Utrecht University

Renewable Energy Technologies, Ownership and Development in Rural Argentina

A study on the Sustainability of Renewable Energy in off-grid Argentina

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This thesis is the final product of a study that started about one year ago. After several months of preparation, research in the field and analysis of the results, I am happy to present you my thesis.

This work was carried out as the final requirement of the International Development Studies master programme at the Utrecht University, in the Netherlands.

I decided to focus on renewable energy in the rural environment of Argentina and examine the impacts these technologies have on the local communities. Renewable energy as a whole, is a topic that fascinates and intrigues me and being offered the opportunity to conduct this study in a beautiful country like Argentina is certainly been a great experience.

I would like to take this opportunity to thank some special people that in their own way have made the realization of this study possible. I would like to thank Diego Musolino for being such a great reference before and especially during my whole stay in Argentina; his advices and tips have proven to be crucial not only from an academic perspective but also in many instances, at the social level favouring my integration. I would also like to thank Andres van der Linden, with whom I have shared most of this experience, who has been of great friend and a true ‘jing’ throughout the entire time in Argentina. I would like to thank my parents who have always shown support throughout the entire study. Last but definitely not least, I would also like to express my gratitude to the entire Geosciences staff for making such an incredible experience possible, with a special thank to Maggi Leung and Joris Schapendonk who have helped me with the writing process of this thesis providing fundamental feedback and tips.

Gracias,

Simone de Lucia

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EXECUTIVE SUMMARY

Climate change represents a serious threat for our future; those who are most at risk are the world's poor since they have least alternatives to the increased stress of accessing vital resources caused by the growing carbon emissions (Venema and Rehman 2007). As argued by Teske et al (2007) the link between the lack of energy and poverty is considerable; providing access to energy for the rural poor can be the key to unlocking the vicious circle of poverty (WSSD 2002). Despite the great potential of renewable energy technologies, there are major barriers that impede the implementation of RE on a large scale. This study aims to provide an answer to whether these barriers can be overcome with adequate incentives, policies and a good institutional framework. More specifically, this research will consider the case of three renewable energy technologies, wind turbines, solar photovoltaic and biomass digester, in the specific context of rural off-grid Argentina. The results, analysed by focusing on the aspects of *technology*, *community* and *external support*, strive to highlight whether these systems are sustainable. The sustainability will be analysed through the lens of ownership, effectively trying to determine whether ownership at the local level can be the key to a successful implementation.

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Clean Development Mechanisms (CDMs)

Decentralised Renewable Energy (DRE)

Energy Information Administration (EIA)

European Union (EU)

Greenhouse Gas Emissions (GHG)

Intergovernmental Panel on Climate Change (IPCC)

International Energy Agency (IEA)

Millennium Development Goals (MDGs)

Renewable Energy (RE)

Renewable Energy Sources (RES)

Renewable Energy Technologies (RETs)

Renewable energy technology (RET)

Terawatts (TW)

Watts (W)

World Health Organization (WHO)

World Summit on Sustainable Development (WSSD)

Conversion rates used

Argentine pesos (ARS) per US dollar 4.1101 – 1$ (2011 est.)

Argentine pesos (ARS) per Euro 4.9256 – 1$ (2011 est.)

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Introduction

Since the evolution of mankind, energy, derived from the Ancient Greek *energeia* (Harper 2012) has been an essential aspect of daily and communal life (Vaghefpour and Zabeh 2012). Arguably, the different energy sources used have shaped the different eras of the evolution of mankind. Up until the industrial revolution there used to be only two sources of energy: the manual muscular force of men or animals and biomass, such as firewood used for cooking and heating. Since the mid 19th century, we have used several different energy resources, always adopting the type that provided us the highest energy content (the shift from coal to oil in the late 20th century is a proof of this change), disregarding the eventual outcomes (Rodrigue 2012). This trend has been going on for millennia, until today when we are facing an unprecedented situation; the increasing scarcity of our main energy resources and the growing concerns related to global environmental problems, have grabbed the attention of many across the world. Fossil fuels, which are estimated to make up over 81% of the primary energy supply (IEA 2012b), are destined to run out (Verbruggen et al. 2010) (Srivastava 2000). The limited amounts of these resources have pushed many countries, including the European Union (EU), to import energy from abroad (European Commission 2002). However, importing energy is only a temporary answer that in the long run will not be sustainable. An adequate solution that would solve the world's energy problems argued here could be found by turning to renewable energy (RE). Today only 13% of the world's primary energy demand is generated from renewable energy sources (RES) (Teske et al. 2011) (IEA 2009). Many countries across the world are promoting RE, supporting it with incentives and setting goals for the future. The EU is a great proponent of developing renewable energy technologies (RETs) and has agreed to commit to the RE cause. In the past years, trends show a steady increase of the share of consumed energy generated from RES, reaching 12,4% in 2010. The EU also agreed to set a minimum target of 20% by 2020 (Eurostat Press Office, 2012).

The production of energy from renewable sources is a fair and sustainable process of generating power using the earth's resources without abusing them, making it potentially the greatest solution we can adopt for the future. We must take advantage of the sun's infinite source of power, while accounting for the environmental consequences. Unlike RE sources that are readily renewed, fossil fuels are both limited and extremely polluting. Another noteworthy aspect is that fossil fuels and RES are to a large extent substitutable goods, since both are used to generate energy. Therefore, with appropriate support and promotion of these technologies, we could all benefit from these alternative sources whilst also enjoying a cleaner environment. Having touched upon a number of pro-positive reasons that support RE, it remains unclear why these technologies are still so far from reaching their great potential and why they keep struggling to succeed in the energy market. It is difficult to determine whether the lack of success of RETs is due to economic reasons, which make these systems still not competitive enough to replace the current means (perhaps too expensive to invest in these relatively new technologies) or because of other reasons such as the unawareness of these alternatives.

Considering the importance energy has had throughout history and the way it has left its mark in different eras, renewable energy has the potential to characterize the present one. It can represent the phenomenon that distinguishes a new era shaped by alternative energy, from the current, but destined to end, fossil fuel one. For the time being, an era characterized by renewable energy as a main source of power remains a utopia. Despite RE is slowly but constantly growing in the EU and other developed regions, in developing countries these systems are not as successful as they could be. RE could represent an important solution to the energy problems of some developing countries and possibly, also contribute to rural development and in improving local livelihoods. As argued in a UNEP study (2012) on sub-Saharan African countries, RE technologies open new export opportunities and revenue streams by being eligible for carbon crediting on international carbon markets.

Argentina, located in Latin America, is one of the countries facing energy production problems. I decided to carry out my research here because it is a country with abundant resources and a great RE potential. Considering its advantageous geographical position, Argentina has numerous different types of bioclimatic environments to install different RETs and develop its full energy potential: in the northern part of the country the sun is abundant making it suitable for solar photovoltaic panels. In Patagonia and most of the southern part of the country there are great constant winds, ideal for wind turbines; and throughout most of the country there are great plains and farms with plentiful vegetation that make possible the use of biomass digesters. For this study, I have decided to focus on these three types of renewable energy technologies: solar photovoltaic panels, wind turbines and biomass digesters.

But why has Argentina been considered an interesting study case? Looking at developing countries with poverty problems Argentina has very peculiar characteristics. Despite having an impressive endowment of renewable and non-renewable resources, Argentina has failed to maintain its relative global position in economic, social and environmental development in recent decades. Its GDP per capita ($ 17,400, 2011 est.) (CIA 2012) is substantially higher than the majority of the African countries (weighted average $ 3.539). In 2000–2006 the average GDP per capita growth in SSA was 2.0%, up from –0.7% in 1990–1999 (World Bank 2008). In Argentina, in the same period, we have had + 40,9% (1990-1999) and only +3,4% in 2000-2006, Argentina has been in 2012 N. 67 in GDP per capita but only N. 124 in GDP real growth rate (CIA 2012). Argentina is ranked N.21 in the world as PPP (Purchasing Power Parity) (CIA 2012) and it gives a good prospective for the introduction of in some case expensive technologies. Thus among the possible options for a study-case, being a developing country which is losing its relative position towards comparable economies but still with some relative good average purchasing power, Argentina is considered an interesting case to take into consideration. Apart from the abundance of resources, there are a number of relevant complications: the sheer size of the country, the rough terrains and the strict energy market regulations, have a direct impact on the extensions of the national energy grid. It is estimated that in Argentina over 5 million people (12% of the total population) are not connected to the national electrical grid (CIA 2012)(World Bank 2012) and resort to other means to generate energy. Apart from the abundance of resources, there are a number of relevant complications: the sheer size of the country, the rough terrains and the strict energy market regulations, have a direct impact on the extensions of the national energy grid. It is estimated that in Argentina over 5 million people (12% of the total population) are not connected to the national electrical grid (CIA 2012)(World Bank 2012) and resort to other means to generate energy. This lack of easily-accessible energy is one of the main indicators of poverty: in 2002, the United Nations (UN) Commission on Sustainable Development (CSD) explained during the Global Forum on Sustainable Energy that “poverty reduction goals… would not be met without increased access to modern energy by the world’s poor” (GFSE, 2002). Friedrich

Hamburger, director of the delegation of the European Commission, further explained that improved access to energy is a necessity for meeting the Millennium Development Goals (MDGs) (GFSE, 2002). Moreover, finding adequate solutions and introducing new policies that promote energy access in rural environments is a good approach to promote sustainable development and sustain poverty alleviation (WSSD 2002). Venema and Rehman (2007) explain that Decentralized Renewable Energy (DRE) contributes in numerous ways to achieve several other MDGs on top of poverty eradication, as mentioned above. DRE projects play a crucial role in promoting and improving rural livelihoods by providing decentralized energy services where national grids do not reach (Venema and Rehman 2007 p.892).

This research will focus on this type of energy services offered to the large group of Argentines that are not connected to the national grid. The fieldwork was carried out during a three-month internship period between February and May 2012 and aimed at getting a better understanding of how renewable energy projects function in a rural environment in Argentina. Studying these technologies and examining the impacts and the effects they have on local communities is an important aspect, however it is most significant to first realize whether their effects can be maintained in the future. Therefore, examining the sustainability of renewable energy technologies in this environment is the crucial and central aspect to this research. To maintain focus, the following research question was developed:

How sustainable are renewable energy technologies[1] implemented in off-grid rural Argentina?

A sustainability analysis is important to understand whether these technologies can represent a valuable solution to other more conventional means of energy generation. If this research presents promising results, proving that these systems are sustainable, it will certify that for the future there is a valid alternative that is worth turning to. This study can contribute to a better understanding of these technologies, providing suggestions for what can be improved and providing insight into its strengths. This research is the first step towards a comprehensive knowledge of how these technologies can contribute to improve livelihoods on different levels. Results

[1] RETs to be investigated: solar photovoltaic, wind turbines & biomass digesters

could indicate these technologies as a possible solution to poverty reduction, on top of providing alternatives to the production of energy. The potential of renewable energy and its power to become a solution to energy problems, as well as to different development issues such as livelihood improvement, will be elaborated in the theoretical framework. For the time being, it is important to acknowledge the potential of renewable energy and focus on the essence of what this study entails.

The research question is deliberately broad as it attempts to answer a complex issue. Its complexity lies in the difficulty to comprehend the concept of sustainability and what it entails. How can '*sustainability'* be defined? What or who affects it? The sustainability analysis of the three technologies chosen, solar photovoltaic, wind turbines and biomass digesters, foresees a detailed examination of a number of significant aspects: *technology*, *community* and *external support*. After an appropriate thematic and theoretical preparation for the fieldwork, these are the three aspects considered to be most relevant in shaping and affecting 'sustainability'. Consequently, the following question was formulated to give this research more precision:

To what extent are the aspects of technology, community and external support, affecting the sustainability of renewable energy technologies implemented in off-grid rural Argentina?

This is a more accurate question that keeps the fundamental concept of sustainability at the centre of the research and acknowledges that it is a complex issue, which should be approached from different sides. Its accuracy lies in identifying the three aspects, the way the concept of sustainability should be approached during this study. This question was also useful to orient the research and to give it direction during the fieldwork. This study is extremely relevant as it expands on an important debate on renewable energy, climate change and rural sustainable development providing a specific focus on renewable energy technologies implemented in rural Argentina.

Thesis structure

The following study is divided into several sections; after having introduced the research topic and questions, chapter one will provide the relative contextual background to the topic of renewable energy in Argentina and more specifically of each geographical area where the field data was gather during the research. Chapter two will serve as a theoretical framework used to present the relevant theories and views on renewable energy as a whole, and more specifically the potential and barriers of RE technologies in a rural environment. Consequently, the topic of ownership will be presented and examined as a key to local development. Before moving to the results, the methodology will be described and justified. Finally, the empirical results will be presented and examined in the last four chapters, analysing respectively the aspects of *technology*, *community capacity*, *community willingness* and the *external support* of implementing organizations. The conclusion will summarize the key results emerged from the findings, reflect on some of the theories and provide policy recommendations for the future.

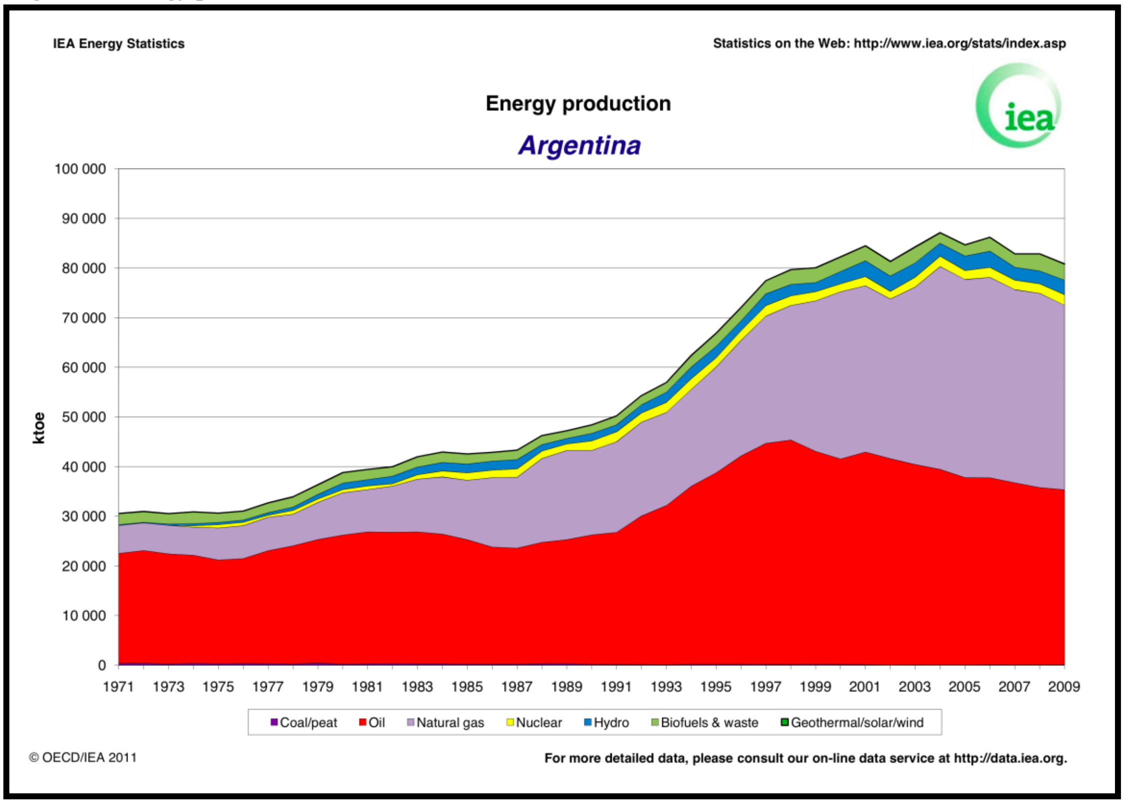
Chapter One

Contextual Background

Energy context

Argentina is one of the biggest countries in the world, second in size only to Brazil in Latin America. Its vast territory is plentiful of resources creating great potential for the energy market, making it the third largest energy sector in the continent (Pampa Energia 2011) (Ernst & Young 2011).

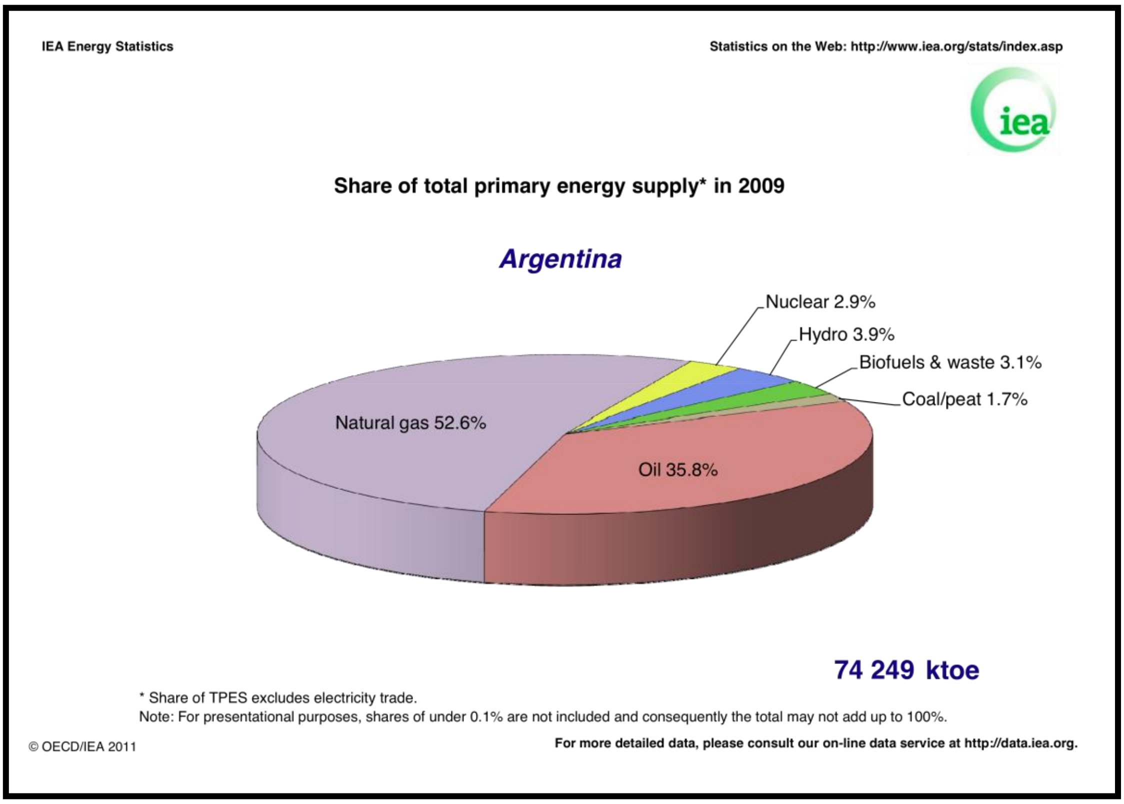
Figure 4: Energy production



Source: IEA

Since the early 1990s, Argentina has been one of the most deregulated energy markets, with both state-owned and private companies catering the national energy supply. About three quarters of the energy is supplied by private companies, including the national electricity grid, which is managed by 'Compañía Nacional de Transporte Energético en Alta Tension' (Transener) after a contract with the government (Ernst & Young 2011) (Dürrschmidt et al 2006). Argentina's total energy production adds to 80819 thousand tonnes of oil equivalent (ktoe) of which 6.6% (5333 ktoe) is imported and 12,7% (10287 ktoe) is exported (IEA 2012a). Considering the increasing scarcity in the last five years of the two major resources, crude oil (30654 ktoe) and especially natural gas (38718 ktoe) that together comprise over 85% of the total produced energy (IEA 2012a), and the steady annual growth in energy demand of 6% (Ernst & Young 2011), Argentina is forced to look for solutions that could be found by turning to renewable energy. Despite the great potential of these resources in Argentina, RE only accounts for 6.5% (5200 ktoe) of the total production, generated from bio fuels and hydro. These two sources are mainly used for producing electricity, adding up to almost 30% (36039 GWh) of the total electricity produced in Argentina (122347 GWh) (IEA 2012a).

Figure 1: Share of total primary energy supply



Source: IEA

Renewable energy in Argentina could be a great solution to the energy problems, as well as to the lack of development in some remote rural areas. With a surface of almost 2,800,000 km^2 (CIA 2012) Argentina has a great range of different bioclimatic areas to develop renewable energy technologies (RETs). According to different regions and the different climates within the country, Argentina is an ideal location to develop different RETs: solar photovoltaic panels, wind turbines, hydropower and biomass digesters are just some of the most appropriate technologies to develop. Being such a vast country there will be very different scenarios in which it will be possible to develop RETs in different formats: areas where there are many isolated houses will require different RETs schemes than areas where there are clusters of house in remote locations. In the first case, where the population is scattered, stand-alone wind turbines and photovoltaic systems have proven to be one of the most appropriate solutions for the generation of power in isolated households (Vallvé et al. 2001) (Nieuwenhout et al., 2001) (Moner-Girona, 2009) (Bates et al. 2000). In the second case, where you find a cluster of houses comparable to mini-grid situations, the size of the project would be greater. The most appropriate type of RET would inevitably depend on the region, even though in this case on top of the wind turbines and photovoltaic panels, communal biomass digesters could also be a feasible option (Moner-Girona 2009). In these cases, the FITs and RPTs schemes discussed above could prove to be a solution to help the projects take off (Thiam 2011).

Moreover, the development of RETs in isolated rural areas can also be beneficial from an economic point of view. On top of bringing energy to remote regions, these projects can trigger local economic development by creating employment and providing new services (Thiam 2011)(Nguyen 2007). Furthermore, as RE is based on proximity of the resources, hence ‘decentralizing’ energy production, inaccessible areas where the national grid cannot reach, will be able to benefit from such projects, triggering local economic development (Ovidiu 2011).

Energy policies

There are several agents in the Argentine energy market and the Secretariat of Energy (SENER) is one of these. SENER acts within the Argentine government as part of the ministry of Federal Planning, Public Investment and Services, promoting policies and implementing the national energy programs (Secretaría de Energía, 2012). Another important agent is Energia Argentina Sociedad Anonima (ENARSA) a state utility created in 1994 that focuses on the generation of energy and electric power (ENARSA 2005) (TECH4CDM 2009). One of the first laws on renewable energy was passed in 1999, is '*Ley de Energia Eolica y Solar'* (Centro de las Energías 2012). This law stated that the generation of electrical energy, by the means of wind and solar power, became one of the main national interests. This was supported by tax redistributions and economic incentives reaching up to 15$/MW on subsidies during 15 years (Guzowski et al 2008). In December 2006 the government passed the law 26.190 in the 'National Program for the Promotion of the Use of Renewable Sources of Energy Destined for Electric Power Generation' that stated that by 2016 renewable energy resources should account for at least 8% of Argentina's electricity demand. This law also introduced a number of FiTs schemes for many RETs: wind, biomass, small-scale hydro, tidal, geothermal would receive circa €2.6/MWh whereas solar photovoltaic circa €150/MWh as feed-in tariffs valid for a period of 15 years. Three years later, in 2009 ENARSA was contracted to generate at least 1GW from renewable energy, which would be sold into the grid at a fixed price for a 15 years (Ernst & Young 2011).

After many improvements in the renewable energy sector, with the passing of several laws and the implementation of numerous incentives and measurements, the potential of Argentina's RE power is still far from realized. RE is still accounted for only a tiny portion of the national energy supply, whereas natural gas and oil are still the two primary resources used. There is great speculation on why that is still the case nowadays, despite the great efforts from the government. One of the most plausible explanations is because of the privatized nature of the argentine energy market. There are still many incentives supporting investments in fossil fuels rather than in renewable energy. This clash calls for further changes otherwise it will remain a *'...fight between different interests, influences and discourses, in which well-established organizations seek not to lose power and influence'* (Lund 2010). The privatization of the energy market also means that in areas where the private companies believe it is not interesting or profitable enough to invest in, will simply be left unsupplied (Fundacion Bariloche 2005 p 5).

<u>Target Group and Renewable Energy Technologies</u>

This research focuses on the people that live in a rural environment in Argentina, where private companies often decide not to invest in leaving these areas isolated form the national grid. This group of people, estimated to be over 5,500,000 (CIA 2012)(World Bank 2012), must often resort to alternative technologies to generate power: almost one in every three individuals lacks access to the national electricity grid (Girardin 2003). There is a wide range of technologies that the rural Argentines resort to for generating energy; however, the focus of this study will be on three of the major renewable energy technologies (RETs) used in the country: solar photovoltaic, wind turbines and biomass digesters. The first two technologies use sun and wind power, respectively, and convert them into energy, mainly in the form of electricity. A biomass digester utilizes biomass material and turns it, through an anaerobic digestion process, into biogas that can then be used for heating or cooking.

Organizations and Programs

The argentine energy market is a complex one, with numerous programs and organizations taking actions. Therefore, before engaging in the field research I carried out a number of interviews with government initiatives' spokesmen and other NGOs' members in order to get a better understanding of how the market is regulated. In spite of already having carried out much research on the market's actors, getting first hand information on each initiative's aims and goals facilitated the development of the research.

One of the organizations most relevant to this study is ENERGIZAR, the NGO that I interned, which among many other things, helped me get in contact with other projects to visit and hence carry out my research. ENERGIZAR is a privately started foundation, set up in 2010 by Diego Musolino and Alejandro Loidl, two post-grads engineers who wanted to contribute the development and spreading of RE. Their mission is to contribute to sustainable human development through research, development and promotion of renewable energy. There are 12 employees that work in ENERGIZAR, who contribute in developing and giving courses on numerous RETs among which biodiesel generation, bio-digesters, wind turbines, photovoltaic solar panels and sustainable architecture to small groups of 20 individuals.

PERMER and GENREN are two government programs that aim at promoting RE in Argentina. I interviewed the Secretariat of Energy (Secretaría de Energía, SENER) to obtain more details on their operations, programs and future goals. In May 2009, Energy Secretary Daniel Cameron announced the program GENREN to become Argentina's main tool for promoting RE across the country. On top of the most known goals of reducing CO2 emissions and taking the share of RE in the country's energy demand up to at least 8%, GENREN also aims at protecting the environment, generating up to 8000 new jobs and creating favourable conditions to attract foreign investments. Since its implementation, GENREN has contracted 12 companies who have invested a total of 9 US$ billion in RE infrastructures: solar and wind parks that will supply the national grid are among the biggest projects. Through FiTs schemes, the government in combination with national utility ENARSA, are planning to absorb this investments in a period of 15 years. GENREN will not support commercial businesses for RE but it has allocated a part of its budget for foundations who operate in this field.

The other important government project, which is more relevant for this research, is PERMER (Programa de Energias Renovables en Mercados Rurales). PERMER is a government initiative founded in 2000 for the purpose of bringing energy to rural off-grid communities. Even though the program was launched in 2000, the first projects were only implemented in 2003. Its mission involves alleviating poverty through RE, whilst addressing the improvement of life quality in dispersed rural communities. Most of the people targeted do not have access to basic services, like electricity, at low costs like those who live in urban areas; often they must resort to other means, such as generators that cost a lot of money. The main difference between these two government programs is that GENREN, implemented and developed at a later stage, aimed at promoting RE, whereas the PERMER initiative did not represent a shift of renewable sources, but rather the only option for rural people to obtain electricity since a grid extension would not be feasible. Moreover, GENREN aims at attracting foreign investments, whereas PERMER receives its funds from the World Bank (30 US$ million) and other international agencies such as the Global Environment Facility (10 US$ million). PERMER has its main base in Buenos Aires, where a team of 13 people works on this initiative; there are also other offices 23 offices in each of the country's provinces. Most of the work is coordinated through the provincial governments to reach the rural communities in need across the country. Being a government project there is no profit being made, but they charge only a small sum, which is devoted to the maintenance of the technologies, to encourage responsibility from the users side.

Most PERMER projects involve the installation of photovoltaic solar panels in several different provinces. However, before the panels can be installed, PERMER has to take numerous important steps. In each region, there is a provincial counterpart that organizes trainings and gatherings for the community members. During these meetings, the communities will meet some of the members of the contracting company chosen by PERMER officials to carry out the installations in each home. In the meeting I witnessed, the contracted company was ALDAR a Spanish company specialized in installation small-scale solar panels. Despite being a government initiative PERMER is not being financed by it; however, the policies it put forth (reaching 8% share of RE in the country's energy demand in 10 years) are what initiated PERMER and what are driving it to an extent.

Another important actor in the Argentine energy market and provider of several projects visited during the fieldwork is Fundacion Bariloche (FB). It is a non-profit organization, funded in the 1950s with the help of the government who still today allocates some funds. It started to promote research in four fields: energy, environment, equality and philosophy. Today there are 30 employees working for FB, who conduct primarily consultancy work. FB works also with other governments from other South American countries, a great deal with the Columbian government; they are bidding proposals when project plans are put forward. They are mainly involved in projects related to energy, infrastructure, planning and modelling. Considering the great competition of the numerous organizations across Latin America and the difficulty of finding new 'costumers' for their works, FB tries to differentiate and stand out from the others by making their proposal extremely detailed using special computer models; their publications and works are their best advertisement. Latin American governments are the primary costumers for FB, who also deals with several rural projects in Argentina. Their main goal is to spread the research of energy through their publications in a way that governments will be able to implement proper strategies in the future. Finally, there are positive future prospects since FB has noticed an increasing demand for their services because more governments are getting more conscious about the energy production strategies.

Geographical context

In order to have a clear picture of this research, it is important to further contextualize it, examining the geography of Argentina and, more in detail, that of the specific areas where the research was conducted. The RETs must be installed in appropriate regions, because their functioning is determined essentially by the bioclimatic and environmental conditions of the area. Having already focused on the relevant political and historical aspects of Argentina, this section will exclusively focus on those geographical aspects that contribute to contextualizing this study.

Figure 3 Argentina

Source: EIA

Figure 4: Argentina's position in South America

Source: Mapsof

<u>National setting</u>

Argentina is a republic, divided into 23 provinces and one autonomous city, CABA (Capital Federal Buenos Aires). The president Cristina Fernandez de Kirchner, who is chief of state as well as head of government, has been in office since 10 December 2007 and was re-elected last year October. Argentina, which declared its independence from Spain on 9 July 1816, has a total surface area of 2,780,400 sq km making it the 8th largest country in the world and the second in South America. Argentina's population estimated to be 42,192,494 (July 2012 est.)(CIA 2012) has been slightly but steadily increasing in the past decade. The major cities are Buenos Aires with almost 13 million inhabitants, Cordoba, Rosario, Mendoza and San Miguel de Tucuman with population ranges between 800 thousands and 1.5 million inhabitants, together with other cities they comprise the biggest share of the argentine population; in fact, the urbanization rate is 92.5% (2011 est.)(World Bank 2012).

In 2001 Argentina faced its most severe economic, political and social crisis in its history. In December that year, President Adolfo Rodriguez Saa resigned after declaring a huge foreign debt only days after being elected president. In three years time the national GDP plummeted from 300 billion US$ to just over 100 billion US$, as well as the GDP per capita that plunged from 8,300 US$ (1998 est.) to 2,700 US$ (2002 est.) leaving over 60% of the population below the poverty line (World Bank 2012). Today Argentina has made a good recovery, the GDP grew to 447 billion US$ and the GDP per capita has almost reached 17,400 US$ (2011 est.) ranking 69th in the world GDP per capita scale (CIA 2012).

Being such a vast country, Argentina has several different environments and climates. It is located in the southern part of the continent and features some unique geographical points: with its 6,960m Cerro Aconcagua, located in the Andes in the north-western part of the country, is the highest point in the western and southern hemisphere, at the same time Laguna del Carbon located in the southern part of the country reaches 105m below sea level making it the lowest point in the western hemisphere. The country's conical shape that extends from north to south implies that the climate variations will be significant according to the latitude. Moreover, like the two extreme points mentioned above witness, differences in altitude also shape the climatic regions. Geophysical landscapes can vary from a tundra or sub-Antarctic climate in the south/southwest to a tropical one in the north (CIA 2012). Therefore it is important to understand the environment of each research area to contextualize this study.

Local Setting

Having acknowledged the bioclimatic diversity throughout Argentina, it is important to examine each of the five research areas visited to understand its environment and understand which RETs would be most appropriate to develop.

Province of Buenos Aires

Figure 5: Buenos Aires

Source: Embassy World

The province of Buenos Aires (BA) covers the area around the capital city. Unlike all the other areas examined, it is still quite densely populated and it is not a remote location. The BA province is part of a greater region, known as the *Pampas*, which means 'plains' in Quechua, representing the fertile, flat lowlands around the argentine capital. Most people that live in this area, own big portions of land on which they keep animals. Many farmhouses in this area enjoy many comforts, such as running water that other rural houses visited through the research period do not have; however, many still lack access to the national grid and need to resort to RETs and other means to generate energy. Considering the temperate climate of the area and the mild temperatures also during winter, several RETs could be appropriate in this region: biomass digesters are could possibly be the most appropriate ones, considering the abundance of biomass across this area and the mild wintry temperature that still would allow the conversion processes.

Ingeniero Jacobacci, Rio Negro

The area around the village of Ingeniero Jacobacci, which counts just over 5,000 inhabitants, is one of the most remote and isolated areas visited during the research. With the nearest city (San Carlos de Bariloche) more than 200 km of poor roads away, this area is located roughly in the middle of the Rio Negro province, one of the southern provinces in Argentina. This area, located on one of the central plateaus of the province, can experience extremely harsh weather conditions. Cold winds from Antarctica can push temperatures as low as -35°C during winter. On the other hand, during the summer because of the high southern latitude, days are long and plenty of hours of sun. According to these climatic conditions, the best RETs to develop in this area would be wind turbines and photovoltaic solar panels.

Figure 6: Rio Negro

Source: Embassy World

Alumin, Neuquén

The area analysed around Aluminé matches that of the Aluminé department within the province of Neuquén. This is one of the most western territories in Argentina with most of the area ending in the Andes and bordering with Chile. The area in question however is just at the feet of the South American mountain chain and has a much more temperate climate than then area at the peeks. This also signifies that it will be receiving fewer precipitations throughout the year, making it an interesting area for installing solar panels.

Figure 7: Neuquén

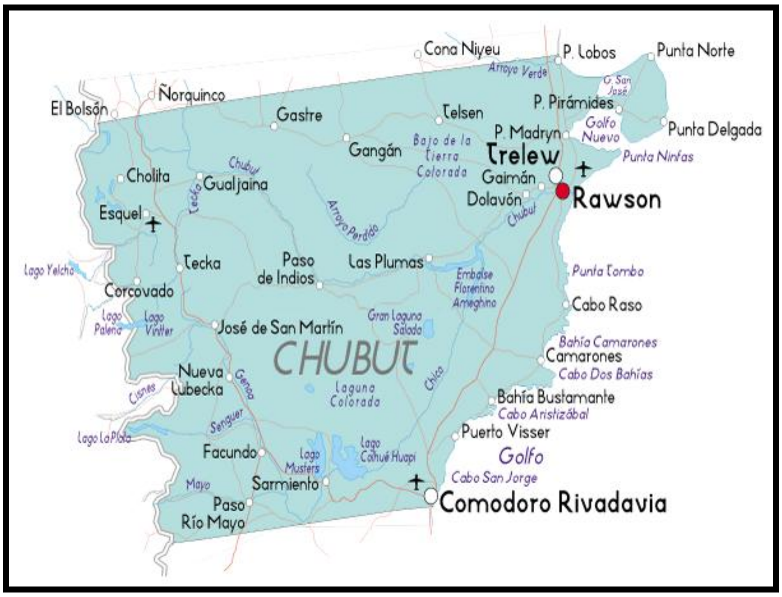
Source: Embassy World

The area analysed around Aluminé matches that of the Aluminé department within the province of Neuquén. This is one of the most western territories in Argentina with most of the area ending in the Andes and bordering with Chile. The area in question however is just at the feet of the South American mountain chain and has a much more temperate climate than then area at the peeks. This also signifies that it will be receiving fewer precipitations throughout the year, making it an interesting area for installing solar panels.

El Maiten, North-West Chubut

The area of research around the village of El Maiten is located in the most Northwestern corner of the province of Chubut. The climate and environment are similar to the area around Ingeniero Jacobacci but just a bit less extreme. Precipitations are common throughout the entire year, as well as snowfalls during winter, when temperatures are and frequently will dip below 0°C but will rarely reach extremes of -20°C or more like in Ingeniero Jacobacci. The featureless lowlands of this area allow constant winds to blow most of the year, enabling wind turbines projects to be adequate RETs to be installed in this area. Another common technology used in this area, is the bioclimatic houses that provide a good natural solution to the long cold winters.

Figure 8: Chubut



Source: Embassy World

Trelew, Eastern Chubut

This final area is located on the opposite side of the Chubut province, bordering with the Atlantic coast. The proximity to the ocean and the warm currents descending from the north make this area's climate extremely different from the central and western parts of the Chubut province. This area is characterized by the strong constant winds arriving from the ocean, making it among the best places in Argentina (and possibly of the entire continent too) to develop RETs that make use of wind power.

Chapter Two

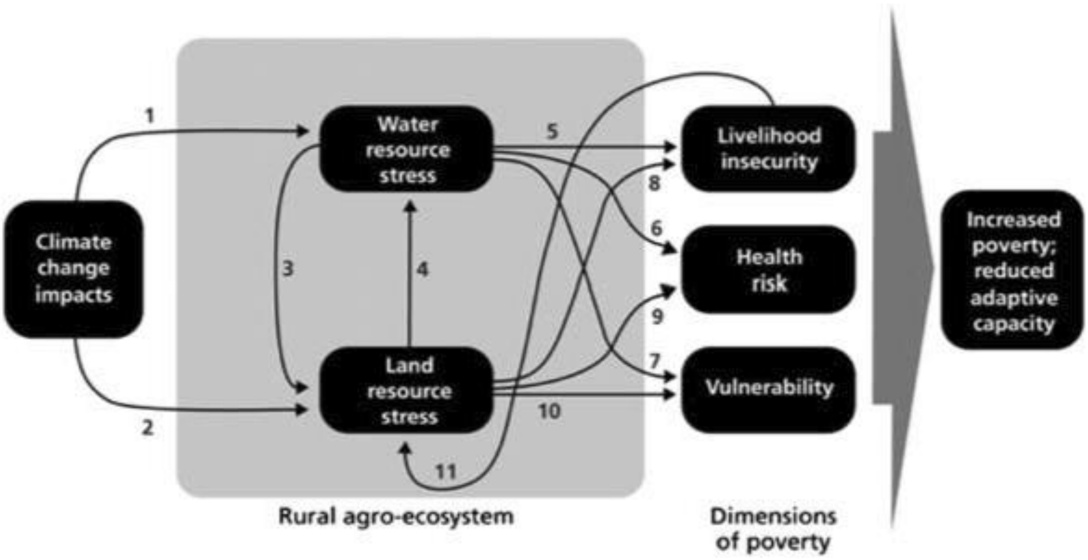
Theoretical framework

Climate Change and Energy in Developing Countries

The most important environmental problem on a global scale is climate change. This phenomenon, often also referred to as global warming, is the consequence of excessive use of polluting resources. For years we have used fossil fuels, globally recognized as one of the main sources of greenhouse gas emissions (GHG), as our major energy resource. For decades we have ignored studies that highlighted the potential risks of excessive use of such resources and identified them as the main cause of global warming. Already in the late nineteenth century Arrhenius (1896) explained the basics of the greenhouse effect: the 'combustion of carbonaceous bodies' (fossil fuels), releases carbon dioxide (CO_2) and causes an increase in temperature over the polar regions and to a lesser extent near the equator. Despite Arrhenius's conclusions were used to explain the ice ages he acknowledged that large amounts of CO_2 emissions generated by humans, would cause an increase in temperature. The climatic changes were not seen in a negative way, until Revelle and Seuss (1957) pointed out that the 'large-scale geophysical experiment' that human beings are carrying out, will not be able to be reproduced in the future. The vast amounts of organic carbon stored in rocks over hundreds of million of years, is now being returned to the atmosphere and oceans with centuries (Revelle and Seuss, 1957; p. 19). For decades we have ignored the warnings of climate change and the first outcomes are becoming visible. The Intergovernmental Panel on Climate Change (IPCC) has drafted a document highlighting the effects of these changes: the global average surface temperature has increased over the 20th century by about 0.6°C; the snow-covered areas are diminishing and the permanent glaciers are retreating; because of that and thermal expansion of the oceans the global average sea level has risen by 0.1 to 0.2 meters during the 20^{th} century; precipitations and cloud-cover over land areas have increased by 0.5% to 1% per decade and 2% respectively during the 20^{th} century; shifts in and altitude and towards the poles of animals and plants are already occurring (IPCC, 2001). On top of that, likely effects of small to moderate warming (Teske et al 2007) have been highlighted as follows:

- Massive releases of greenhouse gases from melting permafrost and dying forests

- High risk of more extreme weather events such as heat waves, droughts and floods. Already, the global incidence of drought has doubled over the past 30 years.
- As severe regional impacts in Europe, river flooding will increase, as well as coastal flooding, erosion and wetland loss. Flooding will also severely affect low-lying areas in developing countries such as Bangladesh and South China.
- Natural systems, including glaciers, coral reefs, mangroves, alpine ecosystems, boreal forests, tropical forests, prairie wetlands and native grasslands will be severely threatened.
- Increased risk of species extinction and biodiversity loss
- The greatest impacts will be on poorer countries in sub-Saharan Africa, South Asia, Southeast Asia, Andean South America, as well as small islands least able to protect themselves from increasing droughts, rising sea levels, the spread of disease and decline in agricultural production.



Source: Venema and Rehman 2007

Figure 9: Linkages between climate change stress, rural agro-ecosystem impacts, and poverty

The consequences of climate change are perceived throughout the entire globe, however there are regions that are affected more than others and are less likely to suffer serious consequences. In developing countries the effects of climate change are more severe because there are fewer alternatives to mitigate the impacts (Venema and Rehman 2007). The world's poor are those who most heavily rely on the natural resources available and depend on the ecosystem's services; in turn, they are also the most vulnerable to the environment's deterioration caused by climate change (IISD 2003). Poverty, as defined by the World Bank (2002), is defined as the lack of income as well as of material means and livelihood opportunities. Climate change diminishes these opportunities by restricting the environmental resources that the poor and especially the children of developing countries depend upon (UNICEF 2007). Increasing temperatures put the world's poor under constant pressure for the access to two vital resources: land and water (Venema and Rehman 2007). The outcomes of climate change that constrain the access to water and land are manifested through three dimensions of poverty: insecure livelihoods, health risks and an increasing vulnerability to such changes (Figure 9). A limited access to water and land will affect the agricultural productivity and the ecosystems natural resources increasing the chances of hunger and starvation (Figure 9 – links 5 and 8)(Teske et al 2007). The health-related risks of water-borne diseases and malnutrition are other important consequences. In 2000 the World Health Organization (WHO) (2002) estimated that climate change caused 2,4% of worldwide diarrhoea and 6% of malaria, targeting mainly the young and the children of developing countries (Bruce et al 2004) (Figure 9 – links 6 and 9). Weather-related hazards, such as flooding and hurricanes are likely to intensify in the warmer regions, which is where most developing countries are located (UNICEF 2007); consequently, the diminishing natural resources are going to further expose the poor and exacerbate their vulnerability (Lloyd and Subbarao 2009). Projections confirm this negative trend: by 2020 climate changes are expected to expose to increased water stress over 75 million people in Africa alone (UNICEF 2007) (Fig. 9 links 7 and 10).

Poverty is both an outcome and a factor of land resource stress: over-grazing, agricultural land clearing, and unsustainable fuel wood consumption are some of the main results of insecure livelihoods that exacerbate environmental resources (Venema and Rehman 2007) (Figure 9 – link 11). Most of these forms of ecosystems degradation are related to deforestation, which is the most damaging of all. In fact, on top of deteriorating the environment and its resources, it also negatively contributes to climate change. Every year deforestation generates a higher amount of carbon emissions than what is produced in the transport sector (UNICEF 2007). One of the main reasons for deforestation in developing countries is the lack of accessible energy (WSSD 2002). Biomass constitutes over 90% of the primary energy supply in rural areas of developing countries (Demirbas and Demirbas 2007). The production of charcoal, timber production, fuel wood extraction and agricultural expansion are effects of energy deprivation (Venema and Rehman 2007).

This vicious circle that sees poverty and environmental degradation as the cause and effect of each other, is destined to escalate unless appropriate solutions are found. Energy is destined to play a fundamental role in this debate. The relation between energy and poverty appears obvious already when overlapping numbers: roughly two billion people lack access to energy; the same number of people subsists on less than $1 a day. About 1.7 billion people do not have access to safe and clean cooking fuels and rely mainly on traditional biomass. Roughly 2.4 billion have no access to electricity, most of whom are also extremely poor and dependent on biomass energy (WEA 2000). The poverty-energy nexus has also been acknowledged by important international bodies: the UN expressed that the provision of energy is a fundamental step towards poverty reduction (GFSE 2002). Also during the World summit on sustainable development (WSSD 2002) it has been emphasised that energy access can facilitate the achievement of some of the Millennium Development Goals (MDGs).

The link poverty – lack of energy is recalled too by the 'PPEO 2012' (Practical Action 2012) which argues: "where poor people have the sustainable energy access needed to grow enterprise activities small and large, it becomes possible to escape the vicious cycle of poverty". With no change by 2030 the total number of people without access to electricity will still be almost 900 million, 3 billion will cook on traditional fuels, and 30 million people will have died of smoke-related diseases, therefore it urges to ensure universal access to modern energy services by 2030. To reduce developing countries' exposure to global shocks such as climate change, and volatile and escalating energy prices, the European Commission has recently proposed (2011) to focus its development aid on sustainable energy. Energy access has a considerable impact on the productivity and returns of farming and working on the land. For smallholder farmers, the increased use of modern energy services can contribute to increasing incomes through a wide range of energy services at each step of the agricultural value chain from production, post-harvest processing and storage, to marketing (Practical Action 2012).

Undoubtedly, access to energy plays a central role in poverty reduction. Their similarities appear not only at the numerical level, where equally large groups suffer poverty and lack of energy, but also at more abstract theoretical level, an interesting parallel can be observed: similarly to poverty that is both the driver and the outcome of environmental degradation, access to energy, which now is the cause of deforestation and loss of ecosystems services in many developing countries, could potentially turn into its driver and become its solution to preserve environmental resources. The increasing vulnerability of the rural poor is determined by a great extent to energy deprivation and a lack of alternatives: "The energy dimension of poverty—energy poverty—may be defined as the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe, and environmentally benign energy services to support economic and human development" (WEA 2000, p. 44). The provision of accessible clean energy for the poor is the key to unlocking the 'vicious circle of poverty' and for mitigating the climate impacts (WSSD 2002).

New Energy Paradigm and Local Development

Energy is an essential element of life, a non-substitutable resource (Schlör et al 2012), which according to Burke (2009) has significantly contributed in shaping different eras in the history of mankind. Nowadays fossil fuels, which are the conventional source of energy of the modern epoch, are the major cause of climate change. As a consequence, global warming should be one of the main reasons for adopting less polluting sources of energy (IPCC, 2007). On top of the environmental question, there is also the issue of fossil fuels' finiteness to be addressed (Srivastava 2000). This is not a new observation since over half a century ago Hubbert (1949) had already exposed the inevitability of this depletion and encouraged an early transition to other sources. The growing fear of an insecure access to energy has pushed several countries, including numerous ones from the European Union (EU) to turn to energy importation (European Commission 2002). However this is only a temporary answer, or rather than a solution, a postponement of the depletion problem. A viable solution is to make the shift to renewable energy (RE) sources, described by Verbruggen et al (2010 p.3) in the following way: renewable energy is "any energy source that is naturally regenerated over a short time scale and either derived directly from solar energy (solar thermal, photochemical, and photo- electric), indirectly from the sun (wind, hydropower, and photo- synthetic energy stored in biomass), or from other natural energy flows (geothermal, tidal, wave, and current energy)."

Potentials

In terms of quantity, RE represents a valid alternative to fossil fuels. The earth receives a huge amount of energy that would more than suffice if harnessed in an efficient and effective way (Teske et al 2007 p.17) (Demirbas and Demirbas 2007). It is estimated that roughly 89,000 terawatts (TW) of solar energy reach the earth every year (Cohen 2008), which is estimated to be roughly about 7000 times more than our average annual consumption (Schlör et al 2012). This clean source of energy is more than just an alternative to polluting resources like fossil fuels, since it has great potential to contribute to local development in different ways. As a confirmation of the importance of clean development mechanisms (CDMs), such as carbon-reducing renewable energy and energy efficiency projects, the Pembina Institute interprets the term "sustainable development" to refer to the livelihood benefits resulting from improved access to energy sources through projects that also lead to reduced GHG emissions (Brunt and Knechtel 2005 p.8).

Environment

Renewable energy technologies (RETs) are the mean by which it is possible to offer access to energy in remote rural areas. As argued by many (Mukherjee et al 2012)(Kanagawa et al 2007)(Jacobs and Kiene 2009), accessible energy is a fundamental step towards local development and the achievement of MDGs. These means represent a good solution particularly for achieving MDG 1 – eradicating extreme poverty and hunger; and 7 – ensuring environmental sustainability. RETs like biomass digesters can improve agricultural productivity and food security by facilitating irrigation and harvesting processes, and using the by-products as fertilizers (Venema and Rehman 2007). The provision of energy through alternative sources improves the environment preservation, mitigates deforestation and reduces biomass extraction. This leads to improved rural livelihoods due to a better access to local natural resources (Zahnd and McKay Kimber 2009).

Improved Efficiency

Photovoltaic solar panels and wind application have proven to properly address rural energy needs in places where the national grid is unable to reach and other solutions are not feasible (Byrne et al 2007). Moreover, users often prefer these technologies to conventional sources and fuel-powered generators, because they are deemed more reliable and efficient in terms of quality, and less expensive in economic terms (Byrne et al 2007 p.4398). Using energy generated from renewable sources reduces the opportunity costs of biomass collection times (Thiam 2011) whilst enabling the users to devote the time saved to other activities (Teske et al 2007).

Economic Opportunities

Some of these activities could be small business like handicrafts, to carry out during the evening hours, making use of the extra light time offered by the RETs (Zahnd and McKay Kimber 2009) (Teske et al 2007). However these technologies can also offer more direct forms of employment. Solar panels and wind turbines are often used in remote and isolated locations across numerous developing countries for telecommunications, railway signalling, switching devices, television stations and costal navigation devices (Bates et al 2000). Implementing, maintaining and eventually repairing these installations are forms of employment that are often taken by local people (Thiam 2011). In economic terms RE enters the energy market as a new agent, increasing competition at the supply level and lowering the prices for local users (Ovidiu 2011). Moreover, RETs also offer an alternative to the rural poor freeing them from their dependency from energy producers, who fix high market prices that are subject to further fluctuations (Byrne et al 2007)(Ovidiu 2011). This gives locals an increased power, making them self-reliable on the amounts and performance of produced energy (Thiam 2011) (Demirbas and Demirbas 2007).

Health

Access to RE may significantly improve health conditions for local livelihoods. Respiratory infections caused by indoor air pollution occurring through open fireplaces for heating, lighting and cooking are considerably reduced (Zahnd and McKay Kimber 2009). An improved access to safe water and sanitation services reduces the spreading of diseases like malaria (Venema and Rehman 2007). Finally, RE also enables the refrigeration of vaccines and the functioning of machines in clinics and hospital of remote rural areas (Teske et al 2007). Others also argue that RE can be beneficial in the general health level, reducing the transmission of infectious diseases; having access to clean water thanks to RETs limits the spreading of cholera and other water borne illnesses (Cloutier and Rowley 2011).

Education

Children in rural areas traditionally have the task of fetching firewood and other biomass materials used for lighting and cooking (UNICEF 2007). The time saved through RETs can be used for educational purposes to raise literacy, improve self-confidence and independence, and increase opportunities for income-generation (Zahnd and McKay Kimber 2009)(Teske et al 2007). Moreover, an improved lighting system also positively contributes to a better education (Venema and Rehman 2007).

Social Cohesion

RE also enhances cohesion within a society: in rural areas most social events take place around smoky open fireplaces. A minimally lit, smokeless area contributes in making the environment more pleasant, strengthening the community structure (Zahnd and McKay Kimber 2009). Meanwhile, the same ‘extra time’ saved can also be used to strengthen within-family bonds like childcare (Teske et al 2007). A more direct form of enhancing social cohesion is through the development and maintenance of the energy technologies that can offer opportunities for building new networks within the society (Thiam 2009).

Barriers

Despite the vast amount of opportunities RE offers, there are a number of hindrances that prevent these technologies from achieving their goals. These barriers, which can be either ‘man-made’ or natural, are factors that prevent, hinder or impede progress or achievement in realizing the potentials of RE (Verbruggen et al 2010).

Among those barriers, one of the most debated in literature is related to the financial aspect of funding required to switch from current means, fossil fuels, to renewable energy sources. This transition will only contribute to development if subsidized adequately and maintained by a good financial plan (Demirbas and Demirbas 2007). However, this requires high initial costs that cannot be sustained due to a lack of loan opportunities (Byrne et al 2007). In most cases, such funds arrive from richer developed countries which, pushed by the increasing competition for scarce energy resources fuelled by raising economies (i.e. China and India), could decide to reduce or end supporting these financial initiatives (Lloyd and Subbarao 2009). Another important obstacle to appropriate funding is related to the immediate effects: replacing old largely carbon-based, polluting technologies with new clean ones is extremely expensive and requires great investments. This is often an insufficient encouragement to make the transition, because a small reduction in carbon emissions comes at disproportionally greater costs (Helm 2005). Moreover, on top of the unfavourable costs-benefit relation, the investment incentive is also affected by the slow rate of implementation of these sources. Renewable energy technologies will require a large time frame before they will be successfully implemented (Teske et al 2007) because of a number of factors. Firstly, the magnitude of the transition required is huge since replacing or adapting all current energy infrastructures will require time: previous energy transitions (for example the switch from biomass to fossil fuels around 1850) took several decades, in spite of a significantly lower energy consumption compared to modern day energy demands (Smil 2007). Secondly, the necessary policy changes to enable the transition will require time after their implementation to become effective and yield its results (Teske et al 2007). Lastly, an underdeveloped rural sector and a limited capacity to pay current prices for renewable energy technologies are clear signs of an 'early stage of development' of local communities (Byrne et al 2007). This underdevelopment affects the pace of the transition process and prevents the RETs from reaching their potential (Nuttall and Manz 2008).

Policies and incentives can assist or obstruct the evolution of the energy market playing an important role in reaching the RE potential (Helm 2005)(Lloyd and Subbarao 2009). However, for a paradigm shift to take place, a *structural break* needs to happen (Nuttall and Manz 2008). These turning factors have always characterized the phases before major shifts in the energy market: the 1970s oil shock led to focus on developing nuclear power (Helm 2004) or after the Iranian revolution of 1979 when oil prices doubled some European economies (i.e. Britain) shifted from being energy-intensive to financial services oriented (Helm 2005). For a paradigm shift to take place the structural break needs to become politically apparent through power cuts, physical threats to supplies or price spikes (Helm 2005 p.16). Once after the severe escalation of events has occurred, the paradigm shifts are recognized and acted upon. For the time being, neither the fossil fuels depletion nor the physical impacts of climate change are sufficiently pressing and development is not a sufficient incentive to trigger such a shift. When either climate change or energy access security will become serious threats leading to a visible crisis the problem could become 'politically apparent' favouring the shift to renewable energy to take place (Helm 2005)(Nuttall and Manz 2008). Smil (2007) argues that on top of the reasons concerning the funding and the pace of the transition, RE lacks the efficiency in quality to appropriately satisfy the energy needs. The current renewable energy systems are still unable to accumulate sufficient amounts of power on a large scale. This is caused mainly by two factors on which we have little control over: the intermittent flow of energy (i.e. wind and solar energy are not always readily available) and the lower energy density (amount of energy contained in a unit of fuel) compared to fossil fuels (Smil 2007). These factors look as the biggest hurdle and raise serious issues over the possibility to put the shift in action.

After having analysed the potential and the barriers of renewable energy, the question remains: to what extent and under what circumstances can these technologies contribute to local development? Surely the potential is great with numerous opportunities to contribute to improve rural livelihoods but the specific barriers pose serious obstacles. The key is to overcome these hindrances through a multi-dimensional approach (Byrne 2007) – facilitating the implementation of policies and incentives through cooperation and technology development can bring significant structural changes to the current energy market (Helm 2005). A viable scenario, suggested to overcome these barriers would be by promoting community participation in implementation of RE projects thus enhancing local ownership. This requires the active engagement of multiple stakeholders, which in turn rests on the adoption of an effective partnership approach at all stages of project design, implementation and evaluation.

Ownership and Renewable Energy

A key factor in overcoming the barriers and achieving the potential of RETs is very often a matter of good project implementation. Developing good ownership by stakeholders at the local level is the key to achieve a project's successful development (Sims 2003). The concept of 'ownership' in development refers to a set of relations among three main groups of stakeholders: the governments at different levels (local, provincial, national) of developing countries, the communities – including single end users and implementing organizations – of those countries, and agencies – donor and development organizations or other financial institutions (foreign or domestic). 'Ownership' refers to the set of relations (among these three groups of stakeholders) that have the power, capacity or influence to set responsibilities for a development agenda (Saxby 2003)

The Paris Declaration (OECD 2005) states that ownership is one of the five key principles to make foreign aid more effective. Involving local community members in decision-making processes, sharing control, information and responsibility, and maintaining good effective relationships between users, local organizations and national and local governments are some valuable strategies to strengthen ownership and make development more effective (CDA 2011). The key to a successful ownership lies in addressing two fundamental aspects: explicit articulation of demand and local involvement starting from an early stage of RET projects (Mondal et al 2010). A successful articulation of demand implies a good understanding of the beneficiaries, including their needs and attitudes, as well as of the available resources and surrounding environment (Rouse 2002). Involving local stakeholders, represented by end-users, local investors and local entrepreneurs from the beginning is fundamental for the success of the project (Subbarao and Lloyd 2011).

Demand Articulation

Understanding and addressing the local needs is a chief aspect of a project's success (Mondal et al 2010). This can disclose a new range of possibilities, from helping locals with practical needs (i.e. purchasing rice cookers and water boilers for each household in the village (Subbarao and Lloyd 2011 p.1608) which indirectly may contribute to the specific project) or understanding what is necessary to properly implement the project (Torretta et al 2012). In terms of RE projects, a successful articulation of demand implies delivering a technology that is appropriate (Mondal et al 2010)(Doukas et al 2012). A common and crucial mistake is to deliver a technology without taking into account the needs of the users or the resources available to develop the project (Lloyd and Subbarao 2009). This method of implementation, often referred to as ‘push-technology’ approach, often results in failure causing great disturbances and offering solutions that are not feasible for end users (Mondal et al 2010). To avoid the ‘push-technology’ approach, a project should follow an implementation planning that takes the beneficiaries’ needs into account from the start. The advantages of an in-depth analysis prior to the implementation are multi-fold: observing the beneficiaries and their costmary habits is a fundamental process to understand how the project will need to be developed (Rouse 2002). Conducting a research and development study of the environment beforehand will highlight the resources available to develop an appropriate technology (Mondal et al 2010). Carrying out workshops with the local community is another important analytical tool that can be used to identify the main energy needs (Torretta et al 2012). The combination of the different methods and approaches used prior to the implementation will provide a good understanding of the needs and local environment. RE technologies have to be developed on the basis of these results and ensure the use of locally available resources (Torretta et al 2012), instead of having to rely on materials imported from abroad (Mondal et al 2010). In fact, allowing the villagers to supply the materials is a good strategy to assure the future availability and a more competitive market price (Rouse 2002). Once the technology is implemented it is deemed appropriate if it does not restrict the beneficiaries in any way (i.e. economically, socially etc)(Mondal et al 2010), but enables income generation activities (Torretta et al 2012)(Rouse 2002). Finally, allowing the beneficiaries to test the technology after its delivery is a good way to check its appropriateness: if the users are able to operate it properly, it satisfies their needs and offers and improved situation from the previous one, the project is likely to be a success (Mondal et al 2010)(Rouse 2002).

Local Involvement

A successful local involvement significantly reduces the threat of not fully understanding and addressing the local needs. Establishing significant partnerships between RET users, implementing organizations and national institutions plays a critical role in terms of delivering and successfully implementing RETs and benefitting from actual sustainable development (Subbarao and Lloyd 2011 p.1608). Creating connections between stakeholders at different levels is important under several aspects: for example, the cooperation with national programs is very helpful for local entrepreneurs, which can benefit from an improved access to local resources, and for the local users, who are stimulated by this presence and feel that they are contributing to a wider national program (Torretta et al 2012). Studies have demonstrated that when local users are explicitly involved as major stakeholders throughout the project, the outcome is more likely to be positive considerably increasing the probability to take ownership of the technology after the implementation (Mondal et al 2010). On the other hand, when private entities are involved, the projects are less likely to succeed: often the approach is more similar to a business focus rather than a developmental focus, resulting in either a wrong implementation or in establishing impossible targets to achieve (Subbarao and Lloyd 2011). In fact, before proceeding with the project implementation, it is advisable to conduct a feasibility study to understand the local potential. This analysis will highlight the human and natural resources available in the project area (Torretta et al 2012)(Mondal et al 2010). An overview of the local resources is an important aspect to understand tools and assets available to develop the project; sufficient knowledge and skills are necessary resources for the maintenance, implementation and eventual reparation of the technologies (Mondal et al 2010). Creating a relevant network of actors and adopting a 'multi-stakeholder' approach, since the beginning of the project, facilitates the establishment of a reliable management strategy before, during and after the implementation of the technology (Mondal et al 2010)(Torretta et al 2012).

Local involvement before the implementation

It is important to carry out a number of activities prior to the implementation to stimulate the local interest and attract people (Rouse 2002). Carrying out experiments and demonstrations in local public environments facilitates the establishment of good relationship between the organization and the villagers, favouring two-way discussions with criticism and suggestions since the beginning (Doukas et al 2012). Community involvement prior to the implementation is two-fold: first, stimulating the interest of locals facilitates the selection procedure of candidates that will cooperate during the project implementation; and second, villagers can contribute to the planning of the project by pointing out characteristics that were not identified before (Torretta et al 2012). A different point of view can facilitate renewable energy planners, projects developers, researchers and the relevant organizations in providing important information required for an efficient implementation (Mondal et al 2010).

Local involvement during the implementation

Torretta et al (2012) argues that it is important to develop a project on ‘knowledge and skills’ that are locally available. At the same time, it is equally important to ensure that technology-related knowledge is correctly transferred to the locals (Mondal et al 2010). ‘Knowledge’ concerning RETs can be of two kinds, ‘hard’ or ‘soft’: ‘hard’ knowledge refers to the technical knowledge of the technology, whereas the ‘soft’ knowledge consists of skills to use the technology, or which organizations to contact for subsidies or in case of problems (Mondal et al 2010). Training the villagers guarantees a sufficient level of ‘hard’ and ‘soft’ knowledge, which is required for a successful project’s implementation (Torretta et al 2012). Explaining the principles and reasons why certain actions are carried out, rather than simply demonstrating how to implement them, often leads to a significantly better implementation (Rouse 2002 p.34). Adopting a demonstration and explanation approach is a valuable method to transfer knowledge: users must feel comfortable enough to have acquired the technical abilities to maintain or build a project on their own (Rouse 2002)(Torretta et al 2012). Moreover, capacity building programmes and trainings are the key to strengthening technical competency, and control and project management skills (Subbarao and Lloyd 2011). Empowering the beneficiaries and making them specialists through trainings is a fundamental aspect. This needs to be carried out thoroughly because it is the business system by which villagers will work and will continue to be paid (Rouse 2002)(Torretta et al 2012). The principal goal of the trainings and the local involvement during the implementation is to empower the beneficiaries to ensure the project’s sustainability, suitability and success through the acquired knowledge (Rouse 2002)(Subbarao and Lloyd 2011)(Torretta et al 2012).

Local involvement after the implementation

After the implementation of the technologies it is crucial that the projects are not abandoned. Carrying out assessments and monitoring systems are important tools to fairly share the renewable energy benefits between the local communities and the project developers (Torretta et al 2012)(Subbarao and Lloyd 2011). Moreover, developing an adequate procedure of on-going consultation and periodical visits can improve the technical performances of the trained beneficiaries (Torretta et al 2012) and ensure the future of the project (Subbarao and Lloyd 2011). It is of great importance that the organizations are present after the implementation to promote the technologies and support the trained beneficiaries. Once the technical abilities of the beneficiaries are established, the organizations can arrange demonstrations and other similar activities to promote the technologies (Torretta et al 2012). Testing the projects and offering incentives are useful strategies to disseminate the business and to stimulate the interest of potential buyers, manufacturers and installers (Doukas et al 2012) (Rouse 2002). The purpose of maintaining connections with the local communities after implementing the technologies is two-fold: to ensure that the technologies are still functioning properly and to offer valuable opportunities to the local community. These two aspects are fundamental for the sustainability of the technologies (Torretta et al 2012)(Subbarao and Lloyd 2011).

Ownership and Sustainability

As discussed above, implementing good local ownership is a viable solution for a RE project's success: a good articulation of demand and sufficient involvement of the local community can represent the key to the effectiveness, suitability and sustainability of the technology (Rouse 2002). Sustainability is an important project component and a fundamental requirement for a technology's final success (Torretta et al 2012). The concept of sustainability is important as it is complex; Bruntland (1987) defines it in the following way: "To meet the needs of the present without compromising the ability of future generations to meet their own needs". In this respect, RETs can be a good solution since the resources used do not compromise the ability of future generations to also access them. In fact, renewable energy technologies are considered as one of the chances to approach sustainability (Subbarao and Lloyd 2011 p.1601). However, the numerous barriers that hinder the development of these technologies are serious threats to the natural resources and hence to our future and that of the coming generations (Rouse 2002). In terms of development, RES technologies can play a key role towards sustainability in the energy sector of developing countries (Doukas et al 2012), by accelerating access to modern energy services for the rural poor (Subbarao and Lloyd 2011). However, in order to contribute to development, the RES technologies must be intrinsically sustainable on an environmental, social and economic level (Torretta et al 2012). The solution to overcoming the hindrances may lay in an effective approach to local ownership and this study aims at providing an answer to this question:

How sustainable are renewable energy technologies[2] *implemented in off-grid rural Argentina?*

Before examining the data collected in the field, it is important to understand the approach used during the fieldwork and describe the methodology.

[2] RET to be investigated: solar photovoltaic, wind turbines & biomass digesters

Chapter Three
Methodology Framework

The research took place in Argentina, in the five areas elaborated in the contextual chapter: the province of Buenos Aires; Ingeniero Jacobacci, Rio Negro; Aluminé, Neuquén; El Maiten, Northwest Chubut; and Trelew, Eastern Chubut. The research has spanned a total of about three and a half months, lasting from mid-February 2012 until May 2012. Given the significant environmental differences across the research areas, I evaluated the most appropriate research methods to use for this study, by taking into account the advantages and disadvantages of a qualitative and a quantitative approach. Both research methods have their strengths and weaknesses. Within this academic debate, there are strong differences of opinion with proponents of both methods. A common thought within this debate, is that each method can be more appropriate according to the goal of the study (Castro et al 2010). A quantitative research is usually concerned with counting of volumes, occurrences and size associations (Gelo et al 2008). This approach is widely used to determine how much there is of a certain entity, for measurements of specific constructs or to examine the strength of variables (Castro et al 2010), because it allows for a reduction of the phenomenon to numerical values that can be used to carry out statistical analysis (Gelo et al 2008). Given the numerical and statistical importance given to this approach, a quantitative research is often considered an *objective* analysis (Long et al. 2000). On the other hand, a qualitative research normally deals with a certain phenomenon and aims at providing a 'thick' or rich descriptive account of it (Gelo et al 2008). This approach is commonly used to examine a '*whole person*' within the person's natural environment (Castro et al 2010). By contrast to the quantitative approach, a qualitative research involves a non-numerical collection of data (i.e. texts, pictures, video etc) (Gelo et al 2008). As a result, this type of research that requires a personal interpretation of the collected data is considered *subjective* (Long et al. 2000).

In order to assure the best approach to the research and the fieldwork data gathering, I began compiling inventories (see Annex) during the first period in Argentina (Table 1). These inventories served to accumulate as much information as possible on the relevant stakeholders. I developed two inventories: a first one with organizations, associations, foundations, initiatives and cooperatives that play a role in the energy market. And a second one comprised of the possible projects to visit in the field. With the help and the connections acquired through ENERGIZAR, my host organization (discussed in the contextual chapter), I was able to successfully compile the inventories and get in contact with a number of important organizations active in the field of RETs implementation in rural Argentina. All the stakeholders compiled in the first inventory were contacted either by telephone or by email and were asked for their eventual availability for a meeting. Understandingly, not everyone I have asked was available to schedule a meeting but a sufficient amount granted me this opportunity (Table 1). The goal of these interviews was two-fold: first, to obtain a better understanding of the institutional aspect of RE in rural Argentina, which was successfully reached with interviews with PERMER and the Secretariat of Energy. Secondly, these meetings were useful to find possible projects and end-users to visit, in order to gather the required data. Most of the interviews with the organizations were carried out during the second phase, mainly in the area of Buenos Aires (Table 1).

Table 1: Fieldwork phases

Phase	**Approximate Dates**	**Location**	**Methodological Tool**	**Content of Method**
First	Feb. 15th – Feb. 29th	Buenos Aires	Inventories: - Organization - Project Visits	Fieldwork Preparation: - Gathering Contacts - Scheduling Meetings
Second	Mar. 1st – Apr. 1st	Mainly Buenos Aires	Interviews Organizations	Information on Stakeholders
Third	Apr. 1st – May 30th	5 Research Areas	Interviews RETs Users	Gathering RETs Data

After considering the specific properties of qualitative and quantitative approaches, the specific goal of the research and the information gathered through the inventories and organizations’ interview, I determined that a qualitative method of research would be most adequate to gather the necessary data. In fact, to successfully define the concept of sustainability in rural Argentina, it is necessary to understand how renewable energy projects are implemented, operated, maintained and how they affect beneficiaries. Addressing these aspects require an in-depth analysis, which is better carried on with a qualitative approach (Castro et al 2010). Moreover, a major limitation of the quantitative methods of research is that the collected data delivers results that do not always take into account the context of the research (Castro et al 2010). This phenomenon, referred to as *decontextualization* (Viruel-Fuentes, 2007), elucidates the importance of selecting the appropriate method and shows how results might appear distorted if an inadequate technique is chosen (Castro et al 2010). As a matter of fact, a quantitative method of research is often considered to be more appropriate in the field of natural sciences because of its objectiveness and precision (Long et al. 2000). In this case, a fully *contextualized* approach is necessary, which is able to provide a rich or 'thick' account of the phenomenon under investigation (Gelo et al 2008). In fact, the holistic approach of a qualitative method is usually considered an appropriate choice for descriptive studies, personal opinions and experiences in the field of anthropological studies (Gelo et al 2008)(Long et al. 2000). Quantitative methods are commonly used in researches for generalizations and explanations; in this study the contextualization and the understanding of the phenomenon in question, sustainability, are mandatory for meaningful results (Gelo et al 2008). As argued in the previous chapter, assessing the appropriateness of the technology and the community involvement in the projects examined, requires an in-depth understanding of the beneficiaries (Rouse 2002) (Torretta et al 2012). Using qualitative research allows the collected data to provide a comprehensive understanding of the participants' perspective (Gelo et al 2008 p.275).

Taking into account the limitations related to the language barrier, the three-month duration of the research period and the sheer size of Argentina, I decided that conducting semi-structured interviews would be the most adequate method and would provide the best results. I used a snowball sampling to indentify the cases that would be most useful to include in the research: the selection of cases was the result of the meetings with key informants scheduled after compiling the inventories, and of the interviews with the organizations. The research areas were identified using a purposive sampling after studying the availability of the resources for the relative

RETs examined. I decided to conduct semi-structured interviews because it 'allows investigating the subject's perspective regarding a pre-defined set of topics' (Gelo et al 2008) but at the same time enabled me to stay flexible and discuss other topics. These topics discussed during the semi-structured interviews with the end-users were selected according to the conceptual model presented below.

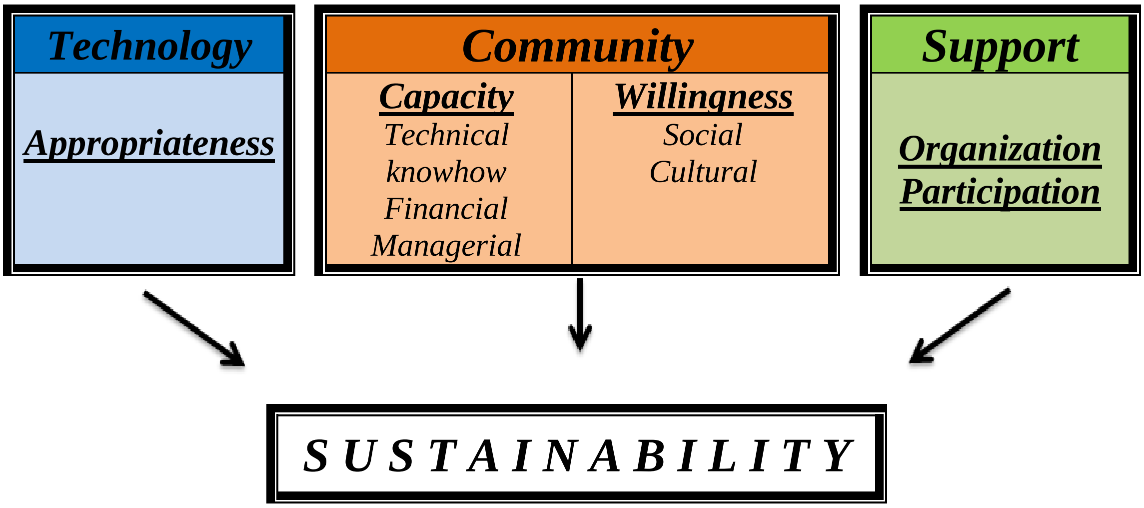


Figure 10: Conceptual Model

The conceptual model (Figure 10) provides an analysis framework of the sustainability of the RETs to examine in the field. As argued by many (Subbarao and Lloyd 2011)(Rouse 2002) (Torretta et al 2012) (Doukas et al 2012) (Mondal et al 2010) sustainability is a fundamental aspect of a successful RET project implementation. As argued in the theoretical chapter, sustainability and consequently the entire project's accomplishment, is significantly affected by local ownership. This model is the result of an accurate research conducted in preparation to the fieldwork and is based on a similar framework used also by Mondal et al (2010). This model aims at framing the in-depth analysis required to understand how the three selected aspects – technology, community and support – affect the sustainability of the projects examined. The first aspect, *technology*, concerns the appropriateness of the technology. The goal of examining this aspect is to understand whether the needs of the users are adequately addressed and satisfied (Rouse 2002). In order to determine this, it is important to understand what makes a technology appropriate and how to examine an implemented technology. The choice of which RE technology to implement, must be based on a cost-benefit analysis taking into account the local climate conditions (Doukas et al 2012 p.413). Moreover, Mondal et al (2010) argues that the technology ‘must be simple, but give a comfortable life, save human energy and time, increase income generation and other activities’ (p. 4627). Torretta et al (2012 p.2664) elucidate this concept saying that appropriate technologies should as far as possible:

- aid humankind at the grassroots level
- provide employment for the average citizen
- be durable over time
- use locally available resources
- promote self-reliance
- encourage self-supporting processes
- be low cost
- limit cultural damage
- limit environmental damage

The second aspect of the model, *community*, examines the local involvement in the project, with a particular focus on the effects on the beneficiaries. This is the fundamental and central aspect of the research, since only by sufficiently involving the community, can the project be correctly implemented (Rouse 2002) and maintained in the future (Mondal et al 2010)(Subbarao and Lloyd 2011). In order to give a sufficient focus to this key aspect, community was divided into two parts: ‘capacity’ and ‘willingness’. The part on ‘capacity’ aims at investigating whether the knowledge and skills to operate, maintain and eventually repair the technology are locally available (Mondal et al 2010 p. 4631). In other words, this aspect examines whether the beneficiaries are able or have been enabled through trainings to ensure the sustainability of RE project. ‘Capacity’ will analyse the technical know-how (Rouse 2002), the financial (Torretta et al 2012) and managerial (Subbarao and Lloyd 2011) requirements of the technology that are necessary for a successful project (Mondal et al 2010). The other aspect, ‘willingness’, strives to provide an answer to whether the beneficiaries appreciate the change and want to use the technology. This aspect will be investigated by examining the beneficiaries' perspective on the technology and their judgment on it; this aspect is relevant because, as argued by Mondal et al (2010 p.4627), the technology 'should be socially equitable and culturally acceptable'. The last aspect of the conceptual model is *support* and concerns the implementing organization and its actions. Its participation with the local community and efforts to develop partnerships between end-users and other stakeholders is a vital aspect (Subbarao and Lloyd 2011). As a major actor of the projects' development, its presence is also found in both *technology* and *community* aspects. However, this part will examine this role from the beneficiaries' standpoint and it will aim at assessing whether the RETs were correctly implemented and whether their actions were sufficient to guarantee the sustainability of the project. In fact, it is fundamental not to abandon the end-users after the project is implemented but to keep supporting and visiting them to maintain or improve the technology's performances (Torretta et al 2012).

To gather the required field data I carried out a series of interviews in the five research areas with beneficiaries of three renewable energy technologies: solar photovoltaic, wind turbines and biomass digesters (Annex). These semi-structured interviews were developed according to the conceptual model (see the template in Annex): there are three major sections focusing on the three aspects elaborated above– *technology, community* and *support*. All the interviews were carried out in Spanish and later translated and transcribed.

It is acknowledged that, despite my competence in Spanish, carrying out interviews in Spanish may have introduced some form of bias in the interpretation of results (Hoggart et al 2002). Moreover, it is possible that the short time frame available for the research may have prevented the creation of a strong rapport with interviewees, which is important when using qualitative data collection methods to reduce interviewee bias (Hoggart et al 2002). This may have led to interviewees over-emphasising positive or negative aspects of the project implementation, depending on what their assumptions were about my own perspective on the issue. Using a neutral interviewing technique, and avoiding the use of leading questions have been the main methods used to minimise this type of bias during my research.

Chapter Four

Empirical Findings: Technology

The data collected during the fieldwork will be analysed according to the different aspects elaborated in the conceptual model presented in the previous chapter. This chapter will focus on the first aspect, *technology*, and will examine its impact on the sustainability of the projects investigated. It attempts to answer the following question:

To what extent is the aspect *technology* affecting the sustainability of renewable energy technologies implemented in off-grid rural Argentina?

This aspect strictly relates to the technical performance of the technological method used; therefore, this chapter will be analysed according to the three types of technologies investigated: wind turbine, solar photovoltaic and biomass digesters.

Wind

All the wind turbine projects examined generate electrical energy used to power a few appliances in the houses. These small installations generate low quantities of energy sufficient to run only small appliances, such as radios and a few low consumption lights, but no high resistance appliances like televisions or fridges. Most beneficiaries found this technology more convenient than the previous means they used, which usually ranged between kerosene lamps and *farol* (lights powered by gas tanks – Figure 11); a few wealthier users, who were using generators run on fuel, said that the quality is similar and that wind turbines are more convenient but cannot support powerful appliances that were possible with the generator. In any case, most users explained that the new technology was significantly better than the previous means used for a number of reasons: first, because this technology is extremely simple: after it being installed, as soon as there is enough wind, the turbine will

Figure 11: Farol - Gas Light

Source: Personal fieldwork data

immediately start generating electricity and is ready to use. Second, it enabled the beneficiaries to save a lot of time and money since they no longer need to buy the resources they used. Estimates show that beneficiaries spent about 25 ARG$ a month on gas and in some cases, up to 30 ARG$ a day on petrol; kerosene was difficult to estimate since consumptions quantities varied greatly. Federico Quiroga, who was using a generator before the wind turbine was installed, explained that "*with the generator you have to go buy petrol and pour it in the generator, whereas with the windmill the energy generated is accumulated and stored in a battery*". This is an important aspect since these resources are not always locally available and have to be bought in the nearest village which can often be several kilometres away. Finally, another improvement highlighted by beneficiaries that were using generators is the significant reduction in noise pollution: generators are extremely noisy whereas the wind turbine does not make any sounds.

An important aspect of these turbines is their durability: most projects visited had been implemented since over a year and only in one case it required serious repairs. Furthermore, all the beneficiaries interviewed acknowledged the local accessibility of the resource; however, many identified in its availability a possible flaw of these technologies. Edgardo, interviewed during the field visit in Ñorquinco Sur, said that usually there is enough wind, but sometimes it is not sufficient to charge the batteries and needs to use the kerosene lamps. Other users explained that the main problem with these installations is the batteries because even when there is abundant and constant wind, the ideal condition for wind turbines, the batteries can only store sufficient power for two to three days, demonstrating that their full capacity is often not met. This shows that in order to benefit from this technology, the wind does not necessarily need to be strong, since even with weak winds the batteries can charge without problems, but it is fundamental that it is constant and possibly available at least every other day.

Despite its simplicity and considerable improvement recognized by all beneficiaries, this technology cannot be considered fully self-reliable since often users still use the previous means as backups when there are wind shortages. Most users are generally happy about this technology but many have expressed their wish to be able to use bigger appliances (i.e. fridges and televisions) but this is not possible with small installations. This is a considerable technical problem of the vast majority of the projects taken into account. However, it remains a problem only of small installations, because in a special case where the project was significantly bigger than the average, this did not occur (Figure 12). In this case the wind turbine stored the energy in the batteries for four to five days and generated a great amount of energy (up to 1,5KW), which was sufficient to power even the high resistance appliances, such as fridge, television, washing machine and an iron board. This proves that the specific technological knowledge allows a great margin of improvement for the smaller wind turbine projects.

In any case, this does not mean that small wind turbines should be regarded as a failure; on the contrary, when examining the costs and the benefits, it is possible to notice many positive sides. In terms of costs the technologies varied tremendously according to size and quality of the project, and of the specific case of the beneficiary. Some interviewees received the technology for free as a part of local or national rural programmes. In other cases, the wind turbines were either fully or partially paid by the user and the amount spent varied between 15,000 ARG$ and 42,500 ARG$ (1€ = 5,70 ARG$, historical exchange rate at March 2012). This is an important feature to take into account in the final assessment; however all users (those who paid and those who received it for free) agreed that wind turbines enabled them to save the money spent to buy the previous resources (petrol, kerosene or gas depending on the cases). Furthermore, the users that paid for the turbines, explained that saw it as an investment, since they were always aware of the costs they would be able to spare, and that in the long run they would reach the breakeven point, after which their energy would be free. On top of the economical reasons, there are also a couple of practical ones: first, beneficiaries have fewer worries about energy or about going to buy the resources to have energy, since it will be ready and available to use. Second, this RET represents an alternative to the previous mean offering the beneficiaries the choice for what to use, which is always

Figure 12: Batteries Wind Turbine

Source: Personal fieldwork data

positive. All in all, even if the prime resource is not always constant and therefore sufficiently available, it still contributes in reducing the amount of times the previous resources (gas, kerosene or petrol) need to be fetched, enabling the users to save time and money on them. This justifies the overall satisfaction of wind turbine users because, even if the beneficiaries' needs might only be partially met, this technology still represents a valuable improvement from their previous situation. An interesting aspect of this RET is that in several cases the uniqueness of this installation attracted the attention of visitors, some interviewees reported that have already been visited by other researchers like myself, who were examining this technology. In other cases, this RET grabbed the attention of local media who interviewed the beneficiary (Federico Quiroga) for the local newspaper and television. This shows how this technology can also offer unexpected opportunities to its beneficiaries.

In conclusion we may say that the stated satisfaction and the contemporary acknowledgement that the wind resources are often not sufficient, shows that this technology is considered complimentary by the beneficiaries, who do not see it as an adequate alternative to fully replace the previous means. This however, depends greatly on the context: the availability of the resources in a given area and the technology size of the implementation are important variables. As demonstrated by the special installation examined in Trelew (interview with Annamaria Ajuirre), bigger installations are feasible and can represent a valid alternative to entirely replace the previous means.

Solar

The vast majority of the solar photovoltaic projects examined were small personal installations serving small families or elderly couples. Most users were not certain about the quantity of energy produced by the panels and guessed around 20W, which I discovered to be the right amount. This current is distributed in 12 volts and is sufficient to power only small appliances and some lights around the household but not for high resistance devices. Similarly to the wind turbine projects examined, also in the case of the solar panels technologies, I visited one special project in a school of a rural community. This installation consisted of twelve panels and twelve batteries, which developed a much bigger amount of energy delivered in 220 volts making it the only installation to deliver the same voltage as the national grid. Marcela Galera, the director of the school, revealed that the installation represented a great improvement in respect to the generator that was used before: the students, she said, are able to concentrate better favoured by the absence of disturbing noises from the generator and an improved lighting system, especially in the mornings when often it is still dark outside. The panels also enabled the delivery of an improved education system: Sebastiana Calfinahuel the secretary and one of the teachers of the school said that since the installation, she can rely on two computers, a radio, a television and other electrical educational means that she could not use with the generator. Also the smaller, more common installations have had a considerable impact on the beneficiaries. Their contribution also improved the lives of most of the single-panel projects' beneficiaries. In fact, most users relied on gaslights and kerosene lamps for lighting whereas now these users can enjoy a better quality of luminosity with five to seven lights and a radio without having to buy those resources. This is a great improvement because the vast majority of the interviewees reside in remote areas that extremely difficult to reach. The rough terrains of these areas often exacerbate the difficult journey to the nearest village: Elba Quinieñau from Chenqhuniyen, near Ingeniero Jacobacci revealed that she normally had to travel more than 30km to reach the nearest village and buy the gas tanks her and her husband used for lighting; in winter however, this journey became even more complicated since her usual passage would be blocked and she had to travel about 50km to reach the same village. Since she received the solar panel she saves a lot of time since she does not need to go to town as often anymore. During the interviews, all the beneficiaries pointed out this aspect and justified their opinion saying the use of panels saved at least one journey to the nearest village.

Some users also identified health reasons to prefer the solar panels over the previous mean; Mariana Vazquez explained that on top of being more convenient, solar panels are also healthier than the kerosene lamps she used before their implementation. Another appreciated characteristic of this technology is their simplicity; in fact, the panels examined are very basic installations that provide immediate power and that rarely break. Most panels analysed had been installed at least two year prior to the interview and none had necessitated major repairs; the only component of the project that required a great attention is the batteries, but in most cases that was normal since they have a shorter life span than the panels.

A fundamental aspect of all RETs is local availability of the resources required. In the cases of solar panel projects examined, all the beneficiaries reported that the exposure to sunlight was easily available and sufficient throughout most of the year. However, there were contrasting opinions concerning the winter time, during which the days are shortest and most cloudy. The majority of the beneficiaries said that even during winter they did not suffer from the reduced amount of hours of sun and explained that the panels always charge very efficiently, requiring only one hour before and one after midday to sufficiently charge the batteries. Other users, living in mountainous areas around Aluminé, reported battery-charging problems during the winter because of the abundant rain and snow. Because of these contrasting opinions, it is difficult to have a clear picture of the availability and accessibility of the resource, namely exposure to sunlight. This surely has to do also with the specific geographical area where the projects were examined. In the area of Ingeniero Jacobacci in Rio Negro, the beneficiaries interviewed said to have never experienced problems of insufficient resources, even during cloudy days in winter, Linda Nilda of Rio Chico said that sunlight '*is sufficient especially in summer but also in winter, it is less but still enough*'. On the other hand, end-users interviewed in the area of Aluminé in Neuquén, resulted to be slightly more pessimistic, even if contrasting opinions within the same area still reoccurred. In the village of Ñorquinco near Aluminé, members of the same community expressed different opinions in concern: Luciano Calhuian, leader of the community and among the first to have received the panels, said that "*in winter* (from April onwards) *there is a lot of snow and rain and often there is not enough energy produced*". A fellow community member, Mariana Vazquez explained that the hours of sunlight are always enough and that even during winter she never experienced any problems. Considering the contrasting opinions it is difficult to determine whether these installations can be considered self-reliable; it is appropriate to say that there are two factors that play a critical role: first and most importantly, the diverse environmental and climatic conditions between areas certainly can make an significant difference, considering the importance of exposure to sunlight for this technology. Second, the way the energy is used probably varies significantly between the beneficiaries. This is a possible interpretation to explain the contrasting opinions on the availability of resources within the same community. In fact, these panels are small installations that produce small quantities of energy, which need to be administered if one wants to benefit from it adequately.

In conclusion, it is important to analyse the benefits and the drawbacks of this technology to understand its impacts. Prior to the installation, the average consumption of gas was quite high and was estimated to be roughly one tank every 15 days for a total of about 20-25 ARG$ per tank. The solar panels allowed the users to save money and especially time, when considering the great distances and difficulties to travel to the nearest village. Moreover, all the projects examined were delivered either for free or for a small symbolic fee. The PERMER projects analysed charged the beneficiaries a small sum of money, 60 ARG$ for half a year, to cover for repair costs. Thus, in economic and logistical terms most users benefit from a substantial improvement. Concerning the availability of the resources, it is important to highlight the differences between regions and possibly of operating styles of these resources between the users, to conclude that these panels function well and are self-reliable most of the year, whereas during winter the sunlight is sometimes insufficient. All in all, solar photovoltaic panels, similarly to the wind turbines, represent a considerable improvement in all the beneficiaries' lives, but do not completely satisfy everyone's needs; in fact also these installations are too small to support big appliances. On the one hand, some users, like Mariana Vazquez said to be completely satisfied with the panels and added that she would not need any other appliances than what she is currently using. On the other hand, other users like Elba Quinieñau said to be satisfied but are considering of getting another panel installed for the fridge. It is important to note that the technical means to improve an installation, in a way that it can power big appliances as well, are already feasible as proven by the installation carried out in the community rural school. Therefore we may argue that reported limits in the technology (only low scale consumptions) are coherent with the projects' goals, set to provide only basic needs.

Biomass Digester

The biomass digesters examined were serving elder people who lived on farms in rural areas since many years. This technology, which produces biogas, is used mainly for cooking and partially for heating. It was often difficult to obtain an estimation of the quantity of gas produced since it varied according to the size of the digester and the amount of biomass inserted in it, but users estimated an average production of roughly 4-5 cubic meters. Regardless of the quantity of biogas available, the beneficiaries explained that has had a positive impact on them and improved their daily routine. The most common resource used prior to the digester's implementation was gas and in a few cases this was complemented with wood used for other activities than cooking, such as to generate heat. Despite most users explained that the quality of gas was substantially the same as the one in tanks used previously, beneficiaries said that they benefitted from other aspects; for example Beatrice Vargas, who lives on a farm with many animals, revealed that she was already used to gathering and cleaning up the biomass around the farm but now see can also benefit from it, since it procures her biogas. Feeding the biomass, which often is mainly animal manure, in the bio digester attracts fewer flies and insects, and contributes to a cleaner environment and a less unpleasant smell. This is because the digester processes the biomass rather than having to keep it somewhere on the farm. Francisco Cañulef said that the by-products of the bio digester make a good fertilizer for the soil in the short term but is expecting an even more considerable improvement in soil fertility in six years time.

The beneficiaries of the biomass digester projects found this technology to be quite simple and explained that supplying one bucket of biomass every 2-3 days (depending on how much gas is needed) is everything that is required for its functioning. One drawback encountered concerns the amount of time required to start generating the gas from the biomass. If the digester is empty it can take up to 25 days to produce biogas for the first time, but if the procedure is kept continuous and some biomass is added before its processing is finalized, the digester will continue to supply the gas. In fact, in most cases this was never identified as a problem since the beneficiaries use the digester on a daily basis and supply the biomass continuously. Another reason the beneficiaries identified as a good improvement is that they now *'have an alternative to more expensive gas'* – Beatrice Vargas. Beneficiaries used one small tank of 25ARG$ each month for cooking and about 20 meters of wood for heating. This is a significant improvement, especially when considering that all the beneficiaries were entitled to receive the digesters for free as a part of different programmes. One of the strongest aspects of this technology is certainly the availability and sufficiency of the resources: all the users pointed out the good accessibility and abundance of biomass on their farms.

To conclude, all the beneficiaries said to be quite satisfied about the digester and explaining that having gas to use for cooking and an alternative to the more expensive gas tanks is everything needed for the time being. Some beneficiaries, like Beatrice, hope to be able to expand in the future and obtain another digester for another stove in her house. This technology proved to promote the self-reliability of its users, offering them a valid alternative to gas tanks and enabling them to rely on easily available resources. Moreover, digesters have also proven to operate efficiently in areas, like in El Rincon in North-western Chubut, where the climate can be quite rigid during winter. Having learnt about this characteristic of biomass digester before the interviews I was expecting this as a potential drawback for this technology, however none of the beneficiaries pointed this out.

A vital aspect in the analysis of *technology* is the simplicity of the installation. This must be strong point of new technologies, because when they are compared to the previous means, the RETs must provide an improved service for them to positively affect the overall sustainability of the project. This aspect made most users happy because the technologies require very little work and are easy to manage. Before the implementation, users needed to buy the resources they previously used to have energy; since the arrival of the new technology they no longer have to worry about the energy-generating process, saving them a lot of time and money. In the cases of the windmill and solar panel technologies, their simplicity is probably the best aspect of their evaluation. In the case of the biomass digesters' projects, the users have to gather the biomass, which is something they were already doing before, but instead of throwing it away now they can benefit from it, by feeding it into the digester. Biomass digesters require the users' actions to function and even if the effort to operate it is minimal, it results less simple when compared to the other two RETs examined because those do not necessitate any actions. Regarding the self-reliability of the technologies, the findings highlight mixed results concerning this aspect. Many wind turbine' and solar panel' beneficiaries experienced difficulties in accumulating enough energy, either because the resources were insufficient or because the batteries were not able to store enough energy even when the resources are abundant. All in all, every interviewee chose the RET received over the previous mean proving that the RETs are simple enough and represent an improvement.

Chapter Five

Empirical Findings: Community Capacity

This chapter will focus on the second aspect discussed in the conceptual model, *community*. It will examine the local involvement, focusing particularly on the beneficiaries and how their involvement impacts the sustainability of the projects investigated. It attempts to answer the following question:

To what extent is the aspect *community* affecting the sustainability of renewable energy technologies implemented in off-grid rural Argentina?

The involvement of the local community and particularly of the beneficiaries is a fundamental aspect of each renewable energy project's success. To have a better understanding of the community involvement in these RETs, this aspect will be examined in two parts: community 'capacity' and 'willingness'. This chapter will focus on the first one, namely community capacity.

The capacity aims specifically to look at the beneficiaries abilities to maintain, operate and eventually repair the technology examined, looking at three aspects: the practical abilities, knowledge and skills that can either be already available to the users or transferred through trainings from the implementing organizations; the financial resources to sustain and run the project; and the communal managerial ability to run the installation as a community.

Technical Know-how

The three RETs examines, wind turbines, solar photovoltaic panels and biomass digesters are three fairly simple technologies. In all three cases, the beneficiaries explained that they were required to do very little to ensure the benefits of their technology. In the case of wind turbines, all users received trainings about the technology's functioning and in most cases also a manual on how to operate it. Federico Quiroga explained that the windmill generates electricity without necessitating any special actions but only needs to be stopped by blocking the blades in case of extreme winds but he said that it does not occur very often. Also Annamaria Ajuirre said that the windmill is a pretty autonomous technology and added that it is necessary to check the level of distilled water in the batteries to ensure they are preserved and appropriately handled. Similarly, also the beneficiaries of solar photovoltaic panels revealed that this technology requires little actions to manage it on a daily basis. Linda Nilda replied that there is '*nothing* (to do) *on a daily basis, just clean it every now and then, in this period a bit more often because of the ashes of the volcano'*. In fact, normally the users simply need to keep the panels clean to ensure their best performances and that during the time of my visit this was necessary a bit more often because of the ashes of an erupted volcano nearby. In other areas, further away from this volcano, the cleaning of the panel occurred much less frequently; Luciano Calhuian replied saying that he cleans his panel every 15 days. Despite the simplicity of this technology, all the users received detailed instructions either through trainings or during community meetings. Luciano is the leader of his community in Ñorquinco and often acts as a mediator between his community and the implementing organization delivering the solar panels, arranging meetings where his fellow villagers can receive trainings and instructions. Mariana Vazquez is part of the same community and was also present during the installation of her panel, during which she had the opportunity to ask the technician of the implementing organization all the questions she needed. The last technology examined, the biomass digester, is the one that requires most works from its users. It is still a simple technology that requires the users to gather the biomass and feed it into the digester. This process does not need to be repeated very often and greatly depends on the quantity of biogas desired; Francisco Cañulef explained he adds about one bucket of biomass every five days if they need a large quantity of gas and only one every ten days if they do not require too much. Similarly to all the other beneficiaries of the other RETs, also those making use of the biomass digester were instructed with basic trainings and a manual on how to operate the digester. Moreover, it is important to report that when asking whether the technology required a considerable amount of work, no one of the interviewees replied affirmatively: all the beneficiaries of the three technologies said to find the technology very easy to manage and to do only minor routine actions, like cleaning it or check the distilled water level in the batteries. Only in the case of the digester the beneficiaries said they needed to keep it 'active' and occasionally fill it with biomass but like Beatrice Vargas said, this is a very easy and does not require great effort.

A major aspect of each project concerns the eventual repairing processes in case of failure or damage. This aspect is often addressed during the trainings, when the beneficiaries are instructed on what needs to be done or who to contact. However, most of the projects examined had never been broken before but two solar panel installations necessitated a replacement of the batteries. Only in one project, a wind turbine installation had undergone serious reparations because the turbines started rubbing against one another. Federico, the owner of this turbine, explained that besides this occasion everything had worked well. Federico like most of the other wind turbine beneficiaries, are held responsible for eventual damages, except for Annamaria Ajuirre who had her turbines privately installed and received a one-year guarantee with it. A common aspect of all the turbine beneficiaries is that no one said to be capable of fixing it: everyone received trainings on how to operate and troubleshoot minor aspects, like checking the batteries, but regarding the specific technical aspects, everyone was instructed to get in contact with their respective implementing organization and schedule an appointment with the technician. Donato Grande from Ñorquinco Sur in western Chubut, said to be happy that his wind turbine has never been broken because he would have to contact and arrange a meeting to fix it with the members of UOCRA, the implementing organization based in Buenos Aries (several hundreds of kilometres away).

The repairing processes of the solar panel projects are often regulated in a different way. The solar installations visited had either been implemented by PERMER, the national programme for rural electrification in Argentina, or by other local organizations. The beneficiaries of the government installation have been instructed on how to operate the technology and, most importantly, what to do in case repairs were required. All the PERMER users interviewed answered that they are not directly responsible for the installation and therefore need to contact the organization because they are not capable of fixing it. In fact, the first family interviewed during a field visit inspection in close to Lago Ñorquinco in Neuquén explained that they would not be able to fix eventual problems of their panel but most importantly they were instructed not to try to repair it and to immediately get in contact with the organization in Aluminé. Other solar panel' beneficiaries who received their installation from other organizations, said that they were responsible for their project and therefore were advised but not specifically instructed to contact the technicians if unable to repair it. The main difference between the two types of solar installations examined is that the first one, implemented by the government programme PERMER is a service offered by the government to specific areas that are not connected to the grid, whereas in other areas where PERMER has not served yet, locals resort to other way to obtain their energy, namely through other local organizations.

The biomass digesters examined had also never been broken and their users seemed less certain of the eventual repairing procedure. Beatrice Vargas said, "*I don't know for sure it never happened, but I would call the technicians who installed it*" and later added that she certainly would not know how to fix it and would require the assistance of the technicians of the association.

In conclusion, the three technologies examined appear to be very simple to operate and all users were trained adequately concerning their functioning. Most beneficiaries were sufficiently 'knowledgeable' about their technology and even if most seemed to be lacking the 'hard' knowledge, such as the technical abilities to fix or repair the technology themselves, most users compensated it with sufficient 'soft' knowledge and demonstrating to be able to operate their RET properly and being aware of who to contact in case of problems (Mondal et al 2010). In spite of the apparent simplicity of the three technologies, most of the trainings were delivered thoroughly also delivering paper manuals to the users. Some solar panels beneficiaries like, Luciano Calhuian revealed that he was even instructed to cut down plants that in the future could grow and potentially overshadow the panels.

Another interesting aspect concerns the PERMER installations that I discovered during my visit to the field in Lago Ñorquinco in Neuquén, when government officials who were carrying out an inspection in that area accompanied me (see Annex – Table 3 interviews 8, 9 and 10). After interviewing the three families (candidates N. 8, 9 and 10), the visit inspectors explained that they place most cables and other technical devices of the installation in specific boxes. Marcos, one of the inspectors said that this served as a deterrent because most beneficiaries are used to self-sufficiency and often try to solve the problems on their own. However, in complex installations like the ones of the solar panels, they would not be able to solve eventual problems but only risk making things worse and harder to repair.

Financial Resources

RETs are by definition expensive technologies and the state of the art is not yet at the point of making those technologies accessible for the entirety of the potential users. Are the RETs financially sustainable for the communities we are considering in this study? This important question could of course affect the conclusions over sustainability of these projects, but concerning what is the scope of our investigation we just have to consider the defined users' framework and try to give an answer to the sustainability for them in the assumed context.

The 3 RETs examined, wind turbines, solar photovoltaic and biomass digester, may have very different implementation costs. In our framework we have sourced information from the users through the interviews, assuming as investment what they have been charged to get the RET. In reality the most of them were not charged at all or charged just with symbolic amounts and we will try to draw a picture of the financial charges and to understand the logic behind it.

Federico Quiroga, user of a wind installation implemented by 500 RPM Eolocal, had to pay an initial lump sum of 15.000 ARG$, which he could afford but in absolute value it is not a negligible amount for the finance of the potential users in the area. Other windmills considered were provided by governmental organizations like UOCRA or other initiatives like ECO CHUBUT; these were also installed for free or charged a relatively small fee of 200 ARG$ after 2 years which seemed an important factor in the users' positive evaluation of the project (Donato).

Much cheaper were the average costs of solar technologies: very small fees are fixed (10 or 15 ARG$ per month) only for the first six months of the project, then beneficiaries were not charged anymore. In some cases (Linda) the fee is required in sheep and for the farmers this appears like a very convenient form of payment. It needs to be said that those symbolic amounts are more intended to get commitment from the beneficiary rather than covering part of the costs of the RET.

Investment cost for the biomass digesters didn't show up in the investigation: the users did not mention this because everyone received it for free and were unaware of the costs. Therefore we consider them out of scope, limiting the investigation to what was effectively charged to the beneficiaries. This resulted then in a general investment affordability from users of solar RETs and wind turbines, while Federico expressed some doubts about eventual future projects to be financed directly by the farmers.

The idea of the subsidy project is to charge just (and not entirely) the operating costs to manage the installation, and the kind of technologies we are considering implies relative low costs for maintenance and repairing. Payments in sheep and lambs (6 or 7 animals per year) are quite well accepted by farmers also to cover those running costs. The relative organizations are used to sell the cattle on bigger markets to repay costs. We have considered mostly individual projects but there is already awareness that sharing the cost of bigger projects (i.e. communal wind turbines) can significantly lower both installation and operating costs. As a conclusion of the financial aspects of Community capacity we can state that in the present formulation and thanks to the governmental support, the project are sustainable. Operating costs in the magnitude registered by interviews are generally considered affordable as amount and modalities.

Management

At the end of the previous part concerning financial aspects of RETs implementation in Community capacity we have introduced the concept of multiple users, which enables to get significant cost reduction. The evolution of this concept leads to a managerial approach of the RET in order to satisfy the needs of a community of individuals, not necessarily living together.

Before leaving to Argentina, I was expecting to analyze projects where the installed technologies would power several dwellings at the time. However, the vast majority of the projects visited had private installations that would power a private house alone. The reason is straightforward; the villages in rural Argentina arise in places where space is abundant. The distance between dwellings is relatively large to allow more space for privacy, to grow crops and to keep animals. Despite the distance between each house is not huge (often around 400-500 meters) it is not possible to develop a sort of 'mini-grid' for each village. This new scenario changed the expectations since private installations lead to less interaction within the community members to operate the renewable energy systems. Having private installations means that the negative effects caused by not maintaining and properly operating the system would harvest worse results for the private user alone. Therefore, the aspects of 'community capacity' and 'community willingness' discussed in the conceptual model had a different impact than the one predicted. Possessing private installations means that the members of the communities will have less interaction concerning the power supply; on the other hand, it is their personal interest to actively be part of the projects and learn how they must be operated to assure they can benefit from the projects.

Moreover within the communities there will be many members who will know the basics for the functioning of the RET, rather than few members knowing everything about the RET and being in charge of it (as one might expect in communal installations). The basic assumption for a managerial approach of the RET is the responsibility for the good functioning of the project is appointed to one person or through a shifting of responsibility among a group of people ruled by a detailed schedule.

The communal project I have visited in Aluminé is located at the community village primary school. This visit was particularly interesting because it is a bigger project, which is used by a much greater number of people than the average installation and because it is not personal, but serves the community. The beneficiaries are not only the people who live there, like in the case of all other installations where the projects are for private houses, but it also benefits those who do not live there. The solar panels are taken care by the school director (Marcela), who has the task to ensure its good functioning and its maintenance. She is allowed to live in the school and to use the panels for herself after the school time. Moreover, she is also the only person of this community who did not have to pay for the solar panels, because it is recognized as a project to enhance education in rural areas. This is a bright example of community capacity, enabling the user(s) to be in the best position to obtain the technology's best performance.

Chapter Six

Empirical Findings: Community Willingness

The other aspect, 'willingness' strives to provide an answer to whether the beneficiaries appreciate the change and want to use the technology. This aspect will be investigated by examining the beneficiaries' perspective on the technology and their judgment on it; this aspect is relevant because, as argued by Mondal et al (2010 p.4627), the technology 'should be socially equitable and culturally acceptable'.

Of course willingness is affected by the quality of the technology; when a technology is very good, it will be more likely that the users will be better disposed towards them. Nevertheless because in most cases the technology is delivered for free by government and/or organizations, the beneficiaries are more inclined to express favorable judgments on it, sometimes stating that they would have paid to get the technology because they can clearly see its advantages. Besides that, the beneficiaries may perceive the interviewer as part of the wide process, which finally granted them the use of the technology and therefore tend to keep the answers positive and enthusiastic.

For what 'willingness' concerns, the investigation was conducted aiming to determine, for each of the three technologies being used, two main conclusions: the will of using the RET (*want*) and, the belief that the change brought is welcome (*appreciation*), with particular reference to social and cultural suitability of the projects. The first general statement verified, regardless the specific type of technology, is the following common framework: all the technologies implemented are used on a daily basis, this indicates an appreciation for the RET which came clear as a feedback to the specific questions, as well as the overall satisfaction of all the beneficiaries.

Wind

The users of the Wind technology all recognize there was a problem before using the RET, Federico Quiroga reports: "….It was horrible when I had no electricity! I knew I needed some alternative to NAFTA, because it's quite expensive and bothersome to have to go out and buy a tank every week. Although the windmill was an expensive investment and I haven't broken even on my expenditure for the windmill yet, eventually I will and will receive electricity for free……" but in general all the candidates report feeling having solved a problem. Implementing the RET was not always their own idea, but they were easily moving to appreciation. Again Federico before choosing the wind technology said: "….Well, I knew I needed some alternative. I considered a bio-digester since I have many cows, but that would take too much effort to gather and shovel manure everyday….". The switch to wind RET was perceived in a very positive way, both socially and financially and leading to no negative impacts on their lives. As a general attitude they would be open to similar new experiences with the same or other technologies.

Concerning the will of effective use of wind technology (want) people use it for all the possible needs of energy, confirmed by Juana Linares who said probably "everyone would like to live in such a house" – referring to the considerable improvement obtained after the installation of wind turbine.

Questions addressed to cost aspects, have highlighted financial barriers to the full implementation of this RET. In many cases the farms are inhabited by the "Gauchos" (farmers looking after the livestock) who would not be able to afford this technology and according to Federico the owners living in Buenos Aires would not be prepared to pay the cost of their "electrification", because in principle the farmers don't strictly need to use electricity. In conclusions users of the wind RET are extremely happy with it: Annamaria Ajuirre reported having everything she needs, namely free energy, though it required a significant investment. She justified this saying that she was "…tired of waiting for the Government" and its promises to extend the grid to her area. All in all, the users' appreciation for this technology must be accounted as to having a smaller impact, because often the beneficiaries were already anticipating positive results and decided to contact organizations themselves to have it installed.

Solar

Not much different is the picture for the solar panel technology users, where we find constant daily use of this RET and an overall appreciation. To be highlighted among the beneficiaries statements, is the one from the interview with Marcela and Sebastiana, representing a community of 16 students. Marcela stated she just wants energy, doesn't care how she receives it: *"Doesn't matter which technology or mean is being used, just matters I have energy!"*. Apart from that, people appreciate the comfort of having the energy source on the spot with financial and time savings. It is generally recognized there was a problem before the implementation of the solar RET, since the most used source of energy (for generators) was gas and, besides its relatively high price, it required a long time to go to town and buy a tank of gas said Elba Quinieñau.

The idea for a switch from gas to solar panels was often of the organizations (i.e. all PERMER cases), but sometimes it was a member of the family suggesting it (case of Elba). The totality of the users has been pleasantly impressed by the use of the solar technology: practicalities, time saving, less efforts are all recurrent comments. Their lives changed for the better compared to the time they were using oil based generators and gas lamps. Sebastiana tells she doesn't need to go to town as often anymore to go buy *nafta* (fuel) and sometimes there was no petrol in town and would waste time (the journey to get there). Main obstacle to a wide use of the solar technology again appears to be the investment. They are very happy and would like to use it also for other household applications (for instance food cooling). The solar technology is used for the basic energy needs, namely light and radio, which are close to the total energy needs of these communities. The willingness to use the RET is present and confirmed: people accept the RET and are open to the innovation even if they realize that efforts and trainings are needed to fully implement the RET in a durable way. Luciano Calhuian, head of the local community reports: "Training is important because they learn a lot about the technology and how it works and what needs to be done. The people realize that this is important and come to the meetings willingly. They also have the opportunity to share their complaints and express their opinion to see what they feel is going wrong or simply to ask questions". Community meetings for training are important also because in Luciano's community people need to sign a contract, which is an obligatory step if you want to receive the solar panel. Advantages in using the RET are very much evident, therefore often there is no need to convince people. On the other hand, the technology is expensive and organizations like PERMER cannot afford to reach everyone. The second family inspected in Alumine confirmed that people do not need to be convinced and already want the RET, but in terms of investment, it is not feasible to reach everyone.

Biomass Digester

This technology differs from the previous two about willingness, people may have reluctance in using bio digester because they do not want to handle dung, but in practice bio digester are used every single day and I collected enthusiastic comments on this technology which offers alternative to fuel and gas for cooking and heating. Francisco reported: *"I think it's great. We don't have any more worries about having enough money to buy fuel for cooking".*

Before the implementation of the technology, living without the biomass digester was not perceived as a problem, but like for all the innovations, the technology made it cheaper and easier, as confirmed by Beatrice Vargas. She also reported she received the digester because she was contacted by the associations ASIS and OUCRA who had heard of her farm through a friend. Also for the bio digester technology, the implementation idea often came from the government or other organizations. We can state that this contributed in raising awareness about the potential of this RET and that its users judged the change absolutely for the better. That implied of course a change in the beneficiaries' habits but most explained that the change was for the better. Francisco reported that they "are still very happy with the free gas for cooking and hot water". In conclusion, we can say that people appreciate the technology and are prepared to extend its use, like Beatrice confirmed:
"I would like another one, or a bigger one to use for the house as well since we are not lacking the resources, we have many animals and much manure".

The biogas obtained by the technology is used mainly to cook and / or to heat. This is of some help in raising small cattle or poultry, but it is not comparable with uses of other RETs. Biogas by RET is considered a great help in cold winters, the down side is the cost of the technology. The users are not yet fully aware of costs, therefore when they get it for free there are no problems holding them back, but this raises uncertainty about the possibility of diffusing the use of the RET in the future.

The interviewed users are reporting general satisfaction about having the technology. Beatrice declares being very happy to use this technology, received for free and she can now greatly benefit from its advantages, duly following trainings and explanations explaining that she considers the them absolutely top important for a proper use of the technology.

Generally speaking about willingness in using RETs it needs to be mentioned that some people, rather than waiting for government projects, opted for the installation of the RET, namely the users feeling they were wasting time and money, decided to contact a commercial organization supplying their personal needs. This shows somewhere a relative financial well being that enables the user to sustain a significant investment.

Many others said they would be willing to invest on other RET that carry out other task, such as generating heat. Usually the worse the previous situation, the more were the users seem willing and appreciative of the new technology. Those who lived in very remote rural areas appreciated the technology more even when malfunctioning (the case of Juana Linares). Some were also quite critical towards to the technology and did not fully rely on the RET (Federico) and used oil based generators. Finally, an interesting finding that emerged from the research is that people would want the technologies, or for those that already have it, would like others, but unless these are granted for free, like state programs or government projects, people usually cannot afford them. This represents people’s opinion concerning the technology overall and more specifically of the efficiency aspect, showing that these projects are appreciated and seen as improvements regardless of the eventual complications.

Chapter Seven
Empirical Findings: Support

This chapter will focus on the third aspect discussed in the conceptual model, *external support*. It will examine the external involvement, focusing particularly on the government and other implementing organizations and how their involvement impacts the sustainability of the projects investigated, attempting to answer the following question:

To what extent is the aspect *support* affecting the sustainability of renewable energy technologies implemented in off-grid rural Argentina?

The RET projects are in most of the cases made possible because of financing by NGO, foundations or governmental organizations like PERMER, ASIS, etc. The main role of those organizations is identifying the need, selecting the technology, implementing the project and delivering trainings, and the after-installation follow-up with services, support and maintenance. In this chapter we will go through the interactions between user and organization with a special focus on the follow-up, the findings are based on the users' interviews rather than on contacts with organizations. It was indented to give priority to the way the beneficiaries perceive the support from organizations.

The first massive interaction between user and organization is at the building of the installation, the installation time may vary but on average it takes about a few days for solar and wind RETs and longer for the biomass digester. The construction and installation of a wind mill, including batteries and circuits, takes few days. Quite longer is the installation of a biomass digester which can take a month of work. That leads to the conclusion that the implementation time is not to be considered a problem. The installation is conducted by the organization or by contractors and it goes in a friendly atmosphere and cooperation with the beneficiary, sometimes, particularly in the case of small organization like 500 RPM, it goes extremely friendly: (Federico) " *It was actually kind of informal. We worked on it, but also played racket-ball, went to the beach and relaxed. They were my friends as well, so we enjoyed ourselves in the process"*. In fact, in some cases there are good relations that are established since early on, in the case of Federico his friendship began during the training courses followed as a preparation to the wind turbine installation.

Sometimes the organizations use as contractors the members of the community, this practice strengthens the sense of ownership and facilitates things, giving to the community also the impression that RETs implementation stimulates the economy.

Figure 13: Photo Solar Panel in the Shade

Source: Personal fieldwork data

Wrong implementation could affect the efficiency of the project: we have found two cases in which this was evident, the first one with the placement of the photovoltaic panel in a tree shade (Figure 13) and the second where the light switch of the energy was placed in between a bathroom door frame preventing the door closing (Figure 14). This is a proof of how important it is that contractors provide good technical support, otherwise all the efforts for the success of the project can be frustrated.

Generally speaking no financial charges is given to the beneficiaries for the installation, with the exception of governmental organizations like PERMER which charges a small monthly fee of 15 ARG$. Extra fees are possible in case of later breaking down of the installation. Already during the installation that can be a first training on how to use the installation. *"Yes, I asked them many questions to make sure I understood how it worked"* (Mariana) and again Luciano: "*The technicians that installed it were useful but the community meetings organized are much more useful and important for the community"*.

Figure 14 Light switch in the way of door frame

Source: Personal fieldwork data

Groups of installers were normally composed by 4 or 5 people but for the more complex installations like biomass digester they could be up to 9 or 10 people.

Other delicate aspect of the support is the training also in consideration of the remoteness of locations, routine visits after the installation are expensive and extremely time consuming. In some cases the training has been judged poor, not enough formalized and sometimes not addressed to the right people, a point of attention for the future.

About the post implementation assistance Federico reported*:"They often call me asking after it"*, and similarly Annamaria said *"Yes, they should come back twice a year. If something goes wrong, I can call them and they visit me".* Users understand the difficulty of being regularly visited and in general terms are happy with the service provided, they are also prepared to being charged in case of malfunctioning of the installation due to users' mistakes. As said, support is in general judged in a positive way and the users look forward to being assisted with new projects in the future *"Hopefully, I can afford it"* (Federico).

As mentioned earlier the choice of which project or which technology it depends on several elements. Sometimes it is decided to provide RET to all the members of a community (geographic criteria) and in this case they first install at the community leaders and then all the other members, as confirmed by many interviews (Luciano, Mariana, Marcela). When the need is to provide energy in remote areas like the one around the village of Ingeniero Jacobacci, the elements to be considered may differ. That region can experience strong cold winds in the winter and long sunny exposure in the summer, that would recommend, in order to maximize the efficiency, to install both wind turbines and solar photovoltaic panels. This is also a very remote location to be reached and not well connected with organizations, with related problems in giving assistance and support. As a consequence in that area solar RETs were preferred to wind turbines which require a higher grade of technical support, but among panels we have those requiring less assistance but also less performing. According to the users (Luciano, Mariana) this steered the choice for this kind of more robust installation.

In conclusion we can state that external support could be crucial for the success of sustainable RETs projects and important points of attention are:

- Accuracy in choosing technically skilled contractors
- Giving good and well formalized explanations and training at the time and after the installation.
- Good interaction between organizations and users

Conclusion

Before coming to the conclusion of this research it is important to have a look at what this research aims to answer:

How sustainable are renewable energy technologies[3] implemented in off-grid rural Argentina?

Using a qualitative approach has proven to be an important choice in order to adequately address such a complex topic. Dividing the research in three different aspects *technology*, *community* and *support* was a good strategy to keep this study focused whilst attempting to provide a meaningful answer. All three technologies examined, solar photovoltaic, wind turbines and biomass digesters resulted to be appropriate in general terms. Every beneficiary interviewed said to have found their technology very simple and a good improvement. This was accentuated when the RET was compared to the previous mean employed before the installation, because it enabled the users to save time and money.

The availability of the resources was usually not a problem but in solar panels and especially wind turbines installations, these resources resulted to be insufficient at times. On the contrary, for the biomass digesters technologies this problem did not occur. Overall, the technologies were satisfactorily addressing the beneficiaries' needs and contributed to a considerable improvement in their lives. In most cases, the implementing organizations were able to successfully deliver their trainings to the end-users, who proved to be sufficiently knowledgeable to operate and maintain technology, facilitated by the blatant operational simplicity of all the RETs, particularly of the solar photovoltaic and wind turbines. On the other hand, the specific technical abilities to eventually fix the installation were lacking in each case; however, this was compensated by the fact the all users were aware of how to obtain the reparations.

Regarding the financial aspect, all three technologies resulted to be too expensive for the average user and, despite their contribution was generally highly appreciated, unless the projects' would be partially or fully subsidised by others their

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[3] RET to be investigated: solar photovoltaic, wind turbines & biomass digesters

implementation would often not be economically feasible. To favour the development of these technologies and particularly of solar panels, the implementing organizations often offer extremely favouring conditions, accepting unusual modalities of payment in some cases or charging only small symbolical fees. Disregarding the economic constraints, all three RETs were appreciated, which was often emphasised by most users' wish to eventually obtain another installation in the future. Finally, it is important to stress that only few beneficiaries seemed specifically interested in the way they received their energy and possibly contributing to a better impact on the environment, whereas most were interested only in receiving their improved energy service.

The role of the implementing organization is of considerable importance in most projects' sustainability. Results show that in many cases establishing a close relation between the organization and the user was often logistically unfeasible and financially unfavourable because the distance was often too big. This strongly impacted the choice of the technology to implement since some organizations often preferred to install more reliable technologies, like solar panels rather than more performing ones like wind turbines. Finally, the lack of assistance during previous RET projects and their subsequent failure, was in some cases the principal reason why some beneficiaries opted for another technology.

Given the complexity of the question it is difficult to give a straightforward answer. Generally, all three RETs significantly improved the beneficiaries' lives, which is a fundamental aspect, were maintained well and broke rarely. The results also highlight specific performance hitches relative to the resources availability for the solar panels and wind turbines technologies. In the case of biomass digesters the main threat could be represented by the cultural and social barriers of operating this technology, however this did not seem to be a problem for the candidates interviewed. Overall all three RETs examined demonstrated to have stronger and weaker aspects but with sufficient technological improvements to compensate the intermittency of the resources and ownership at the local level, biomass digesters, solar photovoltaic panels and wind turbines can provide an excellent scenario for the future of rural communities in Argentina.

Reflection

In today's world at the global level there are three major energy-related goals: have a secure access to energy, mitigate the climate change and fossil fuel consumption, and the provision of modern energy services for developing countries. These three objectives lay at the top of many developed countries policy agenda, however an important distinction to be made is that the first goal, energy security must be reached separately by each country whereas the second and third goals should be achieved through cooperation at the international level. Renewable energy technologies could represent the possible solution to all three problems. Despite the efforts mitigating climate change and especially providing energy access to developing countries are still far from being achieved. Considering the current major sources of energy, which are fossil fuels, having a secure access to energy is an incompatible goal with the provision of modern energy services to developing countries, and especially with reducing greenhouse gases. This appears to be a considerable conflict of interests, which sees access to energy as the most prioritized goal, followed by the other two. Lloyd and Subbarao (2009) argue precisely this and explain that whilst governments are negotiating possible strategies to mitigate carbon emissions, they are '*subsidising fossil fuels…in the disguise of development'* (p.243). Since 2000 the World Bank has invested over $8 billion on fossil fuel project designed for reducing poverty and delivering energy services (Lloyd and Subbarao 2009). The problem concerning climate change and its subsequent consequences on the environment is that in order to obtain an improvement of the environmental impacts, this requires a great sacrifice in economic terms and results in very small effects. This is an investment problem because replacing the old technologies that are highly polluting, for newer ones that have low carbon emissions, is very expensive and would have minor consequences unless implemented on a sufficiently large scale (Helm 2005). Renewable energy technologies could also provide a valid alternative to the imports of fossil fuels (Lloyd and Subbarao 2009) and solve the problem of energy access security, however the same deterrent applies: it requires a noticeable investment. The scenario portrayed above is one that applies to numerous countries, including Argentina. In fact, Argentina is rich in renewable energy resources and has great a potential but relies on imports to satisfy the national consumption needs (IEA 2012a) rather than significantly investing in RE.

Certainly switching to RE technologies is expensive and understandably there are few countries that are willing to significantly invest in it unless it is necessary. When balancing the three goals elaborated above, it appears obvious that this is a matter of priorities: mitigating carbon emissions and improving rural livelihoods is important, but securing the national access to energy is often the prime concern of most countries. This means that for a 'paradigm shift' to occur (Helm 2005)(Nuttal and Manz 2008), development is not a sufficiently strong driver. Both Helm (2005) and Nuttal and Manz (2008), hypothesize the shift to take place only after situations have escalated enough to become *politically apparent* (Helm 2005 p.16) or when climate changes become so evident to change the *public perception of its severity* (Nuttall and Manz 2008 p. 1252). However, our current scenario is one that has not (yet?) escalated this far because climate changes are not pressing enough and fossil fuel reserves are still sufficient for a few decades more. For the time being, these problems have led to new targets to reduce emissions but concrete actions are still lacking. In my opinion, this could develop in a very dangerous limbo: if the development of new technologies is affected by the severity of the problems they would solve (in the case of RETs, climate changes and fossil fuel depletion) a limited implementation of them would only mitigate the problem but not solve it at its root. Ironically, this situation could evolve in a way that if the problem becomes worse, there is a higher chance that it would lead to bolder actions and hence be a positive driver for the changes to occur. This new energy *paradox* is rooted in the people's perception of the problem. As argued by Nuttall and Manz (2008) the perceived severity of the problem is the key and driver to the shift.

This should not discourage stakeholders and lead to a sense of hopelessness because like Helm (2005) explains we are at a point in history where 'policy can assist or obstruct this process of market evolution' (p.6). Therefore, it is of utmost importance to start implementing renewable energy technologies as soon as possible. Moreover, there are a number of reasons to start implementing these technologies in the South in addition to the developmental contribution they can offer. First, developing countries have much smaller per capita energy demand, which would tremendously favour the shift (Lloyd and Subbarao 2009). Second, many countries could skip a step in the transition to RE and avoid developing fossil fuel based energy systems (Helm 2005). Third and lastly, the projected growth of some countries in the global south is huge (i.e. Brazil and India) and unless these countries adopt cleaner energy means, the North's efforts to reduce carbon emission could result vain (Venema and Rehman 2007)(Nuttall and Manz 2008). On top of the aforementioned reasons, RE could represent a valuable opportunity to achieve rural development, regardless of their contribution to de-carbonising global energy systems making it this a 'no-regrets' development option (Venema and Rehman 2008 p.881).

For the majority of the world's poor, the effects of climate change and the 'long term health of the planet' are distant concerns (Lloyd and Subbarao 2009). This aspect was reflected also during the field research when candidates said not to be interested in how they receive energy nor of the environmental impacts it has, but to care only about receiving the service. However, most poor do not have access to energy services and resort to deforestation to satisfy their energy needs. This shows that prioritizing goals, which appears to be the driving force for the evolution of the energy market, without cooperation and interaction between the different stakeholders may result to be the source of the energy problems. Considering the growing pressure of climate changes and the imminent fossil fuel depletion, immediate actions is mandatory and, as suggested by Lloyd and Subbarao (2009), starting with developing countries is preferable considering the easier transition and the increased opportunities for the recipients.

Policy Recommendation

This study highlighted the great potential of renewable energy technologies as well as the barriers that impede their proper implementation. These barriers are not negligible and can be overcome with the right tools and a 'multi-dimensional approach' (Byrne et al 2007). Economic incentives, adequate energy policies and an effective institutional framework are some of the tools that can favour the energy sector's development. To favour its development, RE should be integrated in the national and local development planning, including the decentralized technologies. New markets should be created, by encouraging investments in this sector through financial incentives that favour the development of low-cost manufacturing RE systems. Provincial and local governments should work together to promote the use of RETs by establishing new targets for energy consumptions derived from RE sources. Finally, curing the social and cultural aspects is also an important step towards improved RE services. It is vital to establish good relations among stakeholders:

offering users good services for repairs, maintenance and a good assistance at the local level are fundamental aspects. As demonstrated by this study, local ownership can be the key to successfully tackle energy problems and strive for local development. Sustainable RETs have proven to offer significant improvements to rural communities. One of the major hindrances concerns the financial aspect of the RETs, which for this research was rarely the case because of the numerous subsidies the beneficiaries received. However, this can represent a major obstacle for the success of RE in rural areas. One way to make these technologies more affordable in rural settings is by developing microcredit mechanisms that can finance the industry at the local level (Mondal et al 2010)(Byrne et al 2007). Another possible strategy to assist the development of RETs can be obtained by establishing Feed-in-Tariff (FiT) schemes: electricity utilities agree to purchase a certain amount of electricity generated from renewable energy technologies, at a fixed tariff for a determined amount of time, normally around 20 years (Moner-Girona et al. 2008)(Thiam 2011). This scheme has proven to be extremely successful to promote RE in Germany, Denmark and Spain, however this scheme seemed less adequate in developing countries. The Renewable Energy Premium Tariff (RPT), a variation of the FiT scheme, was developed to stimulate the decentralization of RE production. This scheme applies the same basic concept of FiT and applies it to remote and isolated areas within developing countries where the extension of the national grid is not feasible (Thiam 2011)(Moner-Girona et al. 2008). Governments therefore have a major role in the development of RE to develop and enforce reforms and policies, however they can also active actors. Installing RE technologies in government buildings can expand the market and raise awareness among the local population (Mondal et al 2010).

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Annexes

Annex 1: Interview Beneficiaries template (English translation)

Interview with rural communities

Candidate number:
Location:
Date:

Personal info about the candidate:
Name:
Age:
Community population:
Organization affiliation:
Technology:

Setting: (description of the situation)

1. Profession:
2. Since how long has it been installed for?
3. How did you get in contact with the organization?
4. How did you manage before?
5. What resources did you use?
6. Was it more convenient?
7. How much did the previous technology cost?
8. How much did it cost (each part)?

Technology:

1. What are you using this RET for?
2. How long did it take to install?
3. What appliances does it supply?
4. What amount of energy does it produce?
5. How does it work?
6. How long does it take to have power?
7. Are the resources required to power the RET easily accessible and sufficient?
8. Does it satisfy you with the amount of appliances it powers?
9. Which needs do you feel have most been satisfied?
10. Has this RET led to positive besides energy?
11. Has this RET led to negative besides energy?

Community Capacity

Can people use the technology?

1. Who is responsible for the technology?
2. What do you need to do on a daily basis to manage it?
3. Has anyone received training on it?
4. Does it require a lot of work?
5. Is it difficult to use/manage?

6. Do people have to pay anything for the technology?

7. If so, can they afford it?
8. What happens when it breaks?
9. Who is responsible/capable of fixing it?
10. Has it broken in the past?
11. Who fixed it?
12. How long until it was repaired?

Community Willingness

Do people appreciate the changes in their lives?

1. How often is the technology used?
2. What do people use it for?
3. What do you think about it?
4. Is it hard to convince people to use the technology?
5. Did you feel like there was a problem before the technology was here?
6. Whose idea was it to implement this technology?
7. Do other people who don't have it, want it?
8. Are they willing to pay? How much?
9. Are people generally happy about the technology being here?
10. Did people have to change their lives after they installed it?
11. Do people attend the trainings willingly?
12. What has changed since the technology arrived?
13. Would you want more technology like this?

External Support

1. Did the organization install it for you?
2. Do they charge you for its use?
3. How did they install it and how was the experience?
4. Who received it first?
5. Did the community help?
6. Were they helpful/informative in the process?
7. How many people were there?
8. Did they train people?
9. How many and who did they train?
10. Do they come back to make sure things work well?
11. Do they repair it if it's broken?
12. Are there going to be future projects with this organization?

Annex 2: Interview Organization template (English translation)

Interview with organizations

1. **Standard information of the organization**
    1. What's the name of your organization?
    2. What kind of company is it?
    3. When was it founded?
    4. Who founded it?
2. **Motivation and profitability**
    1. Why was it started when it was?
    2. What was the process of starting it? Loans? Government assistance?
    3. What is the mission statement of the organization?
3. **Organizational setup and finances**
    1. How many employees work in the organization?
    2. What is the institutional hierarchy?
    3. How many offices does it have and where?
    4. What is the business model (to earn money)?
4. **Access into the industry**
    1. Who is your targeted demographic? Why?
    2. How many other companies work in this niche?
    3. How do you differentiate from the others?
    4. Is there oversupply or surplus of demand?
    5. Is it easy to find customers?
    6. How do you contact customers/ how do they contact you?
    7. Do you spend a lot on advertising?

8. Have you made profit from your work?
9. Are you planning on expanding?

5. Desired impact

1. Who are your customers?

2. Why do they need your services?

3. What other services do you offer them?

4. What kind of impact do you hope to have?

5. Do you hope to get repeat business from the same customer?

6. Are there any problems you've encountered with supplying customers?

6. Kinds of problems encountered

1. Are you subsidized or helped by any organization financially?

2. Have any government policies affected your company?

3. Have you encountered any financial difficulties? Why?

7. Institutional support and cooperation

1. Are their major partnerships with the organization?

2. If so, why and to what end?

3. Is there a lot of cooperation or competition in the industry?

8. Future prospects

1. Are you planning on remaining in the industry long?

2. Are you planning on expanding or targeting a different demographic?

3. Is the industry as a whole growing? Is this positive or negative for you?

Annex 3: Inventories

Inventories

1. Possible Organization Interviews

Organization	Contact Person	Result
Fundacion Bariloche	Gustavo Nadal	Emailed: meeting scheduled
INENCO	Gea Lesion	Emailed
Government project	Gimenez Yob	TE: (0351) 4341691 / 3 - 4320440 - Int. 226 - Fax: 4320447 Called: meeting scheduled
INTI – Institut Nacional de Tecnologia Industrial	Government http://www.inti.gob.ar/e-renova/erTO/er02.php	Emailed
ERENOVA: energias renovables para la gente	-	Emailed
PERMER – proyecto de energias renovables en mercados rurales	Marta Carrizo	Emailed: meeting scheduled
Asociacion Argentina de Energias Renovables y Ambiente	-	Emailed
La Cancilleria	-	Emailed
Ecoandina	-	Emailed
Zean	fisicacuantica@gmail.com	Emailed
Enlaces	alejandro@falco.net.ar	Emailed
Enersol	enersolingenieria@gmail.com	Emailed
Biosfera	info@biosfera.org	Emailed
Ecosun		
Eolica del sur	info@eolicadelsur.com.ar	
Eolocal	Esteban	Called: scheduled meeting
Energizar	Diego Musolino	Called
Uocra	Paula	Called: scheduled meeting
Wind association	Esteban	Called: scheduled meeting
IFES	Francisco	Meeting arranged
500RPM	Esteban	Called: scheduled meeting
Energia Rural	http://www.energiarur	Emailed

	al.com.ar/contacto.html	
Energia eolica y solar	http://www.energiaeolicaysolar.com.ar/	Emailed
Bioenergy	http://www.bioenergyweb.com.ar/ bioenergy-chaco@conexin.com.arz	Emailed
Solalterna	http://www.solalterna.com/emp.html	Emailed

Annex 4: Possible Beneficiaries Interviews

2. Possible Beneficiaries Interviews

Project	**Contact Person and/or Where**	**Result**
UOCRA	Diego and Paula	Projects near BA, salta, Chubut - sooner the better
Fundacion Bariloche	San Carlos de Bariloche	mid April (to be confirmed)
PERMER	Neuqen	end April (to be confirmed)
IFES – biogas in school	Francisco In Pergamino	will confirm this week
Wind Association	Esteban (contact) Federico Quiroga (user) Las toninas	Confirm next week
Government Organization	Cordoba	Sent Email – No answer

Annex 5: Interviews with beneficiaries (Table 2)

Table 2: Interviews with beneficiaries

N.	DATE	LOCATION	NAME	BENEFICIARIES	ORGANIZATION	TECHNOLOGY
1	30-03-12	Las Toninas, Buenos Aires	Federico Quiroga	1	500 RPM	Wind turbine
2	04-04-12	Gutierrez, Buenos Aires	Beatrice Vargas	1	CEDEPO	Biomass Digester
3	20-04-12	Ing. Jacobacci, Rio Negro	Linda Nilda - Payeres	2	FERCO SUR	Solar Photovoltaic
4	21-04-12	Ing. Jacobacci, Rio Negro	Elba Quinieñau	2	GENTE NUEVA	Solar Photovoltaic
5	23-04-12	Aluminé, Neuquén	Marcela Galera and Sebastiana Calfinahuel	16[4]	PERMER	Solar Photovoltaic
6	23-04-12	Aluminé, Neuquén	Luciano Calhuian	5	PERMER	Solar Photovoltaic
7	23-04-12	Aluminé, Neuquén	Mariana Vazquez	2	PERMER	Solar Photovoltaic
8	24-04-12	Aluminé, Neuquén	Inspection family 1	4	PERMER	Solar Photovoltaic
9	24-04-12	Aluminé, Neuquén	Inspection family 2	5	PERMER	Solar Photovoltaic
10	24-04-12	Aluminé, Neuquén	Inspection family 3	4	PERMER	Solar Photovoltaic
11	29-04-12	El Maiten, Northwest Chubut	Francisco Cañulef	2	ECO CHUBUT	Biomass Digester
12	29-04-12	El Maiten, Northwest Chubut	Juana Linares	4	ECO CHUBUT	Wind turbine
13	29-04-12	El Maiten, Northwest Chubut	Donato Grande	4	ECO CHUBUT	Wind turbine
14	30-04-12	El Maiten, Northwest Chubut	Annamaria Ajuirre	2	SOLUTEC	Wind turbine

[4] Rural School installation

Annex: 6 Interviews with organizations (Table 3)

Table 3: Interviews with organizations

N.	DATE	LOCATION	NAME	KIND	FOUNDED BY	FOUNDED
1	30-03-12	Buenos Aires	SECRETARIAT OF ENERGY	Government	---	---
2	19-04-12	San Carlos de Bariloche	FUNDACION BARILOCHE	Foundation	Government	1950
3	21-04-12	Ing. Jacobacci	FERCORSUR	Non-profit Cooperative	Julian	1994
4	23-04-12	Buenos Aires	PERMER	Government Initiative	Government	2000
5	26-04-12	Buenos Aires	ECO CHUBUT	Private Company	Edgardo Mele	2003
6	30-04-12	Trelew	SOLUTEC	Private Company	Pablo Ballbe	2005
7	06-05-12	Buenos Aires	500 RPM	Non-Profit Organization	Esteban van Dam	2005
8	11-05-12	Buenos Aires	ENERGIZAR	Foundation	Diego Musolino Alejandro Loidl	2010

Figure 14: Photo Solar Panel

Figure 15: Photo Solar Panel

Figure 16: Photo Biomass Digester

Figure 17: Photo Biomass Digester

Figure 18: Photo Wind Turbine

Figure 19: Photo Wind Turbine