Drivers and Barriers to Rural Bioenergy Entrepreneurships

The Case of Biogas in Vietnam

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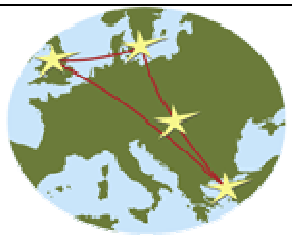

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Abstract

Poverty reduction, first on the list of Millennium Development Goals, requires access to modernized, stable energy to be realized. Rural areas are especially vulnerable, which is why renewable energy technologies (RETs) illustrate a promising solution for modernized energy access. Entrepreneurs play an important role in these sustainable development projects by helping build up an entire sector of services. Acting as indicators for a project's stability, entrepreneurs provide a needed service (energy) while stimulating the local economy. In order to realize their potential, drivers and barriers are to be identified to assess their current situation. Entrepreneurs in Vietnam have had limited time to develop in this contemporary age, however, rapid changes have been occurring they have emerged as key movers in rural bioenergy.

This thesis looks at Biogas in Vietnam as a case study towards understanding the key drivers and barriers to bioenergy entrepreneurs in rural areas and their project dissemination models. The project's surveys rural bioenergy entrepreneurs, households and key informants in the projects. The purpose of this study is to explore what critical factors to bring about the creation of a new business in the developing rural energy sector by identifying the key drivers and barriers to biogas entrepreneurs and the dissemination approaches of each case's development project. Using several analytical frameworks, two programs are analyzed, the Biogas Programme and the Vietnamese Women's Union's (VWU) energy project, with three separate cases conducted in the northern part of Vietnam. The study highlights drivers and barriers and compares dissemination models to aid future research, while making important recommendations for future rural bioenergy entrepreneurs.

Keywords: Biogas; Entrepreneurs; Vietnam; Dissemination Models

Executive Summary

Introduction

Renewable Energy Technologies (RETs) are a promising choice for rural communities with unreliable energy sources by offering a domestic replenishing source of energy, a key foundation in poverty reduction by developing and promoting modernized, energy technologies to improve livelihoods. Many Asian countries are developing rapidly and in order to sustainably develop, energy modernization is necessary to improve public health, provide reliable energy sources and prevent environmental exploitation. Bioenergy is an attractive venture because of its connection to agriculture, and with many developing Asian countries still based heavily on agriculture (Vietnam being on of these); biofuels have already been pursued by some nations.

Entrepreneurs play an important role in sustainable development for rural energy projects by helping build up an entire sector, acting as an indicator of its stability, providing a needed service (energy) and stimulating the local economy. Entrepreneurs in Vietnam have had limited time to develop in this contemporary age, however, rapid changes have been occurring they have emerged as key movers in rural bioenergy.

Rural Biogas Entrepreneurs in Vietnam

In Vietnam, biogas dominates the bioenergy field and as a technology that is renewable, it's derived from agricultural residues, biogas has improved livelihoods, the environment and the public health of many communities around the country. Biogas is a type of energy that utilizes biodegradable organic matter, which is broken down by methane producing bacteria. These bacteria then produce a mixture of carbon dioxide and methane that produce a combustible gas that burns similar to liquid petroleum gas (LPG) and produces virtually no indoor pollutants. The gas can be used for cooking, lighting, heating and electricity generation (Acharya et al., 2005).

In this thesis, Biogas is used as a case study for studying bioenergy entrepreneurships in rural Vietnam, due to the prevalence of programs and the substantial history in the country. Entrepreneurs, or biogas masons, are seen as a key indicator for economic and social growth and the 'health' of a development project (UNDP, 2004). The purpose of this study is to explore what critical factors to bring about the creation of a new business in the developing rural energy sector by identifying the **Key Drivers and Barriers** to biogas entrepreneurs and the **Dissemination Approaches** of each case's development project.

The research's focus is a survey of rural bioenergy entrepreneurs in Vietnam looking at two different programs, the Biogas Programme and the Vietnamese Women's Union's (VWU) energy project. The case studies come from two different organizations and are triangulated to explore three different scenarios in the northern Vietnam. The cases range between three provinces, from a peri-urban setting (Ha Tay), a lowland, coastal agricultural province (Ninh Binh), and a mountainous, more remote area (Son La).

Conclusions and Recommendations

Entrepreneurs play an important role in sustainable development for a project by helping build up an entire sector, acting as an indicator of its stability, providing a needed service (energy) and stimulating the local economy. In order to realize their potential, drivers and barriers are to be identified to assess their current situation.

For the **Key Barriers** to entrepreneurs, they are related to lack of quality control, lack of competition, fluctuations in prices, gender, little to no business skill training, demand and affordability constraints at the households, income not being enough to sustain a full-time job and the perception of biogas as a low skill field.

Key Drivers for biogas entrepreneurs identified subsidies as market promoter's strength, as well as the positive view of the technology and widespread community support. Initial public support and community awareness and education promote biogas and enable an easier climate for 'first movers' in biogas. An open market sector and support to biogas services, such as warranties, Microfinancing, subsidies for households and business training are also major drivers where available.

In the Vietnamese cases, the two organizations research each used a unique approach and theory to spreading their energy development projects. When comparing the sector development and participatory approaches, the research and analysis illustrated that the sector development model supports biogas entrepreneurs more for it's direct involvement and the crucial role the model plays in developing the market and services. Developing a sector development model benefits entrepreneurs working in energy development projects by ensuring better local and longer-term sustainability.

Within the cases studies, major strengths of the dissemination models was the highly informative nature of the projects, education, community meetings and focus on information and boosting the communal image of biogas and its related benefits. Also direct mason support and building a self-sustaining sector. Major weaknesses in both cases showed a failure to target key groups, vulnerable groups, being overly administrative and lack of business or market development. The main strengths were dissemination of information, individual and targeted support, use of local government and building services.

To summarize, **Recommendations** based on the research:

- Biogas sector expansion
- Continue information dissemination efforts
- More renewable and bioenergy policy support
- Business and entrepreneurial training for masons
- Establishing a Microfinancing program for households
- Financial aid adjustments to incorporate inflation and rising material costs
- Inter-project communication, cooperation

The future of biogas and rural energy entrepreneurs is largely dependent on research and interest in the field, key and interesting areas for future research include an evaluation of all biogas programs in Vietnam, barriers to female entrepreneurs and identifying support, further research on dissemination approaches to rural energy development projects, identifying types of supportive policy and an analysis of microfinancing and role it plays in energy modernization. If the Millennium development goal of poverty reduction is to be realized, many approaches will be necessary, entrepreneurs are one key way to bring modernized services and empowerment to rural populations.

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1 Introduction

1.1 The Energy Ladder: Cleaner Development and Poverty Reduction

Improving livelihoods requires a sustainable, reliable energy sources. Poverty reduction is a major task for future sustainability and as the first on the list of Millennium Development Goals, it requires improving access to energy to make it a reality (UNDP, 2001). Renewable Energy Technologies (RETs) are a promising choice for rural communities with unreliable energy sources by offering a domestic replenishing source of energy, a key foundation in poverty reduction by developing and promoting modernized, energy technologies to improve livelihood. These same poverty stricken communities have little change of improving their situation without a reliable, modern energy source (Johansson and Goldemberg, 2002).

Modernized, reliable energy is fundamental to other development projects, without reliable energy, supporting infrastructure is difficult. Shifting from traditional biomass, fuel wood, crop residues or animal wastes, used in traditional ways has many advantages on the local and national level, as well as for global stability, social equality, conservation and environment. Poverty eradication without energy modernization stands to hinder any sort of economic development or improved living standards (Flavin and Aeck, 2005). For cooking resources, household energy use in developing countries makes up 10% of the worlds primary energy demands and when looking solely at biomass use in households, this makes up 7% (IEA, 2006). The figure in reality is likely to be much higher when factoring in non-commercial biomass, illustrating the dependency of many on the use of an energy source that jeopardizes forest conservation efforts, contributes to regional and indoor pollution, and affects public health. This figure illustrates the large amount of biomass used in a largely inefficient energy conversion, requiring better fuels or better technology for consumption and the global potential to modernize this energy source. Outlined in Mapako and Mbewe's *Renewables and energy for rural development in Sub-Saharan Africa*, many adverse health factors can be attributed to, time-consuming biomass collection, physical ailments from the journey, indoor air pollution, use of low quality and inefficient fuels and cost of purchasing fuel (2004).

Reducing poverty is a daunting task, however, energy modernization of inefficient energy conversion technologies plays an important role in this process. Energy modernization reduces poverty in several key ways. One of the primary ways poverty is eradicated through modernized energy services is the improvement in daily life. Modernized energy ranges from improved cooking ability; more free time and reduced income spent on energy services and improved health, energy as service allows for livelihood improvement and self-empowerment of local people. Health and free time this is tied to the inefficient energy systems are burned and collected, resulting eye, lung and other health problems. Free time from reliable, modernized energy also enables the development of the local economy through enterprises, educational opportunities and improvements in agricultural and water supply (Flavin and Aeck, 2005). These link to energy modernization help build stability of energy services, something that, rural areas have less of when compared to most urban centres.

Energy for sustainable development is a critical issue when focusing on global poverty reduction. For developing countries, utilizing RETs is a solution that enriches local development for productive activities, enabling people and their communities to share the development benefit. Renewable Energy Technologies have been explored for their ability to decrease dependency on foreign energy services, environmental impacts and also modernize energy in areas that are rural or remote (Shrestha et al., 2005). RETs offer energy security and affordability by reducing the

stress on rural electrification and also domestically producing or utilizing an existing natural resource. This means less dependency on foreign resources and more security for a country.

With, globally, 2.5 billion people relying on traditional biomass for an energy source, the social and environmental strains have led to local, national and international efforts to provide energy related development solutions (IEA, 2006). One way to support these efforts to aid energy development schemes involves the use of entrepreneurs and small and medium enterprises (SMEs) to commercialize potential RETs, modernizing rural energy services and moving development progress up the 'energy ladder'. Enterprise and local economic development is an especially important aspect of energy services as it enables a local economy to develop and a stable energy source for people to improve their livelihoods.

1.2 Energy and Developing Asia

This section describes the relationship between energy and rapid growth and development in Asia. Developing Asia's rapid growth has intensified the region's energy needs, encompassing over half of globe's population. Developing Asia refers to the developing countries in Asia, excluding OECD Asia, Japan and South Korea. East, South-East and South Asia are home to many of the world's most rapidly developing and growing regions, with a combined global population encompassing over 60% of the planet (UNDP, 2006). Economies and populations are growing and strains on both energy and natural resources are not only apparent in global statistics but are becoming visible realities in daily life and international markets.

In developing Asia biomass and waste account for 21% of the consumed energy (with China excluded this puts the figure at 14%) (DESA, 2008). Another figure, relating to targets to meet MDGs, shows that China alone will have over 260 million people needing to gain access to modern energy by 2015 to meet the MDGs of poverty reduction, a target to modernize 50% of households still using traditional biomass (IEA, 2006) This means that in China alone, over 500 million people are still using traditional biomass for energy. Many Asian countries are developing rapidly and in order to sustainably develop, energy modernization is necessary to improve public health, provide reliable energy sources and prevent environmental exploitation. The situation with energy in rural Asia has already become a visible issue, slowing infrastructure development and preventing people from meeting their potential.

For poverty eradication this rapid growth creates new, and often unforeseen, challenges to sustainable development, meeting the needs of today without compromising those of the future (UNDP, 2007). Many of these challenges are present in large Asian cities; they are the new public health problems of over crowding, urbanization and unregulated pollution. More than 56% of Southeast and East Asia live in rural areas, figures that will transition to modern energy sources or continue to consume biomass and coal, creating regional, environmental stress. Incorporating urban populations into the previous figure, well over half of the people in developing Asian nations do not have access to proper sanitation or a clean water supply (DESA, 2008). These steps are crucial for developing countries, and much of this is provided with steps towards energy modernization to provide power to meet these basic needs. Asian countries also focus on rural energy modernization to prevent and slow national urbanization trends. As this is already occurring at the moment, a modernized rural energy supply would slow the flow of 'environmental refugees' by providing energy stability and opportunity for income generating activities (GNSED 2007). Over a quarter of Vietnam's population is urbanized, with an urbanization growth rate of 3.2% in 2006 (ADB, 2006 / UNESCAP, 2007). In Asia, 60%5 of the population is urbanized, with China at 60 and Vietnam at 74, illustrating similar trends, but

still a discrepancy that some Asian countries will have a greater need to modernize or develop rural areas (DESA 2007).

In order for developing countries to meet higher standards of living and find sustainability ways for aiding economic and population growth, renewable and modernized forms of energy are crucial not only for urban but especially rural areas. In Vietnam, over 70% of the country is living in the rural areas and much of the population needs a more consistent and better form of access to energy (ADB, 2006). In this sense, renewable energy technologies (RETs) and bioenergy provide a different approach to rural development accounting for sustainability, renewablility and reliability.

Connecting rural people to electricity is a resource-intensive and expensive venture for many developing Asian countries. As a result, projects in Renewable Energy Technologies provide off grid solutions are being pursued to give a reliable energy source for communities to empower themselves, improve the local economy, enterprises, health and environment. In order to prevent a 'develop first, and clean up later scenario', a wide array of energy options can be seen for a few countries. 'Investing in renewables' is a more long term and sustainable goal that fit Asian scenarios as being a profitable and socially viable modernization steps. RETs offer Asia a rural energy solution by providing energy security, stability and sustainability for non-urbanizes communities and households.

1.3 Vietnam: Socio-Economic Context

Socio-economic context gives the background to Vietnam through statistics to illustrate development progress and in the second section will detail the energy structure, usage and resources of the country. Vietnam, a developing country of 84 million, has only come to peace in the 1990s through a rough period of modernization and war. As a result, rapid development has put the country as Asia's second fastest growing economy (UNDP, 2007). Accelerated growth in one of Asia's fastest growing economies, foreshadows the future energy needs and related concerns for the Vietnamese people. In Vietnam's rural areas, fuel wood and other biomass have primarily been the traditional energy sources for cooking and heating, however, electrification and renewable energy technologies, such as compressed biomass, biogas or solar panels, have become more available, shifting rural areas upwards on the 'energy ladder' towards cleaner and more sustainable energy services.

1.3.1 Country Profile

The country's economic structure has traditionally been a centralized state and now has rapidly shifted to a socialist free market, opening the country up to many levels of entrepreneurs and outside investment. Private sector growth has been significant in the country, and this is not just apparent in major cities, but outside as well. Vietnam, a diverse country with abundant resources and industry has the advantage of having fossil fuel resources as well as precipitous mountainous areas and rivers for hydropower capabilities. Vietnam's entry into the world trade organization in 2007 illustrates the movement towards liberalization and national development (World Bank, 2007).

In Vietnam, the GDP in 2005 was 52.,4 billion US dollars, comparitively for Sweden this was 357.7 billion USD. The GDP per capita for Vietnam in 2005 was 3,071 , in Sweden this was 32,525 GDP per capita with a growth rate between 1990 and 2005 annually of 2.1% in Sweden. Between 1990 and 2006, the growth rate averaged nearly 6% (UNDP, 2007). While GDP does not completely describe the picture of growth in the country, other figures will highlight that the

growth puts the nation as the second fastest growing in East Asia. In Figure 1, the HDI for the globe is broken down into regions and compared with that of Vietnam. In terms of East-Asia, Vietnam is close to the average national HDI of East Asia. In terms of East Asia, it is just below the average (UNDP, 2007).

Vietnam's HDI is 0.733, this figure expands the notion of GDP by measuring a combination of longevity, education, literacy rates, and living standard from various income factors. It does leave out some crucial factors but illustrates a more accurate picture than GDP sometimes can provide. For instance, Vietnam's HDI value is comparable to Algeria with the same HDI but different GDPs For a range and comparison, Iceland has and HDI of 0.968, as the globe's highest, and near the bottom, Sierra Leone with 0.336. The life expectancy in the Vietnam is 73.7 years, quite high with a literacy rate above 90% (UNDP 20057).

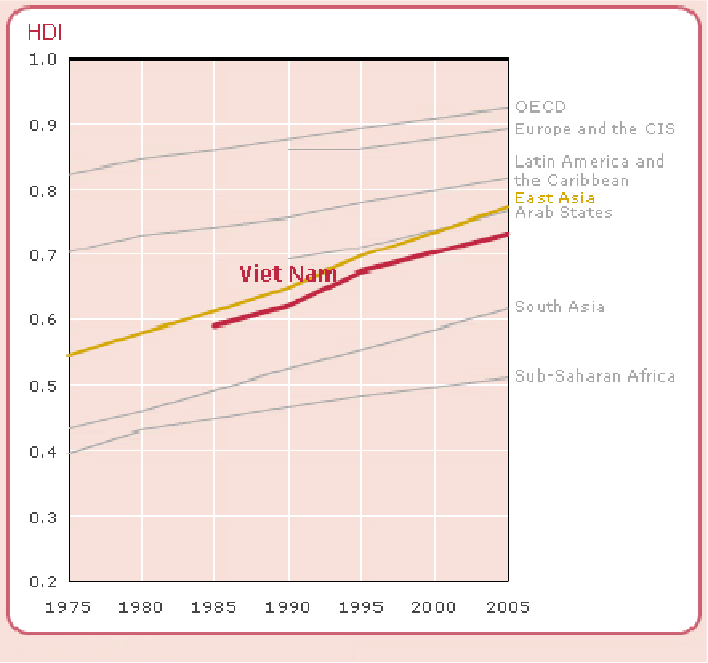

Figure 1-1 . Vietnam's HDI as compared with the global rise (UNDP, 2007).

Vietnam has greatly reduced poverty, to an area around 30% reductions since the early 1990s (ADB, 2007). Despite a higher HDI, only 27% of the population resides in urban areas and nearly a quarter of the population is still living in poverty (ADB, 2007). The economy is still predicted to grow over the next years, effectively spotlighting the opportunities and challenges with such a rapid growth rate.

1.3.2 Energy Situation

As a country with a shifting economic structure and a growing private sector, energy has become a national issue for Vietnam's development, however, Vietnam is an energy exporter. Vietnam has many forms of energy, and structurally as an exporter, energy is viewed as a profitable venture. The energy sector is made up of offshore oil, natural gas, coal and many hydroelectric power projects around the country, working with the geography and resources of Vietnam (World Bank, 2006). The mountainous north and central plains make hydropower and coal better options and the southern areas for offshore gas and oil. The country is then "divided" into three regions, north central and south, each with their own energy niche supplies. For instance, hydropower runs from the north and middle part of the country with, gas, coal and oil utilized for the southern part and filling in the gap areas. Biomass and waste still account for nearly 50% of energy consumed in the country. The latest hydroelectric project is expected to open in 2010 (Tuan 2008, March 25, Personal Interview). For electricity generation, solar, wind and small-scale hydropower are not common in Vietnam, due to the rigid and state controlled energy structure which leaves little room for large scale RETs, they can, however, be found on the smaller, rural scale (Ervin and Tuan, 2004).

Table 1 below illustrates the percentage of each energy type used from the total primary energy supply. The total primary energy supply is a figure reflecting the energy produced domestically and net export/imports (UNDP, 2007). Here Biomass and waste combustion greatly dominate usage, due to the large populations in rural areas. The biomass figure is much lowered than previous numbers, in 1990 the percentage of biomass and waste usage in the country was over 77%, a dramatic shift over the past 15 years down to less than 47% (UNDP, 2007). The main cause for this is the shift downwards in non-commercial biomass and upwards in commercial biomass. Energy supply has also increased greatly; the total primary energy supply in 1990 was 24.3 mtoe (commercial energy consumption) and in 2005, this figure jumped to 51.3 Mt of oil equivalents (UNDP, 2007). Metric Tonnes of Oil Equivalent (mtoe) quantify energy figures for comparison by measuring energy supply in terms of oil.

Table 1-1 Distribution of energy supply in Vietnam, 2005.

Energy Type	Coal	Oil	Gas	Hydro	Biomass and Waste	Nuclear
Usage (% of total)	15.8	24.3	9.6	3.6	46.7	0

Source: UNDP, 2007.

In 2004, 20 million tons of crude oil were exported, a value of 5.7 billion USD. In that same year, Vietnam imported 11 million tons crude oil, at a cost of 3.6 billion USD. After combining these figures, this leaves a net earning of 2.1 billion. The reason for such imports is the lack of technology for refining the high quality oil found offshore. The imported fuel is poorer quality but without the proper technology there is little alternative. By 2020, the country's production is projected to expand to 40 million tonnes per year (ADB, 2007). Much petroleum is imported despite the high oil yields. The reason for this is technological, importing cheap petroleum and exporting the high quality oil found off the country's coast (Tuan 2008, March 25, Personal Interview). Coal production is expected to double, with the highest quality coals (anthracite) used for export and the lower qualities being used domestically. In Vietnam, with the electrification rate at 84.2% in 2005, meaning that 13.2 million people in the country are still without electricity access. In Developing Asia, almost 930 million people are without electricity (UNESCAP, 2008). For China and East Asia, the average electrification is 88%, leaving Vietnam below the average in electricity access (UNESCAP, 2008).

Key Benefits of Renewable Energy Technologies (RETs):

1. Enterprise development
2. Poverty reduction
3. Rural power - Stability
4. National Security
5. Closing the gender gap
6. Public Health
7. Education and Awareness
8. Environment

Figure 1-2. Illustrates the key benefits of RETs (Flavin and Aeck, 2005).

Vietnam's Electricity consumption per capita in terms of kilowatt hours was 560 in 2004, a 324 % change (increase from 1990. To compare this figure to an OECD and country, Sweden's per capita energy consumption was 16,670 with a decrease of -1.9%. (UNDP, 2007). In terms of

Energy consumption, Vietnam uses 47.59 TWh of electricity or 573 Kwh/capita annually. IN Sweden, the per capita consumption is 15,430 kWh/capita and a total annual consumption of 139.34 TWh (IEA, 2007).

The state owned Electricity of Vietnam (EVN) is the dominant power corporation in the country which owns several types of power generation: Thermal plants, hydro power plants and gas turbines (EVN, 2008). Their "electricity network" is composed of several companies operating all over the country and selling electricity. This network is overseen by EVN, and then on the next tier consists of the energy projects owned under the corporation. Electricity produced from national projects is then distributed by regional power companies, and transmission groups (World Bank, 2006). Much of the power usage is divided between Industry and Commercial usage and residential (each around 45% in 2004) (World Bank, 2006). This figure highlights the large electricity use in the homes, but may not take into account that many people are operating a commercial enterprise out of their home, blending the two interests.

More investment will be needed, demand will continue to increase and the major restructuring of Vietnam's electricity system will continue over the next decade. While change is relatively slow in government processes, the state owned EVN may be broken up or face competition as market forces are entering on the local, national and international level. Average electricity growth rate to 2010 12.7% per year increase of energy capacity, unregulated growth has estimated that this will need to jump to 13.4 (World Bank, 2006). Within Vietnam, there is a lack of a competitive energy market on the national scale, however these trends have not been explored in depth on the small, medium and micro enterprise scale related to energy (EVN, 2008).

Many government-sponsored programs to conserve energy and investments in renewables, like biofuels, shows that the country is committed to continue exporting power to neighbouring countries. Local commune electricity access was nearly 95% in 2004 and rural households 88% showing a very high number of electrification, but still a significant number of people who are off grid. At a certain point the cost becomes very high to put the entire country on the grid, this is where the role of RETs comes in. RETs are being explored in Vietnam as off grid sources of electricity that are more sustainable and modernized forms of energy.

1.4 Bioenergy and biofuels

This section gives a brief background on bioenergy, biofuels and the relationship to rural development, entrepreneurs and current policy. Bioenergy is an attractive venture because of its connection to agriculture, and with many developing Asian countries still based heavily on agriculture (Vietnam being on of these); biofuels have already been pursued by some nations. Bioenergy is a type of Renewable Energy Technology, however, not all RETs are biofuels. In the case of Vietnam, biogas has worked well with this system with a need to provide energy and develop the country's rural communities. One of the major attractions for developing countries to biofuels is the potential to domestically produce a fuel and reduce the reliance on a single source. Bioenergy takes an interesting step incorporating agriculture and energy production. Countries with agricultural infrastructure or large potential look towards bioenergy and RETs for their flexibility.

Biofuels, and biogas, have a few major potential benefits; from this perspective they can be divided into environmental, economic, sustainability and security benefits (Katti and Khedkar, 2005). The impacts on the environment are reduced, and in the case of biogas this is no different. The source is renewable and much less invasive than extracting fossil fuels. The end product is also less harmful in terms of air pollution, reducing regional pollution and public health problems when compared to low-standard conversion wood fuel. In terms of energy modernization, bioenergy offers a chance to modernize and diversify energy sources. The appeal on the national level is also the possibility of export (IEA, 2006). In addition, there are co-benefits to using biofuels to modernize. Unlike coal and oil alternatives, they are renewable and emit lower amounts of carbon dioxide from net production. Bioenergy offers an improved and more efficient use of biomass, getting more energy out of the material and proving a stable energy source.

1.4.1 Bioenergy Entrepreneurs

Entrepreneurs play a key role in developing local economies. In a development project, entrepreneurs are one of many indicators that can give insight into the current and future stability or success. In developing countries, off grid communities have little to rely on by way of providing them an energy service, entrepreneurs offer them a solution whether it's selling firewood or coal at a local market to having a business that sells the service of energy and service related technologies, such as stoves. In terms of RETs, these entrepreneurs play a key role in understanding the social, economic and environmental aspects of a community or region. In assessing this, these three areas are all part of sustainability and a step towards poverty eradication. Entrepreneurs are a key step in getting access to the rural areas as it builds up a market, which provides income and an incentive to keep a technology or energy service continuing. Exploring drivers and barriers to entrepreneurs provides a more detailed and in depth analysis of the drivers and barriers of an entire energy project. In order for the MDGs to be progressed, these renewable energy and modernized energy projects need to account for entrepreneurs and take on a sectoral approach to energy modernization (Flavin and Aeck, 2005). Enterprise development is also a key factor to energy modernization as it builds the local economy and uses resources locally, rather than becoming dependent on outside resources.

1.4.2 Policy Context

In terms of providing rural areas with energy, plantation biofuels are a long way off and the government has plans to expand the industry on the large scale, utilizing biofuels for transport and making targets over the next few years. Policy targets thus far have been limited to subsidies and generalized targets to boost renewable energy and the support of other non-renewable energy sources has made development of biogas difficult. Vietnam also has a commitment for 2 percent of its energy is renewable by 2010 and up to 3 percent by 2020 (UNESCAP, 2008). In addition, the Vietnamese government has plans to aid bioenergy with a target over 2006-2010 to develop bioethanol and other bioenergy projects. They are aiming to commercialize the industry with a target of 5.5 litres of biofuel by 2020 (Briones, 2007).

1.5 Biogas in Vietnam

In Vietnam, biogas dominates the bioenergy field and as a technology that is renewable and derived from agricultural residues, it has improved livelihoods, the environment and the public health of many communities around the country. Biogas dominates the biofuels scene in the country, conveniently being one of the more environmentally benign technologies available. While Vietnam has not started it's mass biofuel industrialization (plans and targets are being set),

for rural projects in areas lacking electricity with livestock agriculture, biogas has provided fuel for cooking, heating and lighting.

In this thesis, Biogas is used as a case study for studying bioenergy entrepreneur ships in rural areas, due to its prevalence and long history in the country. There are many organizations working in the country to set up the technology and build a market economy around biogas. Entrepreneurs, or biogas masons, are seen as a key indicator for economic and social growth and the 'health' of a development project (UNDP, 2004). Biogas is used as a case study to answer these overall questions. The reason biogas was chosen for this is that it is the most developed form or rural bioenergy in the country, the public has a high knowledge and multiple organizations are working with the technology. Many of these programs have met mixed success and with an increasing energy demand in the region, practical and environmental solutions are needed as alternatives to large-scale energy projects that often result in adverse human and environmental consequences.

1.6 Scope and Limitations

The project's focus is a survey of rural bioenergy entrepreneurs in Vietnam. The type of bioenergy to be studied is from agricultural residues, mainly biogas and manure, and is primarily utilized for cooking and heating. Biogas is the research's case study, using it as an example of rural bioenergy entrepreneurs and success of dissemination models between two projects. Building on the need for rural energy sources to reduce poverty, the research will focus on small-scale bioenergy projects and entrepreneurships, referred to as enterprises, as a preventative environmental approach in rural development. The modern biofuel looked at in this study is biogas from agricultural residues, such as manure, used for cooking and heating. Other information is also gathered on other forms of biofuels in the country. These local initiatives enable a cleaner development pathway that provides energy in areas disconnected from major electricity grids. The project's scope will take a discerning look at the hindering and helping aspects for rural energy development in the small-scale biogas sector.

A note on spelling, many words in Vietnamese are combined in English for simplification, therefore words like Vietnam (Viet Nam) have alternate spelling. For the purpose of the paper I have used the combined form of Vietnam and Hanoi, among others. A note on the name of the Vietnam Women's Union, in the paper for grammatical purposes, the VWU will be referred to as the Vietnamese Women's Union and are the same organization. For individuals, Vietnamese names are written as they are in Vietnam with the Surname listed first. Conversion rates for the Vietnamese Currency (Vietnamese Dong, VND) are given in US dollars from May 20th, 2008 estimates.

The research was limited by permission from local and national government and the structure of interviewing. Processes and procedures often take longer in rural areas and permissions for outsiders, while part of policy, wastes time and resources and was limiting for collecting data, communication and meetings. Much of the interviews were organized by the local party centres or local agricultural extension centres. Language was also a significant barrier and required an interpreter. Another key dimension of the study was the consistency and availability of power (electricity). In Case 2, Son La, electricity was only available for a few hours a day, which made simple administrative tasks difficult. Another important note was my presence as a foreigner in the country and the limitations of doing a study requiring much permission. In addition to these conditions, the reliability of the information is related to people's trust and motives in the

researcher and interpreter. From the research and communication with interpreters, respondents had no trouble expression opinions and feelings.

1.7 Objective and Research Questions

This research will pose a series crucial research questions that will look at the current sustainability of rural bioenergy practices, energy sustainability and the state of rural entrepreneurs and project dissemination. The project aims to understand the dynamics behind the emergence of rural energy entrepreneurs, by using existing analytical frameworks to identify the key elements that influence the shift towards sustainable rural energy systems. The stability of the bioenergy sector and private rural energy investments is fundamental to energy and sustainable development models, thus these projects require a better understanding of the role of entrepreneurs.

The purpose of this study is to explore what critical factors to bring about the creation of a new business in the developing rural energy sector, using the research questions below to answer an overarching objective:

What are the critical factors that contribute to the success and failure of rural bioenergy entrepreneurships in Vietnam?

It is hoped that this research will contribute to future rural projects in energy and sustainable development, in order to provide all areas with sustainable energy and contributing to meeting poverty eradication.

The major sub-questions to help answer the main objective:

1. What are the triggering incentives and impeding barriers for rural bioenergy entrepreneurs?

2. What dissemination approaches have been used for bioenergy projects? Identify the strengths and weaknesses of their approaches to the biogas projects.

1.8 Methodology

The project research methodology covers a 6-week data collection, during March and April 2008, within the thesis period of January to May 2008. This is preceded with and finished by literature review, reporting and information dissemination, through seminars, thesis publication and, potentially, a scientific journal article. The key research will be obtained through face-to-face interviews with key stakeholders including: communities, authorities, national and local government, business and relevant organizations in Vietnam. For the study's ethical conduct during personal interviews, the research will be disseminated in a thesis report and guidelines for interviews will be clearly stated when speaking with stakeholders.

Each stakeholder grouping is represented by five major groups of interest surrounding biogas. Each respondent interviewed during the research is grouped into three categories of respondents, households, masons/entrepreneurs and key informants. The stakeholders are then each interviewed from a series of questionnaires, individually or in a focus-group style. Figure 3 divides them into categories of related biogas stakeholders.

The interviews and meetings conducted for the research involved with key informants, biogas masons, bioenergy entrepreneurs and households with biogas. This was organized through two different projects, the Vietnamese Women's Union and the Biogas Programme, both based in Hanoi. Through these organizations, work was done with the local governments to allow interviews with key informants, masons and households in three Vietnamese provinces (Ninh Binh, Son La and Ha Tay).

Below, in Figure 1-3, the stakeholder map is divided into five categories. These are the five key groupings of the stakeholder relationship to biogas. Underneath notes their 'type' for the interviews as Key Informants, Masons and Entrepreneurs or Households. Each represents a type and in some cases more than one.

The study intentionally looked at three different cases to triangulate data by utilizing this different qualities but general similarities. The methodology was subject to change as the project went on and many details were added to the study based on field realities. Many of the interviews required the use of an interpreter. The interview style for the masons was a focus group while the households were spoken to on an individual level. Three of these focus groups were conducted in each case for the masons and the entrepreneurs. A comprehensive list of stakeholders and persons interviews can be found in Appendix 1.

The study uses the Sustainable Livelihoods Approach, SWOT analysis and an entrepreneur business model to approach the data collected in the field. This topic is detailed more in Section 4.1 Analytical Framework.

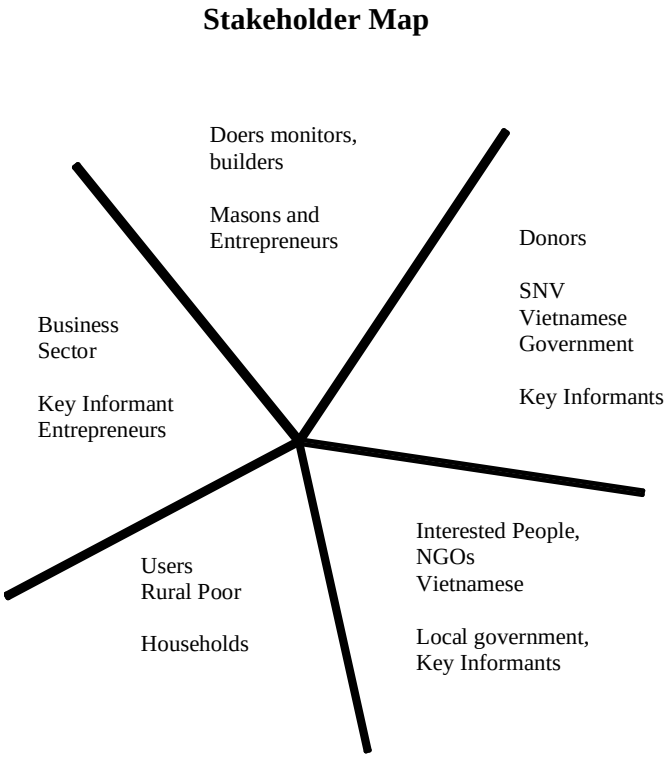

Figure 1-3. Stakeholder theory diagram based on stakeholder categories and interview groups (Friedman and Miles 2006).

For data collection, resources were obtained in Sweden and in Vietnam, through many organizations. It was important for this study not to repeat past research, so while the original initiative was unique, for best results, there was a constant dialogue with each organizations about what would be useful to their efforts.

After the research was conducted, a presentation was given in Hanoi at the biogas programme office for stakeholders on the preliminary findings of the survey. The presentation acted as part of this research to bridge gaps and communication failures between organizations. The research on dissemination models was an addition to the research on entrepreneurs developed in Hanoi. After fieldwork and an assessment of the differences between the two organizations, dissemination models turned out to be very relevant to the research.

1.8.1 Target Groups

The audience of this paper is best described as politicians (and related policy makers), international organizations, academic researchers and private enterprises, in Vietnam and those working on similar projects or within international organizations around the globe. Through the information provided in the study, policy-makers and organizations within Vietnam and internationally can make better decisions from the research.

1.9 Outline

Chapter 2 reviews key literature on bioenergy, biogas and their contexts within Vietnam. The cases in the research will be introduced as well as the concepts of dissemination models, entrepreneur drivers and barriers, rural contexts in development and their relation to Vietnam

Chapter 3 describes the case study data, aggregating the responses from the households, masons/entrepreneurs and key informant interviews. Background to each region and their localized programs will be given, as well as, the dissemination approach.

Chapter 4 is comprised of analysis and discussion of the cases; identification of key drivers and barriers and a comparative look as the dissemination approach realities and the theory.

Chapter 5 explores concluding remarks on the research including opportunities, repetition of the Key drivers and barriers to entrepreneurs, recommendations and exploration of future research in the biogas field. This will describe concluding points and what the future of biofuels in Vietnam may look like, as well as, recommendations.

2 Bioenergy Entrepreneurs in Vietnam

This section will be a literature review on bioenergy, biogas and their contexts within Vietnam. The cases in the research will be introduced as well as the concepts of dissemination models, entrepreneur drivers and barriers, rural contexts in development and their relation to Vietnam

2.1 Bioenergy Background

Bioenergy refers to renewable energy from organic materials, including biomass. In this research, bioenergy will refer to biomass and biofuels; modernized bioenergy will just refer to biofuels and modernized biomass. Biofuels are fuels derived from biomass or biodegradable, organic materials. These materials can be divided into a few categories, gas-based biofuels (such as biogas), solid biofuels and liquid biofuels (de los Reyes, 2007). Solid biofuels can range from wood fuel to more modernized forms of compressed biomass, compressed wood pellets are examples of a common solid biofuel. Gaseous biofuels are mainly methane based and come from the anaerobic breakdown of biodegradable material to create a methane and carbon dioxide mixture. Liquid biofuels are alcohols made from plant starch or sugars, such as bioethanol, methanol or biodiesel a fuel derived form plant oils that can be used independently or combined with fossil diesel fuel. All of these in theory are renewable energy carriers; being derived from regenerated material has potential for renewablility. Sustainability and controversy of biofuels is another matter and another debate (de los Reyes, 2007). Overall, whether biofuels are the most sustainable for of energy is debateable and these arguments and points are discussed further in the "2.8 Controversies" section.

In Vietnam the current state of biofuels has been limited due to reserves of coal, petroleum and natural gas. Much of this is exported, however coal is cheap and widely available. Hydropower is also widespread with dams in operation and a new dam in Son La being built (and operational by 2010) Within Vietnam, these fuel plantations are being developed, however the technology is still new and not yet on the markets (Tuan 2008, March 25, Personal Interview). Vietnam produces many commodities typically associated with biofuels such as coconut oil, sugar cane and cassava, which are available for biodiesel production. (de los Reyes, 2007).

The picture of Bioenergy in Vietnam is a complicated one and largely is very different for each select type of biofuel. While the country is capable of supporting some development of bioenergy whether on the individualized rural scale or industrialized plantations, industry and government have been slow to see bioenergy's potential.. Biofuels face drivers and barriers of their own in order to provide the country with needed domestic biofuels and consideration for export. Worldwide, nations are developing policies and targets related to bioenergy and the production of many fuels, such as biodiesel or bioethanol, have increased since 2000. At least 45 countries have set targets since 2004 on biofuels, increasing bioethanol 13.6% between 2000 and 2004 (Flavin and Aeck, 2005).

In terms of energy supply for bioenergy, it is largely restricted to biogas production at the household level and unmodernized biomass consumption. Households that are producing livestock are targeted for biogas, and in Vietnam's rural areas, small to medium scale business raising of livestock is common and commonly in a small area (Ervin and Tuan, 2004).

For other types of bioenergy, compressed biomass and biodiesel these methods are uncommon. Compressed forms of bioenergy are available, but so are other forms as compressed natural gas

or LPG and coal and firewood are still common and popular in both the rural and urban areas (Ervin and Tuan, 2004). In Vietnam, There are a few bioenergy technologies being experimented with, but biogas is by far the dominant technology. Compressed biomass and utilizing agricultural residues (rice husks or corn cobs) for fuel have appeared in a number of projects but have yet to reach the same scale. In Son La Province these technologies are common, but as an alternative to biogas technology people who are off grid frequently use coal or LPG for cooking, heating and even lighting. In extremely remote areas where electricity is inconsistent diesel generators are used for larger businesses. Because of this scenario, biogas is an excellent case due to its connection to energy projects and the widespread knowledge of the technology. Other RETs can be seen in Vietnam, efficient stoves, PV solar water heaters and geothermal energy have been pursued (Ervin and Tuan, 2004 / World Bank, 2006). Bioenergy has great potential for rural Vietnam, especially for it's agricultural properties. Bioenergy provides an economic opportunity for rural communities to utilize their agricultural skills for a means to first generate a livelihood, second an environmental source of energy and improve their community development.

An 'entrepreneur' has many definitions and approaches, and this is an on going debate. For this research an entrepreneur is a person that "creates and develops new business" and also, based on another view "is an innovator, and therefore a relatively exceptional person who changes the economy in some way or another (Bruyat and Julien, 2000)." In the case of biogas, this definition fits the situation as someone who innovates and develops new business, in this research, biogas. As a result of this and the research being project focused but with people providing information, the SLA Framework is not solely accurate to describe the research question. Recognizing entrepreneurships as complex and heterogeneous, meaning different from one another, allows the research to take in different approaches in finding out drivers and barriers. Like Bruyat and Julien, they argue that in order to fully understand the entrepreneur, the sector around them must also be understood and that analyzing such environment, projects and relationships are just as important as the entrepreneurs themselves (2000).

Table 2-1. Entrepreneurs in energy development projects

Key categories for dividing entrepreneurs for development projects:
1. The demand (households)
2. The project (key informants, meetings experts)
3. Environment (observation, data collection)
4. And finally, the entrepreneurs themselves (masons – "supply")

Entrepreneurs in Vietnam have had limited time to develop in this contemporary age, and in the biogas field many are still new and only now are emerging with proper business skills. Entrepreneurs play an important role in sustainable development for a project by helping build up an entire sector, acting as an indicator of its stability, providing a needed service (energy) and stimulating the local economy. Entrepreneurs are seen as a key indicator for the development of a project and their success and failure correlate with the project. In this scenario, entrepreneurs play the role as indicators highlighting the key drivers and barriers to the modern energy of biogas. Entrepreneurs (and masons), paired with the example of biogas are an excellent

indicator of how markets and businesses meet challenges and opportunities in the field of energy modernization. This approach is a new aspect of energy and development focusing not only on people and the project, but also the dynamics of the service sector surrounding it.

2.2 Bioenergy Technologies – Biogas in Vietnam

For rural development, solid biofuel production and biogas dominate bioenergy efforts in Viet Nam. These efforts push for more modernized bioenergy, utilizing agricultural by-products (such as rice husks), however, many projects are small scale and technology availability is still an issue in many parts of Vietnam (Ervin and Tuan, 2004). As a result, biogas has become a prominent rural energy RET due to the unique use of animals was as a source of energy, realization of co-benefits such as the production of environmental fertilizers, improved health and sanitation and an active public promotion campaign.

Biogas is a type of energy used from agricultural residues, or biodegradable matter, that is broken down by methane producing bacteria. The bacteria then produce a mixture of carbon dioxide and methane that produce a combustible gas that burns similar to liquid petroleum gas (LPG) and produces nearly no indoor pollutants. This process takes place in a "digester", or a chamber where the gas is produced by the anaerobic bacteria. Along with gas is nutrient rich fertilizer slurry. The gas can be used for cooking, lighting, heating and electricity generation (Acharya et al., 2005). The biogas process is largely biological and the anaerobic bacteria need conditions that have a relatively constant temperature (30-40), a neutral pH and little to no oxygen (Johansson, B. and Nordberg, 2008). A typical biogas digester is 6 to 8 M3 in volume, for a household raising at least 5 cows or pigs, most are raising more than 10. The plants can be smaller than 5m3 or larger than 15m3 but, typically range between 5 and 15 m3 depending on space availability (Nordberg, 2008).

Biogas is connected to homes that raise livestock, the majority with pigs or cows and also are frequently connect to a sanitary toilet. In the Biogas Programme 46% of their biogas plants in the project are connected to toilets (The Biogas Project Office, 2006). Biogas plants come in many sizes and are tailored to the number and type of livestock that households raise.

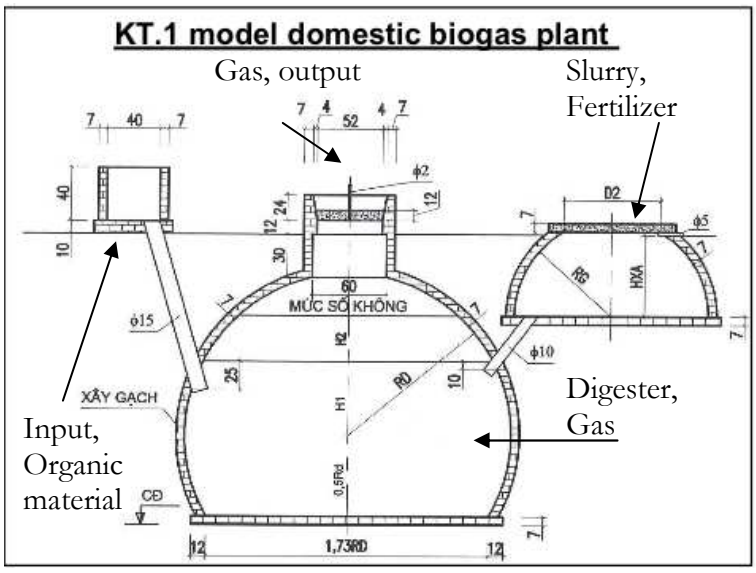

Figure 2-1. The KT 1 model or an example of a fixed dome biogas plant (Biogas Report 2006).

Biogas has a number of designs and models, however in the case studies and the reality in the country a few variations of one model dominate the market, as biogas does for bioenergy. Currently the fixed dome model has been accepted nationally as the 'best' method to promote bioenergy. Figure 4, below, illustrates how the biogas technology works with the current "fixed dome" model technology. There are many types of biogas

but in my study two types dominated, the variations of the fixed dome model, which has a brick top and cannot be removed and the floating dome model, which has a top that is not attached and can be removed (The Biogas Project Office, 2006).

The KT1 and KT2 models are the ones used by both programs surveyed. Other models exist, but these are found to be the least problematic and most conducive to generating gas and fertilizer as well as terrain durability. Both are fixed dome models, meaning the top is cemented to the chamber. The KT2 model differs form the KT1, as its base underground is convex and leads to a point downwards. This works best against up welling pressures and is the best option for areas with high groundwater, common in many low-lying coastal provinces (The Biogas Project Office, 2006).

Biogas has opportunities to expand on a more industrialized and larger scale. In agriculture, these technologies are spreading with large biogas plants. Livestock production is not as regulated in Vietnam, and for the purposes of health and sanitation and a 'free' and convenient source of energy, more farmers and industrial sized livestock farms are shifting to this technology. Biomass gasification for industry is also present on a smaller scale. In the northwest of Vietnam, inconsistent electricity has led many micro and medium sized enterprises to utilize biomass (corn cobs, husks, rice husk and even sugar cane bagasse) to produce energy through gasification or traditional, but efficient, combustion (Ervin and Tuan, 2004).

Aside form biogas, compressed biomass is something that is an opportunity for many provinces, and the substance varies in each province. In the northwest, compressed rice husk or corncobs could be viable for a more efficient generation and are a better alternative than firewood or coal. The latter two being a time and monetary expense and also having a greater affect on the local and household environment. These are still more active on the small scale and a market sector has not yet developed itself (Tuan 2008, March 25, personal Interview).

2.2.1 Biogas Co-benefits

Biogas stand to be a great benefit to rural communities, as in many places agriculture makes up a significant portion of the population's income. (GNESD, 2005). In Son La province in Vietnam, over 80% of the population is involved in agriculture, being a typical statistic for rural Vietnamese areas (Tuan 2008, March 25, personal Interview). What also aids rural energy is drought related electricity problems. Namely Hydropower, irrigation and drought season as a large barrier to consistently providing electricity. Many households with Biogas could be considered on the edge or even inside of a town, so while electricity may be available, it's not always reliable (GNESD, 2005). Not only can biogas provide better energy stability, but also the technology itself reduces greenhouse gas emissions. While the reality may express that this is not a priority in development, it's a co-benefit that can mean important results.

Greenhouse gas (GHG) reduction is a co benefit of the biogas process, Figure 5, below, illustrates this process through the three major points that GHGs are reduces. The first is the biogas is a replacement for 'conventional' energy sources switching form low quality coal, biomass or fossil fuels to a renewable energy source. The next is the manure and management to a lower N2O producing bioslurry and the reduced use of chemical fertilizers (The Biogas Project Office, 2006). The switch provides a reduction of 1 to 3 tCO2 equivalent per year for an average biogas plant. The management of the manures also prevents the release of methane into the atmosphere, and instead utilizes its combustibility as an energy source.

Aside from GHG reductions, Biogas also has other co-benefits besides stability and reducing greenhouse gases. The management of manure is a benefit of health and sanitation through waste disposal, providing a cleaner local environment; health benefits and a more sanitary community, reducing associated diseases. The improved cooking method also saves time from gathering materials such as biomass and income from buy other supplies, which enables more free time for people. This burden is especially reduced for women and children who often bear the burden of these tasks.

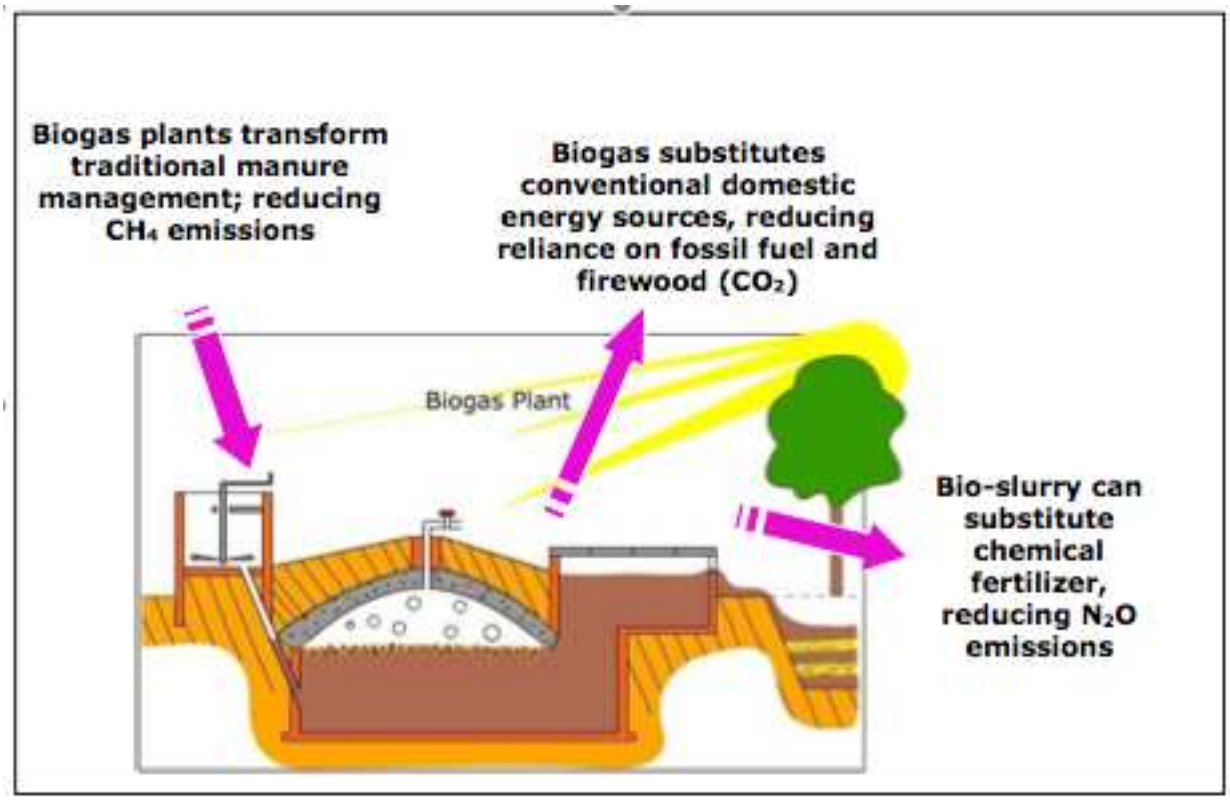

Figure 2-2. Biogas and GHG Reduction. An illustration of how a biogas plant contributes to the reduction of Greenhouse gases towards climate change (The Biogas Project Office, 2006).

Biofuels have caused a debate on the use of arable land, in the fact that with a limited number of spaces to grow food and fuel, which should be priority? Land plots in rural developing areas are often very small, and people may not be able to afford the switch. Biogas offers a method to produce energy without sacrificing too much land, in a sense land does not have to be used at all, many of the plant have cleverly been built underneath structures such as homes and animal pens. Biogas could be described as a medium sustainable solution, however its alternatives (coal, inefficient biomass) are much less sustainable sources of energy (Engelhardt et al., 2005).

2.2.2 Controversies

Biofuels, require a section on the cautions of their use and most recently have come into controversy for their impacts on societies, food prices, world markets and the possible negative environmental impacts. In the case of biogas, manure is the main component used in Vietnam and does not pose a real threat to any of these constraints mentioned. Manure would otherwise be dried and burned (inefficiently) or used as fertilizer, causing health and sanitation issues.

Biogas produces a high quality fertilizer and effectively reduces manure waste in agriculture settings. There have been controversies with biogas that should be mentioned here, dissemination models are a cause for concern, meaning how the technology will spread for their lack of attention to sector and business development.. Subsidies and pricing have also been a concern for either not providing enough support or distorting the market. In addition, the reliability of the current technology, which requires maintenance every few years, and the long-term sustainability. The dissemination model is important for bioenergy, how to spread without causing serious environmental or social consequences.

Other biofuels, like biodiesel have come into controversy for the threat to food security, from prices, land use and competition. There is also a common concern for the shift from subsistence diversified farming to a monoculture. The Vietnamese case has not developed biofuels on such a large scale, to see controversies that mass biofuel farming can potentially have socially and environmentally (IEA, 2006). These are potential drawbacks of biofuels but are not found in every case.

2.3 Biogas Programmes in Vietnam

Biogas is currently being developed by a few projects in the country, most notably is SNV's biogas programme and an energy initiative started by the women's union. Historically several energy based development projects have been developed in the country, but Biogas has received much support. Three major programs were identified during the research, however only two were used as cases. Sections 2.3.1 and 2.3.2 described the basics of each program. Below, are the two organizational cases explored in the research, the Biogas Programme and the Vietnamese Women's Union (VWU).

The third identified, but not used as a case study is the VACVINA program, a new program and technology that utilize human sanitation, fertilizers and aquaculture to encompass an entire Biogas based multipurpose energy system at the household level nationally. VACVINA, broken down means VAC (a Vietnamese acronym for Garden, pond and Stable) combined with VINA, or Viet Nam. This system was developed by Mr. Thanh Van Pham at the Center for Rural Communities, Research and Development in Hanoi. Their research revolved around rural development and utilizing high quality environmental fertilizers and biogas for improved health, sanitation and enterprise development though agriculture and aquaculture (Pham 2008, March 12, Personal Interview).

2.3.1 The Biogas Programme

SNV, The Netherlands' Development Agency, created a partnership biogas program together with the Vietnamese Ministry of Agriculture and Rural Development to develop Vietnam's Biogas Programme. The biogas programme's main work in Vietnam revolves around building up the sector around the energy service to develop rural areas in the country and provide them with a modernized energy service. The approach to rural development is to see a sector where market forces are operating and biogas is sold to generate income and provide the service of energy, and other co-benefits (Teune, 2008). The Biogas Programme has constructed over 41,000 plants since 2003 and has worked in 30 provinces, set to expand to 50 by 2010 (Teune, 2008).

Vietnam has seen many different biogas projects in the last few years. Vietnam has enormous potential for Renewable Energy Technologies form the great amount of agricultural resources. The "Biogas Program for the Animal Husbandry Sector in Vietnam" is cooperation between the

Netherlands's development organization (SNV) and the Livestock production Department in the Ministry of Agriculture and Rural development in Vietnam (Biogas 2007). These two organizations established the Biogas Project Office in Hanoi (The Biogas Project Office, 2006). Nearly 10,000 plants have been installed in 12 provinces in North and Central Vietnam with plans to expand in the future (Biogas, 2007). The project is under the jurisdiction of the biogas project division, which appoints provincial biogas project divisions to govern a specific area. The project operates in three different periods, the first starting in 2003 to 2006 covering tithe 12 provinces in the north and central parts of the country. The second part is the preparatory time for the next phase; expect to take place from 2007 to 2010 in 50 Vietnamese provinces and cities. The projects five year span acted as a response to the depletion of local resources from biomass burning (firewood) and since then has reduced the dependency on firewood, reduction of adverse impacts on public health and reduced deforestation, sanitation and pollution (Biogas, 2007). The project has provided 37,000 biogas plants and training for nearly 1000 personnel in the public and private sectors. The project was also awarded the Energy Globe Award 2006 for the success at rural development and contributions to reducing global climate change (SNV, 2007).

Objectives of the project:

The SNV BPO case provides substantial amounts of information enabling for a more accurate view of the situation in Vietnam. The project has set clear future goals within it's overall objectives of "exploiting effectively biogas technology and developing a commercial viable biogas sector in Vietnam; and contributing to rural development and environmental protection via provision of clean and affordable energy to rural households, improvement of community's sanitation and rural people's health, creation of job for rural labor and reduction of greenhouse gas emission" (Biogas, 2007). Below are key elements from the project objectives to illustrate the organization and future plans for the biogas project.

- A current 41,000 plants have been built since 2007 nationwide in more than 30 provinces.
- Plan to expand to another 35 provinces with a goal of 140,000 plants
- Train appropriate personnel per province: 1 provincial biogas technician, 1 district biogas technician and 2 biogas teams per district.
- Provide provincial training and operation seminars
- Enable more free time for women and children with reduced time spent collecting fuel
- Reduce GHG emissions through biogas plants
- Replace "293.000 tons of agricultural waste/ 377.000 tons of firewood/ 3.100 tons of charcoal/ 43.000 tons of anthracitic coal/7.800 tons of petrol or 5.600 tons of LPG" with clean biogas energy for rural environment and health (Biogas, 2007).

2.3.2 The Vietnamese Women's Union

The Vietnamese Women's Union[1] have a biogas program that is being conducted with many other partners in the country under the Ministry of Industry and Trade since 1998. The project is targeting women's work in households and reducing the cost of energy, increasing efficiency and free time for households utilizing. They're environmental and energy saving project has a three-pronged approach:

1. Energy saving light bulbs
2. Solar water heaters
3. Biogas plants

(Pham 2008, March 12, Personal Interview)

As of 2007, they are working in 6 provinces with the biogas programme and will increase this to 9 provinces/cities during the next year. The Vietnamese Women's Union operates as its own organization, but with funds from the government and other donor organizations. Its energy project is to help build up rural infrastructure and also promote liberalization (Pham 2008, March 12, Personal Interview). For the energy projects, the funds available for subsidies and technology are allocated from the government's budget. Each aspect has a special subsidy; they subsidized 30% of the cost of two light bulbs, 1.5 million VND ($92 USD) for each solar panel and 1 million VND ($60 USD) for each household.

The women's union trains masons for three months on the local level with qualified personnel trained at local and national chapters. They have installed either a biogas plant, a solar heater or worked in the light bulb campaign in over 6000 households in 6 provinces. In 2007, 87 biogas plants were built in these provinces and. All of the households participated in the energy saving light bulb program (Pham 2008, March 12, Personal Interview).

In the future, the VWU's energy campaign has a target of 3,000 energy saving bulbs, 100 more biogas plants and 50 more solar panel water heaters. Government financial support will continue to be offered (VWU, 2007).

2.4 Program Drivers and Barriers

This section is a description of some factors that affect the outcomes of bioenergy projects in Vietnam and will explain past findings in these programs and show, before introducing the case details, how my research will build on top of old cases. In the case of Drivers and Barriers, the Biogas Programme has received the most literature review and dominates the research on entrepreneurs and biogas in Vietnam. Drivers and barriers are realities that help and hinder the growth and success of a project are identified for entrepreneurs.

The Biogas Programme, the oldest of the two surveyed has over the past few years undergone four external evaluations and many have shown points on focus points for the program and biogas in general in the country. Below are drivers and barriers related to entrepreneurs in the field and biogas program characteristics deemed relevant. This study build on these findings

[1] As mentioned in Section 1.6 Scope and Limitations, the actual English name of the organization is the Vietnam Women's Union (VWU), however, for grammatical purposes, the VWU will be referred to as the "Vietnamese Women's Union" in its long form.

from the studies and takes a more in-depth analysis through the case studies by triangulation of three cases and a comparative study between two biogas programs. There is a substantive lack of literature about entrepreneurs and biogas in Vietnam outside generalized studies. Much has been done on biogas itself and the technology, however, and studies in other countries are available. In China, bioenergy projects are more diverse due to its varying climates and large geographic space and population. In these projects, barriers to them, and thus entrepreneur and sector development included technical issues, lack of policy support, poor institutional design (lack of communication between institutions), limited financing and little public support (Han et al., 2008). This study is important as it reflects problems with biogasification projects in China, identifying key barriers.

As with any technology, there are a series of drivers and barriers related to renewable energy technology in energy modernization. Much of these drivers and barriers are generalizations and may apply more to some technologies than others, but are generally accepted as key points to consider before implementing the technology. For key barriers, RETs offer reduced dependency on foreign energy services such as oil, appealing to energy security. They have environmental benefits and reduced impacts compared with other types such as fossil fuels or nuclear. Income generation activities and the development of enterprises are also part of RETs. Their unique nature and applicability in rural settings enable business development of services that require energy or even the energy service itself. These previous activities all for stability of energy supply in communities and households and enable micro-enterprises and the local economy to develop (GNESD, 2007 / Flavin and Aeck, 2005).

Key Barriers also exist for RETs, and many have been identified for many geographic locations and types of technologies. The first barriers often viewed are policy and financing. Policy needs to be in favour of RETs in order for them to develop, and policies working against them will certainly prevent their development. Financing is daunting for many energy projects as RETs are viewed as having especially high start up costs. What often are not factored are the income-generating strategies RETs can provide. Quality control of the technologies is a barrier, many RETs are complicated and require professional maintenance or repair and the capacity for this is often missing. Another key is the knowledge gap, how to educate people on the technology (Flavin and Aeck, 2005).

Alternately, in a study on biogas projects in African countries, major barriers Identified by Mapako's study pointed towards training to build plants, poor operation, a definite reduction in financing and inability to maintain the plants as factors that led to many of the biogas plant failures (2004). These factors took the form of poor financial mechanisms for support, lack of training for maintenance and any "quality control" of the projects. Quality control refers to qualified persons on the project for installation and maintenance of the plants. In many cases the great reduction in financing diminished the incentive for this and the plants gradually fell into disuse.

While some of these barriers seem difficult, there are many viable solutions to overcome them. For capacity and knowledge, training and information campaigns are highly effective and can even be conducted in the event of illiteracy. Start up costs can be high, but more importantly it's the long-term benefit of enterprise and local economy development that need to be factored into decisions. In the renewable energy network's report on RETs and the MDGs, "nurturing micro-enterprises" is listed as a key driver for the future of RETs, to promote harnessing of energy and improving energy as a service to reduce poverty, which is essential to supporting energy projects (Flavin and Aeck, 2005). Policy perhaps is a more difficult task to overcome and will require

education, support and lobbying from RET groups. Developing institutions to support RETs and dictate quality control is also a proactive and income generating approach to maintenance issues. Finally, encouraging a broader stakeholder involvement, especially the private sector, can bring in financing and foster better relationships. Private sector and entrepreneurs have much to offers energy development projects, and are able to influence barriers to implementation.

Some of the most important points from these reports found that the major drivers for entrepreneurs related to subsidy system and directness to customers. In terms of the project, information dissemination was high and people's awareness of the technology is a positive driver for the program. Some of these positive aspects that were realized in two surveys done on the Biogas Programme were the household satisfaction with biogas from the energy source provided and time saved from dealing with another energy source. Financial savings on the household levels were also a key driver, illustrating that much of the drivers for the biogas sector for entrepreneurs were on the demand side and from high information awareness.

Key barriers involved much of the structure of the rural markets and the roles that local and national governments should take on when dealing with entrepreneurs. On these levels over complicated administration and too much involvement from national and local government have suppressed the market. A structural problem with the subsidy is also a barrier to the very poor, as the subsidy favours all incomes equally. Technology failures and the lack of quality control technicians and enforcement are very large barriers that make up a promising part of the biogas sector.

Opportunities exist to overcome some of these challenges to biogas enterprise development, such as in monitoring schemes and partnering with other biogas projects in the country. On top of this, reduced government involvement and increased research and development stand to aid the biogas market. Letting the market forces take over is not always the best opportunity and to help ease the transition, commercialization efforts should be made as well as, giving masons more responsibility for their work. Some important opportunities noted about the Biogas Programme were establishment of monitoring schemes, linking with other biogas programs, increasing opportunities and responsibilities of masons, more R&D and marketing efforts and reduced role of government. More opportunities will be discussed in the Conclusion section in addition to these found in previous studies (Biogas report 2006/ BUS 2005 / Engelhardt et al., 2007).

2.5 Development and Dissemination Models

Dissemination model will be defined and this section will describe the two different types of dissemination models. This section will describe the types of dissemination models that exist. This section will explain dissemination relationships to the research question, define the theoretical models and explaining their relationship to rural development, energy and entrepreneurs.

1. Definitions
2. Importance for rural development
3. Importance for energy
4. Relationship to entrepreneurs

Dissemination models are important for development because they define approaches that project leaders and organizations take to spreading their projects in a region. Dissemination models must be tailored to national, regional and local scale and able to meet these project needs. For biogas and entrepreneurs, dissemination, or theoretical, development models affect how an organization perceives and support entrepreneurs. For biogas, the dissemination model acts as a vector for spreading the technology on the local level. Does the organization focus on information or technology or do they spend more time building up services around biogas? Answers to questions like these will frame the research in Chapter 3.

Dissemination models provide a frame for the drivers and barriers for entrepreneurs and information collected from interview responses and observations illustrates the foundations for each case. Dissemination models are identified in each case through key informants on the national and local levels. The models are then discussed and analyzed in Chapter 4, framing the research question of drivers and barriers to bioenergy entrepreneurs.

2.5.1 Sector and Market Development Models

Sector Development is a new approach and is the dissemination model for the Biogas Programme in Hanoi. Sector development incorporates the characteristics of market development, which describes market-based methods and tools for micro, small or medium sized enterprises to find sustainable development solutions (Lusby, 2006). Market and sector are not interchangeable, as the market is a vital part of the sector's development. In addition to this, sector development also focuses on services around the market, stakeholder participation and rural context. More on Sector development is discussed in Section 4.2 Rural Context.

Sector development involves commercialization and the entire structure around a development project, this method acts as to disseminate the project on a local and national level by training and providing infrastructure through financial, policy and capacity support to develop ea project (Teune, 2008). For sector development, not only proving the energy service is important, but to build sustainability around that service. This means the development of ways in sustaining and as many places have seen developing the market for this energy stand to be one method of doing this. Not only the buying and selling of the service but also the related services around this (Gitonga and Clemens, 2006).

For rural development, sector development is an asset as it incorporate stakeholders participation and facilitates the development of enterprises and local economy. Relating to economy, the upfront costs are quite high with many energy initiatives and methods to combat this are important but should avoid long-term dependency. Cooperation between stakeholders is also essential. Local communities are very influential in their own change, but also depend on the roles of national and local governments, the private sector, civil society and international organizations (Gitonga and Clemens, 2006). Stakeholder cooperation, especially partnership between public, private and local sectors is a unique feature of sector development, projecting awareness for sustainability. Sector development expands markets utilizing the support of these important stakeholder groups. The primary idea of Sector Development theory is that all services within a sector become self-sustaining through private sector and public sector support (Teune 2008).

Sector development advocates individual or communal activities for the poor, giving opportunities to employment and becoming a part of the many parts of, or value chain. This expands the rural markets by helping the poorest sectors of society become part of this overall

goal, opening up communication between stakeholders (Teune, 2008). Entrepreneurs benefit greatly from development projects that take a sector development approach. They are one of the focuses, as their relation to the energy projects persistence and the development of the local economy are tied.

2.5.2 Participatory Development Model

Participatory development approaches build on project based by incorporating local decision-making and stakeholders for communities and individuals to have a voice in a development project or program (Jennings, 2000). The project based development approach focuses on individual scale projects; these can be characteristically participatory or may exclude 'people' from the process. As a traditional development approach, this has naturally been critiqued as not doing enough to sustain the project. This focuses on the end rather than the means, as Sen would explain in his Development as freedom book, both are instrumental in a successful project (Sen, 1999). A more pessimistic view of these approaches takes the form of asserting them as instrumental, narrow minded and short term (Jones and Carswell, 2004). This approach is related to participatory or community based development, where the projects are largely in the hands of local people and not experts. The project-based elements of the past Participatory elements are often found within communities and other stakeholders, giving the project certain 'people-based' elements (Jones and Carswell, 2004).

Participatory development has built upon these project models and characterizes use of stakeholders, local people as participants, local decision-making structure and information. The type of participation can also widely vary, in some cases people are incorporated into the decision-making and in others; they may be consulted, meaning others interpret their input.

The participation model does not specifically use empowerment as a development model, and as described by Jones and Carswell, it is very much a "radical" form of participation (2004). Empowerment is not so much a dissemination model but a characteristic. In section 4.3, this participation model is compared to the women's union's approach and the level of participation is discussed.

For rural development, participatory approaches have a few advantages. The first is their utilization of stakeholder approaches and encourage participation through education, training or learning processes. This enables local people to become a part of the projects, extr4acting key insights and tailoring the project to people. Another important reason for rural development is the incorporation of localized decision-making, taking advantage of structures already in place and going with the flow of a community rather than against. In these communities, this utilization is beneficial to the project and its success (Jennings, 2000).

For energy related project, participatory approaches are advantageous for many of the same reasons for rural development, but like any resource based initiative, the project becomes pat of the local community and gives it a better chance of success from the side of social acceptance. The connection of people to the project, or energy source, is also advantageous building this social aspect. Relating to entrepreneurs participatory models do little direct work at promoting enterprises, markets or services. Indirectly, government participation fosters education and awareness, aiding advertising efforts. Outside of these aspects, little relation can be derived to benefit entrepreneurs.

3 Case Studies – Entrepreneurships in Vietnam

In this chapter, the data from three biogas cases in Vietnam will be presented, they take place in the provinces of Ninh Binh, Son La and Hay Tay. The case studies come from two different organizations and are triangulated to explore three different scenarios in the northern Vietnam. The cases range from a peri-urban setting, a lowland, coastal agricultural province and a mountainous, poorer and more remote provincial setting.

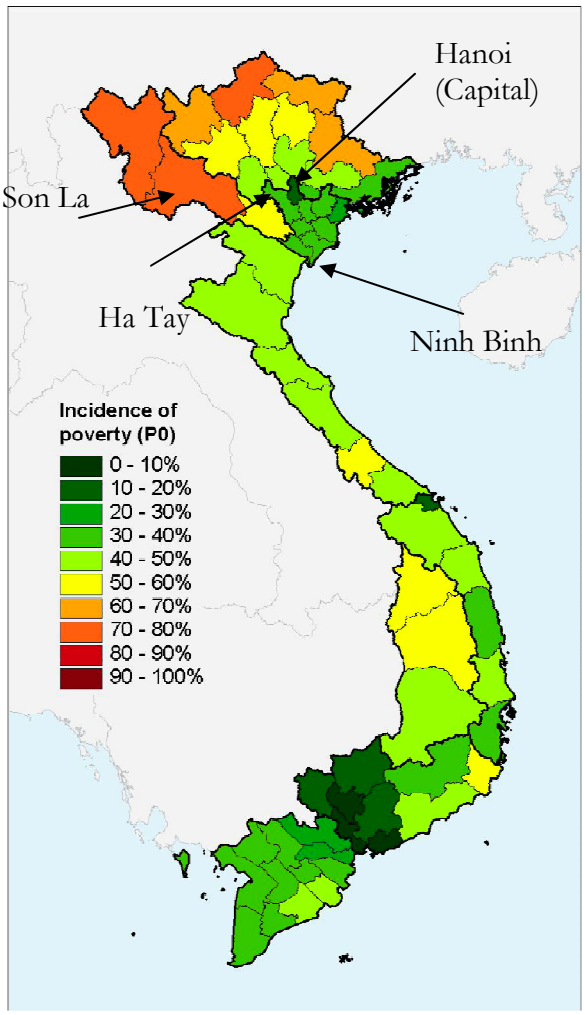

Figure 3-1 A map of the poverty incidence in Vietnam and geographic location of the provinces studied (Minot et. Al 2003)

Case 1 takes place in Ninh Binh, a coastal province popular for tourists and very agricultural. Case 1, Ninh Binh, is part of the Biogas Programme and has a more developed market for Biogas. Case 2, also part of the Biogas Programme, takes place in the mountainous province of Son La, one of the poorest in the entire country. Case 3 is in the peri-urban province of Ha Tay, just to the west of Hanoi. Ha Tay is highly agricultural also containing popular tourist and historical sites. This case is part of the Vietnamese Women's Union energy programme to develop biogas, solar water heaters and energy saving light bulbs (VWU). These three studies allow for three comparisons of what entrepreneurs would face in different setting in Vietnam as well as, a comparative study for two types of models with a similar goal, to provide a renewable and sustainable energy source for rural, agricultural households and to improve the livelihoods of these communities.

In the province, households, masons/entrepreneurs and key informants were interviewed to answer the research question on drivers and barriers. The masons and entrepreneurs were interviewed in a focus group style, whereas households were interviewed on an individual level. Key informants represented field experts, organizations and local government. In the following sections back ground to the provincial cases, a summary of responses to questions or 'indicators' will be found for both house holds and masons, drivers and barriers are identified and project dissemination approaches are described. To differentiate, masons refer to those who physically build the biogas plants, but also may sell the service. Entrepreneurs are seen as bringing a new service and while they sell biogas, do not physically build the plant. Entrepreneurs will also refer to masons and entrepreneurs as a group. All of the masons and entrepreneurs interviewed were

male, other interviewees varied. For a full list of names and details of those interviewed, see Appendix 1. For greater detail on the case interviews, see Appendix 2 and Appendix 3.

3.1 Case 1 – Ninh Binh – Biogas Programme

3.1.1 Background

This section will give detail on the case background in Ninh Binh province. Ninh Binh is a northern, coastal province in Vietnam just south east of Hanoi in the north. Its natural and cultural destinations make it one of the top spots to visit for tourists travelling to the north of Vietnam. Tourism aspects have aided with the province's development allowing for special attention from outsiders and initiatives to highlight some of the country's most interesting attractions. In a dialogue with Ninh Binh's local AEC provincial technician, Nguyen Tuyen, he explained that having the advantage of better roads, tourism and the government's focus on both agricultural and cement industries, infrastructure in Ninh Binh has been improving (Nguyen, V.T., 2008, March 17, Personal Interview). The province's Biogas Programme has been operating since 2006, with basic biogas projects in the province since 1998. Around the city, there is a collective of entrepreneurs that operate their business on a small scale No local policies for biogas could be identified other than subsidies provided for the households.

In Ninh Binh Town, one of the respondents, an entrepreneur, owned a store in the town that sold biogas services. The presence of the store in Ninh Binh Town illustrated the presence of a Small Enterprise, the only one owned by those interviewed during all case studies. The other respondents could be considered micro-enterprises for their small number of employees or case use basis (Srestha, 2005). The data collected for Ninh Binh mostly revolved around the state of the business sector in the region and the status of the biogas projects, which have been operating since 2003.

3.1.2 Mason Case Data

The surveys' indicators were divided into general information, Technology, Human Issues/Skills/Knowledge, Social Issues, Financial Issues, Policy Issues and Future.

For the mason case data, this was conducted in a focus group style with four participants. Three of the participants worked as masons and one of whom is a self-identified entrepreneur owning his own business in Ninh Binh City. They all operated around the province building biogas plants, selling the service and some even selling lanterns, stoves and LPG. In the Ninh Binh mason study, the primary technology used was the fixed dome model, either KT1 or KT2, built according to plans. For experiences with the technology, overall it was not seen as complicated but certain aspects of external issues affected the quality of the plant. This is the geography of Ninh Binh, having high groundwater, limestone and weather conditions. The masons perceived a need for a more flexible technology or ways to modify existing plans.

All of the masons and entrepreneurs were trained at the Local Agricultural Extension Center (AEC). In terms of service and physical construction, only one exclusively sold the service, one built and two sold the service and built the digesters. In addition to the store in Ninh Binh City, others sold extra services such as lanterns and stoves.

No specifics were mentioned about market development by the masons, however, when discussing competition, both internally and externally, all agreed that it was either nonexistent or very low. Competition largely reputation based and entrepreneur Dinh Huu Thanh responded

that Biogas is "not a high interest job due to the low skill, low labor and high transport costs" (Dinh, H.T. 2008, March 17, Personal Interview). Between plants of the same size and design there was little price difference and the prices were largely changing based on the size, geography and transport cots. When asked about the livelihood improvement, they all agreed that building biogas plants was better than a normal construction job but there were disagreements over the quality of skill and the intellectual challenges.

For financing, all of the masons utilized biogas as their sole source of income, though the entrepreneur (business-owner) had other investments. They all were in control of their own business ventures and would often all take projects outside the biogas programme. The respondents were not bound to the organization, but were still receiving projects from the AEC. In terms of subsidies, masons received none, but households were given a subsidy of 1 million Vietnamese Dong (VND), ($60 USD) from the national government according to the masons. As far as an international presence in Ninh Binh, SNV operated in the province but the local government handled the biogas programme's ventures. When asked about improving the presence of international and national organizations they agreed that the money is fine for a richer family but for a poor family it does not do much, for the region the subsidy may only cover 1/7th of the cost (Nguyen, V.T., 2008, March 17, Personal Interview).

For the future of biogas the prediction by the masons was that the demand will rise and that this will still provide a business in the future deposing the fixation on in business availability. Some possible risks they thought they would face inflation, devaluation of the currency, disease and withdrawing financial support for the plants.

3.1.3 Household Case Data

A more detailed description of the household questionnaire and indicators can be found in Appendix 3.

In Ninh Binh the four households interviewed were located on the outskirts of Ninh Binh City and ranged from having biogas plants for less than one year to two years. All were commissioned through the local AEC, biogas programme. Each household raised livestock, pigs or cows, and prior to biogas had used coal or biomass for energy. Some of the changes found in each household due to biogas were the cleaner environment, positive results with the technology, money saved, time-saved from collecting coal or firewood, improved cooking and also household health improvements (from removal of smoke and better sanitation).

When asked about warranties, two of the households had warranties, one did not and the other did not know. All the households had a positive response to the biogas service and believed that people were interested in buying. They all had some concerns about land availability in peri-urban settings and issues with getting wastewater out of communities, the flow of gas, pressure clocks and broken gas valves. In a few cases, scum built up over time in the plant resulting in a slowed, or stopped, flow of combustible gas. Within the communities, there is a high acceptance with no complaints.

For the subsidy, some of the households received a 1 million VND, ($60 USD) subsidy and others did not disclose the amount. All respondents were satisfied, or very satisfied, despite some problems and in the future; a few had even planned to expand their agricultural production because of biogas benefits.

3.1.4 Drivers and Barriers

Based on the data given by the households, masons and key interviews key barriers and drivers have been identified from Ninh Binh for entrepreneurs in biogas. Drivers found for the province included a positive perception of livelihood improvement (very positive), a more developed market sector, community acceptance, subsidies and the presence of national support, knowledge of warranties and their importance as a service, all generated a steady income from biogas and the low competition situation. On the end of barriers, some of the drivers could go a more challenging way such as the lack of competition as a barrier to market forces, local conditions, failures in technology and project availability or uncertain demand. Key opportunities found in the Ninh Binh case include developing a local warranty scheme to cover the failures, utilize communal acceptance and training in business skills and expansion outside the Biogas Programme.

Driver and Barriers in Case 1, Ninh Binh

Drivers	**Barriers**
Livelihood improvement	Local conditionals (land availability, weather, high groundwater)
Developed market sector	Technological failures
Community acceptance	Lack of competition for market forces
Subsidies / national presence	Demand and project availability
Warranties	Quality Control
Income provisions	
Lack of competition	

Figure 3-2. Drivers and Barriers identified in Case 1, Ninh Binh

3.1.5 Dissemination Approach of Biogas Programme in Ninh Binh

Sector development is the primary dissemination approach for Ninh Binh Province's case. This is very apparent with the highly developed biogas sector in the region. Despite this the sector is still very small scale for biogas and fairly undiversified with one major business operating in the capital, Ninh Binh City. When describing the model, communication is a key factor and information campaigns. In terms of dissemination, they are helping the provider through communicating about biogas and advertising the message in the area. The AEC describe the advantages of having biogas for rural households and why rural areas should have it. However, they don't interfere directly, just to inform through media communication (Nguyen, V.T., 2008, March 17, Personal Interview).

3.2 Case 2 – Son La – Biogas Programme

3.2.1 Background

The Son La project currently has about 250 biogas plants operating around the province, and 200 of these have been built by the local agricultural extension center leaving a significant portion self-built by masons or community initiative. According to Le Anh Tuan, an advisor at SNV Son La, this demonstrates the high flow of information even in the remote areas of the province (Tuan 2008, March 25, Personal Interview). Son La has one of the highest incidences of poverty in Vietnam, as it can be see in the northwest corner in Figure 3-2, and even though this is the case, information dissemination is quite high (Minot et al., 2003). According to the local agricultural extension center, the provinces primary dissemination method is to inform the public (Nguyen Quoc 2008, March 26, Personal Interview). This can be seen on billboards, pamphlets, hear don radio and even television (although the access at biogas households is not incredibly high). The people of Son La, especially in the provincial capita, were well informed about biogas; enough to point researchers in the right direction. Son La is a province highly dependent on agriculture, with over 87% of the province involved in agriculture or it's processing (Ervin and Tuan, 2004). These high numbers in the field show support for agricultural related energy generation. Biofuels are still a long way off in the province as the technology would not be as available, however, biogas is well known and the idea of turning waste from livestock (primarily cattle and pigs) into energy greatly appeals to farmers. Despite SNV's recent program in the province, biogas can be traced back to the early 1990s, according to some households. In the two areas surveyed TX Son La and Moc Chau. Ethnic minority groups comprise a significant portion of the population and their numbers in agriculture are above 83% (Ervin and Tuan, 2004).

For energy generation, Son La uses a range of materials from firewood, coal bricks, cornhusks and cobs and biogas among other agricultural 'leftovers'. Electricity is common the province, but important to note that during the study power was limited to a few hours each day for diverting hydro power to irrigate fields. In this case most businesses in TX Son La either chose to run without electricity or used back-up diesel generators.

3.2.2 Mason Case Data

In Son La, two masons were interviewed and each had 15 years of experience working as masons, but only with biogas since 2006. Both operated in Son La Town, the provincial capital through the local AEC's Biogas Programme. In Son La, the primary technology used is the fixed dome model and built according to project plans. There were no complaints about the technology and both masons felt that their experience with it was positive. In Son business awareness is quite high, with many people wanting biogas plants in their households. The two masons were trained by the local AEC and were both selling the service of biogas and building the plants. When asked about female masons they said there were none in Son La they knew about.

In terms of competition the market has no real competition and if it is it's not fierce. For external competition there is a fair amount of outsourcing of projects to masons in neighbouring provinces. They are usually contributing labor or building the plant itself. For the plant price differences, they are fairly equal and major variations are due to size. In terms of livelihood, one mason expressed that it would be better if more projects were available and could be the sole source of income. Continuing with finances, price changes created concern for both of the masons. Prices for materials have doubled in Son La and transport costs have gone up as well. Wages have not changed with this and there are not enough projects available. Out side the

projects they worked other construction jobs, mainly with buildings. Building biogas projects outside the AEC did not occur because of lowered or unknown demand.

Households were given subsidies but they did not know how much. In the future biogas will expand as long as people are demanding the service. They both hoped that there would be enough future business to develop more income but now this is not adequate.

3.2.3 Household Case Data

In Son La Town, surrounding communities and Moc Chau Town, nine households were interviewed. Three of these ended up being self-building masons and had been involved with biogas plant construction. Using this opportunity, they answered questions related to the mason survey. All raised livestock and worked in agriculture or were masons. The time in Biogas varied greatly as one dated from 1992, a few in the middle range around 2000 and more recently to 2007. Some of the projects were built by the biogas or local AEC and three operated by independent masons or help from the local government.

The households all agreed positive changes came to the household in the for of clean energy, better sanitation, saved energy, better cooking and no more need for wood for energy. Money was especially a key benefit. Only one respondent had a warranty and the rest did not know, had no warranty or the information was not available. For the community, environmental improvements and a more reliable energy source benefited the area and there were no complaints from neighbours. In terms of improving biogas, the scum build up and flow of gas was also an issue after a certain amount of time. The technology changed too frequently for people to keep up. Financial aid is given as a subsidy from the government and the local AEC, all but two of the self-built biogas masons received a subsidy. Most received at least 1 million VND, ($60 USD) with a few 800,000 VND, ($50 USD) and or 1 million VND, ($60 USD) form the government and an additional 500,000 VND, ($30 USD) form the local AEC. All of the households were very satisfied despite a few plants not working properly.

As for the future, a few technology issues exist and the households interviewed viewed biogas services as a promising venture. When talking with those who built or help build the plant, they expressed that high costs and lack of demand prevented many from going into the biogas field. When asked about the risks for biogas business, a few were unsure, however, others brought up points of not enough local demand, not enough income, it's only part time due to weather, it is not very high skill and lacking interest in developing a business.

3.2.4 Drivers and Barriers

When discussing Biogas as a business, both the mason's and households had comments on the issue. The main concern of the masons was the lack of demand and not enough opportunity for income generation. For the households and those that had self-built biogas plants, they saw the job as being too low skill and with not enough demand or income generation. A few agreed that the service sector around biogas, such as maintenance and quality control, could be a good business opportunity. Key opportunities found in the province are to pursue development of business skills and independent advertising

Son La Province's barriers are related to demand and financial factors. The lack of visible consumer demand, has created problems of masons and affordability for households is also an issue on top of this. From this demand, neither respondent was able to generate a full time income and the increase in material costs for construction complicated matters. Communication

across the province was a problem, as were geographic and transport issues. Quality control was not readily available and some business was lost to outsourcing labor or biogas masons from other provinces. There was a confidence barrier and general view that working as a biogas mason was still a low skill job despite training.

For key drivers, education does not seem to be an issue with the SNV case. In reality people are very aware, highly educated and often able to take matters into their own hands based on the knowledge of where and what to access. This has been demonstrated in people fixing the biogas plants themselves and also building them. Drivers identified were the subsidy pushing household demand, the financial and training support of the local AEC, the reliability of biogas over electricity and the high awareness in communities about biogas. Another interesting point, which has shifted between driver and barrier, is the financial structure of buying and selling. The profit on each biogas plant built is quite low. For the key drivers in the Son La case, subsidies were identified as helping develop the market as well as the support of the local AEC. Electricity unreliability in the region has put more faith in biogas, creating demand for more plants. The local education and awareness campaigns have also helped the process greatly. From these drivers and barriers a few demands (discussed more in section 4.x) have been identified. Based on the efforts the AEC has invested in propaganda campaigns training for business skills such as advertising was mentioned as being something to help reduce barriers to biogas entrepreneur development. To summarize the key drivers and barriers:

Driver and Barriers in Case 2, Son La

Drivers	Barriers
Subsides	Design complications – quality control
Local government support (AEC	Lack of visible demand (invisible demand) – communication barrier
Reliability of biogas energy	Domestic Outsourcing
Community and consumer awareness	Skill debate
	Income, not enough to sustain a full time job
	Material cost – price fluctuations
	Transport/geography
	Communication
	Affordability

Figure 3-3. Drivers and Barriers identified in Case 2, Son La

3.2.5 Dissemination Approach of Biogas Programme in Son La

As in the Ninh Binh case, the Son La case utilizes a Sector based dissemination model advocated by the Biogas Programme and SNV in Hanoi. The Local AEC representatives describe the situation, as well as the respondents' perception of the model. In Son La, information

dissemination is quite high, especially on biogas and related development initiatives. The local AEC and government are active in this process. SNV's role is to promote entrepreneurs in different fields, but the "environment for business is underdeveloped in [Son La]" (Tuan 2008, March 25, Personal Interview). The dissemination model focuses on sector development and building the services around biogas. Much of the sector and business is quite underdeveloped in Son La, making it difficult to earn a full time income or start a business in one area. The AEC noted that the main efforts to disseminate biogas in the community were through public awareness and campaigns launched by the AEC. The AEC acts as a resource centre for those interested in building (supplying) and those who wish to have the technology at their household (Nguyen, Q.T. and Nguyen, T.M. 2008, March 26, Personal Interviews).

3.3 Case 3 – Ha Tay – Vietnamese Women's Union

3.3.1 Background

Ha Tay is a peri-urban province bordering the national capital of Hanoi. Due to its proximity to Hanoi, infrastructure and information knowledge was more advanced than many other areas of the country. During the case, a focus group was conducted in Binh Minh, a small commune of Ha Tay near the provincial capital of Ha Dong. In addition key interviews were conducted with officials from the local government centre in Binh Minh and the Vietnamese Women's Union chapter. Households were visited in Binh Minh commune. Ha Tay has the second largest VWU chapter in the country and the main focus of their project is on building biogas plants and solar water heaters. So far 740 biogas plants had been built in the province since April 2008.

The project is coordinated through the local VWU chapter and the communal governments. In the Binh Minh community they have worked over 3 years in biogas. In Ha Tay the project has officially started 3 years ago, but some communes been involved with Biogas for over 5 years.

The VWU coordinates the subsidy of 1 million VND, ($60 USD) given to a household for each biogas plant. In addition to this they also monitor a loan that is given (up to 4 million VND, or ($250 USD) through a national bank. No targets or policies were mentioned in the meeting, although there was a large discussion of raising the subsidy due to inflation and higher costs of materials. The Women's Union is currently petitioning the government to increase the subsidy but at the time had no communication about the issue (Xua 2008, April 8, Personal Interview).

3.3.2 Mason Case Data

In Ha Tay, six masons met in a focus group in Binh Minh from around the province. They all were trained by the Vietnamese Women's Union and worked in the local commune and around the province. The primary technology used in Ha Tay is the KT1 and KT2 fixed dome models. KT1 is the preferred model of the masons for the easier constructed base. Some comments given about the technology included its ease to work with, flexibly with materials, cost saving with retained quality. Some difficulties encountered were water drainage within the plant, pressure, gas flow and weather conditions during construction.

In case 3, the public in Ha Tay are well informed and aware of biogas business, according to the masons. The masons were trained by the local VWU in Binh Minh during a three-month program. For training improvements they had no comments. The VWU program commissioned the biogas plants constructed by masons thus far. When asked about female masons, they said they existed and 'worked very hard' but were not the main masons in biogas.

The market in Ha Tay is not very competitive, as described by the masons stating that it was low and external competition was not something they knew about. Biogas offered them a livelihood improvement but not very different from other low skill jobs. And continuing with financing, price changes are something very apparent in Ha Tay, stating that the price of an average sized biogas plant has jumped from 5.5 million, VND, ($340) to 8 million VND, ($495 USD) (PC Mason interview 2008). This sector does not provide enough income for a full time job; because it's seasonal, only available during the dry season and that there are not enough projects now. Other than biogas, masons were working other construction jobs. The programs given to them by the VWU as the market is not developed but are allowed to build outside projects limit them. Households receive a 1 million VND, ($60 USD) subsidy from the government ant then a microfinance loan of up to 4 million VND, ($250 USD) is given to households as well. There was no international organizational presence but the local government was quite involved. They suggested that the loan or subsidy be increased to allow more projects to happen. In the future they see demand increasing but would like to see biogas become a more full time venture, with the possibility to provide enough for a business if projects become available.

3.3.3 Household Data

In Ha Tay only two households were interviewed, after one was not available. Both households raise pigs, with biogas plants installed in 2007, less than one year at the time of the interview (April, 2008). The local VWU and notices cleaner environment, saved money and modern energy, assisted them with saved money, a cleaner environment and modern energy. The switch from coal and firewood to biogas was greatly beneficial in both respondents. Each household received the 1 million VND, ($60 USD) subsidy and one household had been given a loan of 4 million VND, ($250 USD). They have a one-year warranty guaranteed by the VWU. They both had no complaints about biogas but expressed concern over the subsidy and money for households. One of the key elements in holding back biogas development is money for households to buy the service, biogas is still viewed as a good business and service.

3.3.4 Drivers and Barriers

In Ha Tay, a few key drivers and barriers stood out. The financial situation for households had a higher level of stability, however there were concerns about demand, work availability and business skills. In Hay Tay, technology construction and instructions, training and public awareness campaigns were strong points, or drivers, for masons. Aiding the public support and awareness. The government support through subsidies and loan system has helped masons start (as first movers), and enticed many in the region. The focus group in Ha Tay was the largest survey of Masons.

Ha Tay province also had a number of barriers to entrepreneurs and their development. Some constraints found in the interviews were the long and medium term failures, after a few years on the technology (this was a concern of the masons), the lack of competition and other market forces, and the seasonal demand. These influence the business structures of entrepreneurs and the perception of their occupation as low skill, unavailable household income for biogas construction, local conditions and price fluctuations were barriers to them and their businesses. Gender also represented an important barriers, one mason voiced that women do indeed work in construction, but never as the main mason (Dinh, C.T. 2008, April 8, Personal Interview). The price changes in the national and local economy threatened the business, as material and transport costs may become too high to make biogas profitable. Some opportunities suggested in Ha Tay to overcome barriers or other problems for biogas entrepreneurs were to pursue

competition, build outside VWU projects and take advantage of the positive communal perception of biogas.

Driver and Barriers in Case 3, Ha Tay	
Drivers	**Barriers**
Ease of technological construction	Long to medium term technological failures
Training	Local conditions (high groundwater, flooding, heat)
Public awareness / advertising campaign	Lack of competition, no market forces
Government support - subsidy	Price fluctuations
Loan system .warranty	Income generation (lack of projects and demand)
	Perception of occupation (low skill)
	Household income
	Seasonal demand
	Little development of business skills
	Affordability
	Gender

Figure 3-4. Drivers and Barriers identified in Case 3, Ha Tay

For livelihood improvement, in Ha Tay the perception was different on the supply (mason) and demand (household) side. For the masons, only some were satisfied with their livelihood and much of this was because of a lack of demand or consistent income from building the biogas plants. On the household side, the respondents had said that their livelihoods had improved. In terms of opportunities identified in Ha Tay province, pursing competition, encouraging business outside the project and utilizing positive community responses were identified.

3.3.5 Dissemination Approach of Vietnamese Women's Union in Ha Tay

For the Dissemination model in Ha Tay, they have several steps for spreading the information around the province and dissemination of Biogas. Primarily the Ha Tay VWU works with the local authorities and communal government with people trained at the provincial VWU or in Hanoi. Then they initiate an information campaign to the public and hold meetings, talking to people about the issue of biogas or their entire energy program. After the information has been dispersed and households are located for biogas plants, they coordinate the subsidy and loan efforts given by the government. In the case of Ha Tay this is a 1 million VND, ($60 USD)

subsidy and a long term, low interest bank loan of up to 4 million VND ($250, USD), monitored by the VWU. The use of local governance, authorities and training people at local levels is part of the dissemination structure in Ha Tay. There is also a certain amount of participation, however, much is in the form of education, awareness and 'propaganda' campaigns.

4 Analysis and Discussion - benefits and risks to setting up rural bioenergy systems

This section will discuss the drivers and barriers to entrepreneurs and project dissemination model from key informants, households and masons. A more detailed analysis can be found in Appendices 3 and 4.

4.1 Analytical Framework

Many of these cases studies, authors and writings use different frameworks in respect to development and environment, but there are crucial similarities. Some frameworks reflect more on human potential, others on environment or have exercised a preference for techno-centric solutions to the issue of rural energy supply. The UK Department for International Development Sustainable Livelihoods Approach (SLA), known for its five forms of capital, to look at the biogas programs is one of the approaches used in the analysis (Farrington et al, 2004). The framework utilizes five forms of capital (human, financial, physical, natural, and social), and is used by the Asian Development Bank, to view poverty in economic and non-economic terms. This framework is utilized for research, analysis and comparative interpretation of the cases. Some examples of each form of capital include, but are not limited to, human capital as skill knowledge or labour, social capital illustrating relationships or interconnectedness, natural capital as natural resources or services, financial capital as money or equivalents and physical capital representing infrastructure and goods such as water or energy (UK DFID, 2001). The benefits of using the SLA Framework is their emphases on strengths, ability to show multiple interactions, categorize project characteristics and illustrate links and influences (UK DFID, 2001). As an analytical framework, factors are qualitatively identified under each of these categories for comparison across the cases, while taking into account that each of the five aspects of capital in a development context (Schelzig, 2005). In addition to this my research framework, the paper consists of a literature review of relevant articles, case studies and any related national and international material.

The SWOT analysis is utilized to describe these categories and 'indicators' showing if something is a strength, weakness, opportunity or threat. Strengths and weaknesses are internal factors to an organization or project and opportunities and threats come externally. After each statement is determined to be one or many of these factors is given a (-1,0 or +1), which correspond to (Barrier, Neutral or Driver) and are then discussed in the Analysis and grouped into key points. The indicators are then given corresponding (1,0 or -1) to the driver, neutral barrier category. For determining the key drivers and barriers, the ones selected from each case are rated on a negative, neutral and positive scale to select which are most relevant, or irrelevant, to one or some of the cases.

In essence, entrepreneurs are creating new value from a good or service, and as detailed in the methodology and Introduction, they are crucial to developing an energy project. For this perspective, combined with SLA and SWOT characteristics the data will be analysed and grouped into the key drivers and barriers for entrepreneurs while also looking at similarities and differences between the three cases and the two projects.

4.2 Rural Vietnam

With many development projects, regional and local factors often influence project outcomes. Part of this study was to identify these factors, or rural contexts, which act as barriers and drivers, not only to bioenergy entrepreneurs but the entire sector and success of the projects based on their dissemination models.

The primary point to ascertain from the rural contexts is that some conclusions in the research are case specific, or unique to a certain region, however, with these contexts in mind, this does not mean that they will not be factors in other regions. The diagram, Figure 4-1 below details the Rural context diagram, illustrating how the services around the market expand form the supply and demand and within that the rural context describe them (Nes, 2007). Each service contributes to the structure of the biogas market, in turn, aiding biogas entrepreneurs. The importance of thinking outside a project, and even the market, is demonstrated in the diagram

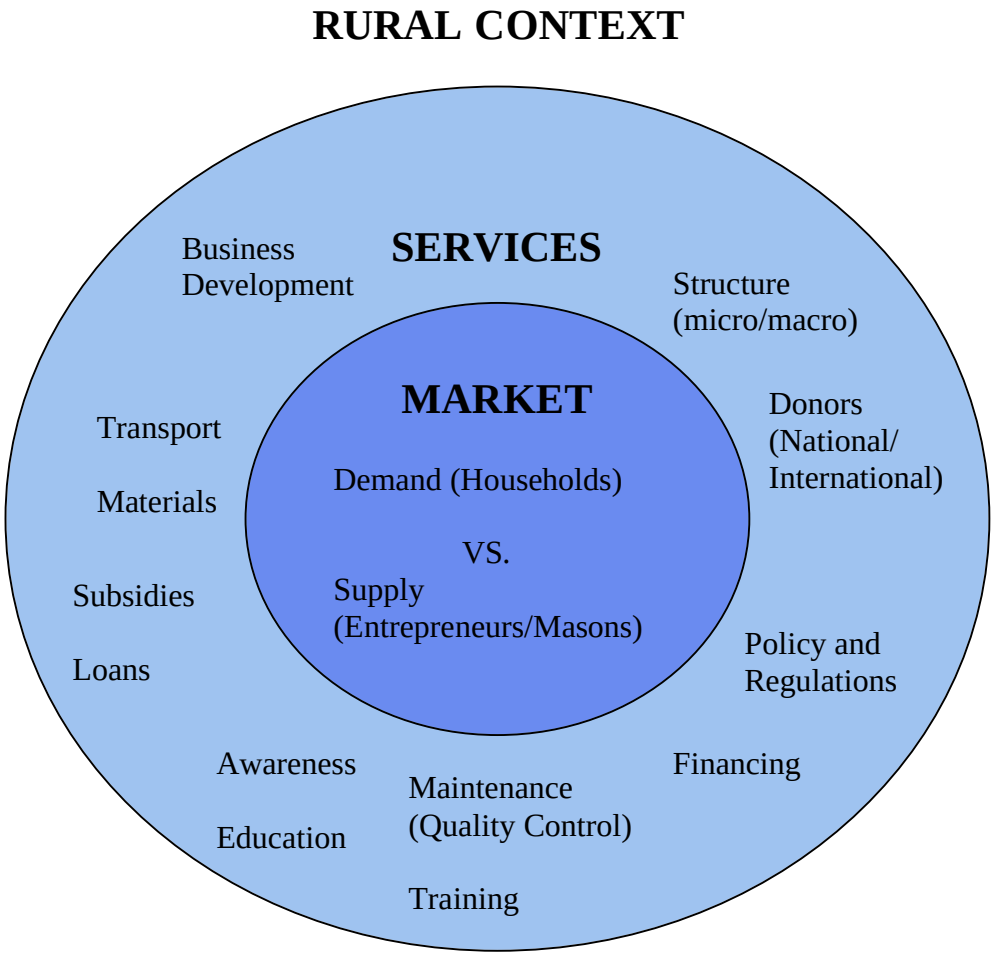

Figure 4-1 the rural context in relation to sector development (Teune 2008, March, Personal Interview).

In the various cases, these realities have led to the disuse of many bioenergy technologies and at the same time have facilitated a 'trial and error' innovation. With biogas, many types of plants,

or plants exist and have proven to be effective in some provinces (Ninh Binh) where others have stopped working. In Son La, reported figures of nearly 80% of the biogas plants built are no longer in use. Many reasons exist for this such as lack of knowledge, not producing enough gas, not enough fuel to sustain them or dissatisfaction with the gas smell (Ervin and Tuan, 2004). As these results vary, they affect biogas entrepreneurs by creating a business for new technology or could result in a public disinterest in the technology. Despite this, in many of the rural areas, information dissemination is high and the presence of bioenergy in communities and among neighbours is also high.

4.3 The Biogas Market

Business development and commercialization are important factors in the rural context; they are the basis of how developed or underdeveloped the markets are for entrepreneurs and the introduction of a new technology. Figure 4-1, it illustrates the Market vs. the Product. The graph shows mapping the rural context according to the development of a product and the market. In the four squares there are key events that are happening based on how new or existing markets and technology are. Similar to this is the rural context diagram, which illustrates the center part of the study and the layers around it dictating the level of commercialization and sustainability. In rural areas, the context provided says much about a business sector's development based on the historical or newness of the product and the market itself. This graph will act as a reference in describing the situation for each case and comparing the different commercialization of each scenario in Vietnam.

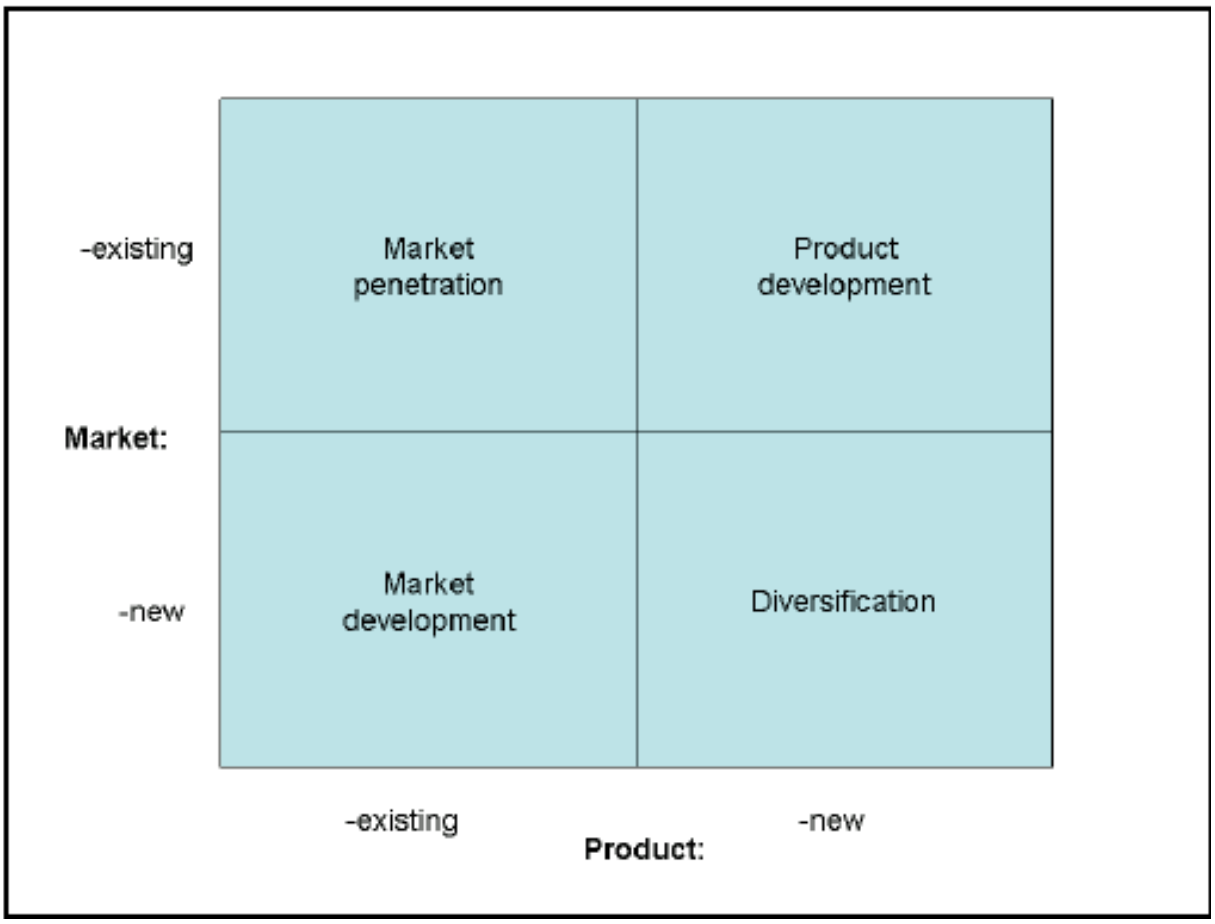

Figure 4-2 A diagram of market and product development, in rural areas this describes how advanced or new a business or service has become (Friedman and Miles, 2006/ Teune, 2008/ Nes, 2007).

In Figure 4-3, the different cases are mapped according to the development or

underdevelopment of the market (for biogas) and the product (biogas itself and as a service). As much of the opportunities, barriers and drivers identified relate to market development, this graph is fitting for mapping the cases. Here, Ninh Binh, Case 1, is the most developed with a product that has been on the market some time but, also that the market development and product development have already or are currently taking place. Market penetration, or selling more on the same market, is happening now in Ninh Binh, however some demand has come to a standstill. Spreading more biogas within the same area has become the target after initial plants. An interesting comparison is the spread of many biogas projects around an area, but few in each spot versus spreading the projects heavily inside one community. Son La, Case 2 and Ha Tay, Case 3, have new markets and are just in the process of market development, however the product has existed longer in Son La from the household responses than in Ha Tay.

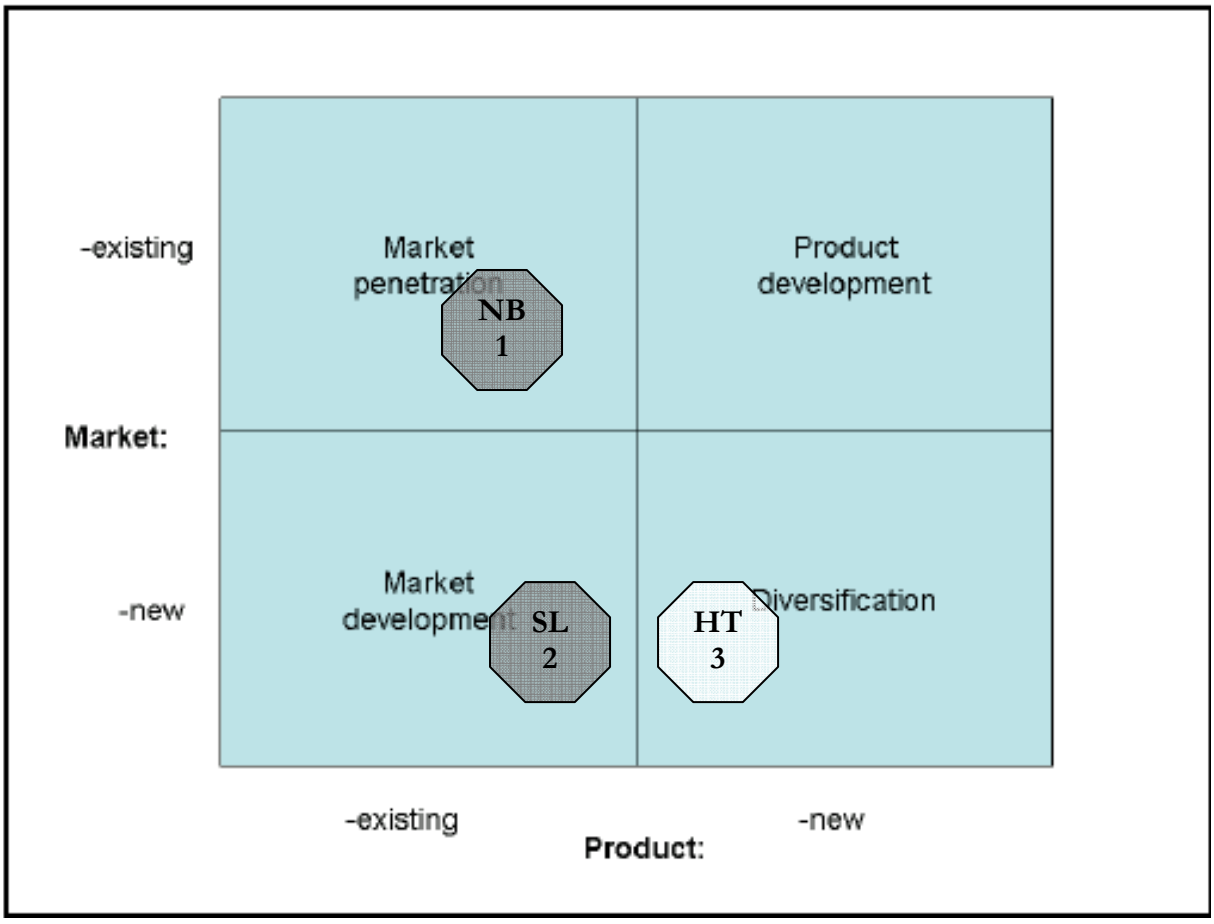

Figure 4-3 The three mapped cases according to their market and product advancement. Grey represents the sector development model, while white is the participatory approach (Nes, 2007).

4.4 Dissemination Approach Comparison

The Dissemination Approach Comparison will discuss the differences between the theory and reality, as well as identify strengths and weaknesses of the approach in the three cases. For the Biogas Programme, sector development is the main model approach, and the overall objective is to develop the sector around biogas commercializing its development on the national and local levels (Teune 2008, March 5, Personal Interview). Long-term success is key in the program, however, in order to achieve this, more on the local level must be done to meet these needs. Vietnam has positive conditions for biogas and this was true in all three cases, however, a lack in

market and individual business development is problematic if the main approach is to develop the sector around biogas. As mentioned in Section 2, sector development acts to sustain services around biogas through private and public sector 'incentives,' some of these services include transport or quality control. As Bastiaan Tuene of the Biogas Programme has described, the local level model is not supporting these services actively enough (Teune 2008, March 5, Personal Interview / Teune 2008). In terms of business development for masons, much is being done for them and no training for business skills was available in all three cases. Based on the findings here and looking at the market models, an explanation for why markets have failed to develop is that the biogas market is too risky and that relying entirely on the private sector has not allowed enterprises to develop (Nes, 2007/ Teune, 2008). This is very much apparent in Case 2 where Biogas is highly well known, but because of uncertainty and potential risks, many masons are not able to take the step as first movers and develop a full-time business.

The VWU's dissemination model largely sticks to the participatory approach, with a heavy focus on information saturation, propaganda and workshops. The VWU program implementation has eight important steps for its dissemination and implementation that heavily revolve around informing and educating in many media forms; these are visible in Figure 4-4 (VWU, 2007). They focus around project awareness and education campaigns, workshops and advertising. The VWU, and generalizing for Vietnam, utilize propaganda, the word having many connotations, however, and the organization leaders are self-aware and utilize its effectiveness as well as promoting it. Propaganda is viewed more as a tool for informing and is not seen as a form a manipulation.

Methods of implementation of the project:

- Start-up workshop: introduced program design and relevant experience in energy-efficient models
- Preliminary study (awareness, statistics, etc. before the program implementation)
- Training for local facilitators
- Awareness campaigns
- Advertisement and propaganda on the central and local media (radio, TV, newspapers)
- Manuals, leaflets
- Build pilot models
- "Propagandist" competition

Figure 4-4 Dissemination implementation steps for the Vietnamese Women's Union (VWU, 2007).

The approach is targeted at spreading information but in terms of a long-term biogas stability goal, this development approach is a large barrier to development of entrepreneurs and the biogas sector. Comparatively, in an interview with Ms. Pham Han Sam, an energy expert at the

Vietnamese Women's Union in Hanoi had much to say on dissemination barriers. Her concerns were limitations in government budget, which only had allocated money for 50 to 100 biogas plants this year. The funding was around 800 million VND, a value of over $50,000 USD. The national support for biogas as a way to save electricity as well as the programs other elements are supported but funding for the project and subsidies has been limited. Another barrier in dissemination and to entrepreneurs is the habits and traditions, especially in the form of cooking fuel. Many women have difficulty with the new energy technology and the technical aspects can also be challenging, as they often learn eminence, participate in labor and choose the site and size of the biogas plant (Pham 2008, March 12, Personal Interview).

As a model for dissemination, information and targeted areas are the key goal for the Vietnamese Women's Union. Having one plant set up enables others to follow suit, people are very enthusiastic about plants in many areas and when the benefits are viewed, many people wish to have the technology. Much more growth and development can be seen in this area. One of Ms. Pham's key comments was that the biogas program has been the most efficient program ever implemented in her experience, it "celebrates women's labor," in her words (Pham 2008, March 12, Personal Interview). This deals with the element of empowerment, which is an aspect of the participation and feeling that people have when involved in a project benefiting their livelihood.

Eventually, it's the goal of the VWU to expand to all of the communes in the Vietnam and provide at least 10 households in each commune with biogas to enable a domino effect of development to other people in the communities and that the community support will enable the growth of these type of systems (Pham 2008, March 12, Personal Interview).

For the participatory approach, the VWU is weak in respect to participating with key groups like masons and entrepreneurs. Their strength is in community participation, not individual. People participate through seminars, meetings and training. They also utilize local government set up well, taking advantage of the VWU structure and the structure in local governments. What especially aids them is the participation with the Vietnamese government and the support from the local centers. The VWU targets women as the heads of the household, and as found in the survey women are not biogas entrepreneurs and are not often masons. So then supporting the sector may not be entirely obvious for the project. The model's participatory and information based steps are only part of the development approach. In terms of dissemination models, fostering the sector and services around biogas will be local economy and more stability to the project in the long run. Support is still needed from public and NGO institutions; however, the incentives of income generation will keep biogas a stronger success than solely public awareness.

What was a major strength of the Biogas Programme's model, especially in Ninh Binh was the support directly to the masons and guidance to build a self-sustaining sector. In Case 2, Son La, this was less apparent due to lack of resources. In terms of information and community support, this model and Case 3, Ha Tay, was by far the most advanced. The major weakness of the participatory approach in the Vietnamese Women's Union was the failure to target important and vulnerable groups, namely masons are trained on skill. More work is still needed to build up the biogas market, entrepreneurial skills and the services related to biogas.

A summary of the main strengths and weaknesses found in the cases:

Table 4-1. Key strengths and weaknesses of dissemination models between programs and cases.

		Strengths	Weaknesses
Biogas Programme	Case 1	Builds services	More business skill training
	Ninh Binh	Supportive of masons, market	Service sector
		Information dissemination	
	Case 2 Son La	Information dissemination	Little basic business training
		Supportive of masons, services	Too supportive, masons become dependent
Vietnamese Women's Union	Case 3 Ha Tay	Use of local government and stakeholders	No sector or market development.
		Education and high information dissemination	Project, not people are the focus
		Community targeted	No business development
			Targeting key groups and the vulnerable

4.5 Key Drivers for Entrepreneurs

This section will analyze and discuss the key drivers for entrepreneurs in the three case studies. For key drivers, there are a few major advantages for the cases and could help aid entrepreneur development in the future. While the table above illustrates how prevalent the driver itself was in the case, all of them are key drivers. For instance, Income provisions, meaning the ability to generate an income received only a positive mark in Case 1 and negative in Case 2 and Case 3. This is due to the fact that in case 2 and 3, none of the masons were able to generate a full time income from this driver, however, at the prospect that they could, all were interested in continuing. Therefore, the ability to generate a full-time income could be seen as a key driver.

Among income generation, the support form the local AEC, subsidies, government support and the large public awareness all contributed to the start-up success of biogas entrepreneurs. This initial support net that is provided by local government acts as an incentive for actors to be a 'first-mover' or start selling and building biogas in the area. Indirectly, warranties and micro financing (loans) acted as help to build confidence in households and fiscally allow them to build

biogas plants. The training programs are drivers in both the Biogas Programme and the Vietnamese Women's Union; the long training program (3 months) provided by the VWU may help build not only better skills but also networking and communication with the local authorities.

For the Son La case and what would be similar of other remote provinces, energy reliability was a driver in the case of erratic electrical power of shortages of other traditional fuels. Community acceptance is also seen as a driver, having a highly informed and supportive community for the technology. This could lead to many opportunities for biogas entrepreneurs to utilize this positive view. In addition, the idea that biogas related work field improve livelihoods, seen in the Biogas Programme cases is a self-advertising mechanism, illustrating a job that has more alluring qualities than others.

The development of a market sector is also perceived to be both a driver, and a barrier. The lack of market development is an absolute barrier to business development; with an underdeveloped market there is little change for a business to grow outside of projects coordinated by a local governmental body. In Ninh Binh, building outside biogas programme projects was possible and happening, driving business and enterprises in the region. Case 2 and 3 had no development of this kind, limiting projects to what was given by local bodies. A developed market sector is a driver to entrepreneurs and should be viewed as such.

In Son La, Tuan, a microenterprise developer from SNV, expressed concern for the focus on subsidies. He described that the way government and people perceive e subsidies and come to depend on them is one of the largest barriers to enterprise development in his rural province and around Vietnam. While people cannot always afford technology, they become overly dependent on the subsidy, waiting for change, more funding or refuse to pay until some form of financial aid is present. In this sense, subsidy perception is an indicator of the sustainability of the sector.

A summary of the key drivers identified in the cases:

Table 4-2 Drivers Identified in the three case studies, they are rated as being very applicable (++), applicable (+) or neutral (0). The more positive the mark, the stronger the driver in each individual case.

Drivers	**Case 1 Ninh Binh**	**Case 2 Son La**	**Case 3 Ha Tay**
Ease of technological construction			
Training	+	+	++
Public awareness / advertising campaign	++	++	+
Government support	+	+	++
Warranty	++	0	++

Microfinancing	0	0	+
Subsidies – financial support	+	++	++
Local AEC support	+	++	++
Energy reliability	0	++	0
Livelihood improvement	++	+	0
Developed market sector	+	0	0
Community acceptance	++	++	++
Ability to generate a full-time income	+	0	0

4.6 Key Barriers for Entrepreneurs

This section will analyze and discuss the key barriers for entrepreneurs in the three case studies. Many barriers have been identified in each case, and for more detail, section 3 and Appendices 3 and 4 present them with more detail. In the case of key barriers to entrepreneurs, several have been identified from field research. Technical problems in the short term have not been found to be an issue; however long term and medium term biogas problems are barriers to the confidence of households (the demand aspect) for entrepreneurs.

Basic private sector elements also acted as barriers, competition, however, is a complex version to this. For the masons and entrepreneurs, no competition is a positive aspect for the first movers. Eventually this will stagnate and fail to drive down prices or give an incentive to better one's own business. A choice-less market, or localized monopoly, is not beneficial to the demand side of biogas, which could be subject to being competition from a different source of energy.

Financially, there are a few barriers associated with costs, pricing and income. The first barrier is the inability to generate an income full time; this has prevented entrepreneurs from developing or local enterprises. The fluctuation in prices of materials is also a cause for concern, in some cases prices of bricks tripled (Xua 2008, April 8, Personal Interview) and in others; costs have doubled with rising fuel. Transporting goods and the constructions costs have raised in turn, making the biogas plants more expensive for households and less likely to be built for biogas masons.

Quality control is another issue to consider along with the development of market sectors. The little development of business skills is from the lack of teaching and guidance on that level and the over involvement of the local government and VWU, the support may be viewed as creating an unnecessary dependency of entrepreneurs on the organization.

Despite the project being started and partially funded by SNV, the results and sector development is largely in the hands of local people. Research findings revealed that on many levels the idea of "who is in charge" was mixed. While Hanoi may dictate subsidies, information and policy, it is largely up to the local centres to distribute this knowledge and facilitate the

development of bioenergy for the rural scale. The responses to the questions formed a picture of sector development in the province and offered a contrast to Ninh Binh, where bioenergy as a business is far more developed. A barrier is the structure of local and national government, in addition to the over involvement in some cases. Realities in the capital and rural areas are very different, and similar bureaucratic structures have slowed processes in rural areas.

A summary of the key barriers identified in the cases:

Table 4-3 Barriers Identified in the three case studies, they are rated as being very applicable (--) applicable (-) or neutral (0). The more negative the mark, the stronger the driver in each individual case.

Barriers	**Case 1 Ninh Binh**	**Case 2 Son La**	**Case 3 Ha Tay**
Medium to long term technological failures	-	-	0
Local conditions (high groundwater, flooding, heat)	-	--	-
Affordability for Household	0	-	-
Lack of competition, no market forces	-	--	--
Price fluctuations	0	--	--
Business Skills	-	--	--
Perception of occupation (low skill)	-	0	--
Design complications	0	-	-
Lack of visible demand (invisible demand) – communication barrier	0	--	-
Domestic Outsourcing	0	--	0
Quality control	--	--	--
Income, not enough to sustain a full time job	0	--	--
Material cost – price fluctuations	0	-	-
Transport/geography	0	--	0
Underdeveloped Market Sector	-	--	--
Demand and project availability	0	-	-

4.7 Opportunities

The section details opportunities identified in the cases and discuss their applicability and approach. Opportunities represent ways to overcome barriers or facilitate drivers further by using the local context and resources of a project. Here are some identified in the case studies with the literature examples still relevant in many scenarios. Key things to note are the opportunities to shift towards a more privatized sector but still with public sector oversight and involvement. The case marked in Table 4-4, if the opportunities were present or apparent that they would fit into the local conditions.

Opportunities to develop warranty schemes and teach business skills are apparent in Ha Tay and Ninh Binh due to better structural support and close ties with local government. Quality control improvement and monitoring was found in Ninh Binh and Ha Tay with close-knit ties between people and those working with biogas. This is an excellent way to establish a monitoring scheme or local reporting on the state of biogas plants. Development of advertising and expanding business beyond the projects is an opportunity in cases that have a better market development and more established product. Utilizing the positive community response is perhaps one of the most important opportunities in all cases. Here the perception allows for new initiatives and to develop biogas further.

The loans and microfinancing in the Ha Tay case not only illustrated a driver in biogas sales but an opportunity for public sector to overlook private sector financing and building up a service that supports biogas construction. Opportunities have been previously identified and a few were found to be realities in the three cases such as monitoring schemes, increasing the responsibilities for masons and commercialization efforts (Nguyen, 2005). A summary of opportunities found in the cases:

Table 4-4 Identifying opportunities in the case studies; those present will be marked in each case.

Opportunities	**Case 1 Ninh Binh**	**Case 2 Son La**	**Case 3 Ha Tay**
Develop a local warranty scheme	X		X
Quality control/ monitoring	X		X
Mircofinancing			X
Business skill development	X		X
Advertising and development	X	X	
Expanding business outside projects	X		X
Utilize positive community response	X	X	X

5 Conclusions – The future of Bioenergy in Vietnam

This section explores concluding remarks on the research including opportunities, repetition of the key drivers and barriers to entrepreneurs, recommendations and exploration of future research in the biogas field. This will describe concluding points and what the future of biofuels in Vietnam may look like, as well as, recommendations.

5.1 Key Drivers and Barriers

Entrepreneurs play an important role in sustainable development for a project by helping build up an entire sector, acting as an indicator of its stability, providing a needed service (energy) and stimulating the local economy. In order to realize their potential, drivers and barriers are to be identified to assess their current situation. Several of the drivers and barriers stand out as being significant to all, or most, of the case studies and as current indicators of biogas entrepreneurs, masons and future markets. New key drivers and barriers are discovered and past findings are further substantiated.

Key drivers for biogas entrepreneurs identified subsidies as market promoter's strength, as well as the positive view of the technology and widespread community support. Initial public support and community awareness and education promote biogas and enable an easier climate for 'first movers' in biogas. For the biogas masons, the appeal to be able to generate a full time income and improve livelihood is a driver for new people to enter the field. Reliability as an energy service is also viewed as a key driver when in the case of scarce or unreliable energy services. An open market sector and support to biogas services, such as warranties, microfinancing, subsidies for households and business training are key economic drivers.

Key barriers to entrepreneurs are related to lack of quality control, lack of competition, fluctuations in prices, gender, little to no business skill training, demand and affordability constraints at the households, lack of a steady income and the perception of biogas as a 'low skill' field. An underdeveloped market is a prominent key barrier that embodied several economic barrier issues; much work is needed in market penetration and development of entrepreneurial skills.

5.2 Dissemination Models

Dissemination models and their real world applications naturally appear different from one another due to the rural contexts involved. In the Vietnamese cases, the two organizations research each used a unique approach and theory to spreading their energy development projects. The local approaches in the three cases contrasted the theoretical approaches by revealing strengths and weaknesses in both models. When comparing the sector development and participatory approaches, the research and analysis illustrated that the sector development model supports biogas entrepreneurs more for it's direct involvement and the crucial role the model plays in developing the market and services.

In the future, this method is favourable for biogas projects and entrepreneurs, not just in Vietnam but, also in other countries. Developing a sector development approach may look different between countries; however, the goal of benefiting entrepreneurs working in energy development project ensures better local and longer-term sustainability.

Within the cases studies, major strengths of both dissemination models were information dispersal, the use of local governance and promoting a positive communal image of biogas and its related benefits. The major weakness of the participatory approach in the Vietnamese Women's Union was the failure to target key and vulnerable groups, namely masons and the very poor. Within the participatory approach, more work is still needed to build up a biogas market, entrepreneurial skills and the services sector. Separately, the sector approach has the primary key strengths of information dispersal, targeting key groups, building services around biogas and supporting a market. What was a major strength of the Biogas Programme's model was the support directly to the masons and guidance to build a self-sustaining sector. Weaknesses of the sector approach included inadequate business skill training and being overly administrative.

5.3 Recommendations

For the project, a few recommendations have come out of the research, dissemination models and drivers and barriers to entrepreneurs. These recommendations are based on case data and analysis. After looking at key drivers and barriers to entrepreneurs, information dissemination effort should be continued, as should efforts to expand the sector around biogas. For the policy and government role, more policy support to bioenergy and RETs is necessary and developing programs with the government to promote business skill training.

Microfinancing, or loans, is an interesting area to explore and may open up the possibility of more households to afford modernized energy technologies. With microfinancing, subsidies should continue but also wary of the dependencies that they can create. For future subsidies, inflation and rising material costs should be taken into account and adjust the prices accordingly. Finally, inter-project communication is necessary for biogas entrepreneurs. Through combining the efforts of the different organizations in Vietnam, new perspectives and methods will aid rural energy modernization.

To summarize, recommendations based on the research:

- Biogas sector expansion
- Continue information dissemination efforts
- More renewable and bioenergy policy support
- Business and entrepreneurial training for masons
- Establishing a Microfinancing program for households
- Financial aid adjustments to incorporate inflation and rising material costs
- Inter-project communication, cooperation

5.4 Future and Research

The future of biogas and rural energy entrepreneurs is largely dependent on research and interest in the field. While all research on biogas and rural entrepreneurs is valuable, key and interesting areas for future research include an evaluation of all biogas programs in Vietnam, barriers to female entrepreneurs and identifying support, further research on dissemination approaches to rural energy development projects, identifying types of supportive policy and an analysis of microfinancing and role it plays in energy modernization.

The efforts of biogas entrepreneurs, the Vietnamese Women's Union and the Biogas Programme to modernize rural energy have brought insight and knowledge to the steps towards poverty eradication. As a case study, the study provides an excellent example for drivers and barriers that rural energy entrepreneurs would face, as well as, the dissemination models, or

frame of a development project. If the Millennium development goal of poverty reduction is to be realized, many approaches will be necessary, entrepreneurs are one key way to bring modernized services and empowerment to rural populations.

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Abbreviations

ADB	Asian Development Bank
AEC	Agricultural Extension Center
BP	Biogas Programme
CCRD	Center for Rural Communities Research & Development
EVN	Electricity of Vietnam
GDP	Gross Domestic Product
HDI	Human Development Index
IEA	International Energy Agency
MARD	Ministry of Agriculture and Rural Development (Vietnam)
MTOE	Metric Tons of Oil Equivalent
RET	Renewable Energy Technology
SLA	Sustainable Livelihoods Approach
SME	Small and Medium Enterprise(s)
SNV	Netherlands' Development Agency
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VND	Vietnamese Dong (currency)
VWU	Vietnamese Women's Union

Appendix 1: List of People Interviewed

Names	Occupations	Location (province)
Key Infomants		
Nguyen Van Tuyen	Provincial Technician, Local AEC	Ninh Binh
Tuan Anh Le	Technical Advisor, SNV	Son La
Nguyen Quoc Tuan	Manager of AEC, Son La Province	Son La
Nguyen Mai Thi	Office technicial for AEC Son La	Son La
Ms. Xua	President and Vice Preseident of local VWU chapter, Ha Tay	Ha Tay
Pham Hanh Sam	Vietnamese Women's Union, Industry and Energy Deputy Director	Hanoi
Teune, Bastiaan	SNV advisor biogas/ renewable energy	Hanoi
Pham Van Thanh	VACVINA - CCRD (Center for Rural Communities Research & Development	Hanoi
Households		
Ngo Thi Tuong	N/A	Son La
Vu Dinh Mien	N/A	Son La
N/A (Female)	N/A	Son La
Mr. Tuan	N/A	Son La
Mr. Hoa	N/A	Son La
Mr. Thao	N/A	Son La
Mr. Kim	N/A	Son La
Mr. Bao	N/A	Son La
Nguyen Huu Bon	N/A	Son La
Tong Thi Khuyen,	N/A	Ninh Binh
Dinh Xuan Truong,	N/A	Ninh Binh
Nguyen Thung Kien,	N/A	Ninh Binh
Dinh Thi Ly	N/A	Ninh Binh
Nguyen Thi Tien	N/A	Ha Tay
Nguyen Tun Vinh	N/A	Ha Tay
Masons/Entrepreneurs		
Le Xuan Cuong,	Mason	Ninh Binh
Bai Tong Truc	Mason	Ninh Binh
Dinh Van Manh	Mason	Ninh Binh
Dinh Huu Thanh	Entrepreneur/Business Owner	Ninh Binh
Nguyen Van Lau	Mason	Son La
Nguyen Duong Thong	Mason	Son La
Nguyen Van Vinh	Mason	Ha Tay
Nguyen Tien Khoi	Mason	Ha Tay
Nguyen Duy Truong	Mason	Ha Tay
Nguyen Duc Tuan	Mason	Ha Tay
Nguyen Duc Truong	Mason	Ha Tay
Dinh Cong Tuy	Mason	Ha Tay

Appendix 2: Mason Interview Questions / Analysis

Indicator	**Case 1**			**Case 2**			**Case 3**		
Analysis Category	**Response**	**SWOT**	**Driver/ Neutral/ Barrier**	**Response**	**SWOT**	**Driver/ Neutral / Barrier**	**Response**	**SWOT**	**Driver/ Neutral/ Barrier**
Names	1. Le Xuan Cuong, 2. Bai Tong Truc, 3. Dinh Van Manh, 4. Dinh Huu Thanh			1. Nguyen Van Lau, 2. Nguyen Duong Thong			1. Nguyen Van Vinh, 2. Nguyen Tien Khoi, 3. Nguyen Duy Truong, 4. Nguyen Duc Tuan, 5. Nguyen Duc Truong, 6. Dinh Cong Tuy		
Occupations	Mason, Mason, Mason, Entrepreneur	strength	1	Both Masons - no known Entrepreneurs in the province	opportunity	-1	All Masons	opportunity	-1
History with program	10 years - 2 with project, 8 years - 2 with project, 6 years, 13 years			15 years as a mason, both worked in Biogas since 2006.			Around 1 year		
Location	Primarily Ninh Binh but also Hoa Bing, Thanh Hoa and Nam Dinh Provinces			Son La Town (Tx Son La)			Ha Dong, Binh Minh and surrounding areas, Hay Tay Province		

Type of Bioenergy Project	All Biogas, most are also selling LPG, stoves and lanterns. Biogas Programme			Biogas - Biogas Programme			Biogas - Vietnamese Women's Union		
	worker to collective and entrepreneur business			Freelance masons			Mason Collective		
A. Technology									
Technology used	Fixed Dome model - no distinction made between KT1 and KT2. - all build following the plans of the project.	strength	1	Fixed dome model	strength	1	KT 1 and KT 2 fixed dome models used, KT 1 the preferred type.	strength	1
Technological Improvements	Project flexibility for geography and weather would benefit the plants. Overall the technology not complicated	Threat/ Opportunity	-1	N/A		0	Drainage, Gas Feed/Pressure	opportunity/ weakness	-1

Positive experiences with Technology	Not very difficult, can be more adaptable	strength	0	Following guidelines, no problems and agreed the experience was positive.	strength	1	Fairly easy to construct and work with. Flexibility of new materials and ways to save costs but keep quality, gas disposal and feed	strength	1
	Geography, terrain, weather - low temperatures cause bacteria process to slow or stop	Threat	-1	N/A		0	Water drainage in the plant, heat during construction and occasionally pressure	Threat	-1
B. Human Issues/Skills/Knowledge									
Awareness of personal enterprise	High awareness of their businesses and high =knowledge of biogas - media dispersal also active. Some skepticism from the public still exists	Opportunity	1	Yes, awareness of business is high in Son La and many people want biogas plants at their households	Opportunity	1	Well informed public and business awareness	Opportunity	1

Training Information	Trained by the Local Agricultural Extension Center	strength	0	Trained by the AEC, Son La	strength	0	Trained by eh local VWU in Binh Minh chapter three month program	strength	0
Training Improvement	N/A		0			0	No comments		0
Building and Selling the Biogas Plant - Service	Some built only, the entrepreneur only sold the service and two both built the plant and sold the service.	Opportunity	-1	both	Opportunity	0	not bound by the project, some do both others just build as part of team.		0
Presence of Women Entrepreneurs/Masons	N/A		0	No - note, on observation women were working in construction around the province.	weakness	-1	Yes, but are not the main workers.	opportunity/ weakness	-1
C. Social Issues									

Competition Internal	Competition either nonexistent in some areas or very low - reputation based and "not a high interest job due to the low skill, low labor and high transport costs" - #4.	weakness/ opportunity	-1	there's not really any real competition between people in the province	weakness/ opportunity	-1	Since few are adequately trained, not much competition within the region.	weakness	-1
Competition External	Not Present or noticed	opportunity	1	competition not fierce but there is a fair amount of outsourcing form neighboring provinces to either build the plant or contribute to the labor	threat	-1	Low, did not know about status		0
Price differences between Plants and enterprises	Almost no price differences, largely prices depend on size, geography and transport costs.		0	costs fairly equal, major variations are due to size.		0	N/A		0

Livelihood improvement through involvement in Biogas	Overall yes, agreed consensus it's better than a normal construction job. Disagreements over skill and intellectual challenges	strength/ weakness	0	this would be better if they could have it as a primary source of income, too few projects to make a judgment	weakness	-1	Some, but not different from other low skill jobs	weakness	0
D. Financial Issues									
Future Price changes	N/A			Material costs have doubled, transport costs high	threat	-1	The past year has seen a jump from 5.5 million VND to 8 million VND.	threat	-1
Does the Biogas sector provide enough income	all masons had biogas as the sole source of income, the entrepreneur had other investments.	strength	1	No, discouraging. Wages are not very different and not enough projects	weakness	-1	No, can only work during the dry season and there are not enough projects now.	weakness	-1
Other income generation strategies	N/A		0	construction, other projects	opportunity	0	Other construction jobs	opportunity	0

Building outside the project	yes, all had control of their own business ventures. The AEC also brought them a lot of business through these projects.	opportunity	1	N/A - most projects from AEC, some directly go to masons		0	yes, but limited to ones given by program so far	opportunity	0
							advertising cost mainly covered by local AEC or WU through information dissemination	opportunity/ threat	0
E. Policy Issues									
Subsidies	Masons are not given subsidies, Households are given subsidies	Strength	0	Households receive the subsidies - for labor costs	strength	1	current is 1 million to the households, masons receive none. Also, 4 million loan	strength	1
Who gives the subsidies and how much	1 million VND to households, from National Government, this was not known by Masons interviewed	strength	1	N/A		0	National Government gives 1 million and a local bank with a VWU gives a 4 million VND loan (microfinance)	strength/ opportunity	1

International Org Presence	SNV present in Ninh Binh, most of the support through local and national government		0	N/A		0	N/A		0
National Government Presence	Gives financial support	strength		N/A		0	Subsidy	strength	1
How can any of these help Better?	The money is not much for a richer family but to poor this means a lot, the subsidy covers around 1/7 or 1/8 of the cost in the region.	threat	0	N/A		0	Increase the loan to represent more of the project (1/3 was suggested)	opportunity	1
Future									
Future of Bioenergy in the area	Demand will Rise	opportunity	1	It will expand as long as the demand is there.	opportunity	1	Demand will go up, would like to see this as a full time venture.	opportunity	1
Providing enough demand for a business in biogas	variation in business availability	weakness/ threat	-1	The hope is that there will be more business in the future, right now there are not nearly enough projects		0	yes, more projects needed.	threat	-1

Future Business Risks	inflation, devaluation, disease, supports to build the plant.	threats	-1	N/A		0	N/A		0

Appendix 3: Household Interview Questions / Analysis

Indicator	Response Case 1 - Ninh Binh			Response Case 2 - Son La			Response Case 3 - Ha Tay		
	Response	**SWOT**	**Driver/ Neutral/ Barrier**	**Response**	**SWOT**	**Driver/ Neutral/ Barrier**	**Response**	**SWOT**	**Driver/ Neutral/ Barrier**
Names	1. Tong Thi Khuyen, 2. Dinh Xuan Truong, 3. Nguyen Thung Kien, 4. Dinh Thi Ly			1. Ngo Thi Tuong 2. Vu Dinh Mien 3. N/A (Female) 4. Mr. Tuan 5. Mr. Hoa 6. Mr. Thao 7. Mr. Kim 8. Mr. Bao 9. Nguyen Huu Bon			1. Nguyen Thi Tien 2. Nguyen Tun Vinh		
Occupations	All are involved in agriculture and raising livestock			1. N/A 2. Pig farmer 3. N/A 4. Livestock Farmer / Mason 5. Livestock Farmer 6. Livestock Farmer 7. Livestock Farmer 8. Livestock Farmer 9. Dairy Farmer / Mason			Pig farmers		

Time involved with Biogas	1. 2007 (> 1 year) 2. 2007 (1 year) 3. 2006 (2 years) 4. 2007 (1 year)			1. N/A 2. 1st built in Son La 3. 3 plants, 1st in 1992 4. 1998, 18M3 5. 2003 6. 1999 7. 2000 8. 2007 (1 year) 2 plants 9. 2007 (1 year)	1. 2007 (> 1 year) 2. 2007 (> 1 year)		
Location	Ninh Binh Town and Outskirts			1. Son La Tx 2. Son La Tx 3. Son La Tx 4. Son La Tx 5. Son La Outskirts 6. Son La Outskirts 7. Son La Outskirts 8. Son La Outskirts 9. Moc Chau Town	Ninh Minh Commune, Ha Tay		
Number of people in HH	1. 5 2. 6 3. 3 4. 4			1. N/A (5?) 2. N/A 3. N/A 4. 4 5. N/A 6. N/A 7. N/A 8. N/A 9. N/A	1. 4 2. 6		

Groups involved	Biogas Programme, Local AEC	Strength	0	Biogas Programme, Local AEC / Independent Masons and (PPC)		0	Vietnamese Women's Union Project		0
Household Changes	money saved, positive technology, cleaner environment, less odor, time-saving (coal and firewood collection), improved cooking, health improvements	Strength	1	clean energy and better sanitation, saved energy, cooking capabilities, no need for wood for energy, money saved is key benefit.	strength	1	Cleaner environment, saved money, modern energy source (switch from wood and coal	Strength	1
Warranties, Insurance or follow-up	1. Warranty, 1 year guarantee 2. N/A 3. Warranty 4. No warranty, (follow up scheduled after meeting)	Opportunity/ Strength	1	1. N/A 2. N/A 3. No warranty 4. none 5. none 6. No warranty, self-repair 7. Did not know 8. yes 9. No warranty, self-	Weakness / Threat	-1	Each has a one year warranty through the VWU	Weakness	-1

				repair					
Are people buying the service / Interest	People are very interested in the technology and service	Opportunity	1	N/A		0	Yes (not much information on this subject)	Opportunity	1
Biogas and the community	positive response, land availability and space to get out water are issues	Strength / Threat	1	environmental improvements, more reliable, electricity often cut.	strength	1	Yes it has improved the community's health and environment	Strength/ opportunity	1
Improvements for Biogas	Problems with gas flow, pressure clocks and gas valve. The gas flow would slow or stop over time, expelling water effluent difficult (hamlet design) and water drainage issues.	Threat	-1	Scum build up, slow flow of gas, one case all three plants have stopped working entirely. Scum removal. Technology changes too frequently (consistency). Technology difficulty	Threat, weakness	-1	Only mentioned subsidy increase	Strength	1
Government or outside help	Subsidized, some additional support for labor (#1 received funding	Strength	1	Subsidy from the government and local AEC, some amounts	Strength	1	Each had a subsidy, one had a loan	Strength	1

	for a stove and pressure clock).			for labor or material costs, specifically. Some receive plans and guidelines for maintenance and repair from the local AEC					
Subsidy Information	1. 1 million VND 2. 1 million VND 3. Subsidy 4. N/A	Strength	1	1. 1.5 million VND (500,000 from AEC) 2. 1.5 million VND (500,000 from AEC) 3. 800,000 VND 4. None (self-built) 5. 800,000 VND (from AEC material/labor) 6. 1.2 million VND - helped with construction 7. 1 million VND - (self-built) 8. 1.5 million VND 9. none (self-built)	Strength, Opportunity	1	1. 1 million VND, 4 million VND loan 2. 1 million VND	Strength, Opportunity	1

neighbors	The technology is accepted by the community, easily accepted and with no complaints. The reduced smell and better sanitation helps the process.	Strength / Opportunity	1	No complaints or complaints reduced.	Strength	1	N/A - No complaints	Strength	1
What is holding back households from purchase	N/A		0	High Cost, lack of demand	Threat	-1	Money, key factor	threat/ opportunity	-1
Livelihood improvement	All respondents satisfied or very satisfied	Strength	1	Very satisfied, satisfied despite plants not working, all had this opinion.	Strength	1	Satisfied		1
Views on Biogas as a business	N/A		0	# 3, maintenance could be a good business. #4 low labor income, not a	Weakness, Opportunity	-1 / 1	Helpful, the masons are needed, good idea		

				high skill job, #6 could only be part time, not much business. #7 not sure about it #8 not enough money #9 not enough local demand, no interest in making it a business.					
Energy used prior to biogas	1. Firewood (Biomass)/ coal 2. N/A 3. Coal 4. Coal	Opportunity/Strength	1	1. N/A 2. Firewood (Biomass) - still in use 3. N/A 4. Firewood (Biomass) 5. LPG (still in use) 6. N/A 7. N/A 8. N/A 9. N/A	strength	1	1. Firewood (Biomass) / Coal 2. Firewood (Biomass) / Coal	Strength	1
Future	A few respondents planned to expand agricultural production due to biogas	Opportunity	1	Technology issues (design), always room for improvement, potential entrepreneurs	Weakness, Opportunity	1	N/A		0

Animals Raised	1. N/A 2. At least 5 pigs 3. 4+ pigs 4. 10 cows	0	1. Pigs 2. Pigs (10+) 3. Biogas plants (3) no longer in use. 4. Pigs 5. variety 6. Pigs (22) 7. N/A 8. N/A 9. Dairy cows	0	1. At least 10 pigs 2. At least 10 pigs		0