Duke Energy incorporates the cost of planning a nuclear development in its customers' utilities rates, regardless if it's built or not. For their proposed plant in South Carolina, the planning costs were estimated to be USD 160 million in 2008 (Downey, 2008).

While nuclear may continue to play a major role in NC's electricity production, it is still an industry with many uncertainties economically, environmentally, and politically speaking. In 2008, Duke Energy changed the estimated cost for that same plant in SC from USD 6 billion (Downey, 2008) to around USD 11 billion (World Nuclear Association, 2010). Environmental issues still surface surrounding nuclear waste disposal, safety, and water sources for cooling. These issues currently seem to only have temporary solutions. The debate over nuclear within the political arena still continues where some see it as the ultimate answer to our energy problems with others who resist this notion (Progress Energy, Inc. - AR, 2009). These factors greatly contribute to NC's energy vulnerability and provide even more incentive for communities to engage in local energy development projects instead of waiting for the nuclear solution.

Energy Planning, Emergency, and Crisis Response

North Carolina has developed both a State Energy Plan (2005) as well as an Energy Emergency Plan (State Energy Office, North Carolina Department of Administration, 2003). Neither will be reviewed in detail but there are a couple of items from these documents relative to this report. One important statement they have in both documents is that in the occurrence of energy issues, the primary responders will be the energy companies since the majority infrastructure is owned by private companies or cooperatives. The state's roles are to coordinate communication, advise citizens, and remove barriers to effective private action.

In the case of an energy shortage – short-term or long-term – an assessment will be made of the impact area and the relative vulnerability within the affected sectors of the population will be determined based on relevant demographics. The primary producers of energy are required to keep some level of fuel reserves on hand for energy shortage situations. The State Energy Emergency Plan showed that projected reserves from 2002 to 2011 were approximately 17% for Duke Power, 12.5 to 15% for Progress Energy and 13 to14% for Dominion NC. This "set-aside" would be used for pre-defined priority users as listed below:

- agricultural production and distribution,
- aviation including ground support,
- cargo, freight & mail,
- emergency services,

- energy production,
- government/sanitation,
- health care,
- public passenger transportation,
- telecommunications,
- utility services (including water), and
- nonmilitary shipping.

The actual order of priority amongst these consumers will be determined at the time of the shortage by government representatives as well as the energy producers. Furthermore, the emergency plan's Appendix 7 states "the Set-Aside does not dictate cost; all fuels delivered through the program are purchased at the market price and, ordinarily, through the priority customer's usual supplier(s)" (State Energy Office, North Carolina Department of Administration, 2003, p. 98).

Putting these factors together, one can see a potentially vulnerable situation for the average NC citizen. Essentially, it seems from the emergency plans of action discussed just previously, the private companies will have control or at least a significant influence on the energy supplies and costs during times of emergencies or crises. They will be active participants in deciding who gets the available set-aside as well as the potential to manipulate the price (State Energy Office, North Carolina Department of Administration, 2003). Of course, the intention is to ensure that the basic functions of society are able to continue such as health care, communications, and distribution. But it one could suggest that this can also lead to a situation where whomever is willing to pay higher prices for the energy will have greater access to it. Even amongst hospitals and schools, some have more funding than others and there are large variations in supplies and services available within those sectors of society even today. Could this also imply that as fuel costs rise, some people will be able to afford more energy and therefore employ it for uses with less importance? For example, one kWh of electricity used to watch a TV sitcom could be utilized for someone else to heat their home on a cold winter night or for life-support equipment.

These ideas may seem dramatic, but as conveyed throughout the paper, there are parallels that have shown the reality of the situation in previous energy shortages around the globe. Regardless if this scenario plays out as a worst-case, in NC there is potential for this vulnerability to be exposed. There is also just as much or more potential to change to a more energy-efficient and renewable energy production paradigm.

Renewable Energy in North Carolina

On August 20, 2007 NC became the first state in the Southeast to adopt a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) (North Carolina Utilities Commission, 2010). The bill passed was Session Law 2007-397 (Senate Bill 3) and is summarized below in Table 3 and Table 4 (General Assembly of North Carolina, 2007):

TABLE 3 – NC REPS PUBLIC UTILITIES (INVESTOR OWNED)

Calendar Year	REPS Requirement
2012	3% of 2011 NC retail sales
2015	6% of 2014 NC retail sales
2018	10% of 2017 NC retail sales
2021 and thereafter	12.5% of 2020 NC retail sales

TABLE 4 – NC REPS ELECTRIC MEMBERSHIP CORPORATIONS (COOPS) AND MUNICIPALITIES

Calendar Year	REPS Requirement
2012	3% of 2011 NC retail sales
2015	6% of 2014 NC retail sales
2018 and thereafter	10% of 2017 NC retail sales

Although there are some further restrictions for investor owned utilities, basic approved methods of meeting these requirements include (General Assembly of North Carolina, 2007):

- Generate electric power at a new renewable energy facility.
- Use an existing renewable energy facility other than waste heat from the combustion of fossil-fuel.
- Implement energy efficient measures. (Limited to no more than 25% of requirements for investor owned utilities, 40% after 2020).
- Purchase electric power from a new renewable energy facility.
- Purchase renewable energy certificates from a new renewable energy facility. (Limited to no more than 25% of requirements for investor owned utilities).
- Carry-over credits from excessive generation from the year before.

Moreover, it's worth mentioning that there are further requirements for solar production as well as swine waste resources as shown in Table 5 and Table 6 (General Assembly of North Carolina, 2007).

TABLE 5 – NC REPS SOLAR (GENERAL ASSEMBLY OF NORTH CAROLINA, 2007)

Calendar Year	REPS Requirement
2010	0.02% of total kWh sold
2012	0.07% of total kWh sold
2015	0.14% of total kWh sold
2018	0.20% of total kWh sold

TABLE 6 – NC REPS SWINE WASTE (GENERAL ASSEMBLY OF NORTH CAROLINA, 2007)

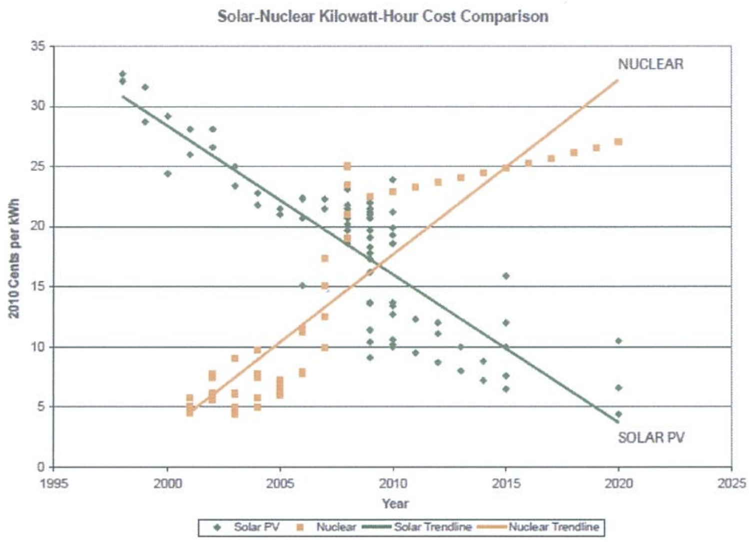
Calendar Year	REPS Requirement
2012	0.07% of total kWh sold
2015	0.14% of total kWh sold
2018	0.20% of total kWh sold

Although North Carolina has made strides for increased energy efficiency and renewable energy, they still have plenty of room to expand into these areas. The American Council for an Energy-Efficient Economy recently released an in depth study on North Carolina entitled *North Carolina's Energy Future: Electricity, Water, and Transportation Efficiency* (Eldridge, Elliot, & Vaidyanathan, 2010). This report projected that "significant potential for energy efficiency as a resource will remain untapped over the next 15 years if the state continues on a business-as-usual track" (p. iii). Furthermore, they proposed "a suite of policies and programs that have the potential to meet nearly a quarter of the state's electricity needs and about 11% of transportation fuel by 2025. And by making these significant investments in energy efficiency technologies and practices, the state stands to gain 38,000 net jobs in 2025 and save consumers a net $3.6 billion cumulative by 2025 in lower energy and water bills" (p. iii). The point must be emphasized that energy-efficiency measures must be coupled with renewable energy implementation. Whereas this topic could be another paper in itself, it has been shown that energy-efficiency is the least costly and most rapid approach to increasing EROEI (Lovins, 2005). While the renewable energy movement is gaining ground, it will need as much buffer room possible during the transition. This buffer zone can be created by exploiting energy-efficiency opportunities.

Returning back to NC's renewable energy potential, the state is quite wealthy in renewable natural resources. A recent study performed by John Blackburn, Ph.D. about renewable energy and utility loads in NC found that the proper mix of wind, solar, hydro, biomass, and landfill gas could cover all but 6% of the state's hourly electricity demands (Blackburn J. , 2010). His model assumes a non-optimized 76% contribution from solar and wind along with an energy-efficiency adjustment from the current 125 billion kWh load to 90 billion kWh.

The state is divided into geographic regions with mountains, the piedmont, and a coastal plain. The different regions provide an array of climate – although fairly mild overall – each with advantages for different types of naturally-based renewable energy (Blackburn J. , 2010). North Carolina ranks among the top 10 States in wind power capacity (US Energy Information Administration, 2010). "Wind speeds are usually higher at night than in the daytime, and are higher in winter than in summer. Solar generation, on the other hand, takes place only in the daytime and is only half as strong in winter as in summertime" (Blackburn J. , 2010, p. 5). NC generally has long summers and therefore significant daylight hours throughout the year (average around 60% (National Climatic Data Center, 2004)) and an average solar radiation of 4-5 kWh/m^2/day (National Renewable Energy Laboratory - Resource Assessment Program, 2010). A recent report published in July of 2010 showed that solar just crossed-over nuclear in cost (cents/kWh) for electricity in NC and is projected to continue to decline while nuclear cost is expected to increase (Figure 20)Figure 20 – Solar and Nuclear Costs - The Historic Crossover (Blackburn & Cunningham, 2010) (Blackburn & Cunningham, 2010). Furthermore, due to the significant amount of agriculture and notably the hog industry (Bevill, 2008), there is also a high level of potential for biofuels from methane production or biomass combustion.

FIGURE 20 – SOLAR AND NUCLEAR COSTS - THE HISTORIC CROSSOVER (BLACKBURN & CUNNINGHAM, 2010)



NC GreenPower

As discussed before, NC GreenPower is "an independent, non-profit organization established to improve North Carolina's environment through voluntary contributions toward renewable energy and the mitigation of greenhouse gases" (NC GreenPower, 2010). Their program is similar to a feed-in tariff but it is not entirely funded by the state, mainly relying on "donations". A typical contribution of USD 4 per month adds about 100 kWh to NC's energy grid supply and mitigates around 500 lbs of carbon dioxide or equivalent. (NC GreenPower, 2010). Their primary focus is to improve the environment as well as reduce the reliance on external fuels for energy production. Some "$6-7 billion leaves the state's economy to buy energy from other states and foreign nations" (Shirley, 2010).

Although this program is commendable in its intentions, there are several deficiencies that can ultimately characterize it as unsustainable. The heavy reliance on voluntary funding from private citizens and businesses can create an unreliable revenue stream. Since these contributions are discretionary, they can thus dwindle during more difficult economic times or if someone would rather save for a vacation for instance. Furthermore, the significant outlay for installation costs of renewable energy production mechanisms must be footed by the private residences or businesses from which NC GreenPower purchases power. Moreover, the voluntary basis of funding makes it difficult to guarantee the continuous buy-back for generators – as opposed to a feed-in-tariff 20 year guarantee for instance – and therefore creates more difficulty for loans and payback period calculations. While this program has seen some success, this paper argues there are too many variables and potential inconsistencies to label it the best approach for significant proliferation of decentralized renewable energy production.

North Carolina's Electric Cooperatives

NC electric coops originally organized to provide electricity to the rural areas of NC where the municipalities and IOUs previously did not. After years of smaller cooperatives popping up around the state, in 1958 they all formed the North Carolina Electric Membership Corporation (NCEMC) to manage the general interests and directions of state electric cooperatives as a whole. As mentioned there are currently 32 cooperatives in the state, all members of NCEMC. They serve more than 2.5 million people and operate in 93 of the state's 100 counties. Each cooperative is non-profit, member owned, and governed by an elected board of directors. Furthermore, 25 of the cooperatives are members of Touchstone Energy® which is a nationwide alliance of electric cooperatives with more than 700 members in 46 states (North Carolina's Electric Cooperatives, 2010).

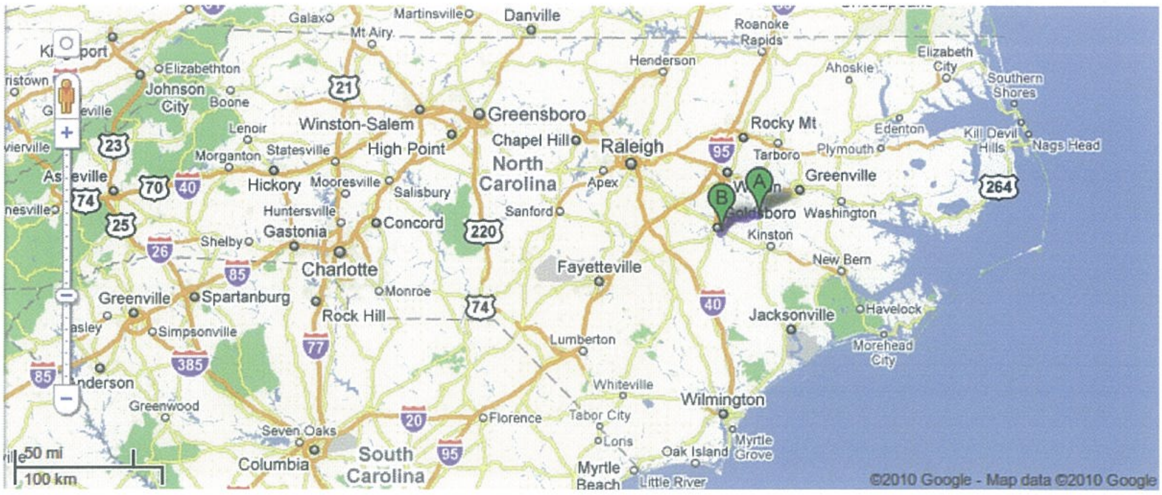
After the passing of the REPS for NC, 25 of the cooperatives banded together in April 2008 to form a green services company named GreenCo Solutions, Inc. to help the coops “define and meet their energy efficiency and renewable energy goals” (GreenCo Solutions, Inc., 2010). In reviewing their projects and their website, their main purpose is to secure renewable energy production and implement energy efficiency programs to meet the requirements set forth in the NC REPS. This includes funding and management of new developments as well as procuring renewable energy from projects where they are not directly participating.

PROJECT DETAILS & DATA

LOCATION

As pointed out before, the area of our case study is in eastern North Carolina. For the RETScreen model, the location of “Goldsboro Seymour Johnson” was specifically selected since it was the closest area available from the model’s select list. This select list contains the locations for which the data is gathered and included in the program. Figure 21 shows the distance between the center of the focus area (A) and Goldsboro Seymour Johnson (B), where the data is coming from in RETScreen.

FIGURE 21 – SNOW HILL (A) TO GOLDSBORO SEYMOUR JOHNSON (B) (SRC: MAPS.GOOGLE.COM)



Below in Table 7 you can see the data associated with this location provided by RETScreen.

TABLE 7 – CLIMATE DATA FOR GOLDSBORO SEYMOUR JOHNSON (RETSCREEN)

	Unit	Climate data location	Project location						
Latitude	˚N	35.4	0.0						
Longitude	˚E	-78.0	0.0						
Elevation	m	33	0						
Heating design temperature	°C	-3.3							
Cooling design temperature	°C	34.2							
Earth temperature amplitude	°C	17.3							
Month		Air temperature	Relative humidity	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
		°C	%	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January		6.4	67.4%	2.47	101.7	2.7	5.0	360	0
February		8.4	66.0%	3.17	101.6	2.9	7.1	269	0
March		12.0	63.0%	4.25	101.4	3.1	11.2	186	62
April		16.5	61.6%	5.23	101.2	3.0	16.7	45	195
May		21.2	66.4%	5.80	101.3	2.6	21.5	0	347

June		24.9	70.5%	5.93	101.2	2.4	25.0	0	447
July		26.9	74.4%	5.78	101.3	2.2	26.5	0	524
August		25.8	75.9%	5.10	101.3	2.1	25.3	0	490
September		22.7	74.9%	4.53	101.4	2.3	22.1	0	381
October		17.2	72.0%	3.83	101.6	2.2	16.7	25	223
November		12.6	70.2%	2.79	101.7	2.4	11.8	162	78
December		8.1	67.9%	2.29	101.7	2.7	6.4	307	0
Annual		16.9	69.2%	4.27	101.5	2.5	16.3	1,353	2,747
Measured at	m					10.0	0.0		

Renewable Energy Technology

After researching the types of renewable energy sources available in the area of focus, it was determined that solar is the only practical one at the time of this writing. Referring to Figure 16 it can be seen there is not much potential for wind energy. This agrees with the RETScreen climate data (Table 7) which shows that this area has only a 2.6 m/s average annual wind speed. This not enough energy to be economical for even a medium size wind project. According to the RETScreen textbook, a minimal speed of 4 m/s is required (RETScreen International, 2005).

The other possible source of energy in this area is biomass derived from the numerous hog farms around the eastern part of the state. North Carolina is the second largest hog producing state in the nation with over 9.5 million hogs (Bevill, 2008). Due to the REPS mandate outlined above, there has been considerable investment in the production of energy from hog waste. However as of July 2010, there still has yet to be any electricity produced in the state from this energy source after three years of pilot programs (Norfleet, 2010). One of the reasons for the lack of success in the pilot programs is that the participants must be serviced by the public utilities sector in order to be eligible for participation. "According to a January report, of the 218 farms that showed interest, 170 of them were ineligible because they were served by electric membership corporation or municipal utilities" (Norfleet, 2010). The other issue relates to the financial investments required for this endeavour. Many farmers simply do not have the upfront capital for bringing these plans to fruition. For example Thomas Butler, a swine farmer, "had covers put over his waste lagoons two years ago but hasn't secured enough money yet to get an electric generator, which he said could cost as much as USD 375,000. Instead, he burns the methane from his lagoons" (Norfleet, 2010).

Although this type of energy production is not viable for this project, there are many advancements being made within this field of technology which may make it worthwhile in the near future. This would definitely be something that the COSEE could look into for future projects using the funding provided from this initial one.

Since the focus is on electricity production, solar PV is the most practical option for producing renewable energy in this area.

Project Information

For this project, a "Grid type" of central-grid is used which means all the energy will be sold back into the grid. Method 2 is selected for the Analysis Type which is able to provide more detail in certain areas which leads to a more accurate model. The Analysis Type simply distinguishes between different complexities available for the project model.

Energy Model

In this section, the details will be defined for the type of solar installation utilized as well as the electricity export rate. For this exercise, the solar-tracking model is One-axis which entails more costs but increases efficiency for output. One-axis tracking essentially means it will tilt the solar panel as the sun passes over the sky for optimum angular solar intake. The Slope and Azimuths are also important factors. The Slope is the fixed angle of the other solar pane axis and is set to the latitude of the area (35.4°) for this project. This is a general rule for maximizing the efficiency of the angle at which the sun hits the panels. The Azimuth is 0° which means that the panels are south facing.

RETScreen comes preloaded with a large range of solar products and their specs. This project will use polycrystalline silicon (poly-Si) which is growing in popularity due to its lower manufacturing costs as compared to monocrystalline silicon modules while still achieving commercial efficiencies of more than 14% (Oxford University Press - ed. Boyle, Godfrey, 2004).

In order to find realistic prices and availability, the author researched solar manufactures servicing the area. North Carolina Solar is a division of Solatron Technologies, Inc. based out of California but has been involved in NC's solar industry for over 10 years (Solatron Technologies, Inc. / North Carolina Solar, 2010). Their website provides pricing and specs for different solar manufactures which enabled me to incorporate true costs. Furthermore, several of the products were in the RETScreen database so the specs would be automatically included in the model. The author spoke with a representative as well from North Carolina Solar on the phone (Diana @ ext. 106) and after going over some of the project background, it was decided that the best solar setup to use would be Suntech's STP280-24/Vb-1 High Performance Solar Panels. These were also in the RETScreen software database. A 20.160 kW setup was chosen for this project. Table 8 shows the specs and costs according to the NC Solar website and RETScreen as of 17-Sep-2010.

TABLE 8 - SPECIFICATIONS OF SOLAR INSTALLATION

Manufacturer	**Suntech**
Model	STP280-24
Type	poly-Si
Capacity per unit	280 W
Efficiency	14.4 %
Frame area	1.94 m^2
Number of units	72
Capacity	20.160 kW
Inverter (included in cost)	PVP4800 (Quantity – 4) (96 % efficiency)
Racks (included in cost)	Unirac SolarMount
Warranty	25 years for panel, 10 years for inverter
Cost	USD 72,576

According to RETScreen, given the specs provided, the annual solar radiation is 1.56 MWh/m^2 (horizontal) and 2.14 MWh/m^2 (tilted). Table 9 below shows the electricity exported to the grid in this scenario. The export rate will be explained further below in the financial section.

TABLE 9 – ELECTRICITY EXPORTED TO GRID (RETSCREEN)

Month	Daily solar radiation - horizontal	Daily solar radiation - tilted	Electricity export rate	Electricity exported to grid
	kWh/m²/d	kWh/m²/d	USD/MWh	MWh
January	2.47	4.42	180.0	2.547
February	3.17	4.93	180.0	2.537
March	4.25	6.05	180.0	3.385
April	5.23	6.56	180.0	3.486
May	5.80	6.97	180.0	3.764
June	5.93	6.80	180.0	3.505
July	5.78	6.74	180.0	3.559
August	5.10	6.33	180.0	3.354
September	4.53	6.09	180.0	3.153
October	3.83	6.18	180.0	3.373
November	2.79	4.93	180.0	2.670
December	2.29	4.31	180.0	2.466
Annual	4.27	5.86	180.00	37.799

Cost Analysis

Although RETScreen provides a significant amount of details to input into this section, only a few of the major ones have been entered (Table 10). Assumptions will be outlined further below.

TABLE 10 - COST ANALYSIS – 20 KW (RETSCREEN)

Cost of system (includes all balance of system components)	USD 72,576
Cost of installation (estimate from North Carolina Solar) (USD 1.50 per W)	USD 30,240
Total Start-up Costs	USD 102,816
Annual Operations and Maintenance (estimate from North Carolina Solar) (1% / kWh)	USD 377.99

Exclusions and Assumptions

- Pricing for the site has not been included. Ideally these would be placed on rooftop space in the area to prevent further deforestation or having to utilize valuable farm land.. This could be on agricultural facilities or local businesses. Rental cost would need to be included in the calculations at that point.
- Land or site permits costs.
- Transmission connection costs.
- Property insurance costs.
- Project management and consulting services.

Emission Analysis

RETScreen provides in depth emission analysis which can demonstrate the positive environmental impacts of potential projects. For this project of even a small size of 20 kW, there are significant reductions of greenhouse gases (Table 11, Table 12). By entering in the baseline mix of fuel sources for NC (Figure 15), RETScreen provides us with several environmental matrices specific to this project.

TABLE 11 - BASELINE FUEL MIX AND EMISSION FACTORS – 20 KW (RETSCREEN)

	Fuel mix	CO_2 emission factor	CH_4 emission factor	N_2O emission factor	Electricity generation efficiency	T&D losses	GHG emission factor
Fuel type	%	kg/GJ	kg/GJ	kg/GJ	%	%	tCO_2/MWh
Coal	60.0%	92.7	0.0145	0.0029	33.8%	6.0%	1.063
Nuclear	32.0%	0.0	0.0000	0.0000	30.0%	6.0%	0.000
Natural gas	3.0%	49.4	0.0036	0.0009	40.8%	6.0%	0.467
Hydro	3.0%	0.0	0.0000	0.0000	100.0%	6.0%	0.000
Diesel (#2 oil)	0.4%	69.3	0.0019	0.0019	28.4%	6.0%	0.944
Biomass	1.0%	0.0	0.0299	0.0037	23.3%	6.0%	0.031
Totals	99.4%	179.7	0.0290	0.0057	-	-	0.656

TABLE 12 - GREENHOUSE GAS ANALYSIS – 20 KW (RETSCREEN)

	Base case GHG emission	Proposed case GHG emission	Gross annual GHG emission reduction	Net annual GHG emission reduction
Power project	tCO_2	tCO_2	tCO_2	tCO_2
	24.8	0.2	24.5	24.5
Net annual GHG emission reduction	24.5	tCO2	is equivalent to	4.5 Cars & light trucks not used

The GHG emissions avoided in NC would be more significant due to their heavy use of coal along with coal's large CO2 emissions (Table 11). Considering Table 12, this project would annually reduce CO_2 emissions equivalent to 4.5 cars. Imagine if every community in the US did something like this?

Financial Incentives

Before going into the financial analysis, it would be prudent to pause and look at the external financial mechanisms available for this project. There are numerous financial incentives available at the federal and state level for renewable energy projects in NC (Table 13, Table 14). Unfortunately, many of them are setup as a tax credit benefits. Since a for-profit corporation will be formed for the community initiative social enterprise in this case study, taxes must incorporated. But there will be little taxable income initially. Further discussion of how taxes will factor in is found later in the *Financial Analysis* section. The primary income will be from selling the energy back to the grid. This will be used for repaying back loans, operations and maintenance, and of course reinvestment into future projects.

Basically for the first pass at this, only the federal Renewable Energy Grant will be incorporated into the financials. This grant is "equal to 30% of the basis of the property for solar energy. Eligible solar-energy property includes equipment that uses solar energy to generate electricity" (North Carolina Solar Center and US Department of Energy, 2010). This is a significant incentive for renewable energy projects nationwide. Other potentially applicable incentives for a project of this nature are outlined below and will be discussed in the *Further Analysis* section. The information below comes from the Database of State Incentives for Renewables & Efficiency (North Carolina Solar Center and US Department of Energy, 2010). The darker highlighted rows are incentives that will be utilized in this proof-of-concept. The lighter highlighted rows are incentives that would most likely be able to be included in a real project, but due to the uncertainty of the obtainable or reducing amount, they have not been included in the primary calculations for this proof-of-concept.

TABLE 13 - FEDERAL LEVEL FINANCIAL INCENTIVES (NORTH CAROLINA SOLAR CENTER AND US DEPARTMENT OF ENERGY, 2010)

Modified Accelerated Cost-Recovery System (MACRS)	Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in certain property through depreciation deductions. The MACRS establishes a set of class lives for various types of property, ranging from three to 50 years, over which the property may be depreciated. A number of renewable energy technologies are classified as five-year property (26 USC § 168(e)(3)(B)(vi)) under the MACRS, which refers to 26 USC § 48(a)(3)(A), often known as the energy investment tax credit or ITC to define eligible property.
U.S. Department of Treasury - Renewable Energy Grants	30% of property that is part of a qualified facility, qualified fuel cell property, solar property, or qualified small wind property
USDA - Rural Energy for America Program (REAP) Grants	Maximum 25% of project cost. Applicable sectors: Commercial, Schools, Local Government, State Government, Tribal Government, Rural Electric Cooperative, Agricultural, Public Power Entities

Property Tax Abatement for Solar Electric Systems	80% tax exemption of the appraised value. Applicable sectors: Commercial, Industrial, Residential, Agricultural
North Carolina Green Business Fund	Amount varies with maximum incentive of USD 500,000. Applicable sectors: Commercial, Nonprofit, Local Government, State Government, Agricultural, Institutional

Financial Analysis

While the RETScreen's financial section is relatively easy to use and understand, there are a lot of complicated calculations that occur in the background. It is a very powerful aspect of the program and quite important since the go-ahead for many projects often come down to financial components. A few of the input values required in order to create the financial model will be introduced now (Table 15).

TABLE 15 - GENERAL FINANCIAL DATA (RETSCREEN)

Fuel cost escalation rate (U.S. Energy Information Administration, 2010)	2.4%
Inflation rate (US Average inflation rates 2000-2009) (Inflation Data / Bureau of Labor Statistics, 2010)	2.6%
Discount Rate - Rate used to convert future cash flows to the present - Utilized 20 year US Treasury Bond Yield average for August, 2010 (US Department of Treasury, 2010)	3.5%

Table 16 shows how the Federal grant factors into covering 30% of the costs leaving USD 71,971 in debt required to obtain. It also provides the terms of the debt including a

20 year payback period since this is the same amount of time that the power purchase buyback is guaranteed for.

TABLE 16 - FINANCIAL CALCULATIONS – 20 KW (RETSCREEN)

Incentives and grants (Federal Grant = 30% of total project costs)	**USD 30,845**
Debt ratio	70%
Debt	USD 71,971
Equity	USD 30,845
Debt interest rate	4.6%
Debt term	20
Debt payments	20 years

A debt interest rate of 4.6% is used in order to cover inflation and still return 2% real interest (Nominal interest (4.6%) – Inflation (2.6%)). The 2% real return is the goal for this initial project. This provides a modest return to investors while still retaining enough income for reinvestment into other projects.

TABLE 17 - PROJECT COSTS AND SAVINGS/INCOME SUMMARY – 20 KW (RETSCREEN)

Initial costs				
	Power system	100.0%	USD	102,816
	Balance of system & misc. (included in Power system costs above)	0.0%	USD	0
	Total initial costs	**100.0%**	**USD**	**102,816**
Incentives and grants			**USD**	30,845
Annual costs and debt payments				
	O&M		**USD**	378
	Debt payments - 20 yrs		**USD**	5,581
	Total annual costs		**USD**	**5,959**
Annual savings and income				
	Electricity export income		**USD**	6,804
	Total annual savings and income		**USD**	**6,804**

TABLE 18 – YEARLY CASH FLOWS – 20 KW (RETSCREEN)

Year #	Pre-tax (USD)	After-tax (USD)	Cumulative (USD)
0	0	0	0
1	835	835	835
2	825	825	1,660
3	815	815	2,475
4	804	804	3,279
5	793	793	4,072
6	782	782	4,854
7	771	771	5,625
8	759	759	6,384
9	747	747	7,130
10	734	734	7,865
11	722	722	8,586
12	709	709	9,295
13	695	695	9,990
14	681	681	10,672
15	667	667	11,339
16	653	653	11,992
17	638	638	12,630
18	623	623	13,253
19	607	607	13,860
20	591	591	14,452

FIGURE 22 - CUMULATIVE CASH FLOWS GRAPH – 20 KW (RETSCREEN)

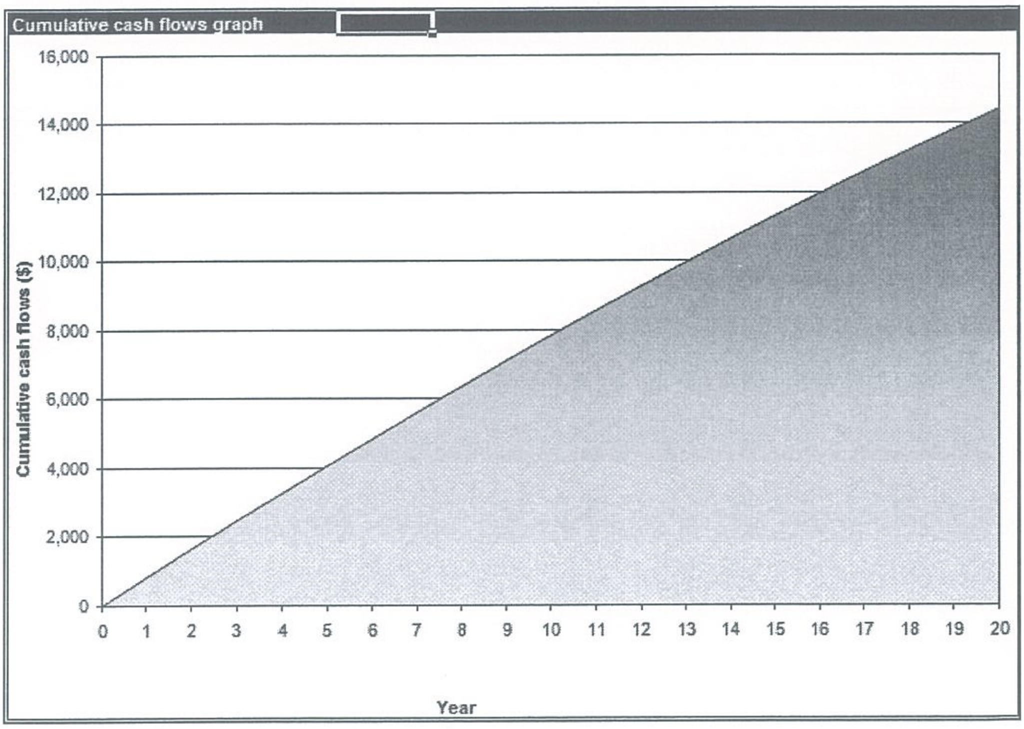


TABLE 19 - FINANCIAL RESULTS AND VIABILITY – 20 KW (RETSCREEN)

Pre-tax IRR - equity	%	positive
Pre-tax IRR - assets	%	-12.5%
After-tax IRR - equity	%	positive
After-tax IRR - assets	%	-12.5%
Simple payback	yr	11.2
Equity payback	yr	immediate
Net Present Value (NPV)	USD	10,520
Annual life cycle savings	USD/yr	737

In Table 18 and Table 19 the reader may notice that the pre-tax and after-tax numbers are the same. This is because the taxes have not been factored in for this particular scenario. In the *Further Analysis – Taxation and Depreciation* section, these numbers will be incorporated in a more detailed analysis.

40kW Project

Before going further into the analysis, below is a breakdown of what would happen if a 40 kW project was implemented instead of the 20 kW. This first part shows where there were adjustments made in the input values.

TABLE 20 - COST ANALYSIS – 40 KW (RETSCREEN)

Implementation Costs	
Cost of system (includes all balance of system components) - A 3% discount for economies of scale has been made as compared to the 20 kW system.	USD 104,797
Cost of installation (estimate from North Carolina Solar) (USD 1.20 per W) - Again, a discount has been assumed from USD 1.5/W to USD 1.2/W.	USD 52,052
Total Start-up Costs	USD 192,849

Annual Costs	
Annual Operations and Maintenance (estimate from North Carolina Solar) (1% / kWh)	USD 750.73

All other factors have been left the same which resulted in the following outputs (Tables 21, 22, 23 and 24).

TABLE 21 - GREEHOUSE GAS ANALYSIS – 40 KW (RETSCREEN)

	Base case GHG emission	Proposed case GHG emission	Gross annual GHG emission reduction	Net annual GHG emission reduction
Power project	tCO_2	tCO_2	tCO_2	tCO_2
	24.8	0.2	24.5	24.5
Net annual GHG emission reduction	48.7	tCO2	is equivalent to	8.9 Cars & light trucks not used

TABLE 22 - PROJECT COSTS AND SAVINGS/INCOME SUMMARY - 40 KW (RETSCREEN)

Initial costs				
	Power system	100.0%	USD	192,849
	Balance of system & misc. (included in Power system costs above)	0.0%	USD	0
	Total initial costs	**100.0%**	**USD**	**192,849**
Incentives and grants			USD	57,855
Annual costs and debt payments				
	O&M		USD	751
	Debt payments - 20 yrs		USD	10,468
	Total annual costs		**USD**	**11,219**
Annual savings and income				
	Electricity export income		USD	13,513
	Total annual savings and income		**USD**	**13,513**

TABLE 23 - YEARLY CASH FLOWS - 40 KW (RETSCREEN)

Year #	Pre-tax (USD)	After-tax (USD)	Cumulative (USD)
0	0	0	0
1	2,275	2,275	2,275
2	2,255	2,255	4,530
3	2,234	2,234	6,764
4	2,213	2,213	8,977
5	2,191	2,191	11,168
6	2,169	2,169	13,338
7	2,146	2,146	15,484
8	2,123	2,123	17,607
9	2,099	2,099	19,706
10	2,074	2,074	21,781
11	2,049	2,049	23,830
12	2,023	2,023	25,853
13	1,997	1,997	27,850
14	1,970	1,970	29,819
15	1,942	1,942	31,761
16	1,913	1,913	33,674
17	1,883	1,883	35,557
18	1,853	1,853	37,411
19	1,822	1,822	39,233
20	1,790	1,790	41,023

TABLE 24 - FINANCIAL RESULTS AND VIABILITY – 40 KW (RETSCREEN)

Pre-tax IRR - equity	%	positive
Pre-tax IRR - assets	%	-9.7%
After-tax IRR - equity	%	positive
After-tax IRR - assets	%	-9.7%
Simple payback	yr	10.6
Equity payback	yr	Immediate
Net Present Value (NPV)	USD	29,559
Annual life cycle savings	USD/yr	2,080

From this scenario it can be seen that doubling the capacity can increase the NPV by almost 180% (USD 29,559 vs. 10,520) and doubles the tons of CO_2 avoided (Table 21 vs. Table 12).

Further Analysis

Reviewing the data provided, it is shown that the project can be successful in both scenarios from a financial perspective. For the 20 kW project, the cumulative cash flow at the end of the 20 years was USD 14,452; which represents a net present value (NPV) of USD 10,520. Furthermore, the equity internal rate of return is positive which ensures that the project is worth doing over investing the money elsewhere. These shares can be a great investment for individuals' long-term retirement portfolios or for their children. For example, someone looking to retire in 20 years can be guaranteed their principal plus the 2% real annual interest. It could also be a great gift for a newborn child, similar to a bond where they would be guaranteed the return on investment in 20 years.

In addition to these numbers, there is a positive environmental impact of 25 tCO_2 avoided annually for the 20 kW project, equivalent to 4.5 cars or light trucks off the road. Couple this with the reinvestment potential from the profits into other community endeavours and it can be concluded that the enterprise fairly equally distributes its operations among the triple-bottom line of economic, social, and environmental components (Elkington, 1998).

Investment Strategy

Using only the basic federal grant as mentioned above, USD 71,971 (Table 16) will need to be raised to cover the initial expenses of equipment and installation. This is where the community will come in. As discussed, a corporation would be setup to be managed by community members with assistance from outside consultants as needed. This company will sell shares in a project. Through discussions with the community, it can be ascertained whether they wish to raise this capital from within or by including external investors.

The benefit of funding the project from within the community is that the investment is easier to sell. Since only a modest 2% real interest rate (4.6% nominal – Table 16) is assumed for investors' returns, there must be other incentives for their participation. This is where the social enterprise aspect of the project becomes a factor. Demonstrating that the profits will go back into the community gives extra indirect benefits to local investors. For external investors, while they may still desire to contribute based on the minimal ROI and knowing that they are helping a good cause(s), it may be more difficult to engage their support on purely a financial basis.

To raise the USD 71,971 needed, 2879 shares at USD 25 are to be sold. This way, people can purchase as many as they want, but also gives those that are less affluent and opportunity to participate. These shares are to be treated like a 20-year bond in this scenario. In this way, as you saw in the yearly cash flows (Table 18), enough profit will be generated to pay back the principal plus interest, cover maintenance costs, and still have profit left over for investment into the community.

Another option is to give the investors the choice to forgo the interest and/or principle payment, giving it back to the enterprise for investment into other environmental and social projects. This would be more of a philanthropic ideology which benefits the enterprise, but does not represent the core intentions of the organization's vision.

Other Incentives

Looking back at the potential financial incentives available, it can be assumed that a project of this nature would be able to obtain further grants and benefits. For instance, if the full 25% of project costs was obtained from the Rural Energy for America Program (REAP), only USD 46,267 would need to be raised. This would result in the following financial data (Table 25:

TABLE 25 - COMPARISON OF CASH FLOWS WITH REAP (RETSCREEN)

	20 kW		**40 kW**	
USD	**Without REAP**	**With REAP**	**Without REAP**	**With REAP**
20 year cumulative cash flows	14,452	51,315	41,023	115,794
NPV	10,520	38,976	29,559	82,693

This is a significant change in income which provides more flexibility for adjusting the interest rates to investors and also the terms of payment. It also provides more funding for future community endeavours. There is also the North Carolina Green Business Fund which can augment the project costs.

Once the company is making more profits as a whole through the operations of multiple projects, then there will most likely be more income for leveraging the tax rebates allowing further reductions in the total costs of implementations.

Taxation and Depreciation

It has been assumed in the scenarios so far that the income generated from the power purchase agreement is not taxable. Although researched, the author was not able to find a clear answer on how this income is accounted for on a tax basis. If it is considered regular business income, then the tax rate would be 15% (Small Business Taxes & Management via IRS, 2010) since the company would be making between USD 0 – 50,000. Furthermore, the project could utilize a declining balance, half-year, straight-line depreciation based on an estimated 20% depreciation rate (U.S. Department of Treasure - Internal Revenue Service, 2009). Just factoring in these numbers, the 20 kW project (without REAP grant) would end with cumulative cash flow of USD 9,825 instead of the USD 38,040. The after-tax internal rate of return is 15.9% with the NPV at USD 5,893 instead of USD 10,520. This does not factor in the tax rebates available or the Modified Accelerated Cost-Recovery System (MACRS) depreciation. Under this policy, the equipment can be depreciated over a 5 year period at a double-declining balance which would actually lead to an even higher bottom line, with more income in the first five years. Moreover, there is the tax rebate mentioned above that can be applied to reduce the taxable income as well (Table 14).

Unfortunately, a more in-depth accounting exercise would need to be undertaken to arrive at the actual annual tax liability, which is out of the scope of this paper. But, just by factoring in the 15% rate and basic depreciation, the project is still highly viable.

Other Costs

As mentioned in the Cost Analysis section, there were several costs being excluded in this scenario which will factor into the bottom line. While they are important in the actual undertaking of the project, they are considered less significant in this model. These included:

- Pricing for the site has not been included. Ideally these would be placed on rooftop space in the area. This could be on agricultural facilities or local businesses. A rental cost would need to be included in the calculations at that point.
- Land or site permits costs.
- Transmission connection costs.
- Property insurance costs.
- Project management and consulting services.

Strategies

In this section of the paper, a strategy will be devised for community-oriented sustainable energy enterprises utilizing what has been discussed thus far. Some of the points addressed earlier will be reemphasized, building on that foundation to formulate a comprehensive approach to expand and flourish the concept in the real world.

Sustainable Industries

Sustainable industries are emerging throughout society increasingly every day. These can be offshoots from traditional industries such as sustainable fashion or can be relatively novel such as renewable energy. The general definition of a sustainable industry according to Russo is:

An ecologically sustainable industry is a collection of organizations, with a commitment to economic and environmental goals, whose members can exist and flourish (either unchanged or in evolved forms) for lengthy time-frames, in such a manner that the *existing and flourishing of other collectivities of entities is permitted at related levels and in related systems.*

(Russo, 2003, p. 319)

Sustainable industries recognize and take into account the value of many different but interrelated areas of life. They go beyond pure economic motivations, but account for the costs and benefits realized from natural and social capital. As Russo pointed out, “organizations in sustainable industries evaluate success on multiple dimensions, at least one of which depends on ecological criteria” (2003, p. 318). This creates new challenges for management when compared to traditional for-profit companies. It is indeed difficult to achieve a true balance of the Triple Bottom-Line priorities (Social, Economical, Environmental) and also be sustainable as an organization.

While it is argued that many sustainable industries can more easily obtain benefits such as reduced waste costs (Porter & Linde, 1995) not often realized by traditional businesses (Walley & Whitehead, 1994); it is common for sustainable industries to encounter financial difficulties, especially at the onset. This can be attributed to several factors such as distribution of resources towards social and environmental priorities or costs of new technology and economies of scale. Furthermore, many sustainable industries threaten the norm and therefore barriers to entry are mounted in defence by traditional players. Social and sustainable enterprises in their nature are difficult for many hard-lined capitalists and traditional business people to accept. Many feel they endanger the very fabric of profit-driven, wealth increasing classical mentalities.

Sustainable Energy Industry

It has been proposed that the rate of sustainable energy development can be more accelerated in less developed countries due to the lack of mature energy markets already in existence (Russo, 2003) (Christensen, 1997). But, in developed countries the emergence of this industry presents a threat. Pulling from Michael E. Porter’s concept of the Five Forces of Competition (How Competitive Forces Shape Strategy, 1979), in the case of sustainable energy development, the industry threatens conventional energy business by offering a substitute as well as providing customers with more bargaining power. Electricity generated from renewable energies (without hydro and wind) supplied 18% of the world's energy in 2007 and is predicted to be at 23% in 2035 while renewable energy use is expected to increase 3% per year (U.S. Energy Information Association, 2010). Although these numbers are not significant in comparison with the urgency of the need for the transition, they are enough to instil some level of insecurity in the major players currently in the traditional energy industry. Lobbyists are employed to ensure traditional fuel costs remain profitable and barriers to entry are established or strengthened through fuel pricing for example.

The US government has attempted to spur the movement with "$13 billion in loan guarantees for clean-energy projects" (Progress Energy, Inc. - AR, 2009, p. 38) committed in 2007 by the US Department of Energy (DOE) and "$38.5 billion in loan guarantee authority for innovative energy projects" (Progress Energy, Inc. - AR, 2009, p. 38) authorized by Congress in 2008. This provides incentive for many electricity providers to diversify their energy sources portfolio through a significant risk reduction associated with being unsuccessful in these endeavours. But, it must be noted that of the USD 38.5 billion mentioned above, USD 20.5 billion is set aside for nuclear power, USD 10 billion for renewable and/or energy-efficient systems, USD 6 billion for coal-based systems, and USD 2 billion for coal gasification (Progress Energy, Inc. - AR, 2009). Obviously, the US government is banking heavily on nuclear to solve the energy crisis, which in reality makes sense. Unfortunately, nuclear is the only source that comes close to replacing fossil-fuels for satisfying the existing and growing energy demand within a reasonable time frame. But, the fixed cost of building a nuclear plant is extremely high and without the immediate demand to match, it can be a lengthy investment recovery period (Blackburn & Cunningham, 2010) (Progress Energy, Inc. - AR, 2009).

Although conventional power companies have been investing in sustainable energy development, the uncertainty of the industry's future direction has stagnated growth somewhat. In the 2008 annual report of Progress Energy, Inc. – which serves NC, SC, and Florida – they often use the phrase "We cannot predict the outcome of this matter". In one instance, referring to Florida's new comprehensive energy legislation, they stated "We cannot predict the impacts to our liquidity of complying with Florida's comprehensive energy." In 2007, North Carolina authorized the Renewable Energy and Energy Efficiency Portfolio standard requiring, among other obligations, that 12.5% of retail electricity come from renewable energy sources by 2021 (PE - Global Climate Change Report, 2009). Below is a general statement which summarizes Progress Energy's position:

"We cannot predict the costs of complying with the laws and regulations that may ultimately result from these executive orders. Our balanced solution, as described in "Increasing Energy Demand," includes greater investment in energy efficiency, renewable energy and state-of-the art generation and demonstrates our commitment to environmental responsibility."

(Progress Energy, Inc. - AR, 2009, p. 37)

This seems like a great approach, but in 2009 they only purchased 1.25 million MWh (Progress Energy, Inc., 2010) of renewable energy (excluding hydro) in the Carolinas and Florida. Hydro accounted for 65.1 MWh. This seems like a lot, but when compared to their total generation for 2009 (97,246,764 MWh), renewable energies barely achieves 1.2%, and only 1.9% with hydro (Progress Energy, Inc., 2010).

It can be argued that conventional energy companies are becoming involved in order to: 1) have a stake in the potential profits, 2) manage the direction of the emerging industry, and 3) improve public image. This makes it difficult to nurture the budding industry into something unlike its predecessors. Not only does the sustainable energy industry need to produce sustainable energy, it also must be sustainable in itself with a balanced portfolio of financial, natural, and social priorities. While profits are important, this paper argues that they should not be maximized at the expense of the environment or quality of life for society. It is a concern that traditional energy companies will not embrace this ideology when furthering renewable energy development since in the past heavy emphasis has been on maximizing shareholder wealth (Costanza, et al., 2000).

Community-Oriented Energy Enterprises Strategy

Considering the current development of the renewable energy industry, there seems to be ample opportunity for community-oriented enterprises (COE) to enter the market, although there are some hurdles to overcome. While the renewable energy movement is rocking the proverbial conventional energy companies' boat as mentioned before, it still does not hold a significant enough share to warrant a considerable threat. This is especially apparent at the level of community-oriented energy production (Hopkins, 2008) (Lerch, 2009).

Life from a Thousand Cuts

It can be said that due to the nature of the grassroots movement and the inability to replace conventional energy sources in a one-to-one relationship, there exists the possibility of entering the industry under the radar so to speak. This approach presents a great opportunity since smaller individual projects do not tend to endanger the conventional energy sector as a whole. The beauty of this scenario though is the positive cumulative effect of these community projects over time which can gain a larger percentage in the overall energy production portfolio. This can reveal a strategic growth opportunity for enterprises of this nature. This is all written in theory as there is no evidence of this occurring yet. It is still early in this type of movement. But, as pointed out in the *History and Supporting Literature* section, there have been successes in the past and the momentum is growing currently. Of course once the movement has gained a large enough share of energy production, a new strategy will need to be developed since it will present a greater threat to conventional energy players (Mintzberg, Ahlstrand, & Lampel, 1998).

Geographic, Social, and Legal Circumstances

In related fashion, the importance of the geographical and legal framework which a community enterprise is operating within must be considered. The natural capital that renewable energy relies on is not portable. Wind energy as it exists now cannot be gathered and carried somewhere else for the actual transformation to electricity. Along with solar, geothermal, hydro, and wave/tidal; it is utilized and converted at the source.

This demands site specificity as well as the proper social capital in that area (Russo, 2003).

It is crucial for the community to be involved and utilized to create a successful project. The available social capital in an area and the willingness to get involved can make or break a COE and its projects (Peredo & Chrisman, Toward a Theory of Community-Based Enterprise, 2006). What is social capital really? There have been numerous works written on this subject. With respect to COEs, Peredo & Chrisman's interpretation of Larson & Starr and Onyx & Bullen is highly applicable:

The elements typically identified in the notion of social capital include densely interlocked networks of voluntary relationships, a high degree of reciprocity in which short-term sacrifices are made with the implicit understanding that they will be repaid over time, trust, or a willingness to take risks with the conviction that others will respond cooperatively, and broad agreement on social norms.

(Peredo & Chrisman, Toward a Theory of Community-Based Enterprise, 2006) (Larson & Starr, 1993) (Onyx & Bullen, 200)

Obviously it would be more lucrative to introduce the idea of community-oriented energy projects in areas where some of these characteristics already exist. Previously successful community projects as well as a general sentiment of cooperation would foster a more conducive environment for success. Most people like the idea of energy conservation and local energy production projects, but active support and participation can fluctuate. In one study done on 46 community properties in the UK, it was found that "There was widespread support for local generation and use of renewable energy, with respondents expecting benefits from a project in terms of increased community spirit and conservation of natural resources. However, desire for active involvement was lower and residents viewed themselves participating as consultees, rather than project leaders" (Rogers, Simmons, Convery, & Weatherall, 2008, p. 4217). The community members generally liked the idea of a local energy project not only for the global environment but also heavily for the community-relationship building as well as individual responsibility. But, as stated, they were not always eager to become active participants citing reasons such as time, personal priorities, and doubt in the feasibility (Rogers, Simmons, Convery, & Weatherall, 2008). Furthermore, scale has been noted as an issue as well for these projects. The authors of the same article referenced another study where a proposed biomass gasifier in rural Devon was rejected after heavy local campaigning. Following the refusal, a follow-up survey was undertaken which "revealed that 69% would support a smaller project proposed by a local group for the same site, if it was controlled by the community (Rogers, Simmons, Convery, & Weatherall, 2008) (Upham, Follow-up questionnaire survey: Winkleigh Parish opinion of the proposed WINBEG biomass gasifier, 2007) (Upham & Shackley, 2007).

For these reasons, it is important to incorporate the community at multiple levels and stages of projects. It is also crucial to incorporate the appropriate management, including external, as part of the project to fill the gaps where social capital may not. This requires a proper assessment of the resource pool as well as willingness to participate. Family and community interrelationships provide a climate for risk-taking that would not be as acceptable at the individual level (Peredo & Chrisman, Toward a Theory of Community-Based Enterprise, 2006). In order to gain this advantage, it must be emphasized how these projects can bring the community together with the intention of a shared experience that can enhance everyone's life.

It must be noted as well that what works in one area may not work in another due to differences in environmental and social conditions (Russo, 2003). Referring to Espinoza & Vredenburg, who compared the renewable energy industry development in Ecuador and Costa Rica; due to the massive oil and gas reliance and subsidies found Ecuador, the same approaches cannot be used in the two countries. Costa Rica never had the heavy dependency on oil along with subsidies which exist in Ecuador and therefore were more willing and able to transition towards wind energy (Espinoza & Vredenburg, 2010). Russo's study about the wind sector in California also found similar results even at the county level. Due to the natural and social capital as well as the legal framework, little correlation was found between the quantity of projects in adjoining counties. Although these issues may seem like barriers, they could actually be opportunities for community-oriented energy enterprises.

Learning School – Adaptive Management

This approach requires adaptive management as discussed in the learning school strategy. "According to this school, strategies emerge as people, sometimes acting individually but more often collectively, come to learn about a situation as well as their organization's capability of dealing with it. Eventually they converge on patterns of behavior that work" (Mintzberg, Ahlstrand, & Lampel, 1998). This is highly relevant to community enterprises and especially those involved in sustainable energy development. The multiple factors and dimensions found in different communities and projects along with the evolving nature of renewable energy demands this kind of flexibility. Those organizations that embrace this strategy will emerge more stable through their ability to adapt to ever changing circumstances and environments (Mintzberg, Ahlstrand, & Lampel, 1998).

Proactive vs. Reactive

Community driven enterprises must take a proactive approach to development. The energy industry is mature in its operations and most of its players have been taking a reactive stance. Many traditional energy companies have been sitting back on their heels waiting to see what institutions and customers will demand with relation to sustainable energy development, as noted above in the case of Progress Energy, Inc. (Progress Energy, Inc. - AR, 2009). Moreover, from popular opinion, Progress Energy would be considered as one of the more proactive large energy companies in the US.

The reactive nature of the energy industry with respect to renewable energy development provides an opening for grassroots community projects. These community enterprises must be proactive in order to establish a stable and successful competitive advantage (Brown, 2001). As a distributed energy model, these enterprises must exploit first-mover benefits. If there is to be renewable energy, decentralization is inevitable and therefore represents a highly penetrable market for those that wish to be proactive in getting involved (Greenpeace, 2005).

Human Resources

In order to be adaptive and proactive, it is important to have the proper people involved internally within the management and core infrastructure of the projects. In this section, the assertion is made that human resources refers to those directly involved in engaging the project more or less as a full-time endeavour. These team members can come from the community's social capital pool or externally and must support the organization's mission while also engaged on their own accord. It is important that they all feel ownership of the enterprise's goals and ambitions. This will lead to individuals being proactive which ultimately contributes to the overall effectiveness. They must generally contain some degree of entrepreneurial spirit which spurs them to look for opportunities as well as adapt to evolving circumstances without always waiting for explicit directions. Making the organization's goals and mission clear upon recruitment and hiring is crucial so that those that are joining are aware of the expectations. Often these people are looking for more rewarding work rather than purely financial gain (Hart, 1997) (Hall & Vredenburg, 2003).

Fortunately, with proper recruitment, less time and devotion should be needed to ensure the staff is behind the organization's direction. In theory, the human resources will already align with the values and vision of the organization. Often in traditional companies a lot of time and resources are expended in value-changing activities as well as ensuring people are acting in the interests of the organization, community, and environment (Robbins & Judge, 2009). These driving forces should be more intrinsic for community-oriented organizations due to the basic nature of the business from the start.

Value Chain

In order to properly address all the various needs of the organization and general public, it is important to identify the value chain for the community-oriented energy enterprise. Below in Figure 23 you will find a diagram created by the author which outlines primary and support activities that should be considered in community-oriented energy enterprises.

FIGURE 23 - VALUE CHAIN ACTIVITY DIAGRAM

Support Activities	Firm Infrastructure Planning Identify and account for stakeholders Government relations Strategy and sustainable growth model (vision) Human Resources Recruitment (vision portrayal) Compensation Training Understand and execute adaptive measures Technical capabilities
Primary Activities	Financial Management Feasibility assessments Payback calculations Sustainable returns on investments Investors and other outside funding Procurement Office space and supplies Supplier and construction contracts (e.g. – obtain pre-owned wind turbines) Natural capital (e.g. – land for a wind turbine) Life-cycle analysis of physical capital Navigating Legal Framework Zoning issues (e.g. – land use, rights to a river for hydroelectric) Incentives, subsidies, and feed-in tariffs Social & Environmental Management Impact assessments Community relations identify and address social & environmental areas of importance seek out participation and involvement (social capital) Post-implementation Operations assessment and management (making any necessary adaptations) Ongoing physical maintenance Ensuring continued community awareness Social, environmental, and energy re-investment (What's the next project?) Transfer management to community members

CONCLUSION

First of all, it is safe to assume there is no direct replacement for oil. The transition to a more sustainable energy paradigm must happen through multiple avenues. Having said this, the first objective demonstrated how our current energy and economic structures are quite fragile. There is a lack of understanding and accountability of the true values and costs for the natural resources relied on daily and this has produced a false foundation for our developed systems (Wackernagel, et al., 1999). This should spur society to transition to a new energy paradigm.

The second objective covered sustainability and resilience. Although the proof-of-concept does not actually result in a completely resilient and sustainable community; this does bring them closer to these objectives. With continued reinvestment and other implementations, communities can incorporate more renewable energy into their portfolios. If enough projects are implemented, they could use this energy directly in the community in the future, reducing reliance on larger centralized energy production. If all communities do this, then the grid itself could become based on renewable energy which can be traded amongst communities as needed. For instance, if one community in the coastal area of NC has implemented primarily wind turbines while another area in the center of the state is using more solar, they can share or trade the energy as natural circumstances change (i.g. - seasonal or periodic fluctuations in production). This aligns with decentralization and creates more energy resilience in a sustainable fashion.

There are many factors contributing to the success of the community-oriented sustainable energy approach. As discussed, local culture as well as social capital and values are important in initiating and maintaining successful ventures. This requires awareness and in some instances, a shift in thought and lifestyle. Properly structured incentives are needed to ensure fairness and transparency as well. All of these components require community involvement and active participation, not just a monetary investment.

As we saw in the proof-of-concept, the community-oriented renewable energy enterprise can be successful and should be considered as an integral approach for transitioning to the new energy paradigm. This is especially true in developed areas where they use a substantial amount of energy as compared to developing regions. Unfortunately, until natural resources are properly valued and major subsidies are shifted from fossil-fuels to renewable energy development; it is difficult for the latter to compete with the traditional based on economics. For community-oriented sustainable energy enterprises to be successful in developed areas, they will need to rely quite heavily on financial incentives provided by the government and private organizations. This was demonstrated in the proof-of-concept and its analysis for the NC community. Without the 30% grant for instance, this project would not have been worth doing from a financial perspective or for the community.

This paper proposes that since developed areas are more affluent in general, a good way of spurring sustainable energy development is through government incentives as opposed to private companies. In this scenario, the power purchase buyback is funded by Progress Energy, Inc. While they are doing it to satisfy the demands of the REPS policy in NC, it is still not funded by the people so to speak. Taxes collected from people of developed countries should be used to fund more financial incentives therefore spreading the financial burden of transitioning to renewable energy amongst all citizens. This is also more reliable than a private organization who can choose to stop and start programs as it wishes or even go out of business. In theory, the government would represent more stability to ensure the success of the transition.

Communities-oriented energy projects can urge people to take more responsibility for their energy supplies and demands; alleviating some of the pressure on larger public and private organizations to do all the legwork for implementing renewable energy. This could potentially create a common ground and balance between society, government, and private industry. When everyone is involved, it is more difficult to blame just one party. This paper demonstrated that it is possible to provide a *win-win* for these different stakeholders as well as the environment.

Community-oriented energy enterprises are exciting but also challenging. Although a need for them exists, many people are not aware of this need yet. Along with trying to penetrate the energy industry, these enterprises must also not just account for social and environmental factors; they must play a significant part of the overall strategy of sustainability. With the proper community, internal human resources, and shared vision; these organizations can help usher in a new paradigm of economics. Natural and social capital can become the larger priorities and financials become a means to augment those two rather than the ultimate driving force. Overall, this transition should not be seen as a sacrifice but rather as an opportunity to evolve into a better era for humankind.

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