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HUMAN GEOGRAPHY AND NEW ENERGY REGIMES: THE CASE OF PICO ISLAND, AZORES

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“Esta ilha – a maior dos Açores – é negra até as entranhas, na própria terra, na bagacina das praias, no pó das estradas, nas casas, nos campos divididos e subdivididos por muros de lava, nas igrejinhas das aldeias, requeimadas e tristes.”

(As Ilhas Desconhecidas, de Raul Brandão)

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ABSTRACT

Globally, the dominant energy paradigm of our time is being challenged and changed. As the negative impacts, conflicts and uncertainty over the future supply of fossil fuel energies persists, alternative options are increasingly being adopted and promoted. Principal amongst these are renewable energies, options believed to be sustainable, cleaner and to have a lower environmental impact than that of our current carbon energy regime. Shifting to a renewable energy regime, however, is bound to bring with it its own set of impacts, conflicts and challenges, as energy affects the landscape and the landscape affects energy.

The purpose of this study has been to examine the change to a new renewable energy paradigm through an energy geography lens. This study has attempted to do so by examining a remote island where a shift from the dominant fossil fuel paradigm to one powered by renewable energies is taking place.

The Island of Pico in the Autonomous Region of the Azores was selected for this analysis. This island, being an outermost region of the EU, was selected due to the fact that it has an isolated energy system that is not connected to any outside energy source, and therefore, it has to produce all its energy locally. It was believed that Pico may serve as an example of how a place that is totally dependent on fossil fuel imports may aim to switch to locally produce 100% of its energy from renewable sources.

This study was carried out in three parts: first, a theoretical component involving a literature review on types of energy and the discipline of geography; second, an examination of paradigm shifts on two other EU Islands; and third, a practical component involving a case study analysis conducted on Pico Island through structured interviews and a survey questionnaire.

Such a change in paradigm does seem possible for Pico, as the vast majority of participants believed such a change was possible, that it would be positive for Pico and its image, and they are open to seeing it happen. How, if and when Pico will achieve a 100% shift of paradigm remains to be seen. It was also found that it remains unclear as to whether Pico Island may follow or adapt the models used by other islands or if it must develop its own model to make this shift. This is something that requires further study.

Keywords: energy geography; renewable energy systems, energy paradigm, remote islands, energy self-sufficiency.

RESUMO

Globalmente, o paradigma dominante de energia do nosso tempo está sendo desafiado e modificado. Em razão dos impactos negativos, dos conflitos e da incerteza quanto ao futuro fornecimento de combustíveis fósseis, alternativas estão sendo cada vez mais adotadas e impulsionadas. A principal delas, são as energias renováveis, consideradas sustentáveis, limpas e de menor impacto ambiental se comparadas ao atual regime de energia de carbono. Entretanto, uma mudança para o regime de energia renovável, inevitavelmente, traz consigo impactos, conflitos e desafios, a exemplo da energia afetar a paisagem e a paisagem afetar a energia.

O objetivo deste estudo foi examinar a mudança de um paradigma de energia fóssil para um novo paradigma de energia renovável, sob a perspectiva da 'energy geography'. Este estudo buscou examinar essa mudança em uma ilha remota, onde esta transição de paradigma de energia está a ocorrer. A Ilha do Pico, localizada na Região Autónoma dos Açores, uma região ultraperiférica da União Europeia, foi selecionada para essa análise. Isso se deve ao fato de que a ilha possui um sistema de energia isolado que não está conectado a nenhuma fonte de energia externa e, portanto, necessita produzir localmente toda a sua energia. Acredita-se que o Pico pode ser um exemplo de como um lugar totalmente dependente da importação de combustíveis fósseis, pode mudar para produzir 100% de sua energia a partir de fontes renováveis.

Este trabalho foi organizado em três partes. A primeira, apresenta uma revisão da literatura sobre os tipos de energia e a disciplina da geografia; a segunda, examina as mudanças de paradigma energético em outras duas ilhas da UE; e a terceira, apresenta a análise do estudo de caso realizado na Ilha do Pico através de entrevistas estruturadas e questionários de pesquisa.

Tal mudança de paradigma parece ser possível para o Pico, conforme a opinião da grande maioria dos participantes do estudo. Eles acreditam que essa mudança é possível; que ela será positiva para o Pico e sua imagem; e que estão abertos para que isso aconteça.

Como, *se* e *quando* o Pico alcançará 100% da mudança de paradigma ainda não sabemos. Também não sabemos se a ilha do Pico seguirá ou se adaptará aos modelos usados por outras ilhas, ou se deve desenvolver o seu próprio modelo para fazer essa mudança. Isso é algo que requer um estudo mais aprofundado.

Palavras-chave: 'energy geography'; sistemas de energia renovável; paradigma energético; ilhas remotas; energia autossuficiente.

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INTRODUCTION

Increasingly, the negative impacts that result from our current energy paradigm are becoming ever more apparent. This is as fossil fuels are linked to issues such climate change, global warming, wars and economic crises. Being a non-renewable resource whose peak supply has already been surpassed, it seems logical to reason that the fossil fuel energy paradigm will inevitably come to an end. The question then becomes when will this shift of energy result? and also what will it look like? The recent surge in demand for renewable energy technologies, such as wind turbines, solar panels, geothermal, biomass and hydroelectricity, suggest that a shift to a new renewable energy paradigm is underway.

Historically, such transitions have been slow, as societies tend to be locked-in to a current energy regime via the infrastructure they have created to access it. Moving away from fossil fuels, then, will require new energies to be economically competitive and for there to exist a drive and will on behalf of citizens and the public sector to shift towards them.

What is certain is that such a shift in energy paradigm will change and impact the landscape, just as the landscape will impact and influence it. Understanding how such a shift of energy paradigm can occur and the associated impacts and issues it creates, is something which requires geographical analysis. For this reason, the purpose of this study is to examine the change to a new renewable energy paradigm through a geographic lens. It attempts to do so by examining remote islands where a shift is resulting through an energy geography lens.

This study, therefore, aims to address the following questions as they relate to the Island of Pico in the Azores: Is the change to a renewable energy paradigm possible? Who has a role in this and who will drive this change? Does Pico Island have all the capital to control this change? Is everybody aware of this change? Who will benefit more? Who will benefit less? What individual and collective geographies and landscapes will this change (re)build? Will this new paradigm possibly change the outside image of the island, shifting it towards a more positive perception?

This study will be divided into three parts: First, a theoretical component; second, an examination of paradigm shifts on two EU Islands; and third, a practical component involving a case study analysis conducted through structured interviews and a survey questionnaire.

In the theoretical component an attempt will be made, based on several authors and sources, to frame the subject in question and to do so as detailed as possible. To that end, some statistical information will be collected and added with relevance to the topics that are being examined. All the information that is able to be accessed will be used to its fullest.

The second part, an examination of the Island of El Hierro (of the Canary Islands of Spain) and the Island of Samso (of Denmark) - will later be linked to the themes discussed in the subsequent parts. This will be important as one seeks to understand an energy transition that is resulting from a shift in energy paradigm. This energy transition, it is hoped, will demonstrate the role and relevance of Geography in this study. These two islands were chosen specifically because they are islands which belong to the European Union (as does the case study Island of Pico) and are similar to Pico in terms of their size (area), population and geographical characteristics. Furthermore, they also have been selected as they are both examples of islands that have already made a renewable energy transition away from fossil fuel dependency towards 100% renewable energy independence. In addition, they represent two different contexts and locales, as Samso is situated in Northern Europe while El Hierro is situated off the coast of West Africa and belongs to Spain of Southern Europe. Lastly, both islands possess and are powered by wind energy, the unique renewable energy source which Pico currently has integrated into its energy grid.

The examination of these islands is meant to allow for an understanding of what the energy transition looked like for these islands and how it happened. By understanding how these energy transitions transformed the landscape, territoriality and populations of these islands, it is then possible to develop a triangle analysis model of how each transition happened on each island. Finally, comparisons between the models will allow for an understanding of whether one similar model or two distinct models exist. These findings can be applied to Pico to understand if a third model is needed or if simply the models from these two islands can be applied on Pico.

Following this, a practical component – a case study, will be examined. This is to be based on the shift to a renewable energy paradigm (from a fossil fuel energy paradigm) on the island of Pico in the Azores. It is to be carried out by analysing results from 10 face-to-face structured interviews for a qualitative analysis and 120 survey questionnaires for a quantitative analysis. These results may illuminate the possibilities of energy transitions and show to what extent this can be a global and collective project, without negative effects and without conflicts.

PART I │ ENERGY, SUSTAINABILITY AND TERRITORY

1. ENERGY AND GEOGRAPHY

1.1. THE NEED TO STUDY ENERGY PARADIGMS THROUGH A GEOGRAPHIC LENS

The energy sector and its dominant fossil fuel energy paradigm are increasingly being challenged as renewable forms of energy production are transforming energy paradigms around the globe. It is of vital importance to analyse these changing energy paradigms through a geographic lens in order to be able to understand the implications of and reasons for these changes. This is as the new renewable energy paradigm is “a relatively new phenomenon, [for which] very little research has been published…” (KAZA & CURTIS, 2014: 362).

Also, while historically the topic of energy in the field of geography has been little studied, it is argued that geography has always been of great importance to the energy sector. In fact, the two are tied together so much so that the connections between them are often taken for granted (WILBANKS, 1982). In fact, many scholars have acknowledged the re-emergence of energy as a concern for geographers (BRIDGE *et al.*, 2013; CALVERT, 2016; PASQUALETTI & BROWN, 2014: ZIMMERER, 2011 in HAARSTAD & WANVIK, 2016: 3).

Currently, geographers have much to contribute to analyzing the energy and resource sectors, landscapes and material artefacts (HAARSTAD & WANVIK, 2016: 3). For example, geographers are increasingly important for the study of renewable energies as their use increases because “the relative effects of location and distance on the economics of energy regimes are increasing as we begin to deploy more RETs [renewable energy technologies].” (CALVERT & SIMANDIAN, 2010: 31; HOARE, 1979: 206).

In addition, the discipline of geography is well suited to study energy regimes, for it possesses many aspects through which it can study energy. First, geography may study energy directly by studying the geography of energy sources, landscapes that are shaped by energy exploration, the transportation and storage of different forms of energy and the conflicts that result from energy appropriation, possession and control (something which, for example, brings political geography to political ecology). Second, geography may study energy indirectly by looking at the way in which energy, in its different sources and typologies, changes the landscape, ways of living and territorialities (CALVERT, 2016; HAARSTAD & WANVIK, 2016: 3).

Furthermore, it is important that geographers study the newly emerging energy paradigm, as it possesses many spatial and geographical issues. These issues, such as the spatial characteristics of the economics of energy, still need to be further explored. Due to the position geographers occupy between disciplines and the associated interdisciplinary toolsets they have at their disposal, they must "unpack geographical patterns of energy related socio-spatial change and… examine the causes and consequences of alternative energy policies…to be sure that analyses are not privileging production at the expense of consumption (or vice versa)" and contribute to solving these issues (CALVERT & SIMANDIAN, 2010: 31; JAZEEL, 2016: 649).

Additionally, economic geographers are well suited to study renewable energy transitions due to the fact that they understand economy-environment interactions. These geographers can provide conceptual and analytical tools that structure new renewable energy paradigms. Geographers can direct such tools across many scales (for example, local and regional scales) as renewable energies are site-specific and localized in nature (CALVERT & SIMANDIAN, 2010: 31; JONES, 2016: 697).

CALVERT (2015) has suggested that geographers are capable of interpreting the energy infrastructure that exists in a given area to then be able to explain the energy patterns and decisions that are being made and its impacts on stakeholders and the environment. Also, energy geographers possess a unique perspective that makes them especially well-suited to contribute to debates (scientific and policy) on energy (CALVERT, 2015: 105).

According to CALVERT (2016), energy geographers may use the following to better understand and explain the shift towards a renewable energy paradigm: 1) advanced socio-spatial theory to better understand energy-society relationships; 2) geo-political and geo-economic assessments of (changing) global energy trade networks; 3) geographical perspectives on socio-technical (energy) transitions; and 4) advanced spatial decision-support for energy planning and technology implementation (CALVERT, 2016: 105).

All in all, it is perhaps more important than it ever has been for geographers to examine energy paradigms. This is as a shift from fossil fuels to renewable energies is taking place around the globe. A geographic lens is needed to understand the reasons why these changes are occurring as well as the implications of them. Geography has always been and still is of great importance to the energy sector. This is because the two are tied together as various energies transform the landscape in various ways. Understanding how this new energy paradigm will lead to a new landscape and a new way of living with the landscape is something that geographers must work to understand. Geography, therefore, is key to understanding how this new energy paradigm is linked to a new spatial pattern, something that is explored in further detail in the section (1.3). In the following section, a discussion over which field of geography and which social sciences are included in a study on energy are discussed.

1.2. ENERGY AND TERRITORY: A NEW BRANCH OF GEOGRAPHY IN AN INTERDISCIPLINARY DOMAIN?

As the purpose of this study is to examine the change to a new energy paradigm through a geographic lens, it is then necessary to identify the subfield of geography that will be utilized and its associated scope and focus.

This study aims to address the following questions as they related to the Island of Pico in the Azores: Is the change to a renewable energy paradigm possible? Who has a role in this and who will drive this change? Does Pico Island have all the capital to control this change? Is everybody aware of this change? Who will benefit more? Who will benefit less? What individual and collective geographies and landscapes will this change (re)build? Will this new paradigm possibly change the outside image of the island, shifting it towards a more positive perception? Addressing these questions, it may be argued, can be done utilizing lenses from a variety of different social studies and fields. Included among these are the numerous different sub-disciplines of geography itself.

As was described in section 1.1, geography matters when it comes to energy studies. It is becoming more and more evident that energy studies fit within geography research. This is because geography is broad, pluralistic and interdisciplinary (overlaps with other disciplines) and it is its interdisciplinary approach that allows it to join the debate over energy paradigms (CALVERT, 2016: 106).

Despite this being the case, it is still "difficult to articulate the intellectual, scientific and social relevance of geographical perspectives relative to the wide range of disciplines already engaged in energy issues." (CALVERT, 2016: 107). This makes it difficult to decide on which subfield of geography is best suited to address questions on energy issues. This is because geography uses many "theories, concepts, and techniques borne out of a range of sub-disciplines from very different philosophical positions." (CALVERT, 2016: 108). Such disciplines include:

> evolutionary economics (Kedron and Bagchi-Sen, 2011); cultural studies (Spinney et al., 2012; Nadaı¨ and Labussie`re, 2013); political science (Neville and Dauvergne, 2012); political economy (Huber, 2008); political ecology and legal studies (Andrews and McCarthy, 2013); history (Harrison, 2013) or historiography (Pooley, 2010); sociology (Dorow and O'Shaughnessy, 2013); environmental psychology (Devine-Wright, 2007); science and technology studies (Furlong, 2011; Bickerstaff, 2012; Birch and Calvert, forthcoming); urban planning (Owens, 1986); regional science (Feder, 2004; Mabee and Mirck, 2011; Court et al., 2013); climatology (Li et al., 2011); GIScience (Horner et al., 2011; Calvert et al., 2013; Resch et al., 2014); remote sensing (Sabins, 2004; Wang et al., 2009); and civil engineering/engineering economics (Zvoleff et al., 2009; Nguyen and Pearce, 2010). (CALVERT, 2016: 108).

Also making the question of which field of geography is best suited to address questions on energy is made difficult by the fact that approaches in geography that attempt to do so are considered to be "an academic borderland" between disciplines in the social sciences (CALVERT, 2016: 108). That is to say, geography is:

> a topical field of study where sometimes disparate or disjointed systems of geographical thought and practice, borne out of work rooted in the core sub-fields of geography (see Pattison, 1964; Robinson, 1974; Livingstone, 1992; Sui, 2004; Martin, 2005), converge on the study of past, current, and future patterns of energy production, distribution, and use at various geographical scales (CALVERT, 2016: 108).

Thus, studies on energy in geography are shown to be composed of an overlap of the sub-disciplines of geography and other social sciences. These include geographic information systems, physical geography, nature-society or human-environment geography and human geography. These are all linked to multiple disciplines, as illustrated in figure 1 on the next page.

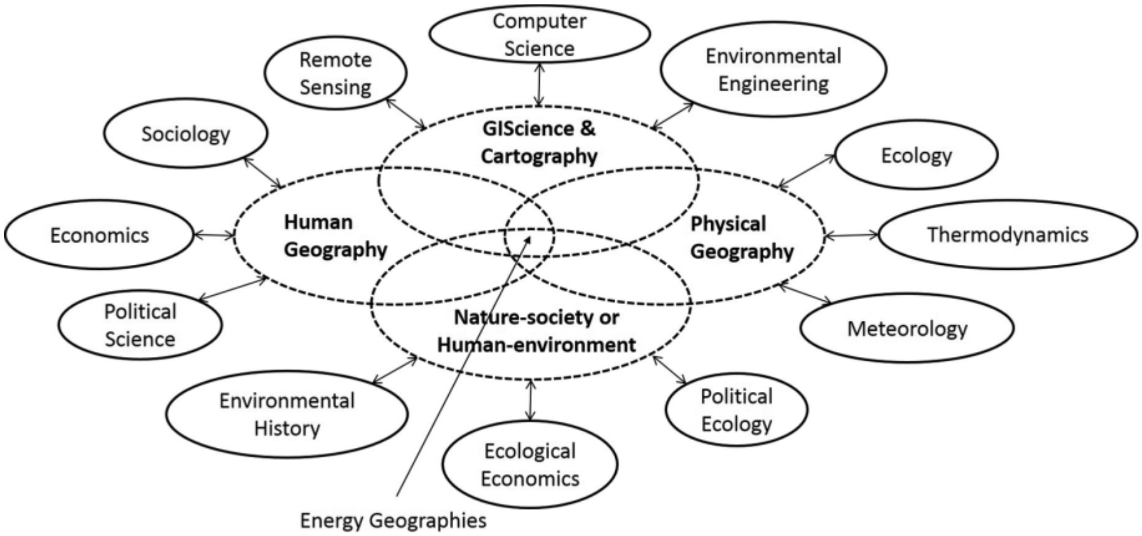

Fig. 1 - Core subfields and borderlands (overlapping subfields) in geography
Source: CALVERT, 2016: 109.

For the purposes of this study, the sub-discipline of geography that has been utilised to address the research questions is primarily that of 'Energy Geography'. This is followed by 'nature-society or human-environment geography' and then by the related and overlapping field of 'political ecology'.

Furthermore, energy geography (as is illustrated in figure 1), is composed of the geographic sub-disciplines of physical geography, human geography, nature-society or human-environment geography, GIS science and cartography. All of these directly relate to the study of energy. Firstly, physical geography is concerned with physical things in nature that are formed from natural processes and that are then transformed through physical systems. Secondly, human geography is concerned with social relationships, as it considers how physical energy resources are socially constructed through political, economic and cultural processes and how these resources lead to the spatialization of social activities. Thirdly, nature-society or human-environment geography is concerned with who are the mediators or drivers of our relationship with energy resources in the environment. Lastly, GIS science and cartography are concerned with why energy resources are not uniform over space and how they are made accessible or inaccessible by site level conditions (CALVERT, 2016: 108-109; CALVERT, PEARCE & MABEE, 2013).

As a discipline, ‘energy geography’ relates to fields outside of geography, such as anthropology, sociology, critical theory, history, natural resources, political economy, and so on. Because of this, it has been argued that ‘energy geography’ is a “distinct subfield” of geography (BAKKER & BRIDGE, 2006 in CALVERT, 2016; HAARSTAD & WANVIK, 2016: 3). Thus, energy geography is the most pertinent subfield of geography that is used to carry out this study.

It is therefore necessary here to define energy geography, since it is the geographic sub-discipline that has provided the lens through which this study has been conducted. Defining ‘energy geography’, however, is no easy task. This is because geographical researchers studying energy possess no desire to create a clearly defined approach as to what it is. Firstly, this is because many of them feel the strength of the discipline lies in its flexibility to be pluralistic and incorporate various theoretical and conceptual ideas so that energy geographers can be involved in multidisciplinary research projects and they can get funding for such research projects. Secondly, it lies in the disciplines ability to be free of a “common doctrine or particular mode of inquiry” thereby offering energy geographers intellectual freedom (CALVERT, 2016: 108).

Despite this, energy geography has been defined. Some have defined it as being “the study of energy development, transportation, markets, or use patterns and their determinants from a spatial, regional, or resource management perspective’…” (SOLOMON & PASQUALETTE, 2004: 831). Likewise, others have attempted to describe it, such as COOK (1976), who describes energy geography in very similar terms as it is:

> the ways in which energy mediates the human-environment relationship. Here, the study of energy is presented as an obvious link between human and physical geography (Hoare, 1979), thereby situating energy studies firmly within geography’s human-environment or nature-society tradition (see also Smil, 2008) (CALVERT, 2016: 107).

Here, we see how energy geography was founded as lying between some of the various sub-disciplines of geography that were outlined above. This has ensured that it has a coherent set of practices and philosophies to guide it. Originally, the field of energy geography used resource and economic geography lenses along with a “managerial and positivist bent” (CALVERT, 2016: 107). Energy geography itself is concerned with the tasks of:

> monitoring energy supply-chain developments; identifying place-based factors which explained observed spatial patterns of energy-sector investment; assessing environmental and economic risk in facility siting,… understanding how energy technology diffuses within and between nations; and mapping regional variations in energy production, distribution, and use (CALVERT, 2016: 107).

Meanwhile, major threads of research in energy geography have included:

> Formulating spatio-temporal models of energy budgets for socio-ecological systems; learning how processes of energy capture, storage, distribution, and use are manifest spatially within socio-ecological systems and how they are related to the physical properties of the resource base; understanding and forecasting spatial patterns of environmental impacts related to human energy production and consumption; and tracing links between energy development, livelihoods, and environmental injustice. (CALVERT, 2016: 107-108).

As a result of incorporating these threads, energy geographers are "well positioned to contribute to scientific and policy debates surrounding energy due to their privileged position at the borderland between various philosophical and methodological traditions" (CALVERT, 2016: 105; CALVERT, PEARCE & MABEE, 2013).

Based upon the above descriptions of energy geography and possessing an understanding of the research aims of this study, the author of this report has aimed to answer the research questions by using an energy geography lens. Now that the lens through which this study has been conducted has been clearly defined, it is now possible to describe the energy and geography relationship of how landscape and energy shape each other. This is described next in section 1.3.

1.3. ENERGY AND GEOGRAPHY: HOW LANDSCAPE SHAPES ENERGY AND HOW ENERGY SHAPES LANDSCAPE

As was suggested in the previous section, Geography is important in understanding how a new energy paradigm is linked to new spatial patterns. This section therefore explores how the landscape patterns of an area are responsible for shaping the energy that exists in a given location. Also, how the type of energy that is utilised in an area results in the shaping of the landscape of that area, is also explored.

The current dominant energy paradigm, that being composed of fossil fuels, shapes the landscape and conversely sees the landscape shape it. These landscapes may be referred to as "Carbonscapes" which are "the social and material landscapes of oil…spaces created by material expressions of carbon-based energy systems and the institutional and cultural practices attached to them" (HAARSTAD & WANVIK, 2016: 1-2).

Included in these 'carbonscapes' are the production zones and networks of the big oil companies which dominate the fossil fuel energy paradigm. These include zones of extraction ("hot zones"), infrastructure (for energy distribution) and spaces of consumption (for example, urban spaces). Modern society's dependence on fossil fuels is visible in the landscapes (material and physical) of countries around the globe. The historic abundance of cheap oil has led to the construction of energy networks around the world that has shaped the majority of our built environments. It must be noted, however, that oil is cheap not only due to the fact that a great abundance of it exists, but also because oil has become cheaper due to the fact that its production has been greatly expanded over time and the technologies needed to extract it have also advanced over time. The resulting 'carbonscaped' environments, in return, affect our behaviour by making us act in ways in which we must continue to use, manage and depend upon fossil fuel energy. Symbols of how important fossil fuels are to our way of life, economy and culture include the many gas stations, oil rigs, tankers, pipelines and extraction sites which dot the globe (HAARSTAD & WANVIK, 2016: 1; HOARE, 1979: 507).

The points where infrastructure, technology, the constructed environment and governing regimes (social, cultural, political) come together are the places where these carbonscapes are created and altered (HAARSTAD & WANVIK, 2016: 2). This concept of carbonscapes (which falls within the dominant fossil fuel paradigm), therefore results as energy shapes the landscape and the landscape shapes energy. The different infrastructures of different energies, whether they be fossil fuel based or renewables, must manage landscape-energy issues (GEIDL *et al*., 2007). In stark contrast to carbonscapes, which include dark and barren open pit coal and tar sands mines, are the landscapes of national or natural parks that reflect a different spatial attitude – that of the need to preserve and protect nature from human development and habitation.

In addition to fossil fuels and their interaction with the landscape, let us now consider the new paradigm of renewable energy which the world is shifting towards. The reason for this change away from fossil fuels and towards renewables has resulted from great pressure from environmental groups, but also because a newly emerging 'green economy' has demonstrated that a new energy paradigm can also bring profits along with it, a fact that is very important to justify and guarantee this shift occurs (FRONDEL *et* al., 2010; FEHRENBACHER, 2015; EC, 2014; EC 2017).

Firstly, the energy sector (fossil fuel and renewable based) is greatly impacted by the geographies of distance, location, and scale. This is as all of these impact the cost of deploying a particular type of energy infrastructure. That is to say, there are "effects of location and distance on energy economics" (CALVERT & SIMANDAN, 2010: 14). Further, the concept of the "friction of distance" affects the choice of energy landscape (that is fossil fuel or renewable) that is adopted for a given location (CALVERT & SIMANDAN, 2010: 13). Due to this 'friction of distance' the new renewable energy landscapes are far different than the dominant fossil fuel based ones. This renewable energy landscape makes up "the new energy paradigm" and is "being reflected in the landscape as distributed, decentralized, and diversified patterns of energy generation." (CALVERT & SIMANDAN, 2010: 31).

Secondly, the physical nature of the energy source determines the type of conversion technology that is necessary to be able to use it or convert it into usable energy. The infrastructure that is needed to move this energy will shape spatial patterns and will determine whether the technology is economically feasible. In other words, location and distance matter in the economics of energy systems. This location and distance includes the points of resource extraction, transport, energy conversion and transmission. These are all intimately tied to the physical nature of the energy source, and can make it economically feasible or unfeasible to develop (CALVERT & SIMANDAN, 2010: 31).

Thirdly, just like the physical nature of the landscape affects the type of energy used, so too does the choice of energy that is used dramatically change the physical, social and economic landscape of a place (CALVERT & SIMANDAN, 2010: 23). The choice of which energy source to exploit will affect a society in terms of how it is organized socio-spatially. The geography of a place will be affected as different types of renewable energies have different types of energy peaks, fluctuations and natures of localization. Decisions to address these will affect local and regional scales and how they are organized. In summary then, with respect to renewable energy use, the physical Geography of the land is "a hugely important limiting factor" (CALVERT & SIMANDAN, 2010: 31).

Similarly, KAZA & CURTIS (2014) affirm that "the nature of energy production and the type of fuel that is harvested have different implications for planners" and thus on the landscape (KAZA & CURTIS, 2014: 360). They argue that to date, renewable energy programs have aimed to significantly alter the natural landscape differently than the ways that the dominant fossil fuel energy paradigm has. According to them, the natural landscape has been altered as renewable energies may be harvested via "centralized generation" (when there exists sufficient economies of scale), or by "small-scale distribution systems" (when fuel sources are widely dispersed), in other words, what is decentralized generation (KAZA & CURTIS, 2014: 360).

Furthermore, the energy-landscape relationship exists as "Energy changes landscape and landscape changes energy because of extraction, generation, transmission and waste disposal" (KAZA & CURTIS, 2014: 356). For example, with respect to the conventional dominant fossil fuel energy paradigm, extracting fossil fuels for "conventional energy applications … [something that] significantly alters the landscape and results in pollution and water consumption." (KAZA & CURTIS, 2014: 356). With respect to transmission, transportation results in issues as it requires the utilization of existing transportation infrastructure (for example, railways and roads) thereby putting additional strain on them. In addition, transmission construction can create siting issues (for example, the case of locating a gas pipeline). Concerning waste disposal, water used for energy generation may drain local water sources and may then be released into local ecosystems after use at higher temperatures than usual. Furthermore, pollutants from burning fuels may also be released into the air and may come to rest on and contaminate the land (KAZA & CURTIS, 2014: 356).

It becomes evident here then, that in terms of the landscape energy relationship, it is necessary to consider the various pros and cons of the various types of energies that are available and that fit within either the traditional fossil fuel energy paradigm or the new renewable energy paradigm. The various types of available energies are discussed further in terms of their relationship with landscapes in section 1.6. Next, how these landscape-energy relationships (of fossil fuels and renewables) can potentially lead to conflict is considered. This is also done for renewables as the new energy paradigm has also brought with it new landscapes (and conflicts), as for example, has been demonstrated by the case of wind turbines in Portugal that have altered the landscape of the Portuguese countryside (DELICADO *et al*., 2013).

1.4. ENERGY: BETWEEN HARMONY AND TERRITORIAL CONFLICTS

Despite the many benefits provided by the current energy paradigm, numerous issues exist with respect to its extraction, generation, transmission and waste disposal (KAZA & CURTIS, 2014). As was affirmed above, through the energy-landscape relationship "energy is at the core of the society-nature relationship" and the dominant fossil fuel energy paradigm involves the combustion of fossil fuels resulting in not only climate change but also "unprecedented rates of land-use and land cover change" (CALVERT & SIMANDIAN, 2010: 27). As a result, energy landscapes may lead to territorial conflicts. It then becomes necessary to employ energy rationality in order to resolve conflicts that result over energy.

As was suggested in the previous section, renewable energy landscapes may be either centralized or decentralized in nature. As a majority of renewable energy production tends to be decentralized in nature, the production of energy from renewable sources " will be visible to a greater proportion of the population." (CALVERT & SIMANDIAN, 2010: 24). The result of this greater visibility of where our energy is coming from is that more protests and public consultations surrounding the locating and production of renewable energy projects will become more commonplace (DELICADO *et al.*, 2013). This is as people often don't want to see energy infrastructure dominating or dotting the landscape of their day to day lives and as a result they may develop 'Not In My Back Yard - NIMBY' attitudes towards the siting of renewable energy projects (MERRIAM-WEBSTER, 2017; MATTHEWS, 2001).

Another issue with increasing renewable energies is energy sovereignty. It is generally believed that due to the decentralised nature of most renewable energies that greater energy autonomy is associated with them. This, however, is not necessarily the case, as in many cases, local stakeholders do not acquire more power or energy sovereignty over their energy as that tends to be possessed by outside stakeholders. This is a fact that is supported by market evidence. One such example is renewable energy "subsidy farming". This inability to acquire greater energy sovereignty is what may be considered "…a common phenomenon… which might be conceptualized as a neo-colonial enterprise." (CALVERT & SIMANDIAN, 2010: 24).

Additionally, another issue is that of competing land use. To implement renewable energy production projects it is necessary to site them on pieces of land. This same land may have current or future land uses that compete with renewables. This is an issue as land is the limiting factor in achieving a 100% renewable energy supplied energy system. That is, the availability of land that is suitable for housing renewable energy production projects is limited. Land with current "land based economic activities or ecosystem services" (CALVERT & MABEE, 2015: 209) must be allocated or reallocated for renewable energy production. The key is to do this without compromising how the land is currently being used and thereby avoiding conflict. (PALMAS *et al.*, 2014; SCHMIDT *et al.*, 2012; STOEGLEHNER, NEIMETZ, & KETTL, 2011; STREMKEY, 2010; in CALVERT& MABEE, 2015: 209).

Conversely, conflict over competing land uses may be resolved, as "multiple technologies can be integrated or co-located at a given site in order to liberate more than a single source of [renewable energy] RE from the same land base." (CALVERT & MABEE, 2015: 209). An example of this is with solar and wind farms being sited on the same parcel of land. However, one energy option may benefit over the other, thus requiring a "trade-off scenario as the allocation of mutual land toward one RE option might reduce or preclude the production potential from another option." (CALVERT & MABEE, 2015: 210). Land can therefore be used to support one or more renewable energy technologies at the same time, or to support the integration of energy and non-energy land uses on the same parcel of land. Examples include integrating solar farms or wind farms together with traditional food production farming (CALVERT & MABEE, 2015: 210; DELICADO *et al.*, 2013; JABER, 2013; BRANT *et al*., 2016; GORMALLY *et al*., 2016).

A further source of potential conflict relates to competing uses of agriculturally produced crops. Whether crops are to be grown for food (to feed people or other animals) or for fuel (to be burned in biofuel energy production plants or to power automobiles) can also be a source of conflict. This is as decisions on how much land to use to grow what, and, how much of what to grow, can affect market prices for a particular crop, thereby negatively affecting both the producers and consumers of food and energy (CALVERT & MABEE, 2015: 209-210; BRIDGE, 2014: 118-119; NATENELOV, 2013).

Solar farming may also present further conflict. Using land which is potentially bio-productive for solar farming may mean sacrificing the ability to grow bioenergy crops for fuel and therefore ensure energy sustainability for a particular area. This is as "regional energy autarky" is dependent on agricultural crops for bioenergy and on forest resources to provide a "base-load of dispatchable heat and power" (SCHMIDT *et* al. 2012 in CALVERT & MABEE, 2015: 210). Despite this, it is argued that solar farms often use insignificant amounts of land and the land itself can be converted back to its original use after the panels are decommissioned (SCHMIDT *et al.*, 2012; in CALVERT & MABEE, 2015: 210).

Furthermore, energy can lead to societal relationships that are either harmonious or that are prone to conflict. This is as the “Built environments, geo-political relationships, and flows of social and financial capital are organized in relation to the quality and location of the energy resources that are available and valued by a society (LUTEN, 1971; CHAPMAN, 1989; in CALVERT, 2016: 105-106). This is also true for eco-political relationships. It has been noted that “energy is the primary mediator in the human-environment relationship and travels through coupled socio-ecological systems” (COOK, 1976; SMIL, 2008; in CALVERT, 2016: 106). It is how these relationships are managed that can either lead to conflict or harmony. This is as energy is problematic to manage as “The act of recovering energy, whether for food or fuel, necessarily requires some intervention in or re-orientation of natural energy flows and at the same time influences the scale and location of human modifications to non-human systems.” (CALVERT, 2016: 106).

Mismanagement of energy resources or poor choices of type of energy to be utilized can lead to suffering numerous negative consequences. These may include: oil price instability; energy insecurity; terrorism; geopolitical tensions; regional oil hegemony competition; environmental degradation; dependence on non-renewable energy sources; de-territorialisation and dispossession problems, along with stronger, more elaborate and powerful indigenous rights movements (for rights, land titles, and protecting traditional land uses); infrastructure vulnerabilities (pipelines, rail lines, ports, ships, roads, trucks and gas stations); and unstable carbonscapes (of extraction, conversion, transportation and consumption of energy) (KAZA & CURTIS, 2014; JACOBSSON & JOHNSON, 2000, FRONDEL *et al*., 2010).

In summary, these issues demonstrate that energy choices lead to conflict. Issues arise over fuel extraction, transportation, transmission, distribution, plant siting, waste disposal, import dependency, climate change, exporting resources (overseas for profit at the expense of national energy security), economic risks, ecological risks, land-use competition, land-cover changes, re-allocation of ecosystem resources and carbon taxation schemes (KAZA & CURTIS,2014: 355; JACOBSSON & JOHNSON, 2000, FRONDEL *et al*., 2010). The next section (1.5) explores what is the driving force behind the new renewable energy paradigm.

1.5. THE NEED TO TRANSITION FROM FOSSIL FUELS TO RENEWABLE SOURCES OF ENERGY: CLIMATE CHANGE, GLOBAL WARMING AND SEA LEVEL RISE

There has been widespread agreement and acknowledgement of the negative effects that have resulted from utilising fossil fuels as the main energy source for modern industrialised economies over the last several centuries. Principal amongst these are the phenomena of climate change, global warming and sea level rise. It is believed that if we continue to burn fossil fuels, thereby continuing current trends in emissions, the mass extinction of species on earth will result. Estimates predict that between 15 to 30 percent of all the earth's plant and animal species will be threatened. Additionally, sea levels will rise by many metres (leading to the loss of coastline lands and Islands), staple food crops will significantly decline, glacial runoff or seasonal snowmelt dependant regions will face severe water shortages, the Arctic`s ice cap will disappear, forests will die and forced displacement (via climate refugees) and wars will increase (KOLBERT, 2008).

Further, climate change has raised the earth's average temperature by about 0.85 degrees Celsius since 1880. Grain crop yield decline, ocean warming and an increase in frequency and intensity of extreme weather events have been connected to human induced climate change that has been attributed to the burning of fossil fuels. This has resulted in death, destruction, loss of incomes and loss of land and resources thereby threatening people's ways of life (UN, 2016).

Globally, there has been an acknowledgement of the negative effects of continuing to use fossil fuels as our dominant energy source. For example, in 2015, some 193 Signatories and 114 Parties of different countries from around the world signed onto the Paris Accord in Paris France, agreeing that they must take action to keep global average temperature rise to well below 2 degrees Celsius. According to the UN:

> Affordable, scalable solutions are now available to enable countries to leapfrog to cleaner, more resilient economies. The pace of change is quickening as more people are turning to renewable energy and a range of other measures that will reduce emissions and increase adaptation efforts (UN, 2016).

In addition to the UN, the European Commission of the European Union also acknowledges that urgent action is needed in order to be able to combat the negative effects of fossil fuel induced climate change. They suggest the problem requires immediately reducing and transitioning away from fossil fuels as a source of EU energy production, as:

> Climate and resource challenges require drastic action. A strong dependence on fossil fuels such as oil and the inefficient use of raw materials expose our consumers and businesses to harmful and costly price shocks, threatening our economic security and contributing to climate change. The expansion of the world population from 6 to 9 billion will intensify global competition for natural resources, and put pressure on the environment. The EU must continue its outreach to other parts of the world in pursuit of a worldwide solution to the problems of climate change at the same time as we implement our agreed climate and energy strategy across the territory of the Union (EUROPE 2020, 2010: 8).

In addition, the United Nation's Intergovernmental Panel on Climate Change (IPCC) echoes these concerns as it itself has warned that human induced climate change caused through the burning of fossil fuels may be catastrophic. The IPCC maintains that the world is experiencing climate change impacts such as sea-level rise, melting glaciers and extreme weather patterns. As a result, it is urging countries and communities around the world to reduce their fossil fuel emissions and to build renewable energy powered societies that are more climate resilient (IPCC, 2016).

Similarly, many non-governmental organizations around the world are demanding an end to fossil fuel energy driven societies. Many are pushing for a fossil fuel free world as they believe moving beyond fossil fuels is an urgent goal humanity must achieve this century in order to minimise the negative effects of climate change that we all are already experiencing globally (DAVID SUZUKI FOUNDATION, 2016; 350, 2016; GREENPEACE, 2016).

Many debates on the environment and energy have focused on the current energy paradigms impacts on the environment. The dominant fossil fuel driven energy paradigm has been linked to being responsible for acidification of the environment and for contributing to human induced global climate change and temperature rise. As of result of this focus, a global demand and call for a new renewable energy paradigm has emerged (JACOBBSON & JOHNSON, 2000: 626).

Furthermore, many nations around the world have begun to see the importance to switch to a new energy paradigm. This is as many countries realize that not only is the current paradigm dangerous economically (as it experiences oil price fluctuations) but it also poses a threat to national energy security. Furthermore, it is also detrimental to the environment, which in turn, can negatively affect the economy. Therefore, more and more nations are switching and committing to 100% renewable energy driven economies (FRONDEL *et al.*, 2010).

However, despite these points mentioned above, it must be noted that in the past a push for this energy transition to clean energy sources was initially done by external pressure, mostly that coming from environmentalists. Now, this change is being pushed because it gives a positive image to places and benefits them economically. As are result, today this push is also coming from internal pressure, as it has been shown to be advantageous economically (and the economic market can be a good certifier and evaluator of good practices). However, behaviour behind such a push remains somewhat erratic and uncertain and at times contradictory. This is as fiscal machines (such as the market) do not always adequately support this energy transition by making an economic argument to push for it (JACOBBSON & JOHNSON, 2000; FRONDEL *et al.*, 2010).

Lastly, within the academic literature there has been much agreement on the negative effects of the fossil fuel energy paradigm. It has been argued that fossil fuels which release CO_2 into the atmosphere are largely responsible for climate change along with unprecedented rates of land-use and land cover change. From this belief, recommendations to shift to renewable energy sources and to utilize better energy planning have been proposed to overcome the negative effects of burning fossil fuels (CALVERT & SIMANDIAN, 2010: 27; *GEIDL et al.*, 2007; GORMALLY *et al.*, 2016).

In summary, the dominant fossil fuel paradigm of energy production is riddled with numerous problems and negative impacts. More and more, stakeholders around the world are realizing that the alternative of renewable energy driven economies may be the answer to shifting away from fossil fuels and to create a new renewable energy paradigm. This new paradigm, however, may also bring with it associated impacts and conflicts. It is therefore necessary to contemplate how both fossil fuel energy and renewable energy paradigms affect the landscape, and in turn, how the landscape affects them. Next, section 1.6 examines the types of renewable energy production that are currently being employed around the globe.

1.6. TYPES OF RENEWABLE ENERGY PRODUCTION

Numerous types of renewable energy production technologies that are capable of replacing fossil fuel driven energy production are already in use around the world. These are proving to be a viable environmental and economical alternative to using fossil fuels to power our societies. As was noted in the Portugal 2020 report, many renewable energy sources can be used in order to replace fossil fuels. These include hydroelectric power, wind power, solar power, biomass, biogas and waste, biofuels, geothermal and wave energy (PORTUGAL 2020, 2011: 49-50).

According to many energy geographers, renewable energy usually refers to energy generated by hydro, biomass, solar, wind, geothermal and hydrogen applications. In this study, with respect to the Island examples included in this paper, renewable energy refers to the following: for El Hierro Island - sun (Photovoltaic), wind (with an energy storage system), water (hydroelectric), geothermal, and wave energy; for Samso Island – wind, biomass (straw bale and wood chip power) and biofuel (canola oil) energy; and for Pico Island - wind, solar, hydroelectric and wave energy (PORTUGAL 2020; GUEVARA-STONE, 2014; KOLBERT, 2008; GUEVARA-STONE, 2013; WEINBERGER, 2014; EDA, 2016).

1.7. HUBS OF RENEWABLE ENERGY PRODUCT PRODUCTION

In order to understand how renewable energy technologies may influence, change and challenge the dominant fossil fuel energy paradigm, it is necessary to consider the geographic location of the centres of power and diffusion of these new renewable energy innovations. This is because these centres of innovation become centres of decision making for these technologies. These centres drive production, innovation and creation of renewable energy technologies. Various actions pushed by these actors influence the appearance of the energy industry (JACCOBSON & JOHNSON, 2000: 629; FRONDEL *et al.*, 2010).

Such actors may be referred to as "‘prime movers’, that is, actors who are technically and/or politically so powerful that they can initiate or strongly contribute to the development and diffusion of a new technology” (JACCOBSON & JOHNSON, 2000: 630). Also, they may allow for the transfer of knowledge (tacit and explicit) and for new problems to be identified and solved (for example, via user-supplier networks or networks which diffuse general information) (JACCOBSON & JOHNSON, 2000: 630; GORMALLY *et al.*, 2016).

These networks may be strongly integrated allowing firms: to increase their resource base (of information, knowledge and technology); to gain greater degrees of freedom; to gain power to influence perceptions of what is possible and desirable; to generate images of the future; to guide investment decisions; and to set technology choice limits. The institutions involved can therefore be “hard" (for example, legislation, capital market, educational system) or “soft” (for example, culture). The roles of institutions vary, as some allow high connectivity in a system, while others influence incentive structures. Institutions therefore “greatly affect the specific path that a technology takes” (JACCOBSON & JOHNSON, 2000: 630; BRIDGE, 2014).

Renewables, however, pose a threat to the dominant diffusers of energy technology, that is, those who dominate the fossil fuel energy industry, such as big coal, for example. The problem is “renewables go against the perceived interest of the dominant actors in the electricity system and their powerful lobbying capacity” (JACCOBSON & JOHNSON, 2000: 629; WUSTENHANGEN & BILHARZ, 2006).

Next, explored are the dominant players and drivers of the renewable energy production industry, that is, of wind, solar, water (hydro), geothermal, wave, tidal, biomass and biofuels.

*Wind Turbines***:** The wind turbine industry is dominated by a few large firms. The largest is Vestas Wind Systems A/S (20% of the market, found in 75 countries, and produce in Denmark, Germany, Italy, Spain, China, India, Brazil and the U.S.A.) (VESTAS, 2016). The top 10 manufactures include: 10. Nordex, Germany (3.4% of market); 9. Ming Yang, China (3.7%); 8. United Power, China (3.9%); 7. Gamesa, Spain (4.6%); 6. General Electric, U.S.A. (4.9%); 5. Sulzon Group, India (6.3%); 4. Siemens, Germany (8.0%); 3. Enercon, Germany (10.1%); 2. Goldwind, China (10.3%); 1. Vestas Denmark (13.2%) (ENERGY DIGITAL, 2016). Production, innovation and development is concentrated in China, Germany, Spain, the U.S.A. and Denmark. These countries are – the main producers and drivers of this technology (ENERGY DIGITAL, 2016). Portugal is not a major manufacturer of wind turbines, so switching to this technology signifies that the county will become ever more dependent on foreign developed and manufactured energy technology. Employing wind turbines in Portugal has been met with some resistance and has been the subject of some well documented conflicts (DELICADO *et al*., 2013).

Solar (Photovoltaic): Principle shapers of the solar PV panel industry include: GCL (China), Trina Solar (China), Jinko Solar (China), JA Solar (China), Wacker (Germany), Hanwha Q-Cells (South Korea), Canadian Solar (Canada), OCI (South Korea), and First Solar (U.S.A.). GCL is the largest, with the biggest market (China) (COLVILLE, 2016). Six out of the ten biggest manufactures are in China (WANG, 2014). The largest consumers of solar energy are: 1. Germany (34.7 GW), 2. China (18.5 GW), 3. Italy (17.8 GW), 4. Japan (13.9 GW), 5. The U.S.A. (12 GW), 6. Spain (5.3 GW), 7. France (4.6 GW), 8. Australia (3.5 GW), 9. Belgium (3.4 GW) and 10. The UK (3.3 GW). These nations greatly influence demand, promotion and uptake of solar technology through their energy policies (WANG, 2014).

Hydroelectricity: Hydroelectricity dams can be significant contributors to a countries energy supply. The largest producers include: BC Hydro and Power authority (Canada), Centrais Electricas Brasileiras SA (Brazil), China Yangtze Power Co. Ltd. (China), Hydro-Quebec (Canada), RusHydro (Russia), Agder Energi A S (majority owned by StatKraft A S) (Norway), Duke Energy Corp. (U.S.A.), Georgia Power Company (U.S.A.), Ontario Power Generation Inc. (Canada), and Stat Kraft A S (Norway)(the largest in the world). Many of these actors sell electricity abroad, service domestic markets and consult on global hydropower projects (for example, Statkraft has 263 plants in Norway, 60 in Sweden, 10 in Germany, 4 in Finland, 3 in the U.K. and 32 in South America and Asia) (TECHNAVIO, 2014).

The countries which produce the most hydroelectricity are: 1. China (652.8 annual TWh), 2. Canada (369.5 TWh), 3. Brazil (363.304 TWh), 4. The U.S.A. (250.916 TWh), 5. Russia (167.271 TWh), 6. Norway (140.437 TWh), 7. India (115.842 TWh), 8. Venezuela (85.596 TWh), 9. Japan (69.630 TWh), and 10. Sweden (65.173 TWh) (IEA, 2016; KHAN, 2015).

Geothermal: Geothermal energy production is on the rise. In 2015, 27 countries were harnessing geothermal energy (total of 12,636.1 MW). First, was the United States (3450 MW), followed by the Philippines (1,870 MW) and Indonesia (1,340 MW) will soon be first as has world`s largest reserve (28,994 MW). Next is Mexico, Italy, New Zealand, Iceland and Japan. The Azores ranked 17th out of the 27 countries, with 28 MW annually (IGA, 2016; GEA, 2016).

Most geothermal companies are in countries that possess geothermal energy sources (The U.S.A., Europe, Southeast Asia and Africa). Hundreds of service providers, developers, drillers, environmental firms and government agencies exist, such as: IADB, KfW Development Bank, the Global Geothermal Alliance, the US DOE GTO, USAID, IADB, USTDA, Ex-Im Bank, World Bank-ESMAP, and OPIC (GEA, 2016). Out of 214 companies listed, the largest are in the U.S.A. (Calpine Corporation (largest), Cal Energy/Berkshire Hathaway Energy, Cyrq Energy, Enel Green Power North America, Inc., Imperial Irrigation District, Ormat Technologies Inc., Terra-Gen Power LLC, US Geothermal, Northern California power agency (NCPA) and ThermaSource LLC (GEA, 2017).

Wave Power: Wave-power generation is not largely commercially employed. Many experimental projects have been deployed (in Portugal, the UK, Australia, the U.S.A., Israel, Greece and Spain). Portugal's Aguçadoura Wave Park (2.5 MW) opened but then closed in 2008, while the Cachorro wave plant on Pico Island has opened and closed many times and remains strictly experimental. Portugal remains commited to wave energy as highlighted in its "National Strategy for the Sea 2013-2020 (*Estratégia Nacional para o mar Portugal, de 2013 – 2020*) (GOV.PT, 2017). Main producers of this technology are in the UK, the U.S.A. and Australia. Big players include: Pelamis of Scotland (first machine to feed a national grid), Wave Hub Ltd (UK) and Ocean Power Technologies (U.S.A.) (largest player, power offshore defense and security installations, oil and gas platforms, ocean observatories and offshore wind markets) (POWER-TECHNOLOGY, 2017; WAVE HUB, 2017; OPT, 2017; ARENA, 2017).

Tidal Power: Tidal power is currently not largely commercially employed, but seems poised to expand as the need for renewables increases. The largest users and producers of tidal energy include: South Korea (254 MW)); France (240 MW); Canada (20MW); China (3.2MW); Russia (1.2MW); Northern Ireland (1.2MW); Scotland (10MW); India (50MW); the U.S.A. (1.05MW) and Wales (320 MW) (TIDALPOWER, 2017; ENERGY PLANET, 2017). The largest producers include: Marine Current Turbines Ltd (MCT)(UK)(the world leader), Atlantis Resources (UK), Lunar Energy (UK & U.S.A.), Oceanflow Energy (UK), Tidestream (UK), GCK Technology (USA), Ocean Renewable Power Company (ORCP) (USA), Tidal Electric (USA), Peswiki (USA), Verdant Power (USA), Tidal Sails (Norway), BioPower Systems Ply Ltd. (Australia), Minesto (Sweden), and OpenHydro (Ireland). Of these, 6 are based in the USA, 5 in the UK, 1 in Australia, 1 in Sweden, 1 in Ireland and 1 in Norway (TIDALPOWER, 2017; ENERGY PLANET, 2017).

Biomass: In addition to tidal power, many countries are now utilising biomass energy. Many countries are increasing their annual amount of biomass energy production. Among these are: Germany 50,000 (TWh/year), the U.S.A. (48,563), China, (44,437), Japan (35,253), Brazil

(35,237), India (25,444), the UK (21,552), Italy (18,732), Sweden (11,640), Finland (11,044), Poland (10,103) and Canada (8,969) (IRENA, 2017). Portugal also has some biomass, for example, at its Mortágua biomass plant (IRENA, 2017). The largest production companies are; 1. Bandit Industies (USA), 2. C. F. Nielsen (Denmark), 3. Herz Energieteknik (Austria), 4. Meva Energy (Sweden), 5. Riebenbauer (Austria), 6. Scheuch (Austria), 7. Swiss Combi (Switzerland), 8.Westtech (Austria), 9. Scandinavian Forestry (Australia), 10. KWB (Austria). Here, we see the largest is in the USA but 5 are in Austria, another in Sweden and one in Australia (WBA, 2017).

Biofuels: Like with biomass, the production of biofuels - bioethanol, biodiesel, vegetable oil and cellulose - is concentrated in the Americas. U.S. corn ethanol and Brazilain sugar cane ethanol production accounted for 87% of the world's bioethanol supply in 2015. Meanwhile, 38% of all biodiesel was produced in the Americas and 43% in Europe. In 2013, total biofuel production used 71 million ha of agricultural land, thus demonstrating the enormous impact it has on the landscape (KUMMAMURU, 2017). The top 10 bioethanol producers in 2015 (billions of litres (BL)) were: 1. The U.S.A. (1.31), 2. Brazil (0.66), 3. China (0.06), 4. Canada (0.04), 5. Thailand (0.03), 6. Germany (0.02), 7. France (0.02), 8. Argentina (0.02), 9. India (0.02), and 10. Belgium (0.01); and the top biodiesel producers were: 1. The U.S.A. (0.17) 2. Brazil (0.14), 3. Germany (0.10), 4. France (0.08), 5. Argentina (0.07), 6. Indonesia (0.06), 7. The Netherlands (0.05), 8. Thailand (0.04), 9. Singapore (0.04) and 10. Malaysia (0.02) (KUMMAMURU, 2017).

The largest companies in biofuel production include: 1. LanzaTech (U.S.A.), 2. GranBio (Brazil), 3. Algenol (U.S.A.), 4. Novozymes (Denmark), 5. TerraVia Holdings Inc. (U.S.A.), 6. DuPont (U.S.A.), 7. POET (U.S.A.), 8. Beta Renewables (Italy), 9. DSM (U.S.A.) and 10. Abengoa (Spain). These companies are global in scope (35 in the U.S.A.) (WBA, 2017).

In conclusion, it is possible to understand how renewable energy technologies influence, change and challenge the dominant fossil fuel energy paradigm. In this section, the geographic locations of the new centres of renewable energy diffusion have been considered. These centres of innovation are becoming the new centres of decision making with respect to energy production and distribution. In addition to production, they are the centres of innovation. The various actions pushed by these actors are influencing the appearance of the new energy paradigm, by either accelerating the shift or by delaying it. This new renewable energy paradigm and the issue of shifting towards it are discussed in the next section (section 1.8) (JACCOBSON & JOHNSON, 2000: 629).

1.8. PARADIGMS: A NEW PARADIGM FOR ALL – THE ISSUE OF SHIFTING THE DOMINANT FOSSIL FUEL ENERGY PARADIGM TO ONE FULLY SUPPLIED BY RENEWABLE ENERGY

As mentioned previously, the dominant energy paradigm of the last century has been that of energy supplied by fossil fuels. This paradigm is shifting as the supply of conventional fossil fuels is diminishing while demand for energy is increasing. This demand is being driven by the emerging economies of developing countries like China and India whose growing industrial base and middle classes require energy and therefore are driving up global demand. To meet this demand there has been a shift towards increasing the amount of energy that is obtained from unconventional sources. These unconventional sources include fossil fuels in underground shale rock containing oil and gas formations (that require fracking technology to extract them) and energy from renewable energy sources (FARRELL & BRANDT, 2006; GREEN *et al.*, 2006; THE ELECTRICITY JOURNAL, 2013; REN21, 2014; in CALVERT, 2016: 106).

For example, fracking has grown rapidly in recent years (by 42.5% from 2005 to 2015) and now accounts for 43% of oil production in the USA (APEL *et al.*, 2015: 9). Similarly, the installed capacity of solar photovoltaic (PV) panels has grown with a compound annual growth rate of 45% (from 1975 to 2014), while, in 2015, China surpassed Germany as the country with the largest installed capacity (LOUWEN *et al.*, 2016: 2). The result of adopting these unconventional sources is that "patterns of energy production and use are currently undergoing fundamental change." (CALVERT, 2016: 106).

This shift can be attributed to the following facts: the global geological limits for crude oil extraction have been approached; geopolitical issues over fossil fuel energy exist and persist (as in Latin America and Middle East Asia for example), significant social and environmental concerns over the issue of climate change exist, national energy security interests suggest a shift is needed, and technological advances in energy recovery systems are allowing this shift to occur (THE ELECTRICITY JOURNAL, 2013; REN21, 2014; in CALVERT, 2016: 106).

Furthermore, new "end-use technologies (e.g., mobile telecommunications), investments into advanced energy distribution technologies (e.g., natural gas liquefaction, smart grids), and changing social expectations" are giving new choice to consumers when it comes to energy. Therefore, this shift in the dominant energy paradigm is a result of broad social and political changes that are resulting throughout the world (SPINNEY *et al*., 2012; VAN DER KROON *et al*., 2013; JUISTO, 2009; BRIDGE *et al.*, 2013; in CALVERT, 2016: 106).

Alterations and changes to the dominant fossil fuel energy paradigm are taking place all around the world. Globally, great consensus exists among scientists and the UN Intergovernmental Panel on Climate Change (IPCC) that this dominant paradigm has been solely responsible for accelerated global warming via carbon dioxide emissions. For this reason, they argue that all stakeholders, including governments and corporations, must make efforts to shift away from fossil fuels. Agreement over this is seen in global grassroots and non-governmental movements, as well as in the signing of international climate change treaties such as the United Nations Framework Convention on Climate Change (UNFCCC, 1992), the Kyoto Protocol (1997) and the recent Paris Agreement (2015) that was signed onto by the governments of 194 countries (UN, 2016).

Despite this consensus and widespread agreement on the causes of climate change, the political ecology of energy is resulting in delays. This is as delays to changing the dominant energy paradigm persist due to rotating political cycles. These cycles operate to either roll back previous gains or to delay the rate of adoption of new measures and technologies. This is as changing the dominant fossil fuel energy paradigm is an ideological battle with advances and setbacks (AGNEW & CORBRIDGE, 1995; HARVEY, 2010).

Rotating political cycles are one such setback that delays this shift. For example, Canada under its center-right Liberal Party (in government 1993-2006) signed onto the Kyoto Protocol in 1997 (along with 194 other countries), formally ratified treaty participation in 2002 and made it law in 2005. However, after taking power in 2006, the more right-wing Conservative Party officially withdrew from Kyoto in 2011 (effective in 2012). This was done because the new government held a different ideological vision than the previous one did. This vision included plans to develop the heavily polluting tar sands oil of the Canadian province of Alberta in order to boost the economy and employment in that region. A move that has proved significant as Canada increased its pollution output and currently ranks 10th in the world in CO_2 emissions and 8th in per capita emissions. This has thereby delayed the shift away from fossil fuels towards a renewable energy paradigm, as Canada has become further entrenched in a carbon locked-in carbonscape (DOSKOCH, 2011; IEA, 2016).

Also, the U.S.A. serves as an example where political cycles can be seen to either advance or delay an energy paradigm shift. Under president G.W. Bush, for example, the Republican Party took a stance of furthering fossil fuel energy production and their politics, as seen in the US energy policy, foreign policy, wars and geopolitics of that era (HARVEY, 2003).

Under the Obama administration, although not significantly altering the fossil fuel energy paradigm, advances were made and resources were added to move towards renewable energy. This is as certain technologies were promoted, certain landscapes were deemed untouchable for oil drilling and exploration (such as the Artic and continental offshore oil deposits) and the construction of fossil fuel infrastructure was blocked (the Keystone XL pipeline and Dakota Access pipeline) (DEMOCRACY NOW, 2017).

Conversely, the new Trump administration seems to be willing to shift the cycle back towards that of greater fossil fuel entrenchment by further securing the current fossil fuel energy paradigm. Examples include how it has appointed Rex Tillerson (the long-time CEO of the world's largest oil company - ExxonMobil) as Secretary of State. Secondly, it has signed legislation to repeal an anti-corruption measure that required oil and mining companies to disclose payments to governments. Thirdly, it has granted an easement to allow the Dakota Access Pipeline drilling to continue even though it had previously been stopped in the courts (DEMOCRACY NOW, 2017). This example again demonstrates what is possible and what may be changed or delayed according to the politics of a given time. Political cycles appear to be the same around the globe as they may at times promote a paradigm shift, while at other times they delay such a shift.

Taking different courses of action to drive paradigm change is possible. Utilising these it is possible to overcome the rise and fall of political cycles as they relate to energy policies. Among these are international accords and localized practices. Accords may act as compromises between groups of stakeholders who may either stand to benefit or stand to lose from a renewable energy paradigm. One such example is the Paris agreement, an international UN agreement reached between countries and influenced by stakeholders (including corporations and oil companies) in 2015. It deals with mitigating the output of greenhouse gas emissions, adapting to the negative effects of climate change and splitting the financing of these activities. It is considered a large departure from the originally legally binding Kyoto protocol which aimed at reducing emissions to pre-1990 levels. This is as the Paris agreement is not legally binding, but rather, lets countries voluntarily arrive at how to cut their emissions and decide as to how to mitigate and adapt the negative effects of climate change. The Paris Agreement demonstrates how international accords may work as compromises on strict goals and targets in order to get everyone to agree to take some action on an issue, thereby changing paradigm via “nationally determined contributions” (UNFCCC, 2017).

Additionally, localized practices and their associated discourses can help create a new freedom and autonomy when it comes to energy issues. This can vary greatly from political cycles (their rise and falls), as local initiatives at the community and grassroots level can lead to energy self-sufficiency and democracy, as seen in the Island examples presented in section 2.

The question of a changing energy paradigm is an issue that is to be studied not only by political ecologists, but also by geographers. This is as an energy paradigm shift is related to geography as it can change landscapes, territorialities and the quality of life of places. In fact, some of the most disrupted and polluted landscapes on earth owe their exploitation to the fossil fuel energy paradigm. Such landscapes are explained in greater detail in section 1.10 and examples of these can be seen below in figure 2 (where the Boreal Forest has been stripped away to extract underground tar sand deposits) and in figure 3 (where a refinery carbonscape exists).

Fig. 2 – Syncrude’s Aurora Open Pit Oil Sands Mine in Northern Alberta, Canada
Source: ESSICK in NATIONAL GEOGRAPHIC, 2009.

Fig. 3 - Aerial view of the Al-Sheiba oil refinery in Basra, Iraq
Source: REUTERS in RFERL, 2011.

Indeed, renewable energy landscapes also can be disruptive and impact the landscape. Although this is the case, at times they may be less disruptive then fossil fuel landscapes. This is as they exist in the landscape in a more decentralized, distributed and diversified pattern. Examples of these new landscapes can be seen in figures 4 and 5 which follow.

Fig. 4 - The 100 hectare Droogfontein Solar Power farm in Sol Plaatje, South Africa
Source: DROOGFONTEIN SOLAR POWER, 2017.

Fig. 5 – Offshore wind turbines in series off the coast of Samso, Denmark
Source: THE NATIONAL GEOGRAPHIC SOCIETY, 2017.

However, it is important to note that renewable energies can bring about conflicts, as do fossil fuels. Renewable energy production involves choices that create issues and that lead to neither neutral nor conflict free energy production. That is to say, they are not immune to creating conflict as they do not necessarily lead to a perfect world without conflict. The process of deciding where to locate renewable energy projects, for example, creates a number of choices that are each associated with a number of associated issues. The necessity to make such a decision therefore has negative consequences, thereby making neutral or conflict free energy production not possible. It therefore stands to reason that there is always going to be conflicts associated with renewable energy production, just as there is with fossil fuel energy production (DELICADO *et al.*, 2013: 11).

With wind turbine parks, for example, the decision of where to locate these creates a number of choices which each have their own negative consequences that may lead to conflict. Although wind parks in general are viewed in a positive light (as they may reduce emissions to mitigate climate change and reduce a countries dependency on energy imports), they also have associated negative impacts at the local or site level. Conflicts can arise over issues such as negative impacts to rural ecosystems, the tourism industry, human health (for example, noise) and the visual landscape, among others (DELICADO *et al.*, 2013: 11).

Another issue associated with renewables has to do with mining and mineral extraction. Minerals are required to produce most of the sophisticated technology (such as wind turbines and solar panels) that is needed to produce renewable energy. This creates a contradiction for renewables, as while on the one hand they bring about many positive gains with respect to energy and the environment (for example, they run without fuel, they don't emit greenhouse gases, and they create a green and ecological economy), on the other hand, they also create material sourcing, production and siting issues and conflicts (for example, mineral extraction and sourcing concerns) (JABER, 2013: 251-252; ALONSO *et al.*, 2012: 3406).

Such a contradiction exists for wind turbines, for example, as they require rare earth minerals to be extracted for their production. This often results in severe negative environmental and public health impacts on local mining communities. Impacts include dumping sites and contaminated and poisoned bodies of water and tailings ponds. These have been found to cause odor problems, to kill plant and animal life, and to cause the teeth of villagers to fall out and their hair to turn white. Also, these mines have been found to result in unusually high rates of cancer, osteoporosis, skin and respiratory diseases and high radiation levels in residents (FISHER & FITSIMMONS, 2013; JABER, 2013: 251-252; ALONSO *et al.*, 2012: 3406).

Increasing future demand for more wind turbines may exacerbate such mining problems. This is as a typical wind turbine contains over 8,000 different components, including magnets made from rare earth minerals (neodymium and dysprosium), the majority of which come from China (provides 95 percent of the world's supply of rare earth minerals). It is therefore these monopoly supply conditions, environmentally unsustainable mining practices and the rapid growth in demand for wind turbines that are negatively impacting local mining sites (FISHER & FITSIMMONS, 2013; JABER, 2013: 251-252; ALONSO *et al.*, 2012: 3406).

Also making this an issue is the fact that it may be easy for people to have an impression of an ideal landscape when looking at renewable energy production installations (for example, wind turbines surrounded by farmland). After seeing such idyllic landscapes they therefore believe that renewables are having a low impact on the environment and are conflict free. The reality, however, is that renewables do have negative impacts in terms of the minerals and materials that are needed for their production and with respect to siting. These may be very polluting, can have a high carbon footprint and can lead to numerous local and site specific conflicts (social, environmental, and political) (DELICADO *et al.*, 2013). In fact "renewable energy sources are not the panacea they are popularly perceived to be; indeed in some cases their adverse environmental impacts can be as strongly negative as the impacts of conventional energy sources" (ABBASI & ABBASI, 2000: 121).

Therefore, as is suggested above, a renewable energy paradigm will bring about many issues and conflicts. This new paradigm may lead to a new colonial regime and a new global stratification. While this is not a new issue (as it is already exists under the current dominant fossil fuel paradigm), conflicts associated with this new global stratification have and continue to intensify (HARVEY, 2003; HARVEY, 2005; HARVEY, 2010; SANTOS, 2013: 93).

All of this has consequences on logistics, as it is leading to a simplification of landscapes. At the moment, this paradigm shift is going through a transition where actors are dictating what new renewable energy sources are acceptable, which ones get to be placed where (for example, location to be grown, planted, sited) and who gets to control them. The State may be such a driver. For example, as argued by HARVEY (2010: 185):

> the two primary systemic agents in our time are the state and capital. The geographic landscape of capital accumulation is perpetually evolving, largely under the impulsion of the speculative needs of further accumulation (including land speculation) and only secondarily in relation to the needs of people.

Corn ethanol in the USA exemplifies this new transition. The U.S. government has largely promoted policies to encourage its development as a renewable fuel to replace fossil fuels, and as a result, the US now controls about half of the world market (KOY, 1990; NATENELOV *et al.*, 2013: 504; HARVEY, 2010: 185).

Furthermore, with respect to bio-combustible fuels during this transition, we see that there is a resultant intensification of pathways. Take for example the forest monocultures that are resulting due to the need to generate bio-combustibles. Demand for these are leading to a simplification of scenery and landscape, as often many kilometers of land is deforested and replaced with monocultures of just one type. The example of Northern Mato Grosso in Brazil is one such case where there has been a "private colonization in Brazil, as a result of the activity of Southern Brazilian land settlement companies and of the immigration of colonists from Southern Brazil" (KOY, 1990: 115). Here, we see how "Timber extraction and gold mining became the most important factors in regional development, which also affected the formation of pioneer towns" (KOY, 1990: 115).

Sugar cane, palm tree and eucalyptus tree plantations in Brazil are other such examples among many others that exist all around the world. This shift in paradigm is creating these contradictions and is leading to a great transformation of the landscape. Resultant forest monocultures are an issue of biofuels that leads to conflict as they are causing huge environmental and social consequences. As these lands are occupied to produce biofuels, other effects such as price increases for food crops may result (explained in greater detail later in this section) (KOY, 1990: 115; HARVEY, 2010).

In addition to these issues presented above, numerous other factors exist to ensure that the shift from a fossil fuel to renewable energy paradigm will be slow and ripe with issues. Currently, the world's primary commercial energy supply is majority supplied by fossil fuels (about 85% of total energy supplied in 2015). The biggest non fossil fuel sources are hydro and nuclear power (accounted for only 8% of total world supply in 2015). Shifting to a paradigm that is majority supplied by renewables (such as biofuels, wind and solar) will be difficult. The reason being is that great technical challenges persist, such as the low capacity factors for mass-scale electricity generation, the fact that wind and solar power are both intermittent and also the fact that biofuels have huge environmental and social consequences (ABBASI & ABBASI, 2000; SMIL, 2016: 195).

Biofuels, for example, have negative impacts that are not easily overcome and which further delay a shift away from fossil fuels. Combustible biofuel (made from mainly cereals, sugar and oilseeds) demand has been spurred on in large part by the increase in car production and ownership in growing economies like China. To meet this new fuel demand, major governments (like the USA) are shifting to produce more of certain crops (for example, cereals). The result of this promotion has had a negative effect on food. This is as food has been affected both in terms of production supply (as biofuel crops are being planted on the same land that was previously occupied by food crops) and in terms of price (as the market price for certain food crops has at times sharply increased and greatly fluctuated). For example, in the USA "corn markets have become more prone to volatility due to ethanol production, especially when the demand for corn is high and/or the crude oil prices are high enough to create a competitive market for ethanol" (NATANELOV *et al.*, 2013: 504; BIRCH & CALVERT, 2015).

As a result of increased demand for biofuels, certain staple food crops have become harder to access and have also become more expensive to purchase. This has meant that many people around the world have become increasingly food insecure. This is as "with the growing demand for biofuels an even higher increase in demand for these crops can be expected. …feed stock prices, in turn, have risen due to high world market demand" (NATANELOV *et al.*, 2013:504). The price of these has increased substantially and as the price rises it becomes very variable on the global market, and therefore in other countries as well. This thereby creates national food security issues and can lead to conflict (APPELS *et al.*, 2011: 4297).

Furthermore, the "limited amount of arable land and the rising global demand for food are important inhibitors for the production of first generation biofuels" (NATANELOV *et al.*, 2013: 504). The need to grow more of them is also leading to increased land conflicts and environmental degradation (APPELS *et al.*, 2011: 4297).

Therefore, these aforementioned conflicts ensure that making renewables the dominant energy source of our societies will take not only decades, but rather generations. SMIL (2016: 194-196) gives numerous reasons as to why this is the case.

First, energy shifts take either centuries or decades to be realised. This is because energy demand keeps increasing and it takes time to develop infrastructure (for example, pipelines, refineries, plants and tankers). For example, "…it took 40 years for crude oil to go from 5% to 25% of the global primary supply (1915–1955) and 60 years for natural gas" (SMIL, 2016: 195).

Also, national energy supplies are mostly diversified ensuring no single primary source can provide the majority of energy supply. For example, "crude oil peaked at… 40% during the 1970s and it has since fallen to about 30%, while natural gas may never reach even a third of the total supply" (SMIL, 2016: 195).

Furthermore, renewable energies have not grown very rapidly (only 3% per year; coal 5% per year (1850 – 1870), oil 8% per year (1880-1900), natural gas 6% per year (1920 – 1940)). To date, renewables only contribute a small fraction of overall primary commercial energy supply, while fossil fuels have contributed 25 times more energy since 1990 (SMIL, 2016: 195).

Moreover, fossil fuels remain the primary provider of commercial energy supply by a large margin, and for decades to come they will supply the bulk of our energy needs. In fact, oil demand is predicted to continue to grow every year until 2040. Oil supplied 97% of the world's energy supply in 1960, 90% in 1990, 85% in 2015, and is set to provide 70% in 2040. Conversely, renewables are predicted to provide only 15% in 2040 (up from 5% in 2020). Thus, shifting away from our oil dependency cannot happen overnight (SMIL, 2016: 195; IEA, 2017).

Also, the shift to a new energy paradigm is driven by the need to decrease CO_2 emissions to reduce global warming. This, however, remains a difficult task as a global unified effort is needed in which all countries of the world need to contribute to reducing total CO_2 emissions. For some countries this is harder to do than for others as their economies may rely heavily on fossil fuels, an issue for international accords like the Paris Agreement (UN, 2017; IPCC, 2017).

In addition, so far renewables have only had a minimal effect on reducing our energy supplies carbon footprint. For example, while wind and solar have grown rapidly (averaging 22% and 37% between 2000 and 2015), they still only supplied 1.3% of primary commercial energy (2.5% if counting biofuels) in 2015. Even under best case scenarios, renewable energy will not eliminate fossil fuel energy by 2050. Fossil fuels will need to make up 60% and renewables 29% of the energy total to reach a 2 degree Celsius emissions target. This is a growth rate that would put renewables in line with the historic growth rates of other previous energy paradigms (SMIL, 2016; 195; IEA, 2017; UN, 2017).

Furthermore, the intermittent nature of renewable energy technologies (such as wind turbines and solar panels) means that they cannot provide around the clock supply for fluctuation periods of peak demand. As such, fossil fuel driven back up generation needs to continue to exist, something that has led to a need to increase the amount of fossil fuel infrastructure that already exists, or that has required new infrastructure like reverse-flow hydroelectric energy generation (LOUWEN *et al*., 2016; JABER, 2013; GUEVARRA-STONE, 2014).

Likewise, in terms of liquid biofuels, renewable energy will not replace fossil fuels in transportation. This is as ethanol (for example, from sugar cane and corn) for transportation currently only supplies 0.005% of global demand and even by increasing it by one thousand times it would still only provide 5% of current world demand, thereby meaning that fossil fuels will remain dominant in the transportation sector for the foreseeable future (SMIL, 2016: 196; NATANELOV *et al.*, 2013).

Moreover, the ability of renewable energies to replace fossil fuel coke (used in the blast furnace production of iron, cement, ammonia and plastics) is even more unlikely as no commercially viable renewable energy substitute currently exists. These options will take many decades to develop and replace coke currently used in furnace production. Additionally, most current renewable energies also require steel, cement and plastic raw materials, all of which are currently made from coke intensive production (SMIL, 2016: 196).

Furthermore, the ingrained carbonscape infrastructure and continued growing demand for energy mean the dominant fossil fuel energy paradigm cannot be quickly replaced or made obsolete. For example, in 2014, global energy demand was majority supplied by fossil fuels (81.1%: oil - 31.3%; coal - 28.6%, natural gas - 21.2%), while renewables only accounted for only 18.9% (biofuels and waste - 10.3%; nuclear - 4.8%, hydro - 2.4%, and other - 1.4%) of demand. This means that the scope and financial foundations of fossil fuel infrastructure are greatly entrenched globally (IEA, 2017).

These points presented above help demonstrate that when it comes to energy, geography does matter. This is because the scale and scope of our dependency on fossil fuels to supply our energy needs is so great and ingrained. Scale does in fact matter and acts as a barrier to shifting towards a renewable energy paradigm (CALVERT & MABEE, 2015).

However, despite these drawbacks, potential for change does exist, as "the carbon–society linkage is also characterized by rupture, unpredictability and instability …[as]…the stability and permanence of society's relationship with carbon tends to be exaggerated" (HAARSTAD & WANVIK, 2016: 2). Furthermore, the vulnerabilities of the current paradigm may be discussed and exposed so that "the narrative of the inevitability of oil that the fossil fuel industry has carefully constructed" can be challenged (HAARSTAD & WANVIK, 2016: 2).

The stakeholders of the current paradigm hold a vested interest in fossil fuels and therefore they attempt to order social practices within society. These include oil companies, political institutions, and the "broader political economy". These "multi-scalar complexes involve the power structures of the global regime of oil" (HAARSTAD & WANVIK, 2016: 3). Through these actors the "hegemony of oil capital is able to destabilize and undercut serious challenges to continued accumulation" of renewable energy (HAARSTAD & WANVIK, 2016: 4). These stakeholders practice "the extraction, conversion, transportation and consumption of energy sources" which are "unstable processes that we use significant resources to contain, control and put into order" (HAARSTAD & WANVIK, 2016: 14; APEL *et al*., 2016). Thus, "carbonscapes are fragmented, contested and converted at particular sites" that are also "anything but stable and permanent." (HAARSTAD & WANVIK, 2016: 11).

Similarly, fossil fuel stakeholders find themselves subject to the weaknesses of the territorializing and de-territorializing processes that they create. For example, cars are territorialized by highway construction, strip malls, big box stores on the edges of towns and socio-cultural discourses. These allow the car to be utilised and require people to own cars for their daily lives. The car, however, is also being de-territorialized by urban regeneration movements, less car centric cultural values, and urban planning for sustainable cities that promote a car free existence. Thus, it is important to understand a place`s characteristics and stakeholders to ensure energy transitions have a positive effect on human well-being (GRALLA *et al.*, 2017; KEARNS & PHILO, 1993; AVRAHAM & KETTER, 2008).

In summary, the process of shifting from a fossil fuel to renewable energy paradigm is full of issues, as it is prone to conflict, delay, is costly, de-territorializing, destabilizing and controversial. Such a change is possible and is resulting as the dominant paradigm and those who control it are being challenged, destabilized and fragmented. Exactly who controls this process and is leading to its delay or acceleration is the subject of the next section (1.9).

1.9. ENERGY AND POLITICAL SUBJECTS: WHO CONTROLS THE PROCESS?

Although full of issues as suggested in the previous section, a change of energy paradigm is possible. In order to achieve this, it is important to identify, understand and confront and/or cooperate with the multiple stakeholders who are involved in these paradigms. Next, how these various stakeholders interact with, influence and change energy paradigms is examined.

Multiple players are involved in maintaining and controlling the current dominant fossil fuel energy paradigm. Similarly, multiple players participate in changing it to a new renewable energy paradigm. These include political institutions, national polities, government, planners (for example, urban), oil companies, industry, developers, financial institutions (local to global), consumption sites, the media (local and global), dominant social institutions, social regimes, social movements, civil society and indigenous communities (CALVERT *et al.*, 2013: 417).

Oil companies, the oil industry and other industries shape energy paradigms through infrastructure. The dominant oil energy infrastructures that span the globe act as barriers to change. This is as they steer practices and promote the perspective of stability, thereby creating social orders and informing institutional and political practice. Fossil fuel infrastructures (for large scale distribution) effect political practices. This is as oil and coal each possess unique infrastructure requirements that have different effects on politics. It is the dominant infrastructure paradigm that ensures that "large-scale infrastructure as the underpinning of power relationships of modern society." (HAARSTAD & WANVIK, 2016: 4). Change within this linked infrastructure-politics system depends on "structural shifts in the broader energy system" as these power relationships "resist any shift away from this petroculture" (MARRIOT & MINIO-PALUELLO, 2014: 83; in HAARSTAD & WANVIK, 2016: 11).

Furthermore, energy infrastructure informs the socio-political order. This is similar to Foucault's notion of 'governmentality' and 'biopower' as 'energopower', as the paradigm sees that electricity is harnessed for social purposes. With respect to energy infrastructure "power and authority are built into its material and social forms." (HAARSTAD & WANVIK, 2016: 4).

It is also important to note that power is now diffused. This is because power today is owed to the new hegemony of "transnational liberalism" as it is:

> polycentric because power in the modern geopolitical economy is no longer…monopolized by nation-states. Economic, cultural and geopolitical power is now embedded in a network of dominant but internally divided countries, … regional groupings, … city regions, … international institutions, and the main circuits and institutions of international production and financial capital (AGNEW & CORBRIDGE, 1995: 207).

This is to say that control of energy (production, transportation, storage, and distribution) is one of the sources of power. Such power may lie in the hands of private corporate monopolies, for example. Furthermore, power diffusion is an important concept as it is argued that the weight of power is diffusion. A part of this power is still associated with energy – who produces energy, who controls the tools needed to build the network of energy, and who controls the energy transportation networks and the transport of energy. Understanding who does this reveals the geography of power (diffusion of energy) at the global scale (AGNEW & CORBRIDGE, 1995).

Again, this is a very important issue for countries that are privatizing there economy, as if energy (that is, the means to extract, refine, transport, build infrastructure and sell energy) is 100% privatized, it still remains an important strategic sector to a country, something that is evidenced by the fact that a good part of the grand actors at the global scale continue to be intertwined in energy. By privatising its energy system a government can be giving up a part of the power they hold and may become weaker as a result. If a strategic sector like energy continues to be controlled by the state, it may be possible for the state to retain some of its power and thereby energy decision making autonomy. These ideologies are leading to important questions as economies transition. These questions include: What role should the state have in this area? Should there be a stronger presence of the state in the energy sector? Should the energy sector be an unprivileged and non-privatized sector? (AGNEW & CORBRIDGE, 1995; HARVEY, 2005; MOL, 2000).

In countries which have been embracing neoliberal ideology and are privatizing their economy (such as Portugal), it is being debated whether this sector, being strategic, should not remain in the possession and control of the State. Therefore, in this respect, energy is subject to ideological disputes (AGNEW & CORBRIDGE, 1995). Questions of privatisation resonate not just with the energy sector, but also over other vital strategic resources such as water. The argument of what to privatise and what not to privatise is leading to great political and ideological debates. This is as these are areas that diverge in the process of many actors. Since the 1980s when privatization of strategic resources began, it has since become a trend sweeping over governments. Those that have resisted to date may refer to themes of political geography and political ecology to inform themselves in national debates. Arguments exist which suggest that many conflicts of the 21st century may be due to the fact that new non-state actors have gained power through privatisation while certain nation states have become weaker as a result. Weak nations may be left unable to assume strong strategic defense policies due to the fact that under privatisation they may be unsure of what the role of the state should be and they thereby are unable to define what a national strategic vision over vital resources like energy should look like (HARVEY 2003; DOS SANTOS, 2016; GORMALLY, 2016; GRALLA, 2017).

In addition, urban planners, or planning regimes, along with urban form, are linked to energy consumption patterns. This is as “Geographers have often understood cities as spatial and material expressions of particular energy regimes” and that change can result in niches, for it is dependent upon large regimes and landscapes interacting with niches (CALVERT, 2016; RUTHERFORD & COUTARD, 2014 in HAARSTAD & WANVIK, 2016: 5)

It is social regimes and their associated power relations that are able to create and uphold an energy paradigm. The energy-society relationship when seen as a ‘carbonscape’ demonstrates how “social regimes and power relations create order and inertia” (HAARSTAD & WANVIK, 2016: 7). The great stages of humanization of the earth, as well as phases of rupture, are due to several factors, but energy is always amongst them. We see this in the inertia of energy landscapes as it is reflected in the lifespan of types of energy infrastructure. For example, fossil fuel infrastructure may have a 50 year or more production lifespan, whereas urban plans may have century-long lifespans. The concept of carbon lock-in, along with that of socio-technical regimes, suggest that "the material inertia of infrastructures may uphold the social orders that produce infrastructures", thereby reinforcing the dominant energy paradigm (COENEN *et al.*, 2012; UNRUH, 2000; in HAARSTAD AND WANVIK, 2016: 7).

Financial institutions, nation state political bodies and sites of energy consumption all mediate the flow of fossil fuel energy. This can be seen when one considers carbonscapes as being assemblages of global oil production networks (of the hydrocarbon value chain). These influencers affect how

> oil moves across space … from extraction sites, through complex pipelines and tankers, oil intervenes and is implicated in various political–economic struggles and landscape-forming processes at many sites. (HAARSTAD AND WANVIK, 2016: 7).

Carbonscapes are constructed via complex geopolitical negotiation between government and industry. This is as the oil industry, with governments, shares the role of operator, manager, maintainer and stabilizer of carbonscapes in conflict riddled extraction zones. In general, industry manages the territorializing processes, such as consultations, environmental impact assessments, local content schemes (of labour and services) and bilateral negotiations of benefits to local communities (HAARSTAD AND WANVIK, 2016: 11; BRIDGE, 2014; CALVERT & SIMANDAN, 2010).

In addition, governments in fossil fuel extraction zones often depend on corporate profits to maintain levels of infrastructure and public services. This is because these governments are seeing a downturn in state budgets, which while leading to government savings, also makes them reliant on private sector funds to operate. This makes governments highly vulnerable to de-territorializing processes (for example, geopolitical tensions, competition over regional oil hegemonies) and external shocks (for example, drop in global oil prices). These processes can at times lead to mass unemployment and massive drops in government revenue (HAARSTAD AND WANVIK, 2016: 11; CALVERT & SIMANDAN, 2010: 19; HARVEY, 2010; FRONDEL *et al.*, 2010).

Also, fluctuations in the price of oil and global geopolitical conflicts can lead to major disruptions in oil production zones. Such disruptions can lead the price of oil to either rise or to decline. When the price of oil is low, for example, the reduced price of petroleum can lead to serious problems for oil producing countries. For example, serious political and social problems have resulted due to the low price of oil in petro states such as Venezuela, Russia, Angola and Canada, among others (LEACH, 2014).

Canada, for example, while perhaps not as vulnerable as other petro states, has shown that it also is prone to suffering from oil price fluctuations. Canada has suffered greatly due to the drop of crude oil prices in 2014 (price dropped from $94 per barrel in June to $55 per barrel in November). This resulted in a drop in oil sands revenues, thereby leading to lower royalties being paid, lower taxes being collected, and oil sands development projects being delayed or cancelled. This resulted in long-term negative economic impacts and mass unemployment. These impacts brought serious problems to multiple scales in Canada, affecting localized areas such as cities and their budgets, all the way on up to the provincial and federal scale. In fact, this drop led to a recession in Canada and helped force a change of government at the federal level. Thus, fluctuating oil prices have dire consequences at many scales for various nations (LEACH, 2014).

These aforementioned factors, combined with the destruction of the environment and the fact that fossil fuels are non-renewable resources, together, threaten the dominant oil production paradigm. They do this by strengthening the argument for the need to shift towards renewable energy and by forcing governance regimes to respond to these realities (HAARSTAD & WANVIK, 2016: 11: BRIDGE, 2014; JACOBSSON & JOHNSON, 2000).

Governments, in addition to defending fossil fuel energy sources, are also delaying the rapid adoption of alternative energy sources. This is as many barriers may be implemented by them to delay the adoption of renewable energies. For example, municipalities often delay the process of approving solar energy projects because they either do not have zoning in place for solar farms, or are unsure of how to classify solar farms (as industrial or other use). Similarly, wind turbines can often easily be blocked by local opposition groups siting noise and height regulations, thereby delaying adoption (KAZA & KURTIS, 2014: 365).

Also, governments may delay the adoption of new technologies by placing high taxes on them. For example, in 2016 in the US, an important customer tax credit was reduced from 30% down to 10%, thus ensuring a drop in purchases and sales of solar panels. Such a move delays the adoption of renewables and progress towards more efficiency (FEHRENBACHER, 2015). Investments in renewable energy projects are largely government relegated thereby allowing them to be maintained and controlled by governments. As alternative fuel technologies mature and become cost-effective, government institutionalized structures are slow in adapting to accommodate them. Furthermore, large privately and publicly owned utilities, unlike smaller publicly owned cooperatives, often have little incentive to invest in emerging technologies. (KAZA & KURTIS, 2014; LOUWEN *et al.*, 2016: 2).

On the contrary, local governments may use active energy efficiency and renewable energy measures as trade offsets, thereby encouraging renewable energy over fossil fuels. Likewise, land (both in rural and urban settings) may be adapted to site renewables as new land use functions and services may be encouraged. With respect to carbon markets, land may be used to sequester carbon in forests to earn tradable offsets. Also, small forest owners may maintain their forests, thereby altering incentives for different land uses. Thus, current land uses may delay the transition to new energy sources (KAZA & KURTIS, 2014: 365).

The media, being local to global in scale, play a role in exposing the landscape impacts associated with fossil fuel extraction. By displaying images of environmental destruction they become an agent of possible energy paradigm change. This is because by portraying places associated with fossil fuels in a negative light, they affect the reputation, attractiveness and economies, thereby making a case for a change to renewable energy production (HAARSTAD AND WANVIK, 2016: 11; PHILO & KEARNS, 1993; AVRAHAM & KETTER, 2008).

Indigenous communities may also act as disruptors of the operation of the dominant fossil fuel energy paradigm. By protecting their traditional land uses and struggling for land use rights and titles, they may act as drivers of change away from current fossil fuel energy infrastructures. For example, Native American water protectors were able to delay the construction of the Dakota Access Pipeline in the USA, a display of the power of an indigenous rights movement to delay new fossil fuel infrastructure from being built (ERBENTRAUT, 2017).

In conclusion, many actors control, participate in and influence the transition to a renewable energy paradigm. Whether acting to delay or to accelerate the shift, they must work within the realities of the landscape-energy relationships that exist. How both paradigms do this is discussed in the next section (1.10).

1.10. ENERGY AND LANDSCAPE: FOSSIL FUEL LANDSCAPES VERSUS CLEAN ENERGY LANDSCAPES

In order to highlight how fossil fuels affect the landscape and how the landscape affects them, it is necessary to first describe the types of energy that make up the current dominant energy paradigm. Fossil fuel energy production tends to refer to energy that is produced from coal, combustion of fuel oil/diesel (thermoelectric), natural gas, and/or nuclear power plants.

Coal is a carbon based rock like substance that is found naturally occurring in nature and it can be burned to release energy. In terms of the landscape-energy relationship, the extraction of coal via mines (surface or sub-surface) significantly transforms the landscape (see figure 6). Part of the coal extraction process is the need to conduct deforestation in areas to be mined. This contributes to debris runoff and subsequent stream sedimentation and burying. Additionally, artificial wetlands must be constructed to deal with mine waste, such as acid drainage tailings ponds. Other wastes must also be disposed of, including ash and sludge. These wastes may also runoff or seep into groundwater and surface water. Also, a land area of on average between 6-18 square meters is required for storage, walkways, and cooling towers, adding to the alterations of the landscape by coal (KAZA & CURTIS, 2014: 356; CUNY, 2017).

Fig. 6 - Mountain in Mud River, West Virginia, USA, before and after coal mining
Source: City University of New York (CUNY), 2017.

Thermoelectric power generation plants, which run on fuel oil, diesel, coal, naphtha and nuclear fuels, also cause dramatic changes to the physical landscape, as they release toxic emissions, contaminate land, and use large volumes of water for cooling (thus depleting local water supplies and potentially creating potable water shortages (KAZA & CURTIS, 2014: 359).

Nuclear energy is also alters the physical landscape via mines needed for the mining of its fuel (Uranium). This mining also requires the burning of fossil fuels for extraction. After mining, the fuel must be transported to a processing facility and special transportation infrastructure is needed (for example, train tracks, roads and trucks) to avoid population centres, thus altering the landscape in remote areas. A nuclear energy plant must also be constructed on land far from urban centres due to the risk of an accidental nuclear meltdown. Also, spent fuel waste uranium rods need to be moved to dry storage casks or reprocessed, as the waste is toxic (GRALLA *et al.*, 2017).

Furthermore, Nuclear energy production leads to radiation contamination of the soil, water and plants. Also, water is needed in large amounts to cool the uranium rods, and is released as hot water back into ecosystems, possibly altering their functioning. Waste, if stored in urban population centres, may depress property values. Lastly, if meltdown occurs, residents may be exposed to radiation, may suffer the ill effects of radiation poisoning which may include death and land may be evacuated and deemed unliveable for decades due to high radiation levels (for example, the city of Chernobyl in the Ukraine) (KAZA & CURTIS, 2014: 359; GRALLA *et al.*, 2017).

Natural gas is another fossil fuel that alters the landscape. Hydraulic fracturing (fracking), for example, utilizes pressurized water, sand and chemicals and injects them deep underground to force trapped gas out or rock cracks and fissures and up to the surface. This alters the landscape directly by drilling (causing earthquakes at times) and by constructing infrastructure and plant facilities. It also indirectly affects the land in terms of competing with other land uses for a given area. Also, sand needs to be transported and chemicals may leak and infiltrate into the ground and drinking water sources, as may the gas itself, thereby contaminating drinking water. The fluctuation of gas prices, the limited and short lifespan of exploration sites, labour migration, and fluctuating tax revenues and population bases for municipalities where production occurs, all end up impacting the landscape (KAZA & CURTIS, 2014: 359; APEL *et al.*, 2017).

Renewable energies (as mentioned in the start of this section above) also affect the landscape and the landscape affects them. How the energy is produced, how it is harvested and how people plan for its siting and extraction will alter the landscape resulting in either centralised or decentralised energy production projects (LIMBURG, 2010; ABBASI & ABBASI, 2000; FRONDEL, 2010; JACOBSSON & JOHNSON, 2000).

Wind energy changes the landscape. This is as the infrastructure needed to transport the energy from wind farms to where it needs to be used may be vast and thus alters the landscape. Also, wind turbines must often be sited outside urban centres due to government ordinances that affect siting by limiting height, land use, and intensity. This can lead to inefficiencies and may lead to having to site wind farms on lands of cultural significance or of environmental sensitivity, thereby negatively affecting the human-landscape connection. Siting in rural agricultural areas can also affect agricultural production, livestock grazing and other agricultural land uses. Turbines also produce noise, a possible issue for neighbours, as is falling ice from blades in cold climates (KAZA & CURTIS, 2014: 360-361; DELICADO *et al.*, 2013; JABER, 2013).

Conversely, the landscape affects wind energy production. For example, wind turbines can only be located on sites where there exists medium to high winds, as turbines are uneconomic if located in low wind areas. In this way, the land determines where wind energy can exist. Also, turbines must be sited in rural areas or offshore far from tall buildings which block the wind. Existing land uses, such as airports and airspace flight paths, require minimum distances from turbines and the turbines must be lit up if more than 61 meters in height, thereby leading to light pollution issues. Large groupings of turbines also affect the ability of radar defense systems to track flying objects, thereby affecting military operations. Also, weather monitoring stations and their radars require turbines to be located far away from them. In addition, offshore turbines must not conflict with navigable water acts and laws, along with clean water regulations. Lastly, wetlands may be impacted from turbine farm construction and must therefore be remediated to avoid significant impacts on the ecosystem of an area (KAZA & CURTIS, 2014: 360-361; DELICADO *et al.*, 2013; JABER, 2013).

Solar energy is another renewable energy which directly impacts the landscape. This is as centralised solar farms (CSF's) need to be sited in large areas with high solar insolation/radiation levels. Also, extraction of minerals to manufacture solar panels has been and still is a source of conflict and controversy. In addition, solar water heating units may require large surface areas on site so as to potentially impact urban form, shape, and density. Conversely, landscape affects solar energy, as tall building shade is an issue. Therefore, height restrictions via zoning ordinances and acts need to be put in place in order to allow sun rays to access panels, thereby changing the urban landscape. A big issue with solar panels is that they possess a low energy density. This means that they need large land areas for centralized production and this leads to them being located in sensitive ecosystems such as deserts (KAZA & CURTIS, 2014: 362; LOUWEN *et al.*, 2016).

Advantages of centralised solar systems include the fact that they allow for greater grid connectivity, institutional support and regulation. Meanwhile, rooftop installations allow for energy to be consumed on site, land to be utilized efficiently and zero environmental impact (post installation). Also, solar panels do not: require fuel or water for cooling, emit airborne pollutants, generate waste, or impact the land via fuel transportation or waste disposal (KAZA & CURTIS, 2014: 360-361; LOUWEN *et al.*, 2016).

Hydroelectric dam construction can have huge negative impacts on the landscape. For example, mega-dam projects are gigantic in size and have enormous impacts. The Canadian James Bay Hydroelectric Dam (constructed in the 1970s) is one such dam that has had numerous environmental impacts. These have included: impacting fish populations, the reversal of natural river flows, the loss of a saltwater estuary, changes in water temperatures, loss of wetland productivity, production of greenhouse gasses, destruction of the shoreline, the creation of dead zones around reservoirs, riverbank erosion and interference with animal migration routes. This case highlights that hydroelectricity is not often a "clean, environmentally safe energy source" as it is sometimes made out to be (LINTON, 2006).

Biofuels (biomass, forest residue, waste) also impact landscape-energy synergies. Biofuel plants tend to be sited on industrial style farm operations and rely on a high amount of land and water. Landscapes are also altered when food crops are switched or grown for energy production, thereby potentially affecting soil nutrient loading. The biofuels used in transportation (biodiesel, ethanol) significantly impact and transform the land as they require large amounts of water and land, decrease biodiversity, lead to water pollution (agricultural runoff), cause food prices to rise, require infrastructure (for storage and transportation) and cause a new race for resources (for example, arable land) (ADEYANJU, 2014; APPELS *et al.*, 2011; NATANELOV *et al.*, 2013; BIRCH & CALVERT, 2015).

The need to produce biofuels is thus leading to a new land race (for example, of farm fields and forests). An example of biofuels impacting the land can be seen in the example of food prices as they relate to corn. With demand for ethanol increasing, corn is increasingly being used to produce more and more ethanol. As a result, the ethanol market is one of many variables that influence corn prices. In essence, increased demand for ethanol increases demand for corn, thereby causing the price of corn to surge. As corn prices go up, pressure increases on farmers to grow more on more land, something which may lead to deforestation, and thereby impacts the landscape (ADEYANJU, 2014; APPELS *et al.*, 2011; NATANELOV et al., 2013; BIRCH & CALVERT, 2015).

Moreover, the need to produce biofuels is leading to a new global stratavism of landscapes. This is as there is a new global stratification for arable land, soils, forests, and so on. The result is leading to the political ecology phenomenon of 'land grabbing' that is in part being caused by these energy issues. That is to say, there is a new race for resources (that is, arable land). This race can be thought of as a kind of 'soft war', for it is an issue of political ecology, as biofuels indirectly affect land transformation (scale and location). If large quantities of biofuels replace fossil fuels, this will lead to increased land use conflicts as high land and water requirements will need to be met (ADEYANJU, 2014; APPELS *et al*., 2011; NATANELOV *et al*., 2013; BIRCH & CALVERT, 2015).

This is also something which may be regarded as a kind of colonialism. This is as biofuel energy is a political issue which is wide ranging, as it goes from market prices (for example, for grain crops) on to causes effecting forests and deforestation. It therefore generates geopolitical questions of an ideological nature (ADEYANJU, 2014; APPELS *et al*., 2011; NATANELOV *et al*., 2013; BIRCH & CALVERT, 2015).

Furthermore, SANTOS (2004), explains how these land grabs are a new form of colonialism (neo-colonialism). Drawing from the colonial model of the 18th and 19th centuries in which European imperial empires colonized the continents of America and Africa, he argues it is possible to make a connection to today's new race for land in these continents. Today, the system is slightly different, but in practice it is essentially the same as it represents a new race for natural resources. This is as nature is transformed into a resource for no other logical reason but to be exploited to exhaustion (SANTOS, 2004: 25-26). This reasoning has led to 'neo-developmentalism' or 'neo-extractivism' as is being practiced by various Latin American governments (such as Brazil, Venezuela, Ecuador, and Bolivia) (SANTOS, 2013: 93). One example of this 'neo-colonialism' is that which is being carried out by the Brazilian government in the exploitation of the lands of Mozambique to benefit Brazilian agribusiness companies. By assuming a sub-imperialist or neo-colonialist position, Brazil reveals that it is an intermediary in relation to renewable energies via land grabbing and deforestation (SANTOS, 2013: 121-122; SANTOS, 2009: 259).

Biofuels lead to deforestation as they create a need to free up land to grow fuel crops. This results in the loss of carbon sinks and negates the CO_2 emission benefits of using biofuels. Pipeline issues also exist, as transporting liquid biofuels in existing oil pipelines does not work, and thus leads to water and siting conflicts. Also, de-urbanisation may result, as small cities that were close to a few large employment firms may become mostly unoccupied. This is because biofuels are creating new incentives for people to vacate the city and to venture to find new arable land, deforest it and then plant it with biofuels. The result is creating a significant phenomenon on the global and international scale (ADEYANJU, 2014; APPELS *et al.*, 2011; NATANELOV *et al.*, 2013; BIRCH & CALVERT, 2015).

In addition, solid biomass impacts landscapes via production, harvesting and transportation. While it may utilize existing plant infrastructure that is already in place, it requires new electricity generation and transmission. Landscape transformation also results due to harvesting and carbon sequestration efforts. Other issues include conflict over alternative land uses (for example, food and materials production), resource competition (for example, soil and water), biodiversity reduction and soil disturbance (KAZA & CURTIS, 2014: 363; CALVERT & MABEE, 2014).

Producing energy from waste (landfill waste or methane) also transforms the landscape. Landis impacted as toxic emissions (dioxins and furans) and volatile metals (cadmium and mercury) are released or produced. Siting issues exist as they are often located on landfills and large-scale facilities are required to achieve effective economies of scale. Also, sites are often disproportionately located in poor and minority neighbourhoods. Again, energy transmission infrastructure is needed and thereby shapes the landscape (KAZA & CURTIS, 2014: 363; CALVERT & MABEE, 2014; CALVERT, 2011).

In summary, we see that fossil fuels and renewable energies both affect the landscape and the landscape affects them. The sum of these impacts is dependent on many factors such as the scale of production, crop yield per unit area (biofuels), land occupation and the time required for ecosystem restoration (KAZA & CURTIS, 2014: 363). In the following section (1.11), the fact that energy also effects territory is discussed. This will be seen not just in terms of landscape but also in terms of territorial marketing for creating positive place images.

1.11. ENERGY AND TERRITORY: USING CLEAN ENERGY TO CREATE A POSITIVE TERRITORY IMAGE AND AS A TERRITORIAL MARKETING TOOL

As was alluded to in preceding sections, energy and landscape are deeply connected across territory. In this section, it is shown how clean energy serves to create a positive image of territory, something which is very important in territorial marketing.

The dominant fossil fuel energy paradigm possesses a complex infrastructure (of pipelines, rail lines, trucks and gas stations) that is deeply embedded in the territories where it exists. These infrastructures affect the image and place marketing of a territory. Despite this entrenchment, they are highly vulnerable and unstable as they cross disputed lands, conflict-prone territories, environmentally sensitive areas and vulnerable choke points. When issues arise over this instability, a negative image of a territory may be portrayed (as in the media, for example) (HAARSTAD & WANVIK, 2016: 12-13).

Moreover, it is possible for the entrenched energy paradigm in a territory to be challenged and changed. This can allow for its image to also be changed. For example, changes in infrastructure can change alliances between stakeholders that previously were divided, allowing them to force change. For example, resistance to the Keystone XL pipeline in the U.S.A. “brought together unlikely allies and mobilized enormous protests” (KLEIN, 2014; in HAARSTAD & WANVIK, 2016: 12).

Furthermore, urban spaces may transform, as they are not fixed by the long lifespan of city infrastructures. This is as they may be changed rapidly via retrofitting, conversion and undermining. Examples of changes that have spread worldwide include policy ideas on; urban sustainability, liveability programs, car sharing schemes, bus rapid transit (BRT) systems, bike sharing, and low emission zones. Such initiatives do not necessarily fully change carbonscapes, but they may “fragment, ‘splinter’ and de-territorialize the assemblages of car-based urbanities.” (GUY *et al.*, 1997; in HAARSTAD & WANVIK, 2016: 13).

Furthermore, marketing is an important method of enacting change towards a more renewable energy paradigm. In fact, clean energy serves to create a positive image of a territory and thereby serves as a positive territorial marketing tool. It is marketing that has become increasingly important for cities/places to brand and sell themselves. This is as it is utilised by territories in today's globalized world as "Places have been repackaged, redeveloped and 'sold' in new ways… to attract inward investment but also as part of a new dynamic in urban cultural politics…discourses [are] involved in manipulating culture and selling places." (LIM, 1993).

It may be desirable for certain places to try to change their image to one of a renewable energy image, especially after they may have suffered from having a negative image of their place projected in the media (for example, of a fossil fuel spill). The negative results of such an event may include decline of its: tourism industry, economy, investments, commerce and in its attractiveness to current and new potential residents. In order to change such a negative image, stakeholders may turn to territorial marketing to try to rebrand themselves and to change their image from a negative one into that of a positive one. Doing this can attract new investment, attention, tourism and migrants (AVRAHAM & KETTER, 2008: xii-xiii).

For instance, via marketing strategies, places may try to garner positive media attention by winning prizes or ranking high on certain indexes. These may include, for example, making the Forbes magazine 'World's Cleanest Cities' list. This list of the top 25 clean cities in the world is based on; problem solving, transportation infrastructure, waste management, clean energy generation, waste control, and recycling (FORBES, 2007). Here, we see how through marketing competitions between places and territories, a paradigm of clean energy is extremely important as this leads to the construction of a positive, attractive place image.

Such marketing is often referred to as "Place marketing", what GOLD and WARD (1994) define as "…Place promotion defined as the conscious use of publicity and marketing to communicate selective images of specific geographical localities or areas to a target audience…"(GOLD & WARD, 1994: 2; in AVRAHAM & KETTER, 2008: 5). Here, stakeholders choose desirable positive images, traits and components of a place, while hiding the negative ones in order to market their place as being attractive to a target audience.

Another definition by SHORT *et al.* (2000) states that "Place promotion involves the re-evaluation and re-presentation of place to create and market a new image for localities to enhance their competitive position in attracting or retaining resources" (SHORT *et al.*, 2000: 318; in AVRAHAM & KETTER, 2008: 5). Here, a new place image is marketed to either preserve or attract various resources.

Furthermore, DUNN *et al.* (1995) defines place marketing as "marketing [that] can be seen as a 'refreshing' of urban or national identity or as the creation of new forms of identity"

(DUNN *et al*., 1995; in AVRAHAM & KETTER, 2008: 6). This may mean using marketing as a tool to move beyond past identities of a territory (for example, fossil fuel production based) to new ones (for example, one associated with green energy).

In addition, NIELSEN (2001) refers to the need for “place promotion,” from an image-related crisis. Places must address a physical crisis (in services and infrastructure) and an intangible crisis (suffered by the place’s image), something which may take many years to do (NIELSON, 2001: 207-208; in AVRAHAM & KETTER, 2008:6). To address these crises, decision makers need to choose what they consider to be a suitable package or plan for marketing their place competitively. These strategic plans often include energy plans because they influence the quality of life of the population and give a place a positive and attractive image (AVRAHAM & KETTER, 2008: xiii).

The process of image making then, such as changing from a fossil fuel dependant place to a renewable energy driven one, is a change that is ongoing, holistic, interactive and wide-scaled. Furthermore, strategic plans are key in that they can lead to economic growth, reduced unemployment, growth in income and tax bases, improved local services, improved infrastructure and greater resident satisfaction and quality of life (DUNN *et al*., 1995; FELSENSTEIN, 1994; GOLD, 1980; GOLD & WARD, 1994; HASON, 1996; KOTLER *et al*., 1993; PADDISON, 1993; POCOCK & HUDSON, 1978; in AVRAHAM & KETTER, 2008).

Besides a need to re-image because of being associated with a negative image, many cities are increasingly being forced to adopt a new image as part of urban regeneration strategies. For example, in many cases, it is necessary to reconvert old fossil fuel landscapes and ensure a requalification of these territories. Such a need has arisen from the fact that many formerly booming fossil fuel extracting and producing cities (at times similar to that of old manufacturing cities) have declined due to import competition, declining domestic markets, an inability to compete with overseas production and an offshoring of jobs to cheaper labour markets. The result is urban unemployment, abandonment, decay and a lack of investment (KEARNS & PHILO, 1993).

Regeneration strategies may include urban image branding and myth projection. The intended outcome is to promote a requalification of these territories and ensure a return and rise of investment in these areas that are in decline. It is hoped this will make cities grow in terms of population, employment, culture, political agents and economics. These cities are promoted by the quality of life they are appropriating. Successfully projecting a desirable quality of life can lead to a requalification of territories and a re-appropriation of the image of a place (REID & SMITH; in KEARNS AND PHILO, 1993: 201). This being the case, renewable energy can have a role in promoting a good quality of life (GORMALLY et al, 2016; LIMBURG, 2010: 1293).

Energy plays a big part in marking these cities. For example, clean energies are important for a clean territory and are thereby associated with a healthy territory. This is because a preconception exists that this is the case. Often, this strategy is found in areas that are less attractive. These places often possess slogans that market themselves as being clean, healthy, and safe. Places such as these are clearly centred in the idea of existing ecologically in nature. One such example of a place which plays on this sentiment is the town of Manteigas in Portugal, whose slogan is “Vale por Natureza” meaning ‘by nature’ and “O Coração da Serra” meaning ‘the heart of the mountain’ (MUNICIPIO DE MANTEIGAS, 2017). By using such slogans, the town has centred itself in this idea of being centred ecologically in nature, as it is in a natural valley and is carved into the Serra de Estrella mountain range. Accordingly, it is possible to see the important value that ecological centrality has. Thus, if territories can project an image of a positive quality of life where energy plays a role by ensuring security and health, they may successfully market themselves (WUSTENHANGEN & BILHARZ, M., 2006; MOL, 2000: 48)

Furthermore, gentrification may be seen as an outcome of urban renewal activities that aim to fight urban decline. Gentrification efforts may include an appeal to greener, sustainable, healthier living. This is something that may be associated and branded with clean energy and renewable energy infrastructure. Such an association can be a selling point in gentrification efforts and place marketing strategies (GEIDL *et al.*, 2007: 25).

In summary, considering the many relationships among territory and energy, along with the various marketing strategies and needs, it is possible to use clean energy as a territorial marketing tool to create a positive territory image of a place. In the next section (1.12), the unique qualities of Islands will be explored as these may also lend themselves to various clean energy marketing strategies that can result in a positive territory image.

1.12. ISLANDS AS A GEOGRAPHICAL SUBJECT: ISLAND TERRITORIES AS ISOLATED ULTRA-PERIPHERY REGIONS AND THEIR GEOGRAPHIES, ORGANIZATION AND COMPLEXITIES

Island territories are distinct in terms of their geography, scale, governance and energy infrastructures. Furthermore, islands, being distinct, are often seen and characterized as being idyllic places of a kind of utopia. For example, in his novel 'Island', Aldous Huxley describes a Pacific island where an ideal, perfect, utopian, blissful society has been able to flourish and exist. In the novel the island becomes a symbol of envy elsewhere in the world. Similarly, Thomas More described islands as being special idyllic places in his book 'Utopia' (1516), which takes place on an imaginary ideal island nation. Hence, throughout history, there has been recognition of islands as being special, different and idyllic places (HUXLEY, 2002; MORE, 2007).

With respect to Energy, islands often suffer challenging energy needs due to the fact that many lack size, possess small resident populations and are often remotely located (lying a great distance from continental mainlands). Since many islands cannot be connected to the national electricity grid, this means that they must often generate their own energy production. Energy is often imported from the outside at extremely high costs and is typically fossil fuel derived. Often the result is an energy production system that is unreliable, unsustainable and highly polluting (GUEVARA-STONE, 2014).

Despite the many challenges islands possess, many islands do possess access to many natural features which may be utilized in sustainable energy production. These include the sun, wind, water, geothermal, waves, tides, etc. Due to this fact, many islands are in a position where they can shift to renewables to power their populations and thereby gain greater energy independence as they phase out fossil fuels (GUEVARA-STONE, 2014).

In island territories there also exists the issue of visibility linked to the landscape. This is defined by the European Landscape Convention as "a part of a territory perceived by populations, whose character is the result of the action of natural and/or human factors and their interrelations" (COUNCIL OF EUROPE, 2000). These interrelationships between landscape and co-visibility are important in terms of impact studies for landscape development (GRISELIN *et al.*, 2006; in MARROU & ROUSSEAUX, 2009). Various landscape developments, for example, may influence the visual perceptions that are held by island populations in relation to the landscape.

This is as development projects can have an impact (positive or negative) on island residents. These development projects may include renewable energy production areas such as wind and solar farms. Island residents may develop positive or negative attitudes towards such projects when they lie within the panorama or zone of visibility of the landscape that they can see (GRISELIN *et al.*, 2006; in MARROU & ROUSSEAUX, 2009).

In addition, islands possess specific geographic realties. This is as islands are often isolated away from the high density centers of the world. Islands can also be remote from other islands or groups of islands within their own archipelago, even if they are relatively close to each other. Islands may also be relatively isolated by being poorly integrated into the global network of flows and exchanges. Furthermore, islands can be prone to experiencing difficulty in circulation between islands (of the archipelago) and can possess a challenging topographical configuration (also making flight circulation between islands difficult) (MARROU & ROUSSEAUX, 2009; MARROU, 2005).

Additionally, often creating problems for island territories is the weather. Difficult weather conditions, combined with strong winds and abundant rainfall, create a number of issues. Not only may islands suffer from natural disasters (for example, hurricanes, cyclones, tsunamis, floods, landslides, earthquakes, volcanic eruptions), but the weather also makes marine navigation between islands very difficult. In particular, the approach to ports is affected by weather, as good port sites are often rare (MARROU, 2005).

Another challenge facing island territories is that of island hierarchies. Such hierarchies may exist due to the presence of integrated networks of flows and exchanges. Hierarchies may also be due to poor or good relations between the member islands of an archipelago. Circulation difficulties combined with the challenging topographical configuration of the islands can exacerbate these hierarchical relationships. In fact, it is the islands which possess good port infrastructures that do the best economically due to the fact that many island economies are export based. The islands with large ports tend to organize archipelago space and relations and dominate over smaller islands which possess poor port infrastructure. Competition for power may result between those islands that have the best quality ports and possess the concentration of administrative power bases (MARROU, 2005).

Additionally, access to new technologies, such as air travel for example, may liberate and transform hierarchies that are in place in island territories. Demand based on political visions of land use planning, for example, may allow for measures to be run at a loss (for example, such as guaranteed flight coverage to remote islands). This can even occur simultaneously with market liberalization (for example, of transport). Such actions may result from the recognition of the specificity an archipelago possesses (acknowledged in the European framework) and the obligation to provide public services to these areas of peripheral position. Recognizing this it is possible to get over common issues facing many Islands. These include: 1) mediocre development, and 2) narrowness of the market due to the low population densities. The market, therefore, may be protected and regulated, both for maritime transport and for air services (MARROU, 2005; EU, 2016).

The public service obligation for islands therefore has a cost that is borne by national solidarity. Some regional governments (thanks to European aid) may reinvest heavily in passenger transport between islands. The combination of European aid and the public service obligation during market liberalization of transport allows some archipelagos to enjoy quality access. A genuine network of efficient air and sea infrastructures is possible. The political will to improve mobility for island populations makes it possible to assist transport service which plays an important role in the cohesion of an archipelago. Regular service has an impact on the reduction of transport tariffs between the islands (MARROU, 2005).

According to the EU, there are many challenges facing EU islands due to their insularity. These include: transportation (inadequate transportation linkages to mainland or other islands); vulnerable ecosystems (for example, vulnerable to drought, rising sea levels, land erosion, overfishing of fish stocks); lack of natural resources (for example, scarcity of fresh water); scale (small land area and populations); topography (often mountainous thus possess a limited amount of arable land); periphery location (for example, sit large distance from EU member states); borderland location (for example, may face migrant influxes but lack resources to process, accommodate, and integrate them); limited economic growth opportunities (due to periphery location, small economies of scale, monoculture economies, economic stagnation, and inadequate social services); lack of human capital; limited public resources (for example, health, education, research and innovation); lack of agricultural, industrial and service sector production and self-sufficiency; strong reliance on imported fossil fuels for their energy needs (as energy sustainability via wind, tidal and solar power has not yet been achieved for many); dependence on mainland energy networks (when located near enough to mainland); import dependency;

goods are more expensive (as most come from outside); higher cost of living; tourism (influx problems in terms of waste and wastewater management); demographic trends (emigration, refugee influxes); unemployment (lack of professional development); lack of a framework of financial support for islands; and agriculture (location, scale, lack of diversity, dependence on local markets and climate change) (EUROPEAN PARLIAMENT, 2016).

Europe's islands are composed of approximately 10 million inhabitants (2% of the total EU population) and face numerous and similar energy challenges. Among these is the issue of attaining their energy needs sustainably, reliably and affordably. Challenges include: market failure, inconsistent regulation, security of supply, emissions, and import dependency (EUROPEAN PARLIAMENT, 2016).

Market Failure refers to islands lacking economies of scale (due to their small size, populations and isolation) to finance power production projects. Energy supply system diversification therefore remains an issue as many must import oil and diesel for burning to generate power to meet their energy needs (GUEVARA-STONE, 2014)

Inconsistent regulation is another issue faced by island territories with respect to energy production. EU solutions that are created in continental Europe to meet continental energy needs are often imposed on island territories which face alternative realities and challenges and therefore need their own catered appropriate solutions (EUROPEAN PARLIAMENT, 2016).

Guaranteed energy security in terms of continuous supply is an issue which faces all isolated territories. Increasing the total amount of renewables (such as wind and solar power) can help achieve greater energy security in isolated regions (EUROPEAN PARLIAMENT, 2016).

Emissions are another challenge facing islands, as many burn fossil fuels to meet their energy needs. Dependency on fossil fuels for energy generation poses many challenges for islands when it comes to meeting EU emission regulations that are increasingly becoming stricter to combat climate change (EUROPEAN PARLIAMENT, 2016).

Import dependency refers to the fact that many islands are dependent on fossil fuels that come from outside their territories to meet their energy needs. Oil based power generation exposes them to the issues of market fluctuations in oil prices, transportation supply issues and geopolitical competition for resources. Additionally, emissions requirements, fuel quality standards and environmental targets also pose issues (EUROPEAN PARLIAMENT, 2016).

By acting through EURELECTRIC's Network of Experts for Island Energy Systems (NEIS) solutions may be attained. Islands advocate for policy changes that enable them to access investment and appropriate policies. To move toward sustainable energy production, islands can:

> 1. Set up an EU Island Sustainable Energy Action Plan 2020; 2. Improve security of supply through diversification of power generation technologies, as well as interconnection where possible; 3. Use islands as a priority test-bed for innovative technologies such as storage, smart grids and RES, foster RD&D on islands and 4. Use exemptions appropriately and address the market failures that often occur as a result of limited size and isolation (EURELECTRIC, 2012: 7).

Various benefits may also be appreciated and derived from the EU's island territories. These include wealth generation (resource and cultural), tourism, agricultural products and handicrafts. By playing to their competitive advantages and relative strengths, the EU's islands may become "lands of opportunities" (EUROPEAN PARLIAMENT, 2016).

According to the European Spatial Planning Observation Network (ESPON) study on the development of islands, they may be "transformed into 'green' islands of equal opportunities and producers of high-quality local products" (ESPON, 2013). Through green technologies and smart specialisation, islands can become self-sustainable and their natural resources can be protected. The "Covenant of Mayors for the environment" program aims to achieve just this (EUROPEAN PARLIAMENT, 2016: 8; ESPON, 2013).

Other opportunities to support islands can include: new jobs in ICT (to remedy the research and innovation gap); new production jobs in high-quality agricultural products and handcrafts; protecting island-produced products by EU geographical indication schemes; rural development aid programmes; blue growth techniques (to address the depletion of fishing stocks and to provide new economic activities in coastal areas); and to promote a unique way of life, a high quality of life, a stress-free environment, and cultural and natural resources (EUROPEAN PARLIAMENT, 2016: 8-9).

In summary, islands possess specific geographic realities, challenges and opportunities. Furthermore, they have been historically characterised as utopic places that may exist as laboratories (social and political) for new innovations. As such, islands have found special status within the EU due to the distinct characteristics they possess. The status of islands within the EU is the subject of the next section (1.13).

1.13. THE EU'S OUTERMOST REGIONS: ISLANDS AS A SPECIFIC SUBJECT WITH SPECIAL AND DIFFERENT TREAMENT IN THE EU

The European Union is composed of 28 member states, each of which is an internationally recognized independent country. Some of these countries possess periphery or insular territories, most of which are islands. These territories may be autonomous or semi-autonomous.

Islands are defined as being territories having "A minimum surface of 1 km²; A minimum distance between the island and the mainland of 1 km; A resident population of more than 50 inhabitants; No fixed link (bridge, tunnel, dyke) between the island and the mainland" (EUROPEAN PARLIAMENT, 2016: 2).

The EU definition of islands is based on the Eurostat definition which states that "island regions are NUTS 3 regions entirely made up of islands. …NUTS 3 island regions can correspond to a single island, or can be composed of several islands, or can be part of a bigger island containing several NUTS 3 regions" (EUROPEAN PARLIAMENT, 2016: 2).

Five categories if islands exist and are based on "the size of the major island related to the NUTS 3 region: 1) Regions where the major island has fewer than 50 000 inhabitants; 2) Regions where the major island has between 50 000 and 100 000 inhabitants; 3) Regions where the major island has between 100 000 and 250 000 inhabitants; 4) Regions corresponding to an island with 250 000 to 1 million inhabitants, or part of such an island; and 5) Regions being part of an island with at least 1 million inhabitants." (EUROPEAN PARLIAMENT, 2016: 2).

According to the European Spatial Planning Observation Network (ESPON), EU islands can be categorized according to their size: 1. Large islands (> 50 000 permanent inhabitants)(15 islands); 2. Medium-sized islands (5,000 – 50 000 permanent inhabitants)(44 islands); 3. Small islands (50-5,000 permanent inhabitants)(303 islands); and 4. Very small islands (< 50 permanent inhabitants)(228 islands) (EUROPEAN PARLIAMENT, 2016: 2; ESPON, 2011).

Island territory - EU relationships vary widely as some islands are formally are part of the EU while others have special arrangements under EU law. These are unique, dynamic, evolving and ever changing arrangements. The island territories of the EU negotiated their own special relationships with the EU when their parent member states joined the EU, what is known as primary community law. Those islands governed by this law include: "ultraperipheral regions, the Overseas Countries and Territories (OCTs), the Åland Islands, the Faroe Islands, the Channel Islands, and the Isle of Man. The ultraperipheral regions and the Åland Islands are formally part of the EU, while the Overseas Countries and Territories (OCTs), the Faroe Islands, the Channel Islands, and the Isle of Man are not (MURRAY, 2001: 1).

EU - Island territory relationships are unique and ever changing, as many similar island territories vary greatly in terms of their EU arrangements. Two main groupings exist, that is of Overseas Departments (DOMS) and Overseas Territories (TOMS). Both overseas departments and overseas territories “suffer the physical and economic disadvantages of being underdeveloped and remote” and have “a special status under EU law” (MURRAY, 2001: 2).

Overseas departments are considered "ultra-peripheral regions" under Article 299(2) of the EC Treaty. Included are the Azores, the Madeira, and the Canary Islands and the French overseas departments of Guadeloupe, Martinique, French Guiana and Reunion. Overseas departments are officially part of the EU and all EC Treaty provisions apply to them. The specific problems of these regions were addressed by the ‘programmes of options specific to their remote and insular nature’ (1989) and its “POSEIDOM” program that gave them funding from the EU’s structural funds (MURRAY, 2001: 3).

The Canary Islands (of which the Island of El Hierro that is included in this study is a part of) is an autonomous community of Spain that falls under the EU’s "ultra-peripheral regions" designation. This means all EC Treaty provisions apply as per Article 299 (2). In 1991, the Canary Islands became a part of the EU’s Community's Common Customs Tariff (CCT) of which they were previously excluded (MURRAY, 2001: 5).

As evidenced in Article 158 of the Amsterdam treaty which makes special reference to islands, the EU recognizes the special nature of the needs of islands. This is rooted in law and forces the EU to adopt policy for them (MURRAY, 2001: 5).

In summary, the islands of the EU possess specific geographic realities, challenges and opportunities, and therefore have been granted special status within the EU. Whether islands are full EU members, partial members, recognized as being overseas departments or overseas territories, the EU has catered its rules and committed itself to including these in the EU. This has and is being done by special EU investments in islands, the topic which is discussed in the next section (1.14).

1.14. THE EU'S SPECIAL INVESTMENTS IN ITS OUTERMOST REGIONS

The European Union is committed to transitioning to a clean energy paradigm. This is as it acknowledges the problems of geopolitical instability and the negative impacts that are associated with a fossil fuel paradigm. Believing there is no alternative but to switch away from fossil fuels, it is attempting to do so by adopting more renewable energy which is now cost-competitive and at times cheaper than fossil fuels. To date, clean energy employs over one million in Europe alone, it is attracting the most investment in its sector, and it saves 16 billion Euros a year on fossil fuel imports. The EU hopes to spread these benefits to all its member areas of the EU, including its Islands, of which there are 286 belonging to eleven EU countries (EURELECTRIC, 2012: 9; EUROPEAN COMMISION, 2017: 1).

Attempts to improve the renewable energy sector in periphery territories include the Cohesion Policy 2014-2020 – an investment strategy for future EU growth and competitiveness. This programs has a budget of 336 Billion Euros, half of this has been allocated as investment for less developed regions. Another example of its commitment is the Social Fund (ESF) which stimulates employment opportunities, lifelong learning and social inclusion in periphery regions. Similarly, the Connecting Europe Facility (CEF) program helps fund periphery island territories as it accelerates the development of transportation infrastructure, energy and information technologies (EUROPEAN UNION, 2011).

Furthermore, the Amsterdam Treaty (1999) introduced provisions for island territories. These apply to islands formally part of the EU and indirectly to islands that have with relations with the EU. The treaty mentions addressing islands by strengthening their "… *economic and social cohesion ... reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions or islands, including rural areas*" (MURRAY, 2001: 4).

Declaration No. 30 on island regions defines the Community's obligations in Article 158. It states that: "*…legislation must take account of these handicaps and that specific measures may be taken, where justified, in favour of these regions in order to integrate them better into the internal market on fair conditions*" (MURRAY, 2001: 4).

Article 299(2) requires adopting specific measures that account for "*special characteristics*, *constraints*, and *insularity*" of islands (MURRAY, 2001: 4-5).

Article 154 focuses on trans-European networks and "*the need to link island, landlocked and peripheral regions with the central regions of the Community*" (MURRAY, 2001: 5).

Article 174 of the Treaty on the Functioning of the European Union (TFEU) states island territories possess a special nature due to their insularity and they therefore need to receive special treatment within the EU. Article 174 states that "'in order to promote its overall harmonious development, the Union shall develop and pursue its actions leading to the strengthening of its economic, social and territorial cohesion'…[with] particular attention [to] be paid to island regions" (MURRAY, 2001: 5).

Despite this acknowledgement, few EU measures have supported islands thus far. These insular territories request that the EU's regional policies take into account their insular factors and dimensions that are disproportionately affecting them (EUROPEAN PARLIAMENT, 2016).

Article 349 on the Treaty on the Functioning of the European Union also addresses the EU's outermost regions. These are regions that are "geographically distant from mainland Europe" (EUROPEAN PARLIAMENT, 2016: 4). Not all, but some of the EU's islands are considered part of the EU's outermost regions. These Islands benefit from special EU status as outermost regions are supported by "specific measures aimed at addressing the challenges faced by these territories as a result of their remoteness, insularity, small size, economic dependence on a few products, difficult topography and climate" (EUROPEAN PARLIAMENT, 2016: 4). Additionally, islands that are not considered part of the EU's outermost regions but that are also insular in nature are demanding recognition of a status similar to that of the outermost regions (EUROPEAN PARLIAMENT, 2016: 4).

Similarly, Article 170 regarding Trans-European Networks requests the EU to carry out actions that address the need to link islands (along with landlocked and peripheral regions) with the central EU regions (EUROPEAN PARLIAMENT, 2016: 3).

Furthermore, TFEU Article 107(3) requests that States give development aid for "less favoured regions" and that this aid "can be exempted from the Treaty ban on state aid". In particular, Article 107(3)(c) "allows aid to be used to facilitate the development of certain areas, where this does not significantly affect competition ('category c' regions)" (EUROPEAN PARLIAMENT, 2016: 3). These 'category c' regions are:

> regions with GDP per head below the EU-25 average; those with unemployment over 15% higher than the national average; or those undergoing major structural change or in serious relative decline; as well as

regions with low population density; islands with a population of 5 000 or less; regions similarly isolated geographically; and regions neighbouring 'category a' regions, where the standard of living is abnormally low or where there is serious underemployment (EUROPEAN PARLIAMENT, 2016: 3).

Despite this commitment, aid for category ‘c’ regions was just 25% that of category ‘a’ regions, experiencing a drop in funding of 39% in 2011 (compared to 2008), for a total of 2.9 Billion Euros (EUROPEAN PARLIAMENT, 2016: 3).

Furthermore, the EU Member States are allowed to provide more financial instruments to their insular territories. The rules governing these are laid out in the Common Provisions Regulation (CPR). Funds aiming to better regional development and growth of insular island territories include: “the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF)”. Under the CPR provision, Article 121 states that the “co-financing rate from the funds to a priority axis may be adjusted to take account of ...island member states” (EUROPEAN PARLIAMENT, 2016: 4). These “… island Member States [are] eligible under the Cohesion Fund, and other islands, except those on which the capital of a Member State is situated, or which have a fixed link to the mainland” (EUROPEAN PARLIAMENT, 2016: 4). Additionally, Member States should seek to “…ensure that areas that share major geographical features (islands, lakes, rivers, sea basins or mountain ranges) support the joint management and promotion of their natural resources” (EUROPEAN PARLIAMENT, 2016: 4).

Moreover, the European Parliament (EP) resolution (2002/2119(INI)) on structurally disadvantaged regions (islands, mountain regions, regions with low population density) stresses the need for solidarity for island regions, as they suffer from “structural disadvantages” such as “permanent geographical handicaps, … mountain areas, and sparsely populated areas” (EUROPEAN PARLIAMENT, 2016: 4-5).

Similarly, the TEN-T programme has been encouraged to focus more on areas suffering permanent handicaps, especially with respect to transport and environmental protection.

Furthermore, EP resolution (2006/2106(INI)) focused on island economic constraints and states that; further work in defining pertinent statistical indicators, better understanding of regions, and increased flexibility in implementing state aid policies is needed. The EP also calls for development in energy, in addition to broadband, healthcare and online medical services, electronic governance, citizens' services, and tourism sustainability (EUROPEAN PARLIAMENT, 2016: 8).

In addition, the study "*The Analysis of Island Regions*" created a statistical database of geography, demography, infrastructure, environment and socio-economic structure and then compared the situation of the islands to the Community and Member States. Its goal was to implement measures and policies to remedy the backwardness in development caused by being an island and to propose future steps (MURRAY, 2001: 4-5).

Island territories have argued that despite their special status within the EU, few EU measures have supported them financially. This is because the EU does not take into account measures on the cost of insularity or the data that is necessary to address the needs of its island territories. Also, a lack of a framework results in islands being neglected in terms of financial support (EUROPEAN PARLIAMENT, 2016: 1).

Currently, islands suffer from the EU system of funding. This is because this system allocates funds to regions based on their amount of total GDP and is based on three categories; 1. less developed regions, 2. transition regions and 3. more developed regions. The result is; a lack of financial support for island territories to address their insularity issues, grouping islands into larger non-homogenous regions (with mainland regions), urban conurbations and diverging island categories. These actions artificially raise the GDP of the region making it appear to be more developed then it actually is, causing islands to lose out on significant EU funding (for things like basic infrastructure) (EUROPEAN PARLIAMENT, 2016: 5).

It is the "European strategy for the economic and social development of mountain regions, islands and sparsely populated areas (2010/2856(RSP))" that states that it is mainly GDP that must be used to determine regional policy assistance eligibility. More relevant 'territorialised' statistical indicators are needed to better describe the development levels of island regions. They may include population, employment, education, and population density levels. These can be used to redistribute funds to Islands based on their specific characteristics (EUROPEAN PARLIAMENT, 2016: 5).

Island local policy makers are demanding a move towards "'insular mainstreaming', that is, the setting of special provisions on how EU programmes and policies are developed for insular territories. This is…as "due to their small populations, an increase in EU funding for insular territories would have only a small impact on the total EU budget, but this minimal increase of funding would provide a significant boost to insular territories (EUROPEAN PARLIAMENT, 2016: 6).

With respect to Agriculture, the EU’s Common Agricultural Policy (CAP) possesses the direct aid assistance schemes of Rural Development Programmes (RDPs) and the European Agricultural Fund for Rural Development (EAFRD). These help address Island agriculture issues such as; location (remote), scale (small), diversity (low), local market dependence, climate change, raw material imports and lack of market access (to mainland markets) (EUROPEAN UNION, 2016).

In conclusion, the EU can invest in its outermost territories via: insular policies (at national and European level), policy ideas (that come from the insular territories) and their organisations (such as 'insular mainstreaming' in national and European policies; measuring the cost of insularity and collecting data to assess the real needs of insular Island territories). Islands may request additional aid incentives to boost their local economies, such as aid to islands in the fields of the environment, energy, transport and infrastructure. Also, islands can get state aid exemptions for islands with populations above the TFEU limit of 5 000 inhabitants and can use additional indicators as well as GDP for the allocation of regional funding (EUROPEAN PARLIAMENT, 2016: 8-9).

In summary, part 1 has presented the theoretical foundations and literature support necessary to allow the analysis of this study to take place. It has been established that by using an energy geography lens, energy paradigms may be analyzed in terms of their landscape-energy relationships. Fossil fuel and renewable energy paradigms are systems that may be distributed, decentralized, diversified and are potential sources of conflict. The energy transitions of the islands of El Hierro, Samso and Pico will be analysed in the following chapters. Next, in part 2, an examination of the energy transitions of El Hierro and Samso is carried out. This is as an energy paradigm shift is related to geography as it can change landscapes, territorialities and the quality of life of places.

PART II │ ISLAND EXAMPLES

2. THE TRANSITION OF RENEWABLE ENERGY POWERED ISLANDS IN THE EU

2.1. CASES: THE ISLAND OF EL HIERRO AND THE ISLAND OF SAMSO

As described earlier in section 1.12 of chapter 1, islands have a special character and face unique challenges. For example, islands often suffer challenging energy needs due to the fact that many lack size and are often remotely located. Energy is often imported from the outside at extremely high costs and is typically fossil fuel derived. The result is an energy production system that is unreliable, unsustainable and highly polluting. Despite this, many islands possess access to many natural features which may be utilized in sustainable energy production. These include sun rays, wind, water, geothermal, waves, tides, and so on. Due to this fact, many islands are in a position where they can shift to renewables to power their populations and thereby gain greater energy independence as they phase out fossil fuels (GUEVARA-STONE, 2014).

One such island that is phasing out fossil fuels is the island of El Hierro in the Canary Islands of Spain. Located off the coast of Northwest Africa, El Hierro serves as an example of how an EU island may move towards 100 percent renewable energy-self-sufficiency and beyond the need for fossil fuels. A hybrid wind/pumped hydro system is said to at times be able to provide up to 100 percent of the energy the island needs, thus making it the first island in the world that can be powered by renewables in isolation with no link to another island or mainland electricity grid (FRAYER, 2014).

Samso, a Danish island of about forty-three hundred inhabitants located in the North Sea close to mainland Denmark, like El Hierro, is an island capable of producing 100% of its energy needs solely from renewables. It is therefore an energy-independent and near fossil fuel free island. It serves as an example of how an island that was guilty of high carbon emissions in the past (due to oil consumption and imported electricity) can convert to all renewables (as it did starting in 1998). Unlike El Hierro, it serves as an example of how an island that is hooked up to the mainland electricity grid can achieve this (WEINBERGER, 2014; KOLBERT, 2008).

Together, these two islands are analysed here in chapter 2. This is done to see what model each employed to transition away from fossil fuels and how these transitions evolved over time. Also, how these energy transitions translated into each islands landscape, territoriality and population will be analysed. In addition, various questions on the issues previously discussed in chapter 1 will be considered. These include: Who controls the process? How did it start? and Who started it? Also, framework will be presented to compare the islands in terms of geography, demography, energy system, and so on. The result of this analysis is to conclude if there are differences between the models employed on each island and to see if they make up one similar model or two different models for two different places. Later, a comparison is then made in chapter 4 to see what the differences are between the transitions of the three islands and to see what is possible for Pico, that is, to see if the same model(s) that were applied in these two islands may be applied or connected to Pico or if a third model and different road is necessary for Pico.

2.2. GEOGRAPHIC LOCATION

Next, the geographic location of the islands of El Hierro and Samso are explored. First, let us consider El Hierro. The island of El Hierro lies in the Northern half of the Atlantic Ocean at latitude 27° N and longitude 18° W (subtropical) and makes up part of the Macaronesia collection of island archipelagos (GEOHACK, 2017; BUENO & CARTA, 2006: 314). El Hierro is one of the seven main islands (along with Lanzarote, Fuerteventura, Grand Canary, Tenerife, La Palma, and La Gomera) that make up the archipelago of the Canary Islands (along with several minor ones) (GEOHACK, 2017). These islands are one of the 17 autonomous communities belonging to Spain. The Canaries are also classified as an Outermost Region (OMR) of the European Union (see section 1.13 in chapter 1) (BUENO & CARTA, 2005; BUENO & CARTA, 2006: 313). The Canary Islands are located Northwest off of the West Coast of the African Continent (100 km from Morocco) and are volcanic in nature and therefore possess mountainous topography with El Hierro possessing a maximum altitude of 1501 metres (see figures 7 and 8 on the following page)(WEINBERGER, 2014; CALAJAN, 2011).

The Island of El Hierro is the smallest and the farthest West and South of the Canaries (TOLEDO, 2015). It has an area of 268.7 km^2 and a population of approximately 11,000 people (2016) (MORALES, 2000; RENALLIANCE, 2016; BUENA & CARTA, 2005: 398). Topographically, it is defined by coastal cliffs and stark volcanic landscapes and lava-sculpted rocks (LEW, 2014; GUEVARA-STONE, 2014).

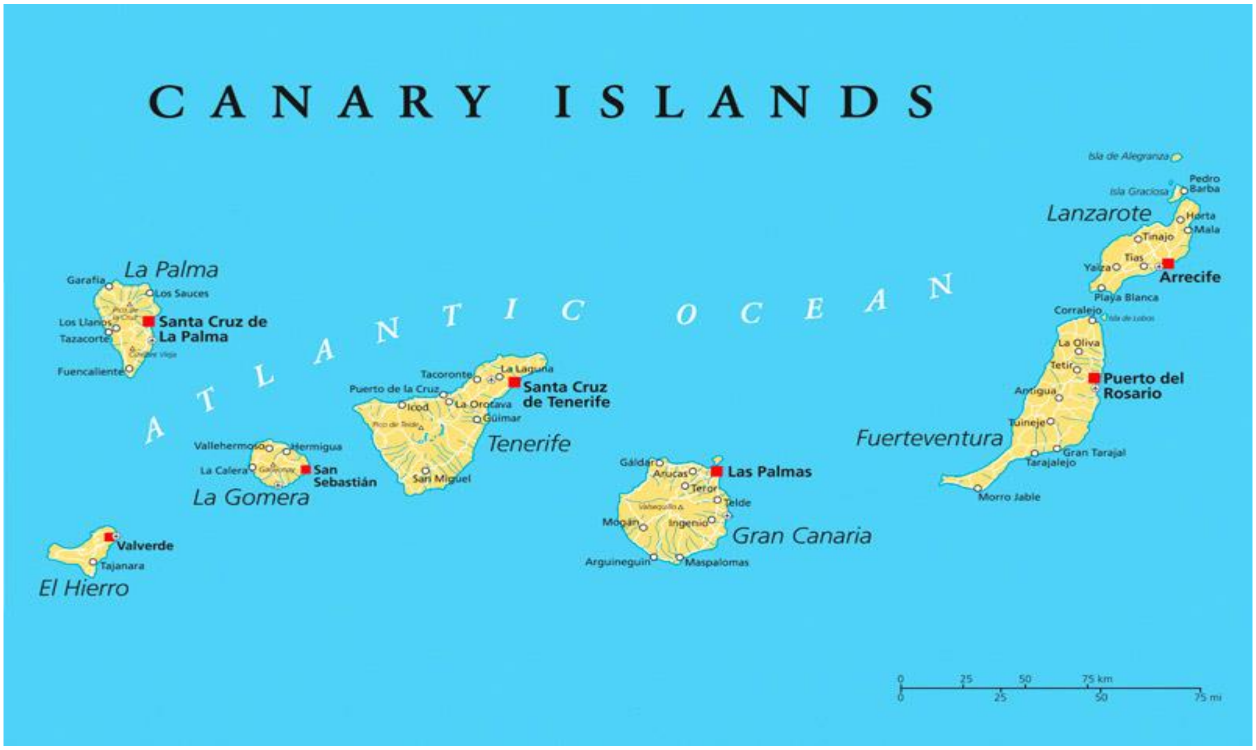

Fig. 7 - The Canary Islands and El Hierro in the Atlantic Ocean West of the continent of Africa
Source: WEATHER2TRAVEL.COM, 2017.

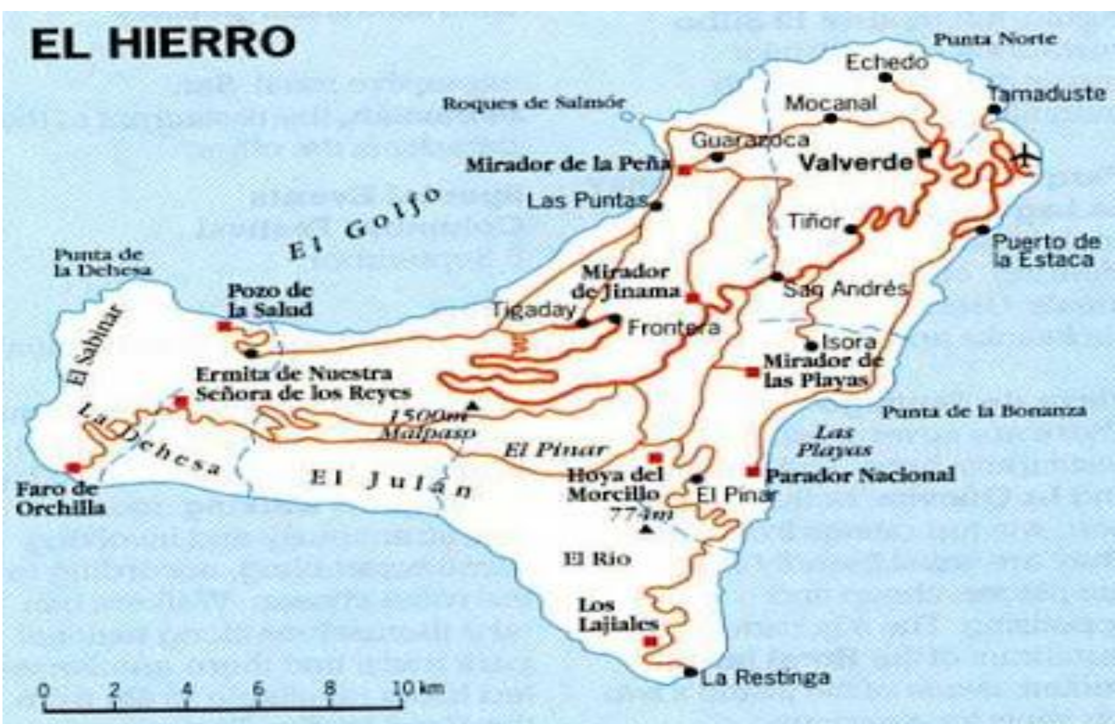

Fig. 8 - El Hierro, the smallest of the seven main Canary Islands
Source: VERBATIMCITATION, 2009.

The topography of the surrounding seabed represents that of an active volcanic island, and for this reason, El Hierro can never be hooked up to a continental power grid (for example, Spain's) nor to that of the nearest neighbouring islands (see figure 9 below) (FRAYER, 2014). It's seabed topography, and the fact that El Hierro is situated in the Atlantic Ocean, means that it is exposed to waves whose wave energy varies seasonally - ranging from very energetic large waves in winter, to mild smaller waves in summer. The size and frequency of waves also varies across the islands shores (IGLESIAS & CARBALLO, 2011).

Fig. 9 - El Hierro's steep topography and jagged coastline landscape
Source: GLOBAL ISLANDS NETWORK, 2017.

The island also possesses vast areas of natural landscape, as only 10 percent of the land has been converted to farmland (LEW, 2014). In the year 2000 UNESCO designated 60 percent of the island a Biosphere Reserve (WEINBERGER, 2014; MORALES, 2000). As a result of its location, warm weather (near-tropical), natural landscape, and clear waters (that make it a diver's paradise), El Hierro is known (as are the Canaries) as being a scenic tourist destination. Unlike the others, however, El Hierro remains relatively untouched by tourism. This is due to the fact that the island has blocked the entry of bulk package tourism (through things like limited hotel bed spaces and no direct flights). Instead, luxury tourism has been embraced to help ensure El Hierro is not overly impacted by tourism. Despite, tourism numbers being less than on the other Canary Islands, tourism still does pose new energy challenges for the island (for example, on the island's energy infrastructure) (ANDREWS, 2014; GUEVARA-STONE, 2014).

Second, let us now turn our attention to Samso. The island of Samso lies in the middle of Denmark and is situated 15 kilometers off the coast of the Jutland Peninsula (HERMANSEN *et al.* 2011 in BRANDT AND SVENDSEN, 2016: 627; WALSH, 2009). Located about four hours from Copenhagen, Samso sits in the Kattegat strait, a bay between the Baltic and North seas at latitude 55°N and 10°E and is surrounded by Denmark (CARDWELL, 2015; GEOHACK, 2017). The island of Samso is considered to be a part of Denmark and operates officially as part of the region of Central Denmark (see figure 11 below). Due to the fact that Samso is located so close to mainland Denmark, it is not classified as an Outermost Region (OMR) of the European Union. Its close proximately to the mainland also means that it is able to be connected to the mainland electricity grid. The island is located centrally in Denmark, as can be seen in figure 11 on the following page.

The island of Samso is mostly countryside made up of a patchwork of wavy landscapes, meadows, woodlands and heath. The coastline is characterized by steep cliffs, stony beaches, and some sandy beaches that make the island popular for tourism. Unlike El Hierro, which is volcanic, steep and high, Samso has just a maximum altitude of 64 metres above sea level (GEOHACK, 2017). Samso is small (smaller then El Hierro) as it has an area of 115 km^2 and has a population of approximately 3,724 people (2013) (see figure 10 below) (LIN, WU & LIN, 2016:9; SAMSOE, 2017).

Fig. 10 - Aerial view of the island of Samso, Denmark
Source: FLYAWAYSIMULATION, 2017.

Fig. 11 - The country of Denmark and Samso Island lying in the centre of the country
Source: FACTS ON FILE, 2000.

In summary, in this section the contrasting geographies, topographies and physical realities that face the two islands of El Hierro and Samso have been presented. Next, the varying geographic populations and their associated dynamics are considered in section 2.3.

2.3. POPULATION

After having established the geographical location and make-up of El Hierro and Samso, here an analysis of the population statistics of the two islands has been carried out. Starting with El Hierro, the island had a population of 10,587 people (5,391 males to 5,196 females) in 2015, with a population density of 39 people per square kilometre (INE.ES, 2017). Furthermore, the island is made up of 3 municipalities which combined contain several villages. In 2015, the island received 656 newly registered immigrants, while it experienced 585 deregisters, for a net migration balance of 71 people (INE.ES, 2017; GOBCAN, 2017).

In terms of the economy of the island, principal activities include agriculture, fishing and tourism (increasingly becoming a more and more important part of Samso's economy)

(GLOBAL ISLAND NETWORK, 2017). Agriculture consists of livestock rearing (majority dairy), fruit growing and grain (wheat) and grass (hay) production. Cheese is produced, as are wines (by the Frontera cooperative) with half the wine converted into spirits (GLOBAL ISLANDS NETWORK, 2017). Historically, the island has had a closed or subsistence economy. It has not been a majority export based economy as it has produced just enough agricultural produce to feed its own population. A number of farming cooperatives have developed over time on the island. In addition, El Hierro has little industrial activity and a service sector for small scale tourism (BUENA & CARTA, 2005: 398). A small canning industry is supported by fishing and small scale fruit production. Tourism, however, is a main and growing economic sector (although less so then in the other larger Canary islands) and is putting additional pressure on the energy system as upwards to 60,000 tourists visit every year (GILS & SIMON, 2017: 343; GUEVARA-STONE, 2014; GOBCAN, 2017). Transportation is also an important sector and a gradual conversion of the transportation sector away from being fossil fuel powered is being pioneered, also helping the islands image (GOBCAN, 2017).

Now, turning our attention to Samso, the island, as previously mentioned, is smaller than El Hierro (possessing an area of just 115km^2) and has a full-time permanent population of 3,724 people (as of January1, 2017), less than half that of El Hierro (SAMSOE, 2017). The average population ranges between 4,000 - 4,300 inhabitants, as many people have a vacation home on the island (WEINBERGER, 2014; KOLBERT, 2008). The population density is just 33 people per square kilometre and is thus similar to that of El Hierro. Furthermore, the island is made up of 1 large municipality of which Tranebjerg (approximately 900 people) is the largest settlement, and is comprised of some 22 small villages (BRANDT & SVENDSEN, 2016: 627).

The island's principal economic activities include farming, tourism and related service sector jobs (FALKENBERG, 2017). Agriculture consists of potato, wheat and strawberry farming. Samso is nationally known for its potatoes, which often arrive a few weeks earlier than most other places in the country, due to the combination of several generations of careful cultivation, a mild climate, less frost and more sunny days then the rest of Denmark. Its mild climate also allows for fruit and vegetable production (SAMSOE, 2017).

Tourism is an important and growing economic sector, as tourists often come on weekends in summertime to enjoy a variety of sport, cultural and recreation activities. Like on El Hierro, tourism is putting an additional strain on the energy system and energy use. Despite this energy pressure, Samso's near 100% renewable energy system has also served to create its island image – that of a clean island that is becoming fossil fuel free. Marketing itself in this way, Samso is becoming more attractive from the tourist point of view. Thus, there exists a contradiction for the island with respect to the relationship between tourism and its energy model, as its renewable energy system is challenged and stressed by more and more tourists, but its existence attracts more tourists. (SAMSOE, 2017; BRANDT & SVENDSEN, 2016:627).

Also, the transportation sector and its associated infrastructure is part of the energy transition on Samso, as the transport sector is fundamental, especially as tourism increases. Solutions have been proposed to grow and produce biofuels on the island to switch the heavily polluting ferry service (which transports people to the island) to biofuel powered. In addition, the small geographic scale of the island has allowed it to run pilot projects of electric passenger vehicles and to start to phase out fossil fuel powered ones (SAMSOE, 2017).

Now that a greater appreciation of the scale and activities of these two islands has been established, it is possible to now turn our attention to the evolution of each of the islands respective energy systems as they have approached 100% renewable energy sustainability. This is the subject of the next section (2.4).

2.4. DEVELOPMENT TRAJECTORY

Having considered in the previous section the population context that is faced by those who live on El Hierro and Samso, it is now possible to consider the development trajectory that has been followed by these two islands.

Starting with El Hierro, in the 1980s and 1990s the island, on average, imported and burned 6,000 tonnes of diesel fuel each year (that is, the equivalent of 40,000 barrels of oil) to power a 11.36 megawatt (MW) diesel-fired power plant. Resulting emissions were in the order of 18,700 tonnes of carbon dioxide annually. Electricity supply was erratic and expensive at a rate of €0.242/kilo-Watt-hour (kWh). Twenty percent of the electrical energy consumed ran three desalination plants that generated water for drinking and irrigation and therefore a lack of energy represented a potential lack of water and food (ANDREWS, 2014; GUEVARA-STONE, 2014; FRAYER, 2014; WEINBERGER, 2014).

Starting in the 1980s the Island Government of El Hierro (Cabildo de El Hierro), UNELCO (local utility company) and the ITC (The Technical Institute of the Canary Islands), with the help of the ALTENER programme, together collaborated on a project that aimed at covering the island's energy demand by renewables (ANDREWS, 2014; GUEVARA-STONE, 2014).

In 1986 the first proposal was elaborated on and set the simulation and size of a scheme to increase renewable energy supply (wind turbines of 300 kW rated power; hydro generators of 1.5 MW; diesel generators of 3.8 MW; 250 and 500 kVA water pumps; and upper & lower reservoirs for hydroelectric generation) (MORALES, 2000: 77).

In the early 1990s, after a review of the Canary Islands' laws that established a limit on the penetration of wind energy into the grid (limit of 12% to avoid imbalances in the electricity system), alternatives to increase renewable energy utilisation were considered. It was found that the islands natural resources included excellent wind potential.

Finally, in 1997, the Island's sustainable development plan was officially approved with the aim to achieve a 100% renewable energy power supply by 2015. The plan called for: a combined wind energy and hydroelectric power station; a desalination plant to fill up hydro plant reservoirs and replace water loss due to evaporation; a high penetration of solar thermal systems for household hot water (to be achieved via promotion, dissemination and financing campaigns); an introduction of PV systems and hybrid systems (PV-Wind) for households connected to the grid (by promotion, dissemination and financing campaigns); implementation of an energy saving and energy auditing programme; a gradual conversion of the transportation sector away from gasoline and diesel power; the introduction of biomass energy production systems; awareness raising campaigns, dissemination events and training courses (to ensure the adaptation of the population to new technologies and organisational structures and to prepare the island to maintain the systems); new biological (organic) agriculture projects via water desalinisation tied to renewable energy; and experimental biogas production (from stockbreeding effluents and sewage via methanogen fermentation) (MORALES, 2000:78).

In the year 2000, 95% of the islands electricity was produced via nine diesel generators (total combined generating capacity of 9,745kW) producing a total of 22.43GWh and consuming 5,364m^3 of fuel (BUENA & CARTA, 2005: 398). At this time there were two wind turbines installed and they supplied 5% of the island's energy needs (140kW power output each) by contributing 991,460 kWh to the islands main grid. Photovoltaic (PV) solar panels contributed another 8,488kW off the grid, while solar heating panels contributed another 390.31m^3 (BUENA & CARTA, 2005:398). Also in 2000, El Hierro became a UNESCO World Biosphere Reserve, furthering the island's sustainability image. Furthermore, at this time the PROCASOL programme promoting solar thermal systems for hot water for households was introduced and provided financial support (a subsidy per square meter and a subsidy to the rate of interest) along with technical support (assuring installation quality, operation, solar collectors and installation maintenance). Also, a local company was created to install solar thermal systems and maintain units (MORALES, 2000: 77, 82; BUENA & CARTA, 2005: 398).

Later in 2000, a reaffirmation of the plan was proposed in which to reach the 100% RES strategy and included: a high independence from imported conventional energy resources; energy to be produced and sold by Canary companies like the local power utility; training for local craftsmen; new possibilities for employment; new local market opportunities for thermal systems; and new opportunities for sustainable tourism (MORALES, 2000: 82).

In 2005, renewable sourced energy was legally able to penetrate into the island grid to a technically permissible maximum of 30-68.40% of the islands total energy. The organisations that were involved in the planning process decided on going for a site permissible maximum volume of 200,000m^3, allowing for coverage of 60h of continuous electricity supply. This saved 7,364m^3 of fossil fuels and 20.9Gg of CO_2 in 2015 (BUENA & CARTA, 2005: 403).

In 2009, after numerous studies, environmental impact assessments, bureaucracy reforms and law changes, El Hierro announced it was to start constructing the Gorona del Viento wind-hydro power station (GLOBAL ISLANDS NETWORK, 2017).

In June of 2015, El Hierro's new Gorona del Viento hydro-wind facility came fully online. In July, over 50% of the island's energy supply was provided by the new plant alone, saving 300 tonnes of fossil fuels (500 tonnes per month is expected saving 40,000 barrels of oil and 19,000 tonnes of emitted CO2 per year) (PLITT, 2015). On the 9th of August, the station was able to provide 100% of the islands energy needs for 4 continuous hours (TOLEDO, 2015). In the summer of 2015, a 50-50 mix of renewable and diesel generated energy was achieved (PLITT, 2015). For the future the island hopes to steadily increase renewable energy supply until the plant is able to supply 100% of the islands energy, as it should be able to do so for 200-250 days out of the year as it stands now (see table 1 next for a review of timeline) (PLITT, 2015).

Table 1 - Timeline of the renewable energy transition of the island of El Hierro

YEAR	ACTION
PRE – 1986	-island dependant on fossil fuel imports (shipped from Valverde 200km away). -6,000 tonnes of diesel fuel burned each year (equivalent of 40,000 barrels of oil) -11.36 megawatt (MW) diesel-fired power plant provides islands energy -18,700 tonnes of carbon dioxide emitted annually -Electricity supply erratic and expensive (€0.242/kilo-watt-hour (kWh)) -20% of burned energy runs 3 desalination plants for drinking and irrigation water
1986	-First proposal for a scheme to increase island renewable energy supply. It includes: -wind turbines of 300 kW rated power; -hydro generators of 1.5 MW; -diesel generators of 3.8 MW; -250 and 500 kVA water pumps; -upper & lower reservoirs for hydroelectric generation)
1990-1997	-Law limits energy penetration (12%) into grid to avoid energy system imbalances
1997	-Island's 100% energy supply sustainable development plan officially approved. Calls for: -combined wind energy and hydroelectric power station; -desalination plant to fill up hydro plant reservoirs and replace evaporated water; -solar thermal systems for household hot water -PV systems and hybrid systems (PV-Wind) for households connected to the grid; -implementation of an energy saving and energy auditing programme; -a gradual conversion of the transportation sector away from gasoline and diesel; -biomass energy production system introduction; -awareness raising campaigns, dissemination events and training courses; -organic agriculture projects via water desalinisation tied to renewable energy; -experimental biogas production via methanogen fermentation (effluents, sewage)
2000	-9 diesel generators produce 95% of electricity (Generating capacity of 9745kW; production of 22.43GWh; consumption of 5364m^3 of fuel) -2 wind turbines installed - supply 5% of energy (140kW each; 991,460 kWh). -Photovoltaic (PV) solar panels contribute 8488kW off the grid -Solar heating panels contribute 390.31m^3 -El Hierro named a UNESCO World Biosphere Reserve (60% of island protected) -PROCASOL programme for household solar hot water systems introduced -reaffirmation of the plan proposed to reach 100% renewable energy
2005	-renewable energy legally able to penetrate grid to a max of 30-68.4% of energy
2009	-El Hierro starts constructing Gorona del Viento wind-hydro power station
2015	- Gorona del Viento hydro-wind facility came fully online - In July, wind plant provides over 50% of the island's energy supply -9th of August station provides 100% of islands energy for 4 continuous hours -50-50 mix of renewable and diesel generated energy achieved (for summer)
2017	-plant should be able to supply 100% of energy for 200-250 days out of the year
Future	-steadily increase renewable energy supply until plant supplies 100% of energy

Now that the trajectory of El Hierro's energy system has been explained, it is possible to turn our attention to the trajectory that Samso followed.

Previous to 1997, Samso imported its electricity via a submarine sea cable, as it was already connected to the mainland electricity grid of Denmark, as its geographical location meant it could be hooked up to the Danish national energy grid. At this time it was fully dependant on imported energy produced from oil and coal (BRANDT & SVENDSEN, 2016: 627). As a result, unlike El Hierro, it didn't make its change in isolation. Most residents historically heated their houses with oil which was imported and transported by oil tankers to the island. Additionally, people on the island were supplied with coal fired generated electricity, leading to a high carbon footprint from burning coal. As a consequence, each resident was responsible for an average of almost 11 tons of carbon dioxide per year. While some local groups were making the case for change, opponents of renewable energy argued that powering a country with only renewable energy was not possible. Such an argument made sense at the time as wind farms cannot generate electricity all the time (KOLBERT, 2008; FRAYER, 2014; WEINBERGER, 2014).

A shift to clean energy in Samso could be linked back to the Danish government who in the 1990s, "inaugurated tariffs that required utilities to offer 10-year fixed-rate contracts for wind power…*That sort of security led to a rapid expansion of wind power at home*" (WALSH, 2009). For Samso, this shift was started by the residents who formed energy cooperatives and did educational outreach to inform and convince other locals to make the switch to wind power. The principal champion of this change was Soren Hermansen, a farmer and environmental studies teacher, who lived nearby and lobbied islanders to go green (WALSH, 2009). Hermansen drafted a financial argument based on an engineer's report that demonstrated it would be profitable to introduce renewable energy on Samso. In consultation with Samso's mayor, Hermansen wrote a renewable energy plan (KOLBERT, 2008). In 1997 a proposal was submitted to the Danish Ministry of Energy's renewable energy contest (to promote energy innovation) called the "Samso Renewable Energy Island Project" (GUEVARA-STONE, 2013). The submitted proposal presented a model as to how Samso could run on renewable energy and cut its dependency on oil and coal imported from the mainland (WALSH, 2009).

In 1997 renewable energy had a share of only 13% of the entire local energy sector on Samso (SPERLING, 2017: 887). In this same year, Samso won the government's competition to be designated Denmark's "Renewable Energy Island". The project's aim was to achieve a self-sufficient energy supply based on renewable energy. This was to be done in combination with a reduction of the community's energy demand and to cover the entire energy sector in the local area, including electricity, heat and transport (SPERLING, 2017: 887). Such an appointment obliged the island to consider greater energy efficiency and to be a role model for the green transition. After the appointment, residents joined forces to impose bottom up change as they, through local entrepreneurship, erected turbines and helped push for a rapid transition to renewable energy (BRANDT & SVENDSEN, 2016: 627). In addition, to follow suit, Samso's municipality committed to working with renewable energy and invested in five of the 10 large wind turbines that still exist offshore south of the island. To implement the Renewable Energy Island (REI) project, two local organisations were founded: Samso Energy and Environment Office (SEEO)(1997) and Samso Energy Company (SEC)(1998). SEEO promoted renewable energy and provided information and advice to residents, while SEC implemented specific projects (for example, wind projects) (SPERLING, 2017:888). An investment of 125 million each year was required to be able to make renewable power for the equivalent of 10,000 families (SAMSOE, 2017; WALSH, 2009). During this time, people were encouraged to remove fossil fuel dependent oil furnaces and to replace them with electric powered heat pumps (KOLBERT, 2008; FRAYER, 2014; WEINBERGER, 2014).

By the 2000s, many changes were underway. In 2000, 11 (1 MW) onshore wind turbines were implemented on the island (SPERLING, 2017: 887). Samso Vindenergi I/S (Samsø Wind Energy I/S) owns 5 of these wind turbines (a local cooperative). Another 3 wind turbines are located near the village Tanderup, one of which one is cooperative owned while the other two are privately owned. The remaining 3 wind turbines are located near the village Permelille, as one is cooperatively owned and the other two privately owned (ENERGIAKADEMIE, 2017).

This same year Samso was honoured with the EU renewable energy island award due to its hard work in adopting greater amounts of wind power and thereby gaining greater renewable energy independence (SAMSOE, 2017). Come the year 2001, the island had already cut its fossil fuel use by 50%. In 2002 the island received yet another award, but this time for its commitment to solar power, as it took home the European Solar Prize (SAMSOE, 2017).

In 2003, 10 offshore wind turbines (2.3 MW capacity each) were located close to Samso and were connected to the grid. These were erected to compensate for fossil fuel consumption in the transportation sector and heating sector (SPERLING, 2017: 887). These turbines are owned by various stakeholders, as the municipalities public utility company “Samsø Havvind A/S (Samso Offshore Wind Ltd.)” owns 5; large external investors own 3, and local cooperatives own the remaining 2 wind turbines (SPERLING, 2017: 887). As a result of its wind energy investments, during 2003 the island at times became an energy exporter by exporting energy back to mainland Denmark (KOLBERT, 2008; GUEVARA-STONE, 2013; WEINBERGER, 2014; ENERGIAKADEMIE, 2017).

Furthermore, in 2005, Samso was consistently producing more energy from renewable sources than it could use and thus it had achieved its 1997 goal. Electric heating was targeted to be phased out in the name of electricity conservation and to aid in enabling the change to happen. Also contributing was a number of awareness raising campaigns, promotions to shift to energy efficient appliances and light bulbs and expansion of the biomass and solar thermal district heating plants. These included the Nordby/Mårup solar & wood chip heating plant (local utility company NRGi owned), the Onsbjerg straw-fired heating plant (local entrepreneur limited company - Kremmer Jensen Brothers) and the Ballen-Brundby Fjernvarme a.m.b.a. straw-fired heating plant (a local cooperative that is 100% consumer owned). These district heating plants were added to the pre-existing Tranebjerg straw-fired heating plant (owned and operated by local utility company NRGi). As a result, heat production from renewables rose from 25% in 1997 up to 65% in 2005 (SPERLING, 2017: 884; ENERGIAKADEMIE, 2017).

By 2007, the island had proven that in ten years it is possible to transform one’s energy system and achieve 100 percent energy neutrality (SPERLING, 2017: 884). Samso is, however, not truly self-sufficient in renewable energy, as it is still connected to the mainland electricity grid and may still draw from it in times of low wind. This is despite the fact that most of the time it is selling its excess energy to the mainland (SAMSOE, 2017).

Today, Samso is 100% powered by wind power. Their system is able to overcome the inability of wind farms to generate electricity around the clock through the use of an energy storage system. Such a system ensures a consistent supply of electricity whenever it is needed and it thus allows for a place like Samso to get all their power from the wind (KOLBERT, 2008; GUEVARA-STONE, 2013; WEINBERGER, 2014).

In the future, Samso hopes to have a fully renewable energy supply by 2030 to cover all their energy needs (for example, electricity, heating, and transportation) (see table 2 for review of timeline) (SPERLING, 2017: 889).

Table 2 - Timeline of transition to majority renewable energy power for the island of Samso

YEAR	ACTION
1990s	-Danish government tariffs require 10-year fixed rate utility wind power contracts -residents do educational outreach to convince locals to switch to wind power -Soren Hermansen, in consultation with Samso's mayor, submits the "Samso Renewable Energy Island Project" proposal to the Danish Ministry of Energy
1997	-Samso wins Danish Ministry of Energy's renewable energy innovation contest -Samso designated Denmark's "Renewable Energy Island" -conference held for the islanders – open space cafe seminar "Cafe Good Energy" where participants were invited to discuss the island's future and plans for transition to renewable energy -renewable energy accounts for 13% of Samso's total energy -residents join forces to impose bottom up change and they erect turbines -Municipality invests in 5 (of the 10) large offshore wind turbines -Samso Energy and Environment Office (SEEO) local energy organisation founded
1998	- Samso Energy Company (SEC) founded
2000	-11 (1 MW) onshore wind turbines are implemented on the island -Samso honoured with the EU renewable energy island award (for its wind power adoption)
2001	-island cuts its fossil fuel use by 50% -new government cuts funding to both SEC and SEEO and both temporarily close
2002	-island receives European Solar Prize for its commitment to solar power
2003	-10 offshore wind turbines (2.3 MW each) are located near Samso and are connected to the grid (municipal public utility company "Samso Havvind A/S" owns 5; large external investors own 3, and local cooperatives own 2 of the wind turbines) -island at times becomes an energy exporter to mainland Denmark
2005	-Samso consistently producing more energy from renewable sources than it can use -awareness raising campaigns carried out -promotions to shift to energy efficient appliances and light bulbs delivered -expansion of the biomass and solar thermal district heating plants is carried out -SEC is finally dissolved -SEC engineer is hired by the municipality to be able to continue the REI project
2007	-island achieves 100 percent energy neutrality -Hermansen founds Samso Energy Academy with wind farm profits
2017	-Samso is 100% powered by wind power
Future	-Samso to have a fully renewable energy supply by 2030 to cover all its energy needs -Gradual phase out of all fossil fuels in the energy system until 2030 -Maintain and upgrade existing decentralised energy infrastructure (wind and heating) -Electrify passenger vehicles and phasing in of alternative fuels in commercial / public transport, including ferry transport -Focus on substantial heat and electricity, achieve 30% reduction of heat demand -strengthening of local processes and partnerships, and -continuing to build on human resources of the island

In summary, in this section the renewable energy transition development trajectories of the islands of El Hierro and Samso have been presented. Understanding how this process happened can allow for one to gain a greater understanding of what is required for an island to move away from a fossil fuel powered energy paradigm towards one that is 100% renewable energy powered.

2.5. ENERGY MAKE-UP

El Hierro’s energy supply is produced by what is called ‘pumped hydroelectric storage’ or ‘pumped-storage hydroelectricity’. This system combines a hydro system with a wind energy system, as it utilizes wind turbines to guarantee a supply of electricity. When winds are strong and excess energy is being produced, the system reverse pumps water up to an upper reservoir to allow it to then be able to run downhill in times of need (low to no wind) and to thereby turn generators and produce electricity to supply energy. El Hierro’s system cost $110 million and its construction started in 1997 as a public-private partnership between the Department for Alternative Energy Research, the Island council, the Spanish energy company Endesa and the Canary Islands Technological Institute ‘Gorona Del Viento’ (see figures 12, 13 and 14) (ANDREWS, 2014; BUENA & CARTA, 2005).

Future goals for the island include replacing all 4,500 fossil fuel driven cars on the island with electric vehicles. This is to be done by offering electricity at the same price as gas, as car batteries will be charged with excess energy from the hydro-wind plant. It is hoped that the $90 million of necessary infrastructure can be recovered in about 10 years’ time. Also in the works is a solar thermal program (intended to replace electric water heaters), a Photovoltaic (PV) rooftop program, agricultural cooperatives switching production to organic and the island obtaining bio-digesters (to convert waste into methane for fuel and fertilizer) (ANDREWS, 2014).

El Hierro’s project benefits to date are: reliable electricity; economic gain - the island profits over time (project cost approximately $93millionUSD, was 50:50 EU/investor funded and earns over $5 million USD a year in electricity sales), revenue (pays for the system and maintenance and then rest will be put back into the local economy energy profits of between $1,400,000 and $4,200,000/year); environmental gain (no CO2 emissions from burning fossil fuels); reducing carbon emissions (by around 20,000 tons annually and keeping 40,000 barrels of oil in the ground); energy security and independence (no longer a need to import fossil fuels), tourism marketing (selling the island as a centre of sustainability and green innovation); and climate change emission target success (ahead of Europe 2020's 20/20/20 target) (GUEVARA-STONE, 2014; TOLEDO, 2015; ANDREWS, 2014; BROWN, 2014; FRAYER, 2014).

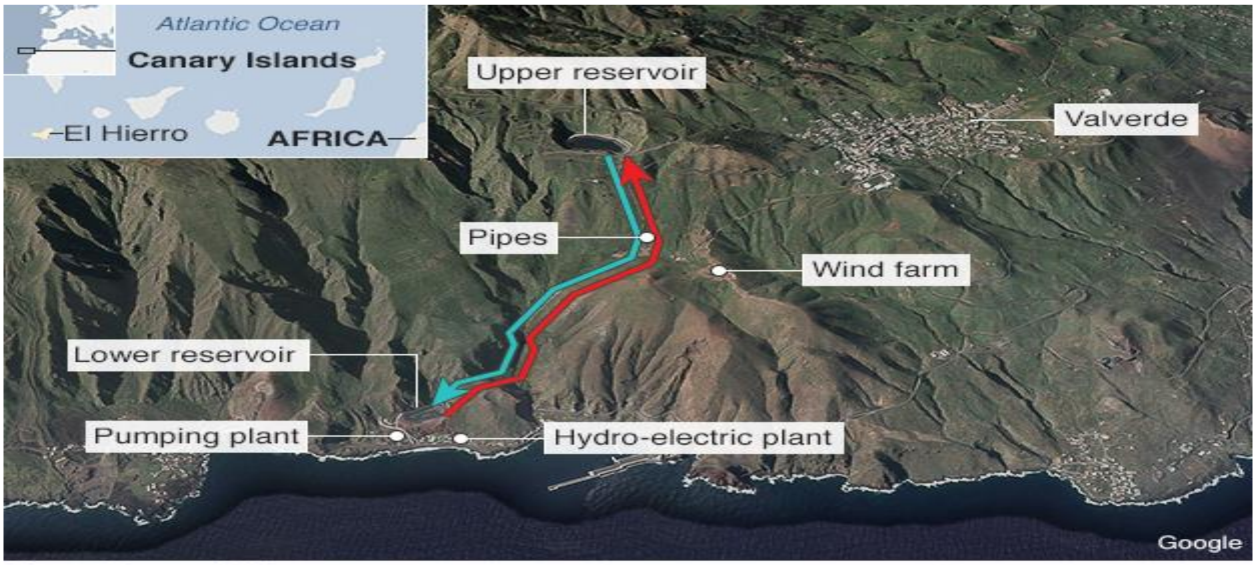

Fig. 12 – El Hierro's Gorona Del Viento combined wind-hydro pumped hydroelectric storage system
SOURCE: GORONA DEL VIENTO in PLITT, 2015.

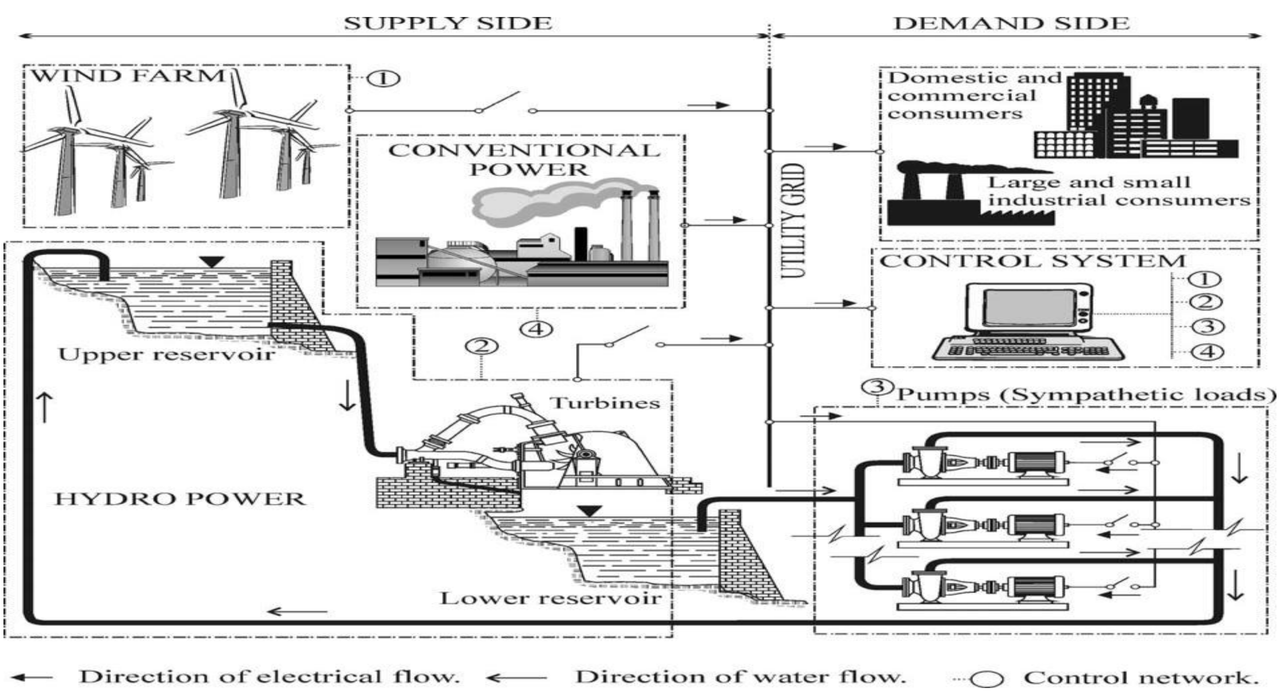

Fig. 13 - A schematic of a pumped hydroelectric storage system like the one used on El Hierro
Source: BUENO & CARTA, 2006: 322.

Fig. 14 – View of El Hierro's pumped hydroelectric storage system, wind turbines and pipelines
Source: LEW, 2014.

Next, to be able to consider another system other than El Hierro's, lets now look at the mainland connected island energy system of Samso. The energy system of Samso is composed of eleven large land-based turbines ($850,000USD/unit), a dozen micro-turbines and ten offshore turbines ($3,000,000USD/unit) (see figures 15 on the next page and figure 5 in section 1.8). These turbines are able to function as they are supplied by a wind supply that is almost continuous. Combined energy production is 26 kWh per year, a quantity near what the island requires to satisfy its energy needs. Electricity production does fluctuate, as at times the turbines are feeding into the national mainland grid, while at other times power must be drawn from the grid. The ten offshore wind turbines were later added to the system in order to compensate for fossil fuel use that was still being used in transportation. These offshore turbines produce a combined eighty million kWh/year of energy. The net energy produced by Samso is approximately 10% greater than it requires to sustain itself. Financing for purchasing the turbines was provided by either private investors or collectively by cooperative members (approximately 900 island residents own shares in the turbines (GUEVARA-STONE, 2014; TOLEDO, 2015; ANDREWS, 2014; BROWN, 2014; FRAYER, 2014, WEINBERGER, 2014).

Fig. 15 – Some of Samso's 11 large onshore wind turbines
Source: GETTY, 2015.

Heating is provided for the island (in addition to the electric system above) through 4 biomass burning plants (3 straw bale and 1 solar and wood chip powered). Straw bales or wood chips are fed into a furnace to heat water which is piped to 260 homes in neighbouring towns to provide heat and hot water. In total, 2,700 tons of CO_2 emissions per year are released, making the system not quite carbon neutral but fossil fuel free (KOLBERT,2008; GUEVARA-STONE, 2013). District heat primarily comes from biomass boilers. These can be replaced by cogeneration of heat and power (CHP) or large scale solar heating. The system utilizes individual heating with current oil boilers as these are the residual and default heating technologies. In addition, biomass boilers, heat pumps and solar heating are being increased as future technologies. These technologies can be shifted to district heating. This can be done in towns and villages which have district heating systems (MOLLER *et al.*, 2012: 342).

In summary, currently energy comes from 21 wind turbines, 4 straw burning district heating plants and extra heat from some photo thermal production (see figure 16 on next page). This provides enough energy for the island for its consumption and the island is a net exporter of electricity back into the mainland Danish power grid. The island's ferries, cars, factories and heating in distant areas are still fossil fuel dependent (NIELSEN & JORGENSON, 2015: 12, 15).

The future may include a greater use of biofuels for the transportation sector, as a few farmers have converted their cars and tractors to run on canola oil. Additionally, the 2,000-Watt Society program is one which is being experimented with in Samso. It is a program whose goal is to reduce the energy consumption of each person in a society. This is to be done through technological advances (energy efficient appliances, energy saving electronic devices, energy efficient buildings and homes, and so on) and applying it where it is needed (KOLBERT, 2008; GUEVARA-STONE, 2013). Many residents hope Samso will be independent of fossil fuels by 2030 and that it will be carbon neutral during the next decades (NIELSEN & JORGENSEN, 2015: 12).

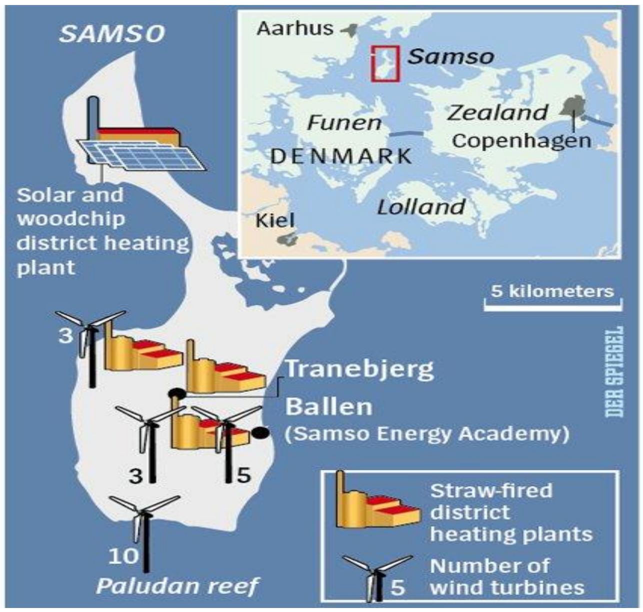

Fig. 16 – Location of Samso's district heating plants and wind turbines
Source: EXPAT GLOBAL ADVENTURES, 2014.

Benefits for the Island of Samso that have come from its energy projects include: reliable electricity; economic benefit (investors receive dividend cheques based on turbine performance and prevailing electricity rates, while payback is about eight years in part due to fixed ten year government energy rate contracts); environmental gain (near zero CO_2 emissions from no longer burning fossil fuels); energy security and independence (no longer need to purchase and import energy from mainland Denmark); increased environmental awareness (of residents towards energy efficiency); pioneer of energy innovation projects; tourism marketing (attract tourists and research institutes to the Island); international reputation (as a leader of sustainable energy innovation); and emission target success (has already achieved and surpassed the EURO2020's 20/20/20 target) (FRAYER, 2014; KOLBERT, 2008). Next, examined are the island landscapes.

2.6 LANDSCAPE

In this section, after having explored the nature of the energy make-up of each of the islands in the last section, here an analysis of how landscape affects energy and how energy affects the landscape has been undertaken. This is possible as was established in part 1 (section 1.2) landscape features affect what type of energy paradigm is employed, and vice versa, the energy paradigm employed affects the landscape of a given area.

Starting with El Hierro, the island has been subject to energy transforming its landscape. For example, it was transformed into a carbonscaped fossil fuel dependant energy powered island. This was due to its isolation, not just from mainland continental Africa or Europe, but also from other islands within the Canary Islands archipelago, as it has been unable to be connected to another mainland or island energy grid. This is because:

> The geographical fragmentation of the Canary Island Autonomous Community, its separation from the major centres of energy production and consumption, and the lack of conventional energy resources have meant that its inhabitants have had to depend to a large extent on the import of petroleum to supply its energy needs (BUENO & CARTA, 2006: 315).

El Hierro, therefore, has operated its energy system in full isolation and was able to do so in the past by being fully dependant on fossil fuel imports. The island’s fossil fuel supply had to and still does come from 200km away from Tenerife, the largest of the Canary Islands. This dependency proved to be not only expensive, but also volatile (as rough seas could delay shipments of fuel) while their resultant use is polluting and contributing to climate change, something that resulted in the island having a high carbon footprint. Using fossil fuels has meant the resultant infrastructure on the island needed to be constructed and therefore the islands landscape was transformed to allow people to access the fossil energy they needed for electricity, transportation and heating, that is, a carbonscape (GUEVARA-STONE, 2014: HAARSTAD, H. & WANVIK, T.I., 2016).

The desire to shift away from a fossil fuel paradigm has forced El Hierro to consider the landscape features that it possesses. As a result of this, its landscape has shaped its new energy sources that have been selected and employed. Firstly, its topography has played a role, as the fact that it is a volcanic island has affected the selection of the islands energy system. For example, El Hierro is mountainous (maximum peak height of 1501m) and it was deemed to possess topographically suitable sites for a pumped hydro-electric-wind power system and its necessary energy storage by means of water reservoirs. Also, the installation of such a system was deemed to be technically and economically feasible and it was for these reasons that a pumped hydro-wind system was selected for El Hierro (BUENO & CARTA, 2006: 338; IGLESIAS & CARBALLO, 2011: 689).

Secondly, El Hierro was deemed to have abundant wind and sun renewable energy sources available on the island. Wind was deemed to be especially promising as its intensity is both high and constant, thereby allowing for the installation of wind turbines on the island. This installation has taken place and resultantly has changed the landscape both visually and physically. This is something that can be interpreted to be both positive and negative, as has been highlighted in other cases (BUENO & CARTA, 2006: 315; DELICADO et al, 2013).

Thirdly, the hydrological characteristics of the island have played a part. The climate is mild and near-tropical (undergoes slight annual seasonal variations). The island as a result is lush and possesses a high amount of solar irradiation. It does, however, suffer from a lack of rainfall and freshwater (GILS & SIMON 2017: 343; IGLESIAS & CARBALLO, 2011: 689). As a result, the island has had to build desalinisation plants to be able to provide enough fresh water for drinking and irrigation, thereby requiring more energy consumption. This has affected the landscape, as in addition to plants and pipes being built, it has allowed agriculture to be expanded on the island (BUENO & CARTA, 2006: 319-320; GILS & SIMON 2017: 343).

Furthermore, El Hierro has been affected by its ocean lying position as it is situated and surrounded by the Atlantic Ocean. This is another example of how the landscape affects energy selection, as "the surrounding water depths are too large to allow for any submarine connection, so its energy needs must be provided for locally" (IGLESIAS & CARBALLO, 2011: 689). Despite this, El Hierro does possess abundant wave resources. This is especially true in its north-western area which is directly exposed to large ocean swells as it is not sheltered like the rest of the island. As it is a volcanic island, it does not possess a continental shelf, and it is thus located in deep water so that its "wave power is unaffected by refraction or shoaling" (IGLESIAS & CARBALLO, 2011: 691-692). Therefore, it has been suggested that a wave farm may be situated on the north-west of the island. This energy source, however, like other renewables, would be subject to seasonal variations (73% of energy available in autumn-winter period) and therefore it could benefit from an energy storage system similar to the one that is already in use on the island (that is, water reservoirs to take advantage of mountainous topography of the island). Thus, in the future, its wave resource may help contribute to making El Hierro 100% renewable energy powered (IGLESIAS & CARBALLO, 2011: 697-698).

Lastly, El Hierro's unique landscape has affected energy on the island. This is as in the year 2000 the island was designated a UNESCO Biosphere Reserve. This means that development and construction options are limited as over 60% of the island has been classified as protected land to protect the islands unique ecology and biodiversity. In addition, the construction of the hydro plant is situated in this reserve, as the site chosen for construction was a protected area and the construction should never have been approved (GLOBAL ISLANDS, 2017). The construction did, however, utilise strict environmental impact measures and rules to limit the impact the project was having on the sensitive ecosystem in which it is situated. Thus, here again we have an example of how the landscape shapes energy (GLOBAL ISLANDS, 2017).

Now, moving to the case of Samso, it is possible to see the relationship of the landscape shaping energy and energy shaping the landscape. For example, Samso has been subject to energy transforming its landscape. This is because Samso, like El Hierro, used to be dependent on fossil fuels coming from the outside. It however, unlike El Hierro, is located close to the mainland and is connected to the national grid via sea cable as the sea surrounding the island is not deep, but rather is shallow. Also, as a result of being dependant on fossil fuel supplied energy it too was transformed into a carbonscaped fossil fuel energy powered island. For example, houses were heated with oil which was brought in on tankers and ports have been needed to unload them (KOLBERT, 2008). The resultant infrastructure on the island also needed to be constructed and thus its landscape was transformed to access the fossil energy they needed for electricity, transportation and heating (NIELSEN & JORGENSEN, 2015: 12).

Additionally, Samso has seen its landscape shape which new energy sources it selects and employs. Firstly, unlike El Hierro, its topography has not played a role, as the fact that it is a very flat island with only a maximum altitude of 64 metres has affected the islands energy system as it cannot use a reverse pumped wind-hydro storage system like that employed on El Hierro (GEOHACK, 2017). Furthermore, Samso's dependency on fossil fuels has also been polluting and has contributed to climate change and a high carbon footprint. Its fossil fuel infrastructure has also been constructed and thus the island transformed to deliver fossil fuel energy where and when it has been needed for electricity, transportation and heating (SPERLING, 2017; KOLBERT, 2008).

Moreover, Samso has also been deemed to have abundant wind (as does most of Denmark) and sun renewable energy sources. Wind is very prominent as it is especially strong and consistent both on and offshore of the island, thereby allowing for wind turbines on both. This installation has taken place, and resultantly has changed the landscape, both visually and physically, being resultantly positive and negative at the same time. Because the sea is shallow near the island, offshore turbines have been able to be located there (WALSH, 2009).

In addition, about $70km^2$ of the island is devoted to agriculture. This is because the island has open, fertile land. It also has soft ground which allows for the burying of hot-water pipes so they are not visible crossing the landscape (CARDWELL, 2015). The arable farmland on the island has allowed energy crops to be grown on the island. Crops are able to be changed to feed the need for biomass energy. For example, hay is now grown in more abundance on the island to feed the plants energy needs, thereby changing the landscape. This hay is sold to the district heating plants and provides farmers with a new stream of income adding to what they earn from the other crops they farm (NIELSEN & JORGENSON, 2015: 15).

Thus, because it has abundant wind, sun and fertile agricultural land, Samso has been able to supply almost all of its energy from renewable sources. This serves as an example of how the landscape shapes the energy systems that are able to be employed. By doing this, however, the landscape has had to be transformed, as energy in turn has shaped the landscape. Both onshore and offshore wind turbines can be seen (and at times heard), as can hay crops that are grown to supply district heating plants for heat energy.

In summary, in this section how the landscape shapes energy and how energy shapes the landscape has been analyzed with respect to the two islands of El Hierro and Samso. By possessing certain renewable energy sources and being able to construct plants and energy sources to harvest energy, these islands have allowed for their landscapes to start shifting from being carbonscapes of a fossil fuel paradigm to those characteristic of renewable energy landscapes. In the next section, the transportation realities of the two islands are explored.

2.7 TRANSPORTATION

In the previous section, the relationship between landscape and energy was explored. This relationship is influenced by the reality of distance and how it affects transportation and thereby energy availability and use. This issue is explored further in this section. Here, it is shown that islands are often remotely situated and thus may be dependent on fossil fuel imports that are typically expensive due to transport costs. This is a reality which is faced by El Hierro, and, to a lesser extent (as it is located close to the mainland) by Samso (GILS & SIMON, 2017: 342; WALSH, 2009). In addition to this transportation that is necessary to connect the islands to the exterior, both islands also possess the challenge of reducing emissions from internal transportation that is necessary for movement within the island.

Therefore, transportation is an issue for islands as they often possess small isolated markets, few actors, a low diversity of technologies and a dependency on seasonal economic activities (like tourism) that create high impact energy demand which effects the structure and variability of an energy system. Overcoming these issues is something renewable energies struggle to do. This is as they often cannot balance fluctuations in power generation with demand via interregional (continental) electricity transmission, as is the case with El Hierro, for example. As a result, other options that offer flexibility - such as storage, demand response, and synthetic fuel production - must often be employed with respect to renewable energy systems on islands like El Hierro and Samso (GILS & SIMON, 2017: 342).

Renewable energy transitions require that the respective transportation sectors of islands be converted away from fossil fuel power sources. Road traffic on the Canary Islands, for example, accounts for approximately 45% of internal final energy consumption (GILS & SIMON, 2017: 343). The transport sector is capable of achieving large efficiency gains, but achieving these requires a complete transformation of transport modes, new technologies and the deployment of new infrastructure (GILS & SIMON, 2017: 354).

Additionally, transport demand on islands strongly differs from demand on mainland systems in two ways. First, road transport on islands covers comparatively small distances (for example, less than 100km) so that the low range of battery powered electric vehicles is not a limiting factor. This makes a quick introduction of electric vehicles technically feasible. Second, due to the remote situation of islands, aviation and the shipping of goods and people to the islands is often relied upon. For example, increases in tourism are further increasing island dependency on aviation so that a shift towards more efficient means of transport (such as ships and rail) is not technically feasible (GILS & SIMON, 2017: 346: GUEVARA-STONE, 2014).

Looking at the case of El Hierro, the island first took steps to address transportation issues by striving to consolidate an alternative transport system on the island. Starting with various demonstration projects, this process was started in the early 2000s. These projects included: 1) incorporation of a hybrid bus to the local fleet (biogas as a fuel option); 2) incorporation of an electric battery powered minibus (for mixed tourist-public use in El Golfo) that relies on a photovoltaic charging station; 3) development and consolidation of an extensive pedestrian network; 4) incorporation of advanced information and management systems within the "El Hierro Digital Island" programme; and 5) development of an ingenious ticketing system for the optimisation of displacements in rural scattered areas that turns private vehicles into collective transport that is supported by electronic systems for payment (MORALES, 2000).

Since these, El Hierro has started an initiative to replace all fossil fuel powered petroleum-run vehicles with an electric fleet of vehicles (CALAJAN, 2011: 2). The island has entered into a partnership with Renault-Nissan alliance to achieve its goal of running 6,000 vehicles entirely on electricity by 2020 (WEINBERGER, 2014; LEW, 2014). The €4 million euros that are anticipated to be generated annually from selling electricity will help finance the replacement of the island's fossil fuel vehicle fleet within five years (CALLAJAN, 2011). These electric vehicles, however, must be powered by renewable energy sources and not the fossil fuel driven thermoelectric plant on the island in order for the island to be truly fossil fuel free - something the renewable energy system must be expanded to account for. In order to do this, the island is offering electricity at the same price as gas so that car batteries can be charged with excess energy from the hydro-wind plant. Transportation of this energy will require new infrastructure on the island and is estimated to cost $90 millionUSD – an amount that should be recovered by the island in about 10 years' time (GUEVARA-STONE, 2014).

For Samso, the transportation sector on the island includes the running of ferries and cars, both of which are still dependent on significant inputs of fossil fuels (NIELSEN & JORGENSEN, 2015: 24). The fossil fuels necessary to power ferries to and from the island account for a large part of the island's fossil fuel consumption (NIELSEN & JORGENSEN, 2015: 12). Organic waste was planned to play a part in developing bio-diesel to run the ferries in the future. This is as one ferry line was to be replaced by one that can run on a 50:50 mixture of electricity and biofuel that is produced on the island. Achieving this would require new infrastructure to be developed and maintained (NIELSEN & JORGENSEN, 2015: 12, 24). The replacement of infrastructural elements, such as a shift from conventional cars to cars driven by an alternative fuel will impact the economy of private households that will have to invest in these new cars. Also, the cost to purchase new ferries will be reflected in the price of tickets, and thus will fall onto consumers (NIELSEN & JORGENSEN, 2015: 12, 26).

The transport sector's initiatives deviated the most from Samso's original master plan. First, rapeseed oil fuel in farming activities was attempted, as was the use of a number of electric vehicles. Both of these, however, have proved to be problematic. First, biofuel use was not scaled up due to the fact that its use in the agricultural sector was not possible due to tax barriers. Meanwhile, the electric cars employed often broke down and required a lot of maintenance. As a result of these failures, both initiatives were abandoned. To make up for this, it was decided to compensate for fossil fuel demand in the transportation sector via excess annual electricity production from 10 offshore wind turbines, thereby representing a shift towards attaining energy neutrality from a position of striving to become fossil fuel free (SPERLING, 2017: 888).

After the original renewable energy island project was carried out on Samso, the Energy Academy and several other actors worked on a vision for phasing out fossil fuels for the island to be completely renewable energy supplied by 2030. Several objectives have been developed and include: 1. a gradual phase out of all fossil fuels in the energy system by 2030; 2. maintenance and upgrade of the decentralized energy infrastructure (wind turbines and district heating); 3. electrification of passenger vehicles and the phasing in of alternative fuels in commercial and public transport (for example, gas-driven ferry to run on locally produced biogas); 4. focus on heat and electricity (30% reduction in heat demand by 2020); 5. strengthening of local processes and partnerships, and 6. building on island human resources to become fossil fuel free and independent (SPERLING, 2017: 888).

In addition, heating energy requirements involve the transportation sector and transportation infrastructure. On El Hierro, a solar thermal program has been initiated to replace electric hot water heaters, and has been paired up with a photovoltaic (PV) rooftop program. These both require infrastructure to transport energy to consumers. Furthermore, agricultural cooperatives have begun switching their production to organic, thereby reducing fossil fuels that are used in pesticides and production. Furthermore, these coops are developing bio-digesters to be able to convert waste into methane fuel and fertilizer (ANDREWS, 2014).

Meanwhile, on Samso, the island has addressed heating in numerous ways. First, oil boilers have been replaced with a higher percentage of heat coming and being transported from the existing district heating systems of the island (NIELSEN & JORGENSEN, 2015: 12, 24). Second, heat production from renewable energy on the island has risen (from 25% in 1997 to 65% in 2005) due to the expansion of biomass-based and solar thermal-based district heating plants (SPERLING, 2017: 887). Thirdly, the Samso Energy Company and the Samso Energy and Environment Office carried out various campaigns that targeted heat savings in private households, as homeowners were approached via “information campaigns, an energy exhibition, open house events and offers for private visits by renewable energy advisors” (SPERLING, 2017: 887-888). This involved training local blacksmiths and plumbers so that they could be certified to install state-authorized solar heating systems in private homes. Additionally, wood burners, biomass boilers and heat pumps were promoted in houses that were situated outside areas where district heating could be transported to (SPERLING, 2017: 888).

In summary, distance with respect to islands affects transportation and thereby energy availability and use. Islands that are remotely situated tend to be dependent on fossil fuel imports that have high transport costs. Both El Hierro and Samso have taken their own approaches to overcome their fossil fuel use in the transportation sector. While El Hierro is striving to phase out fossil fuel use in its transportation sector all together by switching to an all-electric powered vehicle fleet, Samso had opted to go for the option of compensating for its fossil fuel consumption by producing excess wind energy, although recently a new vision and plan have been proposed to also phase out fossil fuels. Having now examined transportation of energy and the transport sectors of the two islands, in the next section the territorial marketing realities of El Hierro and Samso are examined.

2.8. IMAGES OF THE ISLANDS: TERRITORIAL MARKETING STRATEGY AND THE IMAGE THEY ARE PROMOTING

In the previous section, the challenges of transportation and energy were examined. Overcoming such challenges and being able to shift to a renewable energy paradigm for the islands of El Hierro and Samso has been of vital importance for how they market themselves. In this section, how that relationship has developed and exists for each of the islands is explored.

For both islands, tourism is a main economic activity which is increasing every year. Despite the additional strain tourism is putting on their energy systems it has been seen as a positive benefit to each of their economies. As a result, it is something the islands have been striving to attract more of, as they also try to attract and retain a greater number of permanent residents. Being able to create a positive green image of themselves through marketing strategies has been valorized and strengthened by their shift to renewable energy independence (GUEVERA-STONE, 2014; GILS & SIMON, 2017: 343; KOLBERT, 2008).

Considering the case of El Hierro, sustainable tourism and niche marketing have been key to their marketing strategy. Possessing few beaches, El Hierro is known for its dramatic volcanic and natural landscapes and seascapes which provide hiking, scuba diving, paragliding, surfing, mountain biking and caving opportunities. Local arts and crafts, along with annual traditional festivals also help attract people to the island (GLOBAL ISLANDS, 2017).

El Hierro has been able to brand itself as being a niche tourism destination – that of a relaxed and quiet island getaway – in contrast to that of the other Canary Islands that are often overcrowded with tourists. It has been able to brand itself as such by avoiding mass tourism (only approximately 60,000 tourists a year come to the island), and doing so by avoiding mass hotels (only 10 medium-sized hotels) and by resisting package tourism (no direct flights to El Hierro are permitted from Europe). Often referred to as the “forgotten island”, tourism guidelines have been set for the next eight years and hotel developments are regulated (only permitted in a number of coastal areas, most must be of a luxury exclusive nature such as four or five stars and they can only have up to 2,000 beds) (GLOBAL ISLANDS, 2017).

Marketing itself as a renewable energy powered and sustainable natural area have been at the core of El Hierro’s marketing strategy to date. This is as it embodies the slogan “El –Hierro – zero waste”. The sustainable marketing of the island and its initiatives began in 2000 when El Hierro gained UNESCO Natural Heritage site status. The incorporation of a 100% fossil fuel free renewable energy system into its institutional image, together with the application of best-practice guidelines, have allowed the island to strengthen its path towards a sustainable tourism branded image (GLOBAL ISLANDS, 2017; GILS & SIMON, 2017: 342-343). Such branding has already attracted renewable energy tourists to the island, as large numbers of foreign scientists and policy makers have been visiting the island to learn about El Hierro's Gorona Del Viento wind powered pumped hydro station and to see if they can apply similar projects on other islands or in their communities (PLITT, 2015).

Similar to El Hierro, Samso is also reliant on tourism as a pillar of its economy. The island is known for its nature, hiking, golf courses, sports and recreation, culture and arts, museums and health/wellness retreats. Its slogan is telling of its projected image as on its "Visit Samso" website it refers to itself as "Energy Island". This refers to its status as "Denmark's Renewable Energy Island" (SAMSOE, 2017).

Since winning the status of "Denmark's Renewable Energy Island" in 1997, marketing itself as such has been a central goal and thus of vital importance to the island. This was important as at the time the islands meat production facility closed and the unemployment and difficult future prospects faced by its agricultural producers demanded the island come up with some sort of new rejuvenation scheme to reinvent itself and boost its economy. As a result, Samso turned to marketing itself as a green and sustainable island associated with natural landscapes and low environmental impact. From this, Samso has been able to attract a large diversity of tourists and research institutes to the Island. This has been possible due to its acknowledged international reputation as a leader of sustainable energy innovation (FRAYER, 2014; KOLBERT, 2008). The island has helped garner itself this attention by providing an online database called the "Energy Institute", which houses a collection of books, analyses, reports, newspaper articles, videos and planning documents, along with the Renewable Energy Island projects meeting minutes (SPERLING, 2017: 885: SAMSOE, 2017).

Being known as a renewable energy island has let it receive a large amount of international media attention. An outcome of this is that policy makers and planners have flocked to the island to see its energy system in practice. This has heralded the island praise for being a good example of a local renewable energy transition away from the fossil fuel paradigm (SPERLING, 2017: 884). Branding of such an image has been done via multiple levels of government. For example, the island is one of the official showcases that is presented on the Danish government website and its main industry organisations "State of Green" internet portal. This site informs the international community about Samso and of the Danish government's plan to achieve a 100% renewable energy system by 2050. At the local level, the island's Energy Academy (Energiakademiet) serves not only as an information centre for the world, but it also acts as an education centre for locals and visitors alike, receiving upwards of 4,000 annual visitors. Amongst these are students of all ages, business actors, politicians, and ambassadors. In addition, the academy often participates in international conferences and workshops that further bring attention to Samso and help brand it as a green and sustainable renewable energy island (FRAYER, 2014; KOLBERT, 2008: SPERLING, 2017).

Further contributing to Samso's branding success has been the multiple awards it has won internationally. For example, in Europe in 2012 Samso was awarded the Manage Energy Local Energy Action Award, to name just one of the many such awards it has won to date. As of a result of these efforts, Samso now enjoys international recognition as a model of best practice for a community transition from a fossil fuel dependent energy system to a renewable energy self-sufficient powered one (SPERLING, 2017: 884; SAMSOE, 2017).

In summary then, in this section it has been highlighted that both islands have had the possibility to benefit from marketing. This marketing has highlighted the renewable energy systems of the islands and has helped brand them as models and centres of best practice, innovation, sustainability and renewable energy independence. From this, they have both been able to garner international attention which has led to an increase in renewable energy tourists. In the next section, who the stakeholders are that have allowed the islands to get to the point where they are today is discussed.

2.9. STAKEHOLDERS AND IDENTITITES: ADMINISTRATORS, BUSINESSES AND CONSUMERS

Moving on from the previous section where the green marketing strategies and the place image constructions of the two islands of El Hierro and Samso were analysed, it is possible in this section to move on and consider the various stakeholders who have been active in the process of transitioning away from a fossil fuel energy paradigm towards a renewable energy paradigm.

As was previously discussed in section 1.9, many different players control the processes within energy paradigms and their associated transitions. These include: political institutions, planners (for example, urban), oil companies, industry, developers, financial institutions (local to global in scale), consumption sites, the media (local and global), dominant social institutions, social regimes, social movements, civil society and indigenous communities (CALVERT *et al.*, 2013: 417). Such actors as these represent those that are both internal and external to a locale where energy is being consumed.

Next, let us consider the various stakeholders that have been involved in the energy transition on the island of El Hierro. The various actors include or have included: Government (the Spanish government (national level), the Canary Islands regional government (regional-territorial level), the government of the Island of El Hierro (local-Island level), the city government of Valverde (municipal level), village governments (municipal level) and the European Union (EU) (international level); The United Nations Educational, Scientific and Cultural Organization (UNESCO) (international government funded agency); local residents (including farmers); tourists; island factories (industry), policy makers (planners, developers, technicians, engineers, professionals); fossil fuel companies (including gas vendors); automobile manufacturers (Renault-Nissan alliance); renewable energy companies (manufactures and vendors); local utilities (for example, electricity generation plants such as the Gorona Del Viento wind-hydro power station and UNELCO the local utility company) and their shareholders; the island desalinization plants; and local businesses (ANDREWS, 2014; GUEVARA-STONE, 2014; FRAYER, 2014; WEINBERGER, 2014). The exact role that these specific actors have played in the transition is discussed in further detail in section 2.4.

Next, let us consider the various external and internal stakeholders that have been involved in the energy transition on the island of Samso. These various actors have participated and have supported the transition and include: Government - national, regional and municipal offices (that is, Samso Municipality, Region of Central Jutland and The Danish Energy Authority), and the European Union and its partners (that is, AITE Agencia Insular de Energia de Tenerife, EIA Energy Agency in Iceland, Intelligent Energy Executive Agency, and The Directorate-General for Energy and Transport); NGOs (that is, The Energy Service Denmark, The Organization for Sustainable Energy, and the national network of energy offices funded through the Energy Service of Denmark, and The International NGO network of INFORSE and INFORSE Europe); local residents (including farmers); tourists; island factories (industry), policy makers (planners, developers, technicians, engineers, professionals); fossil fuel companies (including gas vendors); automobile and ferry boat manufacturers and fuel system converters; renewable energy companies (manufactures and vendors); electricity generation plants (and their shareholders); local utilities (for example, the regional electric utility company that also runs several district heating plants); energy cooperatives (for example, the cooperative district heating company Ballen-Brundby Fjernvarme a.m.b.a.); financial institutions and grant donors that support Samso's Energy Academy (that is, Realdania, Rheinzink, and Jyskebank); universities participating in the project (that is, Aalborg University, The Engineering College of Aarhus, and The Technical University of Denmark); affiliated research and development departments (that is, Danish Teknological Institute, Danish Hydrogen Association, Hydrogen Innovation & Research Centre, Innovation Centre for Bioenergy and Environmental Technology); businesses (for example, H2O Logic and Hydrogen Fuel Cell Motive Solutions) (ENERGIAKADEMIE, 2017). The exact role that such actors have played in the transition is also discussed in further detail in section 2.4.

Seeing as the actors in both cases are numerous, in order to be able to unite those with similar stakeholder interests, three groups have been identified in this study. These include: 1) administrators, 2) businesses and 3) consumers. The first group – administrators - are those who have a stake in deciding on the drafting, planning and execution of their respective islands renewable energy transition. The second group – businesses – are those who profit from or whose profits are negatively impacted from this change of paradigm. The third group – consumers - are those who consume and pay for energy and are thereby affected by how the energy they need is produced. Together, these bodies of stakeholders collaborated to develop the master plans of both El Hierro and Samso to cover each island's energy demand by renewables (ANDREWS, 2014; GUEVARA-STONE, 2014).

With respect to El Hierro, the groups of administrators, businesses and consumers responsible for the transition have included the following:

1) *Administrators*: Government - The European Union (EU) and the ALTENER and PROCASOL programmes, The government of Spain (national level), The Canary Islands regional government (regional-territory level), the government of the Island of El Hierro (that is, Cabildo de El Hierro)(Island level), the municipal government of Valverde (municipal level), and the island's village governments (municipal-local level); The United Nations Educational, Scientific and Cultural Organization (UNESCO); policy makers (planners, developers, technicians, engineers, professionals); research institutes (for example, the Technical Institute of the Canary Islands (TIC); and local residents (for example, Tomas Padron, president of El

Hierro’s local government and an island electricity company employee who has been the renewable energy champion and entrepreneur driving the shift);

2) *Businesses*: Fossil fuel companies (including gas vendors); automobile manufacturers (Renault-Nissan alliance); renewable energy companies (manufactures and vendors); electricity generation plants and their associated shareholders (the Gorona del Viento wind-hydro power station and UNELCO the local utility company); tradesmen; financial institutions and grant donors;

3) *Consumers* - Local residents (including farmers and seasonal residents); local businesses; tourists; island factories (industry); government entities that consume energy on the island; and desalinization plants on the island (big consumer)
(ANDREWS, 2014; GUEVARA-STONE, 2014; GORONA DEL VIENTO, 2017; EL HIERRO, 2017).

Like El Hierro, various external and internal stakeholders have been involved in the energy transition on the island of Samso. These may also be categorized into the three groupings of administrators, businesses and consumers. These have been:
1) *Administrators*: the European Union and its partners (that is, AITE Agencia Insular de Energia de Tenerife, EIA Energy Agency in Iceland, Intelligent Energy Executive Agency, and The Directorate-General for Energy and Transport, and the ALTENER programme); Government (the Danish government (federal level), the Region of Central Jutland (regional level), the government of the Island of Samso (Island level), Samso municipality (municipal level), village governments (for example, Tranebjerg - municipal level) and the Danish Energy Authority (DEA); policy makers (planners, developers, technicians, engineers, professionals); local residents (for example, Soren Hermansen – green energy champion and entrepreneur, farmer, environmental studies teacher, lobbyist, plan drafter and director of the Samso Energy Academy); universities participating in the project (that is, Aalborg University, The Engineering College of Aarhus, and The Technical University of Denmark); affiliated research and development departments/institutes (that is, the Danish Teknological Institute, Danish Hydrogen Association, Hydrogen Innovation & Research Centre, Innovation Centre for Bioenergy and Environmental Technology); and NGOs (that is, The Energy Service Denmark, The Organization for Sustainable

Energy, the National Network of Energy Offices funded through the Energy Service of Denmark, The International NGO Network of INFORSE and INFORSE Europe);

2) *Businesses*: Electricity generation plants and their shareholders (that is, Samsø Havvind A/S (Samsø Offshore Wind Ltd. - municipality owned), Samsø Vindenergi I/S (Samso Wind Energy I/S – a local cooperative); energy cooperatives (for example, the cooperative district heating company Ballen-Brundby Fjernvarme a.m.b.a.); automobile and ferry boat manufacturers and fuel system converters; external investors (large); local farmers (earn from some wind turbines they own and from the biofuels they produce); local wind turbine and heating plant shareholders; the Samsø Energy Company (SEC); the Samsø Energy and Environment Office (SEEO); the Samso Energy Academy (Energi Akademie); the Samsø Energy Agency (SEA); renewable energy consultants/advisors; renewable energy companies (manufactures and vendors); local utilities (for example, the regional electric utility company that also runs several district heating plants); the district heating plants; local contractors/tradesmen (machinists, mechanics, plumbers, electricians, blacksmiths and farmers); individual renewable energy installations; the DEA (Danish Energy Service/Agency); renewable energy companies (energy technology developers, producers, manufactures, suppliers and vendors (from the mainland) such as H2O Logic and Hydrogen Fuel Cell Motive Solutions;

3) *Consumers*: Local residents; farmers; farming cooperatives; vacation home owners/seasonal residents; island factories (industry); tourists; mainland electricity grid; businesses; and stock market traders

(SPERLING, 2017: 887; KOLBERT, 2008; GUEVARA-STONE, 2013; WEINBERGER, 2014; SAMSOE, 2017; ENERGIAKADEMIE, 2017).

In summary, this section has revealed the stakeholders involved in the energy transitions of the islands of El Hierro and Samso. These have been organised into groupings: 1) administrators, 2) businesses and 3) consumers. How these various groups interact and are interlinked is discussed in the next section.

2.10. LINKS: ADMINISTRATORS, BUSINESSES AND CONSUMERS (TRIANGLE ANALYSIS)

In the preceding section the identity of the stakeholders involved in the energy transitions of the islands of El Hierro and Samso were identified. These stakeholders were then grouped into the three groupings of: 1) administrators, 2) businesses and 3) consumers. The linkages between the stakeholders in each of the groups are now demonstrated in this section visually via a triangle analysis.

The linkages between the three groups of stakeholders are present in both islands and include interactions which flow both to and from each group. Together, these actors have been able to collectively lead to the development of renewable energy systems on the islands of El Hierro and Samso. These interactions may be summarised in a triangle analysis (see figure 17 below). Such a triangle analysis may be applied to the stakeholders who are involved in a renewable energy transition away from fossil fuels. Next, this analysis is applied to the stakeholders that were identified in section 2.9 for each of the respective islands of this chapter - El Hierro and Samso.

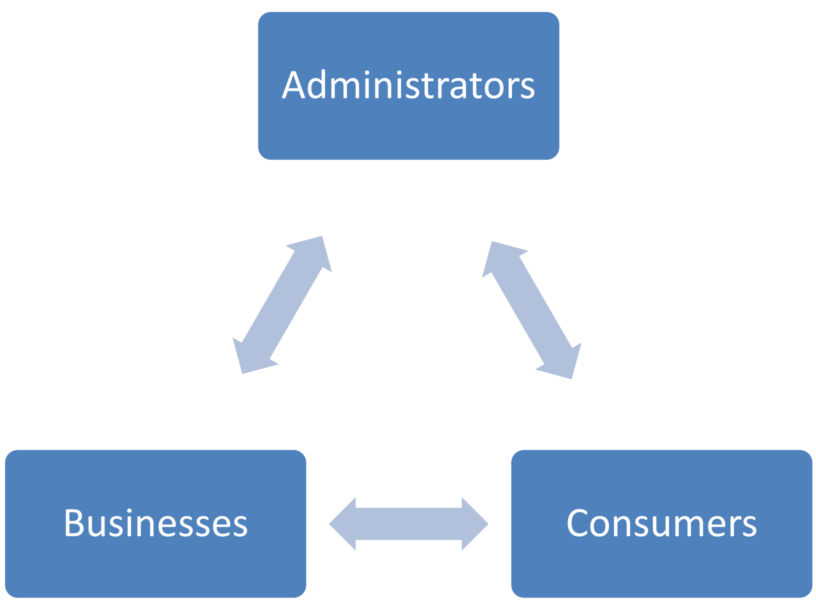

Fig. 17 - Triangle analysis displaying the multidirectional links between the three groups of stakeholders involved in an energy transition from fossil fuels to renewable energy on islands

Starting with El Hierro, the groups of administrators, businesses and consumers contain multiple stakeholders. These stakeholders sometimes act unidirectionally or mulitdirectionally with stakeholders in other groups. Furthermore, some stakeholders have interests in more than just one group, as for example, governments decide on energy plans and are also large consumers of energy. These links can be seen in figure 18 on the following page. How these actors interact to make these transitions possible has been discussed in the preceding sections.

In table 3, it is evident that differences exist between the two islands as their respective energy systems and transitions have been different. This is as Samso is connected and close to a mainland electricity grid, while El Hierro is far and isolated from any other electricity grid. This reality has influenced the type of energy systems that could be adopted by the two islands. For example, Samso, being connected to the mainland grid, was able to just have wind turbines and didn't need to focus a storage system, at least initially (as it can draw energy from mainland at times of no wind). El Hierro, however, being in isolation, had to opt for a reverse flow hydro-wind pumped storage system to be able to produce energy in times of no wind (with thermoelectric backup if that runs out as well before the wind can recharge it). Furthermore, Samso being more north and colder, has needed to address its home heating needs, something done through 4 district heating (straw bale and biomass) plants that are supplied by local farmers.

Furthermore, the drivers of these shifts on the respective islands have been somewhat different. This is as on El Hierro it was the island president who was able to create and implement a sustainable energy plan, pushing it through the island government (and its associated policies, laws and measures) in consultation with the residents. On Samso, the reverse was true, as a nearby local teacher was able to draft and submit a plan to a national government competition, won this competition, then gained the support of local residents (through lobbying, educating and forming energy cooperatives). With the residents driving this change, they were able to pressure the government of the island to commit to join and support the shift.

Similarities exist in that both islands depended on cooperation and support from many actors, which included administrators, businesses and consumers. These provided the capital, such as political (political will) and financial (money) to permit these shifts to occur. This required multi-level support, spanning from the local grassroots level on to the national and international level. Together, multiple stakeholders in both cases created the conditions to allow these two shifts to occur.

Fig. 18 - Triangle analysis displaying the multidirectional links between the three groups of stakeholders involved in an energy transition from fossil fuels to renewable energy on the Island of El Hierro

Next, we see how the actors in Samso's energy transition interacted in figure19 below.

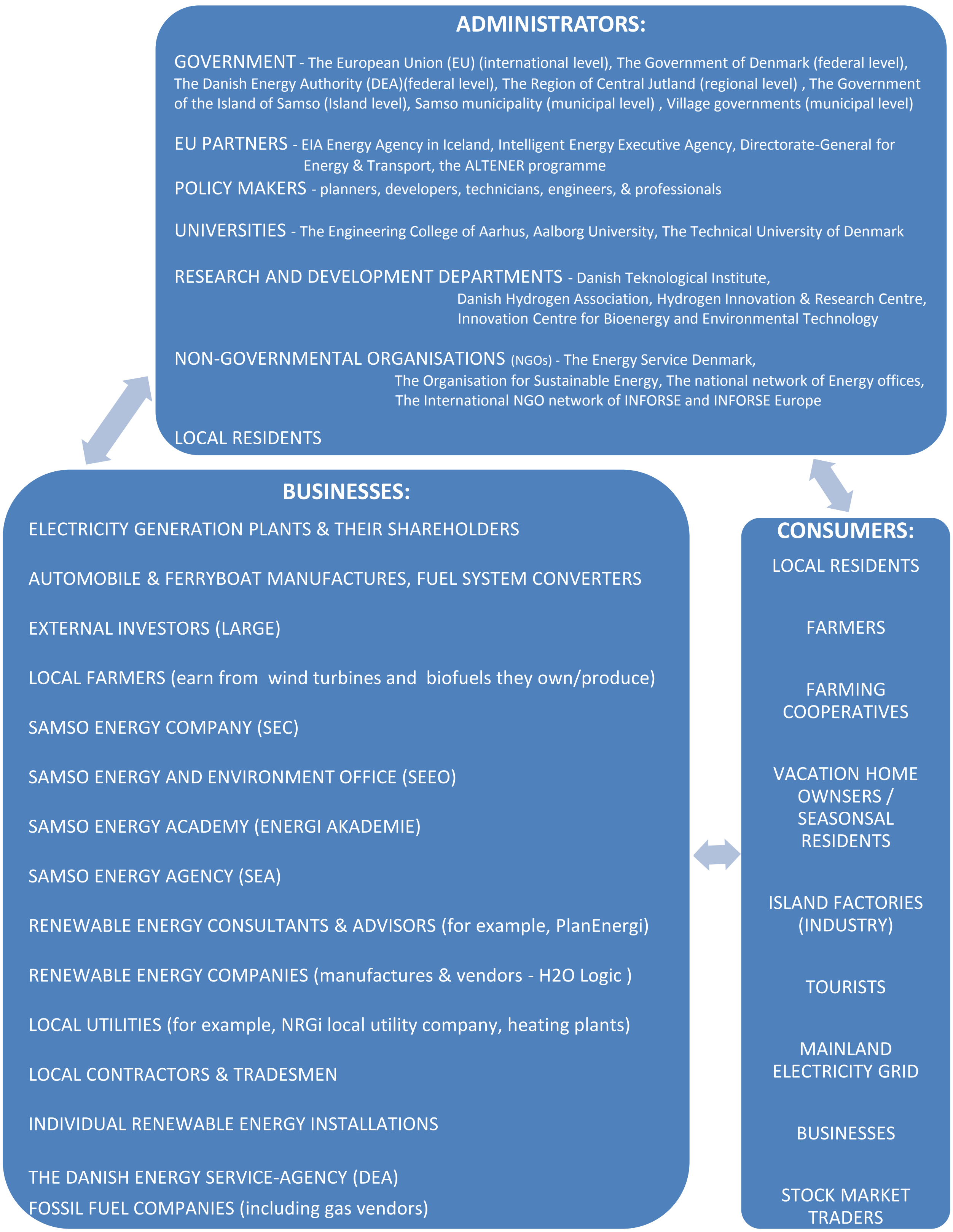

Fig. 19 - Triangle analysis displaying the multidirectional links between the three groups of stakeholders involved in an energy transition from fossil fuels to renewable energy on the Island of Samso

Next, is a brief comparison of the similarities and differences between the islands (see table 3).

Table 3 - Comparison of Energy transitions of the islands of El Hierro, Spain and Samso, Denmark

Characteristics:	**ISLAND OF EL HIERRO**	**ISLAND OF SAMSO**
Location	-Northern Atlantic Ocean (27° N, 18° W) -Island of the Canary Islands Archipelago -Part of the Macaronesia chain of islands -South-western most Canary Island -100 km West of Morocco/Africa	-Central Denmark (55°N,10°E) -15 kilometers off the coast of the Jutland Peninsula -Sits in the Kattegat strait -Between Baltic and North seas
Area	268.7 km^2	115 km^2
Population	approximately 10,587 people	approximately 3,724 people
Pop. Density	38 people per square kilometre	33 people per square kilometre
Climate	Subtropical	Temperate
Topography	-Mountainous -Maximum altitude of 1501 metres -Coastal cliffs -Stark volcanic landscapes, lava rocks -Seabed volcanic and active, steep, deep	-Lowlands -Maximum altitude of 64 metres -Steep cliffs -Stony and sandy beaches -Wavy landscapes
Municipalities	-3 municipalities, several small villages	-1 municipality, 22 small villages
Landscape	-10% farmland -60% UNESCO Biosphere Reserve	-Meadows, woodlands, heath -Farmland, countryside
Political status	-Part of Spain -Autonomous community -EU Outermost Region(OMR)	-Part of Denmark -Region of Central Denmark -Not an EU Outermost Region
Energy System	-Isolated -Cannot connect to continent, neighbours	-Interconnected -Connected to mainland grid
Economy	Agriculture, fishing and tourism	Agriculture, tourism, service jobs
Transformation	-Past: imported fossil fuels to produce energy via a diesel-fired plant -Now: locally produce energy via wind power and hydroelectricity (diesel backup)	-Past: imported energy (fossil fuel derived) from mainland via cable -Now: locally produce energy via wind power and biomass
Role of citizen involvement	-Shift started by island government/people -Chose pioneering development model based on conserving island's environment -Committed to primary sector (agriculture) -Rejected entry of mass tourism to island	-Shift started by the residents -Formed energy cooperatives -Erected wind turbines -Did educational outreach to inform locals to switch to wind
Who had initiative?	Tomás Padrón Hernández: Island resident – Politician: Island government president -Industrial technical engineer -Adopted a sustainable development plan -Pushed 100% renewable energy project	Soren Hermansen: -lived nearby –Farmer & teacher (env. studies) -Green energy champion -Drafted renewable energy plan -Lobbied islanders to go green
Time needed	Approximately 10 years	Approximately 10 years
Actors	Many (see figure 20)	Many (see figure 21)
Differences	In isolation with no link to another island or mainland electricity grid	-Connected to mainland grid -Heating needs due to cold

These two cases also help disprove or debunk a commonly held misconception or stereotype with respect to Northern Europeans versus Southern Europeans. That is, that Northern or Nordic Europeans are generally more concerned with the environment, while Southern Europeans tend to be more resistant to change. The fact that one shift occurred in the North and the other in the South, and that they were similar and were able to result in about the same amount of time, signals that such divisions are merely artificial and just stereotypes.

In summary, both the energy transitions of the islands of Samso and El Hierro have involved multiple stakeholders. These actors may be able to be classified into the groups of 1) administrators, 2) businesses and 3) consumers. Some of these actors may in fact overlap or be able to be classified into more than one group, while others may not. These groups of actors interact and mutually influence one another, as through a triangle analysis, flows of decision making and influence may go from one group to another as is illustrated in figures 17, 18 and 19. Possessing different characteristics and needs, the islands adoptions and transitions to a renewable energy paradigm have been different. As such, different models and trajectories were followed. A comparison of the differences between the two was visible in table 3, and is discussed further in part 4 with reference to Pico Island. Seeing whether the pattern and models of these two islands is transferrable and able to be applied to the energy transition on the island of Pico is something that requires further study. Next, the methodology for the examination carried out here in this section, along with the methodology used for the case study research which took place on Pico Island is discussed next in part 3.

PART III │ METHODOLOGY

3. METHODOLOGY

As touched upon in the introduction, this study is divided into three parts: 1) a theoretical component; 2) an examination of two islands with more advanced energy transitions then that of the case study island; and 3) a case study. First, a theoretical component has been applied to set the stage and give context to the field and study of energy geography as it applies to this study. Second, an examination of literature of two islands with more advanced energy transitions then that of Pico was conducted to be able to compare the energy transitions of different islands to the one that is currently occurring on Pico. Lastly, a practical component, a case study analysis of Pico Island has been carried out by analysing the results of structured interviews and survey questionnaires.

In the theoretical component an attempt will be made to frame the subject in question and to do so as detailed as possible. Statistical information was collected and added with relevance to the topics that were being examined. Although it was not always possible to find or access all the information that was desired, what was found was used to its fullest.

The second part, an examination of the Island of El Hierro (of the Canary Islands of Spain) and the Island of Samso (of Denmark) - are later linked to the themes discussed in the subsequent parts. This is important as one seeks to understand an energy transition that is resulting from a shift in energy paradigm. These two islands were chosen specifically because they are islands which belong to the European Union (as does the case study Island of Pico) and are similar to Pico in terms of their size (area), population and geographical characteristics. Furthermore, they also have been selected as they are both examples of islands that have already made a renewable energy transition away from fossil fuel dependency towards 100% renewable energy independence. In addition, they represent two different contexts and locales, as Samso is situated in Northern Europe while El Hierro is situated off the coast of West Africa and belongs to the Southern European country of Spain. Lastly, both islands also possess and are powered by wind energy, the unique renewable energy source that Pico currently possesses and has integrated into its energy grid.

The examination of these islands is meant to allow for an understanding of what the energy transition looked like for these islands and how it happened. By understanding how these energy transitions transformed the landscape, territoriality and populations of these islands, it was possible to develop a triangle analysis model of how each transition happened on each island. Finally, comparisons between the models allow for an understanding of whether one similar model or two distinct models exist. These findings are applied to the final part to consider what kind of model could be created on Pico and to understand if a third model is needed or if simply the models from these two islands can be applied on Pico.

Following this section a practical component - the case study, is examined. This is based on the shift to a renewable energy paradigm (from a fossil fuel energy paradigm) on the Island of Pico in the Azores. The case study was conducted using 10 face-to-face structured interviews for a qualitative analysis and 120 survey questionnaires for a quantitative analysis.

As part of the case study of Pico Island, 10 face-to-face qualitative interviews were conducted. These were carried out on Pico Island using a set of 14 structured questions that were asked to participating stakeholders (see annex I). These were conducted with the intent of orientating their responses towards the objective questions of this study. Interviews ranged in length from 25 minutes to 1 hour and 10 minutes and were conducted from the 17th of April to the 12th of May. The interviews were scheduled one day after the other or every two days from each other. This allowed for the researcher to inform and incorporate greater efficiency in conducting and guiding interviews as they progressively went on. A rough idea of the relevant Pico specific context was developed prior to conducting the interviews. This was used to structure interviews with open questions to allow for new knowledge to emerge during the interviews.

All interviews were conducted in Portuguese, as this was the mother tongue of 9 of the 10 stakeholders that were interviewed. All questions were asked and all responses were given in Portuguese. All the interviewees were recorded with the expressed permission of the participants and recordings were revisited post-interview for transcription into Portuguese and to allow for further analysis. From Portuguese, responses were translated by the author into English to allow for responses to be presented in the results section of this study and so that they could be quoted by the author.

Also, all the interviewees are professionally involved with energy production, planning and use on the Island in one way or another. Some of these were administrators or directors of the conventional and renewable energy operations that are taking place on Pico, while others were consumers of energy consumed on the island. The goal of the interviews was to be able to get field based detailed information about their contextual understanding, perceptions and future aspirations with respect to energy on the island. During the analysis, the interviews were used to complete and refine the overview of the contextual conditions and linkages and model of the energy transition on the island. The result of these interviews is a summary of the conditions and the interconnected relationships that exist with respect to energy on the island. It is suggested that these can provide a deeper understanding of the factors and conditions that are needed for a successful transition to renewable energy on Pico.

Stakeholders directly involved in the energy sector were represented in a lower percentage then the stakeholders who are not directly linked to the energy sector. Interviews were direct as they involved direct contact (face-to-face interviews) and were not second or third person interviews. These required direct contact with subjects/interviewees and were different then the handed out surveys that were filled in by participants themselves. Participants included those from the three groups of stakeholders: administrators, businesses and consumers of energy. These interviewees have been included in table 4 below.

Table 4 - Groups of interviewees

GROUP NUMBER	INTERVIEWEE & ENTITY THEY REPRESENT
1 – Businesses in the Energy Sector	**Chief Engineer -** Central Thermal Energy Production Plant of Pico - Electricidade dos Açores, S.A. (EDA)
	Plant Manager - Recycling & Waste Management facility **–** CPRVO Pico RESIACORES Centro de Processamento de Resíduos da Ilha do Pico -
2 – Consumers of Energy	**Hotel Manager –** Hotel Caravelas
	President of the Honey Cooperative – Flor Do Incenso – Cooperativa Apícola da Ilha do Pico, CRL
	Director of the CVIP wine cooperative - Cooperativa de Vinho - Cooperativa Vitivinícola da Ilha do Pico, C.R.L.
3 – Administrators	**President of the Municipality of Madalena –** Câmara Municipal da Madalena
	Director of the Natural Park Service of Pico - Serviço de Ambiente do Pico / Parque Natural do Pico / Gabinete Técnico da Paisagem da Cultura da Vinha da Ilha do Pico
	Director of the Department of Agricultural Development and the Environment - Gabinete de Desenvolvimento do Agricultura e o Ambiente - Serviços de Desenvolvimento Agrário do Pico - Núcleo da Madalena
	Director of the Foresty Service – Serviço Florestal do Pico
	Engineer and Coordinator of Construction, Urbanism and the Environment – Câmara Municipal de São Roque

Next, some 120 questionnaires consisting of 20 questions each were filled in by residents of Pico Island (see annex II). Questionnaires were administered solely by the author of this study from April 24th to May 11th, 2017. In total 120 residents were surveyed. These questionnaires provided information which allowed for a quantitative analysis to be conducted in this study. The questionnaires were administered in the three municipal centers located on Pico, that of Madalena, Lajes do Pico and São Roque do Pico. Questionnaires were delivered door to door to businesses and residences in the municipalities so that they could be filled in by participants.

The surveys consisted of open and closed questions. The survey was further divided into parts, in order to understand the characteristics, perceptions, motivations, advantages and difficulties felt by the respondents. These parts included:

1) Identification of the individual to know some personal data of the respondent, as well as questions related to their relationship and interest in the energy paradigm and their energy use;

2) Motivations to resist, adopt, promote, encourage, or fear a shift to a renewable energy paradigm;

3) Energy experience – their experiences to date with the energy paradigm and their anticipated advantages and difficulties associated with the shift taking place, as well as their flexibility in adapting to such a change.

It must be noted here that the survey does not represent a representative sample (as this required additional statistical care which was not conducted). It is therefore rather a sample that was done for convenience due to time and resource constraints.

It was decided to administer both the interviews and the surveys in person to guarantee a high response rate. After making contact with participants, it was stressed to them that they had the free will to either participate or not in the study and that their confidentiality would be respected as per their wishes. Prior consent to use their names, job titles and their affiliations was asked both verbally and in written form before and after interviews took place or questionnaires were administered. Quotes were connected with a direct linkage to the corresponding interviewee/participant as per the permission granted by them.

Furthermore, after obtaining the necessary authorization to proceed with the application of the surveys, care was taken to administer the surveys in the same way as much as was possible to each of the stakeholders in a particular group. Bearing in mind the possible difficulties that the respondents could feel when responding to questions, one version of interview questions was made that included all questions in Portuguese (see annex I). The same was done for those completing the surveys, as the survey questionnaires included all questions in Portuguese (see annex II).

The data collected in the surveys was processed using Microsoft Excel software. Thus, with all the data collected from the questionnaire surveys, it was possible to answer some of the questions that were posed throughout this paper. These questions included: is the change to a renewable energy paradigm possible? Who has a role in this and who will drive this change? Does Pico Island have all the capital to control this change? Is everybody aware of this change? Who will benefit more? Who will benefit less? What individual and collective geographies and landscapes will this change (re)build? Will this new paradigm possibly change the outside image of the island, shifting it towards a more positive perception? These questions were able to first be addressed with the qualitative interview results followed by the quantitative questionnaire results.

Following these analyses, a secondary analysis of the quantitative results could be conducted. This was done by uploading the responses from the questionnaires into the software program Microsoft Excel. Using the program's filters, various variables were crossed and considered to see how the respondent's characteristics aligned with the responses given. First, nationality was filtered to see if there existed a difference in responses between individuals from different countries. Second, gender was filtered to see if a difference in responses existed between male and female respondents. Third, rural versus urban areas were considered, however, since Pico is very small, an urban area was defined as a township capital which has a population of greater than 1,000 people (that is, Madalena, Lajes do Pico and São Roque do Pico) and a rural area is defined as a parish with a population of less than 1,000 people (17 on Pico). Fourth, the ages of the respondents was filtered for different age groups (0-18 years of age, 19-30 years of age, 31-50 years of age, 51-65 years of age and 65+ years of age. Lastly, education was filtered (basic education (elementary school), secondary education (secondary school) and superior education (post-secondary schools).

In the following chapters, these questions are addressed as the results obtained from the examination of islands, stakeholder interviews and survey questionnaires are analyzed and the case study of Pico Island is described and explained.

PART IV | PICO ISLAND

4. PICO ISLAND CASE STUDY

4.1. CASE STUDY: THE ISLAND OF PICO, AZORES

As the islands of El Hierro and Samso once did, Pico Island is majority fossil fuel energy supplied as it draws most of its energy from fossil fuel combustion. Located in the middle of the North Atlantic Ocean, it is one of the nine volcanic Islands that make up the Azores Archipelago. Being a remote island, it too has started a shift towards renewable energy. Like many other islands, Pico suffers challenging energy needs due to the fact that it is an outermost region. This means Pico faces “several obstacles to full development – remoteness, insularity, terrain, climate, economic dependence and the limited natural and human resources” (CALADO *et al.*, 2010: 12). Energy (fossil fuels) has to be imported from the outside at extremely high costs and as a result its energy production system is unreliable, unsustainable and highly polluting. Despite this, the island does possess natural features which may be utilized in sustainable energy production. These include wind, waves, geothermal and sun. As a result, the natural conditions exist so that Pico can shift to renewable energy sources and energy independence away from fossil fuels (GUEVARA-STONE, 2014; CALADO *et al*., 2010).

By looking at the examples of El Hierro and Samso, the island of Pico may learn how it too can be an example of how an island moved towards 100 percent energy self-sufficiency without the need for fossil fuels. This may be done because Pico has a similar profile to these other two islands in terms of its size, population and geography. Currently utilising a diesel/naphtha thermoelectric plant for the majority of its energy production, a growing percentage on the island of Pico is being supplemented and supplied by a number of wind turbines. Analysis and proposals for a lagoon fed piped hydro system have been created and are currently being considered. If adopted, Pico Island may also at times be able to provide the majority of its energy needs from only renewable sources. If fully exploited, this would allow Pico to join El Hierro as an island that can at times be 100% powered by renewables in isolation with no link to another island or mainland electricity grid (FRAYER, 2014; WEINBERGER, 2014; KOLBERT, 2008).

Considering the comparative analysis carried out in chapter 2, which model may be employed on Pico to transition away from fossil fuels is considered in this chapter. Here it is seen whether a different model is needed or if it is possible to employ a similar model for the energy transition that is taking place on the island of Pico in the Azores.

Like in part 2, this chapter analyses how the energy transition on Pico so far has translated into the landscape of the island, affected its territoriality and impacted its population. In addition, the questions previously discussed in part 1 will be considered. These include: Is the change to a renewable energy paradigm possible? Who has a role in this and who will drive this change? Who controls the process? Does Pico Island have all the capital to control this change? Is everybody aware of this change? Who will benefit more? Who will benefit less? What individual and collective geographies and landscapes will this change (re)build? Will this new paradigm possibly change the outside image of the island, shifting it towards a more positive perception?

The result of this analysis is to conclude if there are differences between the models that have been employed on each island and to see if they make up one similar model or three different models for three different places.

4.2. GEOGRAPHICAL LOCATION

The geographic location of the island of Pico is now explored in this section. The island of Pico lies in the middle of the North Atlantic Ocean at latitude 38° N and longitude 28° W (subtropical) and is part of the Azores archipelago that helps make up part of the Macaronesia collection of island archipelagos (GEOHACK, 2017). Pico is one of the nine populated islands (along with Flores, Corvo, Pico, Faial, São Jorge, Graciosa, Terceira, São Miguel and Santa Maria) that make up the archipelago of the Azores. The Azores islands make up the Autonomous Region of the Azores belonging to Portugal and is considered to be an outermost region of the European Union (OMR) (see section 1.13 in chapter 1)(CALADO *et al.*, 2010).

The Azores islands are located 1,430 km West of the West coast of Portugal and 3,900 km East of the East coast of North America (CALADO *et al*., 2010). The Westernmost and Easternmost islands are separated by some 630 km, and thus, the Azores span a vast area of the mid-Atlantic ocean (an area of 2,333 km^2; 2.6% of the national territory of Portugal) and some islands remain very fragmented from others due to great geographical distance between the islands and a lack of co-visibility (MARROU, 2009; CALADO *et al*., 2010). Due to the great geographical distance and fragmentation between the islands they have been divided into geographical groupings as they are considered as being three distinct groups. These include the "Western Group (Flores and Corvo), the Central Group (Pico, Faial, São Jorge, Graciosa and Terceira) and the Eastern Group (São Miguel and Santa Maria) (see figures 20 and 21 below) (CALADO *et al*., 2010:12).

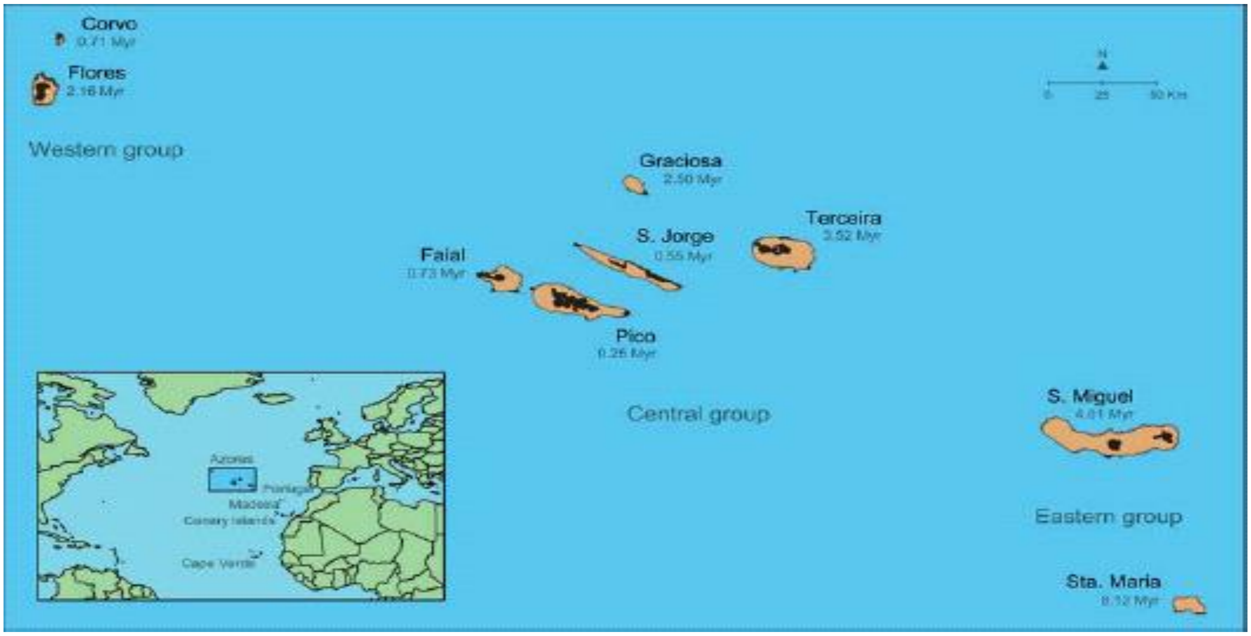

Fig. 20 - Geographic location of Pico Island and the three groups of islands of the Azorean Archipelago
SOURCE: PICO THE AZORES, 2017.

Fig. 21 - Map of Pico Island showing its main towns, villages and roads
SOURCE: CASA DAS BAIXAS, 2017.

The Azores islands are volcanic in nature and therefore possess mountainous topography. Pico has its peak (Pico mountain) classified as one of Portugal's 7 Natural Wonders, as it possesses a maximum altitude of 2,351 metres and is thus the tallest peak of Portugal. The Island of Pico is the second largest of the archipelago and is located in the central group of islands of the Azores. It has an area of 447 km^2 (El Hierro 268 km^2; Samso 115 km^2) and has a maximum length of 42 kilometres and a maximum width of 15.2 kilometres (see figure 21 on previous page) (PICO THE AZORES, 2017; AZORESGOV, 2017).

Topographically, it is defined by coastal cliffs and stark volcanic landscapes and basaltic lava rocks and flows. The topography of the surrounding seabed represents that of volcanic peaks, submerged craters, ridges and faults. This is as the Azores lies between the continents of Europe, North America and Africa along the Mid-Atlantic Ridge on what is known as the Azorean Plateau (situated between the American (West), Eurasian (Northeast) and African (South) tectonic plates (see figure 22 next page) (CALADO *et al.,* 2010: 12; PICO THE AZORES, 2017).

As a result of its tectonic position, some of the deepest sections of the Atlantic are found in the Azores, and it is for this reason that it has been determined that Pico cannot be connected by undersea cable to its neighbouring islands (São Jorge and Faial) as it is too expensive and challenging to do so. Therefore, like El Hierro, Pico at the moment cannot be hooked up to neighbouring islands or to a continental power grid from Europe as it is located too far from the coast of continental Europe (EDA, 2017). Pico's underground topography and the fact that it is situated in the open mid-Atlantic Ocean mean that it is exposed to waves. These waves have their energy vary seasonally, while their size and frequency can also vary greatly. Such waves provide an opportunity for renewable energy production, as experimented by the wave plant project that was piloted in the village of Cachorro in the 2010s. Unfortunately, due to engineering failures it has not been able to contribute to the main electricity grid (EDA, 2017).

The island of Pico possesses vast areas of natural landscape, as it possesses numerous endemic species of flora and fauna and many protected forested and agricultural areas. The island possesses 8 of the 121 designated Geoparks found in the Azores (that is, Fossil arriba of Santo António, Lava fajã of Lajes do Pico, Gruta das Torres, Madalena Islets, Lajido de Santa Luzia, Mount Pico, Achada Plateau and Ponta da Ilha). These Geoparks are areas "with well-defined territorial expression and boundaries, where the existence of an exceptional Geological Heritage is the basis for a strategy that promotes the well-being of the population while maintaining the respect for the environment" (AZORES GEOPARK, 2017). These parks form part of the European Geoparks Network and the UNESCO-assisted Global Geoparks Network that exists to ensure the geological conservation, environmental education and sustainable development of these areas and the people that share them (AZORES GEOPARK, 2017).

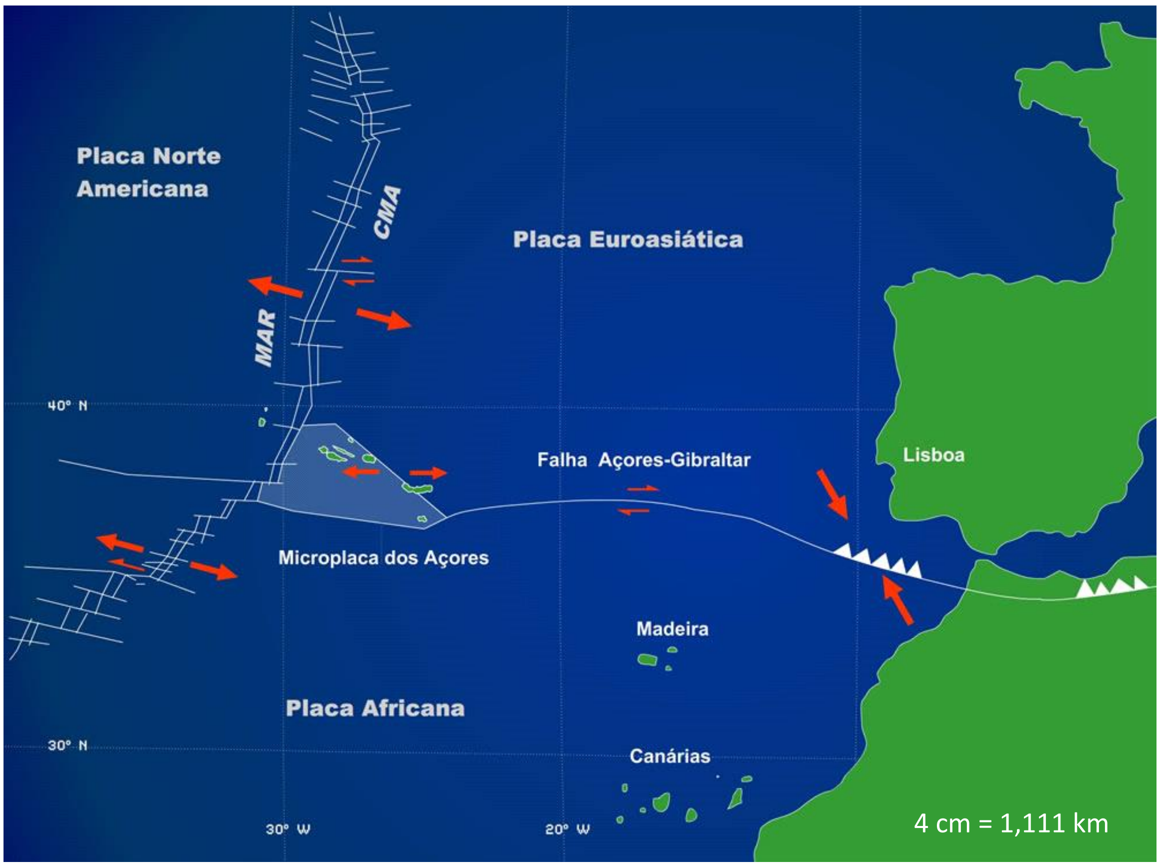

Fig. 22 - Image of the Azores Microplate located between three continental plates
SOURCE: SPELO, 2017.

Furthermore, Pico Island possesses the UNESCO World Heritage Site "Landscape of the Pico Island Vineyard Culture". This is a traditional viticulture region where grapes have been grown for hundreds of years in a unique manner along exposed volcanic rock and lava-flows. Here grapes are grown along the ground and are enclosed with stone basaltic lava rocks to protect the vines from ocean salt water and high winds. With a total area of 987 hectares, this protected area also serves as a testament to the great natural and cultural heritage that exists on Pico (see figure 23 next page) (UNESCO, 2017).

Fig. 23 – Pico's UNESCO World Heritage cultural site of vineyard landscape and Pico Mountain
SOURCE: RADIOPICO, 2017.

As a result of its location, median temperatures (near-tropical), natural landscape and deep blue waters, Pico is known (as are the Azores) for its idyllic natural landscape of lush green nature, great hiking trails, diving, mountain climbing, rich cultural history, wines, regional cuisine and other tourism activities. Tourism in the Azores has been increasing rapidly in recent years and is predicted to continue to rise for years to come as economically the island is becoming more and more dependent upon it as agriculture is decreasing (PICO THE AZORES, 2017; AZORES GOV, 2017).

In summary, in this section the geography of Pico Island has been explored. Next the population dynamics of the Island are explored in the following section.

4.3. POPULATION

Now that the geographic location of Pico has been established in the previous section, here the population statistics of the Island of Pico are analyzed.

The Island of Pico has a population of approximately 14,108 people (2011 Census data). The three largest towns are Madalena (6,046 people), Lajes (4,701) and São Roque (3,361).

Being the second largest island in the archipelago in terms of land area, the Island has a population density of 31.6 people per km^2 (El Hierro 38 people per km^2; Samso 33 people per km^2) (INE.PT, 2017). Furthermore, the island is made up of 3 municipalities (Madalena, São Roque do Pico and Lajes do Pico) which combined contain 17 parishes (freguesias in Portuguese) (INE.PT, 2017).

Economically, principal activities include agriculture, fishing and tourism. Historically, Pico had a closed subsistence economy mixed with some exports run by outside land owners. Today, tourism is growing while industry is declining (GLOBAL ISLAND NETWORK, 2017).

A number of farming cooperatives exist. Agriculture consists mainly of dairy cow and livestock rearing (involves 35% of the Azorean workforce), as diary and meat cooperatives exist and export products abroad. Milk is produced and is processed into famous artisanal cheeses along with other dairy products. In addition, other crops are produced, such as fodder, corn (for grain), sugar beets, potatoes, chicory, sweet potatoes, onions and yams. Mixed farming is prevalent. Timber and vineyard production is located where lava flows have left exposed basaltic rock formations. Grape growing is practiced (for wine and liquor production – the vast majority by the CVIP wine cooperative). A famous white dry wine (that is, Verdelho) is produced and exported. Grapes are grown by training vines very close to the ground in small walled enclosures that utilise the black volcanic rock and soil for heat retention and the rock walls for protection from seawater and wind (GLOBAL ISLAND NETWORK, 2017).

Factories on the island historically have included the Madalena ship building yard (now closed) and the COVACO Bom Petisco tuna factory (scheduled to close this year). Cheese is produced in the traditional method via numerous small local cheese factories (GLOBAL ISLANDS NETWORK, 2017).

Tourism is becoming the new pillar of the economy as agriculture and industrial production is declining. This boom in tourism is contributing pressure on the islands energy system as peak tourism season demand in the summer months strains the system (EDA, 2017).

In summary, in this section the population profile and the scale of activities carried out on the island has been established. Next, attention is turned to the evolution of the island's respective energy system.

4.4. DEVELOPMENT TRAJECTORY

Having considered the population dynamics that exist on Pico Island in the last section, the energy development trajectory that the island has followed is explored here next.

There is significant renewable energy potential on Pico. This is shown by the fact that the contribution of renewable energy to the island's energy needs has experienced a large increase in recent years. This has been possible because Pico, like the rest of the Azores, is blessed with numerous renewable energy resources which include geothermal, wind, solar, hydro (lagoons), biomass and marine (wave) energy sources. The island may optimize its use of these resources by determining which ones are cost effective and are thus feasible to develop. At the same time, Pico must reduce its overall energy consumption if it is to approach 100% renewable energy production (GLOBAL ISLANDS NETWORK, 2017). Currently, renewables (wind turbines) account for between 15-20% of the primary energy supply and electricity produced on the island (15% in 2015, 20% in 2016) (EDA, 2016; EDA 2017).

The energy situation on Pico can be defined by that of fossil fuel driven energy production. Since 1990, the Electricity of the Azores' (EDA's) thermoelectric driven power plant (located in the town of São Roque) has supplied the great majority of Pico's electricity (RICO, 2009: 30; EDA, 2016). The thermoelectric plant of Pico historically supplied 100% of the island's energy needs and is the only source of guaranteed electricity production on the island.

In 1999, an experimental wave energy plant in the village of Cachorro was introduced with the hope of adding renewable energy to the island's electricity grid. This however did not occur, as the plant ran into operational difficulties and had to be taken offline. In 2003, the plant was turned back on but it has not functioned anywhere near its designed capacity. It remains not connected to the island's electricity grid and currently only runs as an experimental plant. Therefore, it was not until the introduction of a wind park in 2005 that fossil fuel consumption dropped as renewable energy was added into the grid (RICO, 2009: 29; EDA, 2016).

Fossil fuel burning supplies 80 - 85% of the island's energy needs in recent years. In 2015, the thermoelectric plant emitted 588.24 g/KWh of CO_2. The plant ensures a high degree of energy security on the island as it is capable of supplying 100% of the island's energy needs 100% of the time. However, a lack of fossil fuels reaching the island means a potential lack of electricity for the island. Increasingly, the wind turbines are contributing more to the energy make-up of the island. The development trajectory of the island is summarized in table 5 which follows (RICO, 2009: 29; EDA, 2016; EDA, 2017).

Table 5 - Timeline of the renewable energy transition on the Island of Pico

YEAR	ACTION
1990	-Pico Island is 100% dependant on fossil fuel imports (shipped from 1000's km away) -EDA's São Roque thermoelectric power plant is constructed -Thermoelectric fuel burning plant is run by burning diesel fuel and Naphtha fuel -4 turbines are generally online, although 6 are present on site -Motors possess a maximum total potential of 13,338 MW
1999	-Cachorro wave plant comes online -Plant soon shuts down due to operational failures
2002	-Terras do Canto wind park is incorporated into the Azores wind energy development plan to develop wind energy in the Azores (Plano de Desenvolvimento de Energia Eolica dos Acores de 2002)
2003	-Wave plant is put back online as an experimental only plant (not grid connected)
2005	-6 ENERCON E-30/300 (30 metre diameter/300 kWh capacity) wind turbines erected -Each turbine is capable of generating 300 kWh of electricity -Wind parks total combined maximum output = 1800 kWh -Annual production of about 5 million kWh (12% of Pico's electricity consumption) -The wind park "*Parque Eolica Terras do Canto*" comes online and contributes to island's electricity grid -Plant saves 1,144 tonnes of fuel oil and 15 tonnes of oil annually -Turbines prevent emission of 4,216 tonnes of pollutants/year entering the atmosphere
2015	-Thermoelectric plant responsible for supplying 85% of the island's energy needs -Thermoelectric plant was responsible for emitting 588.24 g/kWh of CO_2 -Wind power generates 15% of the island's energy needs
2016	-Thermoelectric plant responsible for supplying 80% of the island's energy needs -Wind power generates 20% of islands energy needs
Future	-Increase renewable energy supply until it supplies 100% of the island's energy? -Utilize "Lagoa de Paul" for a reverse flow wind-hydro renewable energy power plant? -Reduce dependency on fossil fuels? -Only utilize thermoelectric fossil fuel driven plant as back-up generator? -Reduce transport sectors dependence on fossil fuels by switching to electric vehicles?

In summary, in this section the development trajectory of Pico`s energy system has been presented. Understanding how this transition is happening and who is driving it can now allow for one to gain a greater understanding of how the respective energy system on the island can function. The make-up and drivers of the island's energy system is the subject of the following section.

4.5. ENERGY MAKE-UP

Pico’s energy is solely produced by the Electricity of the Azores (Electricidade Dos Açores S.A. - EDA), a private-public utility company that possesses an energy monopoly within the archipelago (RICO, 2009). Today, the Island of Pico, like the rest of the Azores islands, has an isolated autonomous energy system. This is because inter-connection of the island’s electricity grid with those that exist on other islands (via seabed cable) has been ruled out as not being an option due to the great sea depth that exists between the islands. In addition to the sea depth, the great distances that exist between many of the islands make the option not cost effective and therefore unfeasible (GLOBAL ISLANDS NETWORK, 2017; EDA, 2016; EDA, 2017).

Pico’s energy system is majority dependent on imported fossil fuels. These are needed to drive the diesel/heavy oil engines that generate electricity at the central thermoelectric power plant. As a result, Pico (and the Azores) are subject to the economic burden of fluctuating global oil prices and high import and transport costs to bring this fuel to the island. In general, in the Azores 40% of primary energy is used for electricity production, 47% for transportation and 6% in industry (GLOBAL ISLANDS NETWORK, 2017).

Currently, the installed capacity on Pico is 11 MW, with maximum power consumption being 1.2 MW and annual energy consumption totalling 11 GWh per year (EU DG RESEARCH, 2015). On Pico, in 2016, total energy consumption as of May of 2016 was 3,216,278 kWh, down 0.8% from the previous year. To meet this demand, EDA currently produces electricity at two production facilities: a thermoelectric fossil fuel powered plant and a wind turbine powered plant (EDA, 2016).

The thermoelectric fuel burning plant (located in São Roque) runs by burning naphtha fuel in 4 diesel motors (although 6 are present on site) that possess a maximum total potential of 13,338 MW (UBI, 2017). These motors produce between 80-85% of the island’s electricity needs, while 6 wind turbines provide the rest (EDA, 2017). The plant currently runs by burning naphtha fuel oil. Last year, the fuel burning plant was responsible for emitting 588.24 g/kWh of CO_2. A value calculated for a fuel rate of 681.36 for the Island of Pico in 2015 (see figure 24 below) (EDA, 2016).

Fig. 24 – Diesel motors of the EDA central thermoelectric power plant in Sao Roque, Pico
Source: Author of this article, 2017.

In addition to the thermoelectric plant, EDA owned wind turbines at the wind park "*Parque Eolica Terras do Canto*" have insured that an increasing percentage of renewable energy enters into the Pico electricity grid. This wind energy supplements the electricity that is coming from the thermoelectric plant. At the central thermoelectric plant, energy from the wind turbines is regulated and entered into the island's electricity grid. The wind park is supplied by six ENERCON E-30/300 (30-metre diameter/300 KWh capacity) wind turbines, each capable of generating 300 KWh of electricity and therefore possessing a combined maximum output of 1800 KW (see figures 25 and 26) (THEWINDPOWER, 2017; E2P, 2017).

The wind plant was part of the 2002 energy plan to develop wind energy in the Azores (Plano de Desenvolvimento de Energia Eolica dos Acores de 2002), cost 2.9 million Euros to construct, was constructed by the EDA Group through the Electricity Company and Gaz Lda.

(EEG) and was added to the grid in 2005 in the municipality of São Roque (850 metres above sea level in the parish of Prainha) (ENERGIAS RENOVAVEIS, 2017, AZORESGOV, 2005).

Fig. 25 - 5 of the 6 Enercon E-30/300 wind turbines that make up the Terras do Canto Wind Park on Pico
Source: ENERGIASRENOVAVEIS, 2017.

On average, it has been responsible for supplying 15.6% of the island's energy needs (EDA, 2016). The plants annual production was estimated to be 5 million KWh (12% of Pico's electricity consumption), a value that has since been surpassed in the last couple of years (5.2 million KWh - 15-20% of Pico's electricity consumption) (AMBIENTEONLINE, 2017; AZORESGOV, 2005). On average, the plant saves 1,144 tonnes of fuel oil and 15 tonnes of oil annually, thereby preventing the emission of 4,216 tonnes of pollutants per year into the atmosphere (ENERGIAS RENOVAVEIS, 2017, AZORESGOV, 2017).

Over their expected lifespan of 25 years, Pico's wind turbines may be able to save the island 29,755 tonnes of fuel oil, 390 tonnes of lubricating oil and 105,395 tonnes of pollutants (UBI, 2017). If more of the energy currently produced by these turbines is allowed to enter more fully into the electricity grid, the wind park could be responsible for Pico achieving the Europe 2020 target of 20% of its energy production coming from renewables (EDA, 2016; EURO2020, 2010).

The energy security supplied by the wind system can be considered to be medium to high. This is due to the fact that the island rarely lacks wind, but in the event of low to no wind scenarios, the island does not have a storage system (such as a battery storage system or a lagoon hydro-wind pumped system like that which exists on El Hierro) to supply energy to the grid during these times. The island therefore relies 100% on the thermoelectric plant in low to no wind scenarios (ENERGIAS RENOVAVEIS, 2017, AZORESGOV, 2005; EDA, 2017).

Fig 26 - The 6 Enercon E-30 wind turbines of the Terras do Canto Wind Park on Pico Island
Source: ENERGIASRENOVAVEIS, 2017.

The third energy production plant which can found on Pico (which is currently offline), is a wave power plant found on the coast of the tiny village of Cachorro “The European Wave Energy Pilot Joule Programme European Oscillating Water Column OWC Wave Power Plant - Electrical Power Plant”. This plant was commissioned as an experimental energy production plant. Since its construction it has suffered some operational issues and has not been able to run at expected or near optimal capacity. Improper construction has partly been blamed for its unreliable and irregular production capacity, and as such, it accounts for no more than 0.1% of energy production on the Island (EDA, 2016; EU DG RESEARCH, 2015; RICO, 2009: 31).

The experimental wave energy plant was constructed in 1999. The project was a joint partnership between: Electricity of Portugal (EDP), Electricity of the Azores (EDA), the

University of Lisbon's Instituto Superior Técnico (IST) school of engineering, the National Institute of Engineering and Technology (Instituto Nacional de Engenharia e Tecnologia Industrial), the company Profabril (Profabril Centro de Projectos SA), EFACEC electronic systems (EFACEC Sistemas de Electronica SA), Queen's University of Belfast and the University College of Cork) (EU DG RESEARCH, 2015; RICO, 2009; JOULE PROGRAM, 1997).

Being the first of its kind in Europe, this "Oscillating Water Column" is located on the shoreline and utilizes a Wells Turbine (wound rotor induction machine) of 500kW capacity that is controlled by a relief valve and revolves at 780-1475 rpm) (EU DG RESEARCH, 2015; RICO, 2009; JOULE PROGRAM, 1997). The project was nearly abandoned after initial operating issues due to strong swells and oxidation problems. Since 2003, it has been operating as an experimental non-grid connected facility with a 150 kW capacity and produces 0.9 GWh per year (see figure 27 below) (EU DG RESEARCH, 2015; RICO, 2009: 31; JOULE PROGRAM, 1997).

Fig. 27 – Pico's Oscillating Water Column wave energy plant in the village of Cachorro
Source: RICO, 2009.

For the future, prospects for Pico include a proposal for a hydroelectric turbine. This is as a potential hybrid water-wind hydroelectric plant like the one found on El Hierro may be developed due to the existence of large volcanic lagoons that exist on Pico Island. It has been suggested that a hydro generator could be connected to a proposed pipeline that is to run from the Lagoa de Paul (lagoon of Paul) on the top of Pico down to the municipality of Lajes on the coast. The municipalities' engineers at the city hall (Camara municipal das Lajes do Pico) have come up with a proposal to impermeate the lagoon (to stop rainwater infiltration) with a possible gel liner and to connect a gravity fed pipe from the lagoon down to the town of Lajes below. The proposed Lagoa de Paul project is intended to deal with the water shortages experienced by the town during summer time - the time of peak demand - as it is the driest season and the peak tourist season. This water will supply the municipality with drinking water and with fresh water for agricultural irrigation. Connecting a hydro turbine to the mid-section of the pipe to generate electricity is a proposition that has been made by EDA to the municipality. This is as EDA hopes it can draw renewable electricity from when the water runs downhill and passes through a hydro turbine. Although not yet approved, the project could potentially be expanded to be connected to a dual lagoon reverse pumped wind-hydro power system like the one that already exists on El Hierro. It remains to be seen if the political will, community acceptance and capital necessary for such a project can be secured. If so, the plan could help Pico near or achieve 100% renewable energy production capacity, as is the case on El Hierro (STAKEHOLDER INTERVIEWS, 2017).

Additionally, like was done in the past on Samso, there is a push by EDA to have consumers reduce their total energy consumption. One program to achieve this end is encouraging consumers to shift their consumption to electric hot water heating units instead of traditional gas powered units. In addition, EDA celebrates World Energy Day with an event where they give out energy efficiency certificates to over 100 clients who have saved energy by subscribing to their tri/hourly energy saving program which encourages users to use energy at non-peak hours. EDA also had a fleet of 100% electric vehicles at the event last year to demonstrate the capabilities, performance, mobility and comfort of electric vehicles in order to promote and encourage a shift away from using fossil fuel driven transportation (see figure 28 on the next page) (EDA, 2016).

Furthermore, EDA, in accordance with Law no. 51/2008 of the Commercial Relations Regulation and Recommendation paragraph 2/2011 ERSE, has had to develop transparent energy labelling. To comply with this law, they have provided the following measures: 1. Internet - created an area dedicated exclusively to energy labeling with monthly information for the island, the energy mix and the carbon dioxide emission factors; 2. Invoices - since 2009 all invoices have information about the energy mix of the respective island and the total CO_2 emissions relating to billed consumption; 3. Leaflets on labeling - together with the monthly bill, all customers receive a brochure on the labeling of electricity with the indication of the previous year on the island, the energy mix, the specific emissions of CO_2 and some suggestions to promote efficient use of electricity (EDA, 2016).

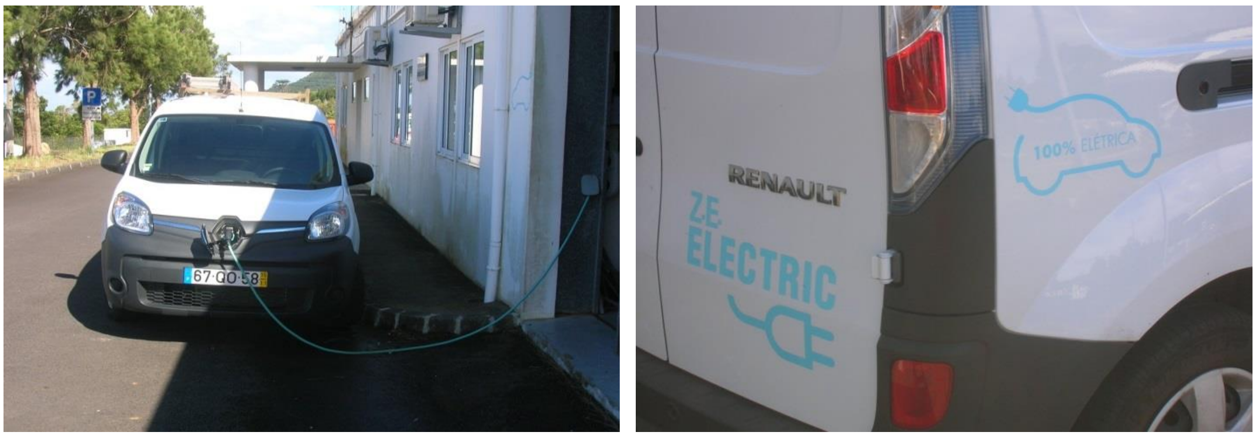

Fig. 28 – EDA's 100% electric demonstration vehicle charging at the central thermoelectric plant on Pico
SOURCE: AUTHOR OF THIS PAPER, 2017.

With respect to reducing fossil fuel use, the EDA action plan to "reduce fossil fuel emissions and CO_2" states that it will: 1. Maintain the efficiency of thermal power generation; 2. Invest in the development of new wind farms; 3. Optimize and develop the capacity of geothermal and hydroelectric generation; and 4. Improve the influence on the consumption of its customers (EDA, 2016).

Taken together, these programs, along with increased renewable energy production on Pico, can steer the Island on its way to not only achieving the regions Europe2020 targets of reducing energy consumption by 20%, increasing efficiency by 20% and supplying 20% of its energy from renewable sources, while also helping Pico eliminate its dependency on imported fossil fuels (EDA, 2016; EURO2020, 2010).

Next, the landscape characteristics and geographical character of Pico Island are analysed in section 4.6.

4.6. LANDSCAPE

Here, since the energy make-up of Pico has been established in the previous section, it is possible to analyse how landscape affects energy and how energy affects landscape on Pico.

On Pico, like on other islands, landscape features affect what type of energy paradigm is employed, while in a reverse relationship, the energy paradigm that is employed affects the landscape of the island.

Taking a closer look at Pico, it has been subject to energy transforming its landscape. It, like El Hierro and Samso, has been transformed into a carbonscaped fossil fuel energy dependent powered island. This is as the main sources of energy are petroleum derived fossil fuels that are subject to volatile and high prices. This fossil fuel dependency has resulted due to the marked geography of Pico Island, as its:

> Geographic factors, such as both the distance between islands and the distance between the islands and the Portuguese mainland, the ruggedness of the ocean bottom, the limitations of means of communication and transport, naturally result in high costs in the generation, distribution and transformation of power, as there is no longer any interconnection between the electricity generating systems of the islands and the mainland, nor between the islands. [Pico is] … not connected to the European network and there is no possibility of such a connection being established (DA SILVA in MARIN *et al.*, 2005: 43).

Pico has thus needed to operate its energy system fully independent of the other Azorean islands and mainland Portugal. It remains majority dependent on fossil fuel imports which arrive from 1,000's of kilometers away just to reach the Azores, then must be delivered 100's of kilometers from other major transport hub islands (for example, São Miguel) to Pico's holding tanks in São Roque. Again, it is clear here to see that such a dependency can be expensive (due to the friction of distance) and volatile (due to rough seas and shipment delays) as is the case for El Hierro. Also, burning these fossil fuels at its thermoelectric plant (mostly naphtha) results in large pollution emissions being emitted which contribute to global warming. This reliance on fossil fuels has also required a network of transportation infrastructure to be developed across the island. This infrastructure is needed not only to transport fossil fuels, but also to transport for the energy that is produced by them. As such, Pico possesses an ingrained carbonscape ((DA SILVA in MARIN *et al.*, 2005: 43). A shift away from fossil fuels will require Pico to consider the landscape features that it possesses, as was the case with El Hierro and Samso. So far, these feautures have influenced the renewable energy technologies that have been employed on the Island. For example, the topography on Pico (being volcanic and mountainous with a maximum altitude of 2351 m and with a high plateau that runs across the middle of the island), have allowed for it to possess suitable sites for locating wind parks. In addition, an assessment has revealed that Pico possesses topographically suitable conditions for locating a pumped hydroelectric-wind power system and its necessary water source (in the form of an old volcanic crater/lagoon). Thus, such a system in the future can be deemed economically and technologically feasible for Pico, as geographically speaking, it already is. However, issues due exist with infiltration, as the basaltic rock base of Pico's landscapes is extremely susceptible to water drainage underground (STAKEHOLDER INTERVIEWS: 6, 9, 2017).

Furthermore, Pico has a significant source of wind and sun renewable energy sources. Wind, in terms of frequency and velocity, has been deemed very suitable for wind parks, of which one, the Terras do Canto Wind Park, already exists. The installation of this park has changed the landscape of Terras Do Canto section of the island both visually and physically. This is as the idyllic visual natural landscape of that island has been altered by the presence of 6 wind turbines and its connected plant. Also, the infrastructure of electricity lines and towers needed to connect this electricity to the central thermoelectric plant has required cutting vegetation and carving up the landscape. These are both activities which may be resisted and deemed negative by the residents of the island, as noted in part 1 (EDA, 2017; DELICADO *et al.*, 2013).

In addition, Pico is affected by its underlying ocean topography and its situation in the middle of the Atlantic Ocean. This is as various studies have deemed that the depth and ruggedness of the ocean bottom do not permit a system of underwater cables to connect to the nearest islands of Faial and São Jorge, as this would be technically and economically not viable. Also, as determined prior to 1999 when the experimental wave plant of Cachorro was constructed, Pico does possess abundant wave resources as it is exposed to open ocean swells and surrounded by deep ocean floor areas. Properly tapping this resource is still a technological issue which remains to be resolved (EU DG RESEARCH, 2015; JOULE PROGRAM, 1997).

Lastly, Pico's specific land uses affect where the siting of renewable energy plants and infrastructure may be located. For example, the UNESCO World Heritage Site of the "Landscape of the Pico Island Vineyard Culture" is a protected area in which new constructions and alternations are not permitted. Only the restoration of existing walls and wine cellars is permitted in this zone, thus a renewable energy installation would not be permitted here. Also, Pico's Geoparks are reserve areas where human habitation and large scale construction is not permitted, thereby again limiting renewable energy siting options. Despite this, however, an advantage exists on Pico, in that the upper plateau of the island, where a current wind park exists, is a zone free of human habitation. This means that siting and constructing wind or solar installations there is a process that is unlikely to be met by widespread citizen resistance, as for the most part they would be out of sight of the population and thus would not be creating visual pollution that can be seen or noise pollution that can be heard (UNESCO, 2017; EUROPEAN GEOPARKS NETWORK, 2017).

In summary, in this section it can be seen how the landscape and energy interact on Pico. Not only does the landscape determine where energy infrastructure and production can take place, but the energy production method selected impacts the island's landscape and citizens.

In the next section, the transportation reality of Pico is explored.

4.7. TRANSPORTATION

As the previous section examined the relationship between energy and landscape, here the role transportation plays in a renewable energy transition on Pico can be examined. As was stated in the previous section, the friction of distance affects transportation of fossil fuel resources and thus energy on Pico. Being remotely located and with a geography that makes interconnection not possible, Pico must pay high transport costs for its primary fuel source. In addition, internal transportation within the island is dependent on fossil fuels and thus poses challenges for reducing fossil fuel dependency and imports (DA SILVA in MARIN *et al.*, 2005; SNIECKUS, 2010).

For Pico, as on Samso and El Hierro, transport to the island is largely achieved by means of commercial ferries that run between the islands and run on diesel fuel. In addition, Pico possesses an airport which receives a handful of flights daily, as these come directly from continental North American, continental Europe and other Macronesian Islands. Thus, planes running on fossil fuels must be refuelled on Pico and their use pollutes the environment. Additionally, private cars are needed for internal transport on Pico, as a private bus service

“Cristiano Limitado”, only runs around the island twice a day and does not pass by or stop at all the parishes that exist on Pico. These cars currently must run on fossil fuels, as a charging station infrastructure does not yet exist on Pico (CAMARA MUNICIPAL DA MADALENA, 2017). In fact, car usage doubled in Madalena municipality from 1991 to 2001, in line with the trend for Pico and the Azores as a whole (CALADO *et al.*, 2010).

A renewable energy transition on Pico then must address the island’s transportation sector. This is as Pico’s current transport systems generate significant negative impacts which include air pollution, noise, energy consumption, greenhouse gas emissions, loss of open space and a dependency on fossil fuel imports (CALADO *et al.*, 2010). Ferries powered by fossil fuels account for a big part of the islands fossil fuel consumption, as do cars.

Reducing fossil fuel consumption on Pico in the transportation sector would require many initiatives. First perhaps, is the implementation of a renewable energy transition master plan for Pico. In addition, converting the ferry boats to run on locally grown bio-diesel is an option that could be proposed and developed. In addition, replacing fossil fuel driven cars with electric cars could reduce fuel demand. This requires new infrastructure (such as charging stations) and enough new renewable energy plants to supply the electricity needed for them to run (so as to not need to burn more fossil fuels in the thermoelectric plant to power them). Also, regular hourly bus service could reduce the need for car ownership. To date, only a couple demonstration electric vehicles exist on the island, being driven and charged on site by EDA and the ministry of the environment and natural parks (CALADO *et al.*, 2010; EDA, 2017; STAKEHOLDER INTERVIEWS: 6, 2017; CALLAJAN, 2011; NIELSEN & JORGENSEN, 2015: 12, 26).

In summary, the issues of distance and isolation affect Pico’s transportation needs, energy availability and use. Being remotely situated Pico is dependent on fossil fuel imports. Pico has no master plan for solving its fossil fuel use in the transportation sector. Taking from the other examples in this study, Pico can phase out fossil fuel use in its transportation sector by switching to electric powered cars and can create conditions for its ferry fleet to run on bio-diesel. Having now examined the transportation situation on Pico, next the territorial marketing realities of Pico Island are examined.

4.8. IMAGE OF PICO ISLAND: TERRITORIAL MARKETING STRATEGY AND THE IMAGE BEING PROMOTED

In the previous section, the challenges of the transportation sector on Pico were examined. By reducing its current fossil fuel dependency, Pico may additionally benefit through new opportunities in how it markets itself. In this section, Pico's marketing image is examined.

Pico Island is increasingly becoming reliant on the tourism sector to grow its economy. This is as Pico has seen a decline in its traditional agriculture and manufacturing sectors. Thus, by having addressed this, tourism is starting to take off on Pico. This is as Pico is known for its idyllic natural landscapes, Pico Mountain, hiking, scuba diving, mountain climbing, culture, festivals, wines, regional cuisine and other tourism activities (PICO THE AZORES, 2017; AZORES GOV, 2017).

Recognizing this, residents on the island have been pushing for new events, gatherings and conferences to be hosted on the island to attract more tourism. Among these is the Azores "Fringe Festival", an artistic expose of Azorean art with the expressed purpose of revealing this to the world. Since having been started five years ago by a Pico resident, over 1,100 artists from 56 countries have attended and participated in the festival (MIRATEC, 2017). In addition, another event lobbied for to attract tourists to the island was the municipality of Madalena's status of Portuguese City of Wine 2017 (Cidade de Vinho, 2017). With this title, the island is able to host a wide array of events throughout the year, drawing people to Pico as a main center of winemaking in Portugal (CAMARA MUNICIPAL DA MADALENA, 2017).

Moving on to consider the projected image of the Island, telling is what is promoted by the Island governments. Projected by them are the "Vineyard Culture Landscape of Pico" that was acclaimed a World Heritage Site by UNESCO in 2004. This wine culture is promoted by the governments with the expressed purpose of promoting wine tourism. In addition, the Island is marketed as possessing Pico Mountain, one of the seven natural wonders of Portugal. Also, the island argues that it possesses the best whale watching and shark diving experiences in all the Azores (PICO THE AZORES, 2017; AZORES GOV, 2017; CAMARA MUNICIPAL DA MADALENA, 2017).

However, despite this wealth of tourism marketing, the island is losing out on the opportunity to market itself as a 'Renewable Energy Island'. Potentially doing so could allow the island to reinvent itself and boost its tourism economy even further. Already marketing itself as a natural island associated with natural landscapes and a healthy environment, becoming a green energy island could further this image. Pico may then appeal to a large diversity of tourists and research institutes to visit the island. Also, shifting to renewable energy will allow it to gain an international reputation as a leader of sustainable energy innovation, thereby gaining international media attention (SPERLING, 2017: 885: FRAYER, 2014; KOLBERT, 2008).

In summary, in this section the image of Pico that is marketed has been touched upon. By shifting to a renewable energy paradigm the island stands the possibility to benefit from marketing itself as a model and centre of renewable energy, innovation, sustainability and fossil fuel free energy independence. This could lead to international attention and an increase in renewable energy tourists. In the next section, the stakeholders that have been involved in Pico's energy transition so far are discussed.

4.9. STAKEHOLDERS AND IDENTITIES: ADMINISTRATORS, BUSINESSES AND CONSUMERS

Continuing on from the previous section where the marketing image of Pico Island was touched upon, it is possible now to consider the various stakeholders who have been and must continue to be active in the transition from a fossil fuel energy paradigm towards a renewable energy paradigm on Pico.

Next, let us consider the various stakeholders that have been involved with energy on Pico. The various actors include: Government – national (the Government of Portugal)(national level), regional (the Regional Government of the Azores)(regional-territorial level), municipal (the 3 municipal governments of the Island of Pico – Madalena, São Roque & Lajes) (local-Island level) and village (17 parish governments (freguesias) of Pico (village level); The European Union (EU) and its partner organisations (for example, the Islepact project) (international level); The United Nations Educational, Scientific and Cultural Organization (UNESCO) (international government funded agency); Local residents (including farmers and seasonal residents), Tourists; Island factories (industry)(for example, COVACO tuna factory); Cooperatives (for example, CVIP wine cooperative); Policy makers (planners, developers, technicians, engineers, professionals); Fossil fuel companies (including gas vendors); Automobile and ferry boat manufacturers and fuel system converters (for example, Renault-Nissan alliance); Renewable energy companies (manufactures and vendors)(for example, Pico Solutions and Next Energy); Local utilities with their electricity generation plants and their shareholders (Electricity of the Azores' (EDA's) São Roque central thermoelectric plant and Terras do Canto wind farm); Local businesses; Tradesmen; Financial institutions and grant donors (for example, the European Investment Bank); Universities (that is, MIT Portugal, University of Porto); and research and development departments (FCT Fundação para uma Ciência e Tecnologia, the Faculty of Engineering at the University of Porto) (EIB, 2016; BURGER, 2016; MCILVAINE *et al*., 2015; AZORES2020, 2014; ISLEPACT, 2012; GREEN ISLANDS PROJECT, 2017; EU, 2017; SDEA, 2015; CALADO *et al*., 2010).

Seeing as the actors are numerous, those with similar stakeholder interests have been grouped into one of three groups of: 1) administrators, 2) businesses and 3) consumers. As described earlier, the first group of 'administrators' are those who have a stake in deciding on the drafting, planning and execution of their islands' renewable energy transition. The second group 'businesses' are those who profit from or whose profits are negatively impacted from this change of paradigm, and lastly, the third group 'consumers' are those who consume and pay for energy and are thereby affected by how the energy they need is produced. Together, these stakeholders may collaborate to develop a renewable energy master plan for Pico and allow for a transition to a renewable energy paradigm (ANDREWS, 2014; GUEVARA-STONE, 2014).

With respect to Pico, the groups of administrators, businesses and consumers responsible for the transition have included the following:

1) *Administrators*: Government – the national government of Portugal, the Regional Government of the Azores, the municipal governments of Pico Island (Madalena, São Roque & Lajes) and village governments (17 parish governments (freguesias) of Pico); The European Union (EU) and its partner organisations (for example, the Islepact project) (international level); The United Nations Educational, Scientific and Cultural Organization (UNESCO); policy makers (planners, developers, technicians, engineers, professionals); Electricity of the Azores (EDA), research institutes (for example, FCT Fundação para uma Ciência e Tecnologia); local residents; and universities;

2) *Businesses*: Fossil fuel companies (including gas vendors); automobile and ferry boat manufacturers (for example, Renault-Nissan alliance); renewable energy companies (manufactures and vendors); local utilities with their electricity generation plants and their shareholders (EDA local utility company with thermoelectric and wind power plants); tradesmen; local businesses; and financial institutions and grant donors (for example, the European Investment Bank – EIB);

3) *Consumers* - Local residents (including farmers and seasonal residents); local businesses; tourists; island factories (industry); cooperatives (for example, CVIP wine cooperative), and government entities that consume energy on the island.

In summary, this section has revealed the stakeholders involved in the energy transition of Pico Island. These have been organised into groupings: 1) administrators, 2) businesses and 3) consumers. How these various groups interact and are interlinked is discussed in the next section.

4.10. LINKS: ADMINISTRATORS, BUSINESSES AND CONSUMERS (TRIANGLE ANALYSIS)

In the preceding section the identity of the stakeholders involved in the energy transition on Pico were identified. These stakeholders were then grouped into the three groupings of: 1) administrators, 2) businesses and 3) consumers. The linkages between these groups of stakeholders are now demonstrated in this section visually via a triangle analysis.

As noted in part 2, the linkages between the three groups of stakeholders include interactions which flow both to and from each group. Together, these actors may collectively lead to the development of renewable energy systems on Pico Island. These interactions are be summarised in a triangle analysis (see figure 29). These stakeholders sometimes act unidirectionally or mulitdirectionally with stakeholders in other groups, as some stakeholders have interests in more than just one group.

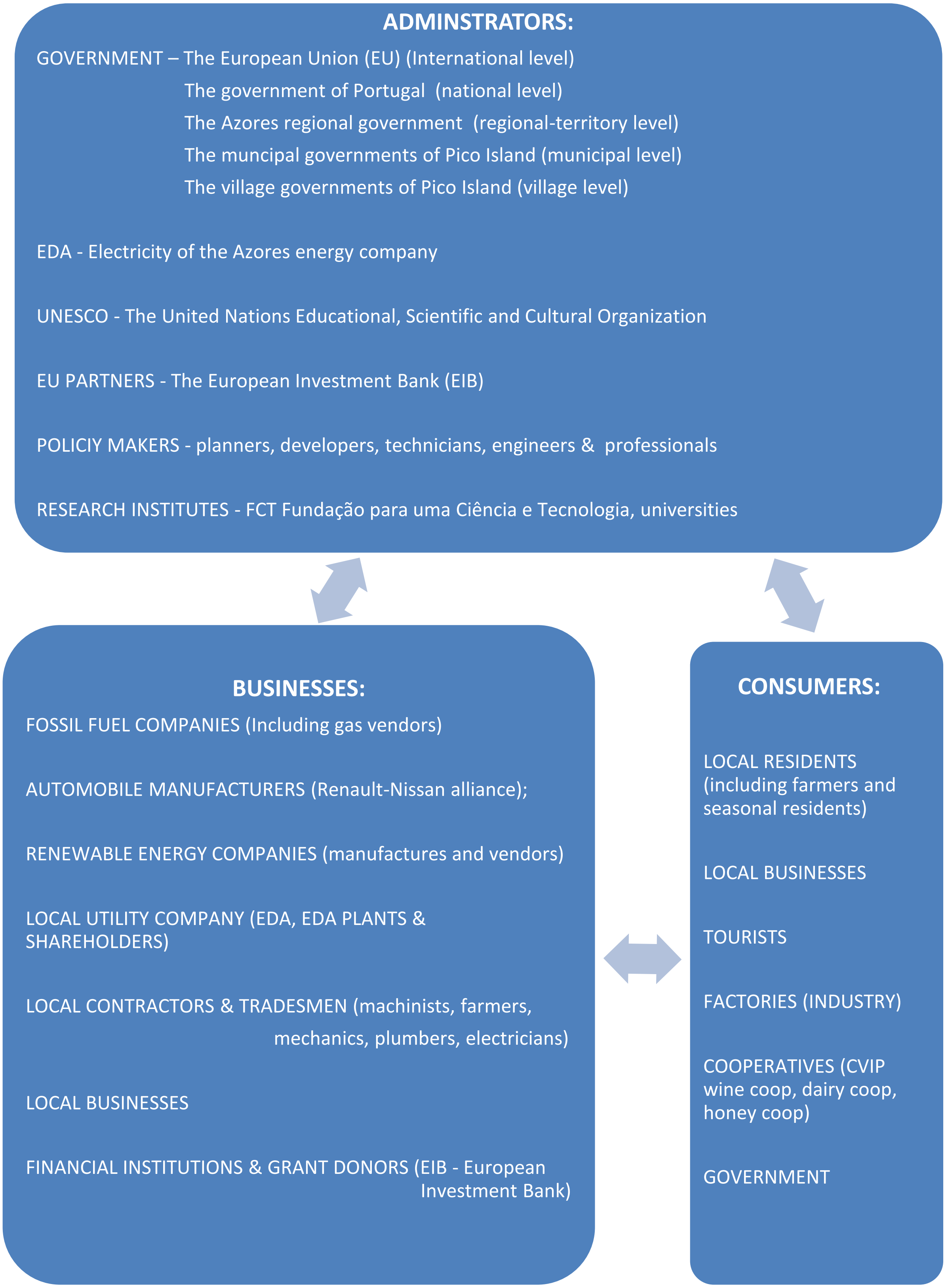

Fig. 29 - Triangle analysis displaying the multidirectional links between the three groups of stakeholders that are involved in an energy transition from fossil fuels to renewable energy on Pico Island

Now that the stakeholders involved in an energy transition on Pico have been outlined in a triangle analysis, Pico's characteristics may be outlined in table 5 below and may be compared to table 3 in part 2 (2.10).

Table 6 – Summary of the characteristics of Pico Island and its respective energy system

Characteristics:	**ISLAND OF PICO**
Location	-Mid North Atlantic Ocean (38° N, 28° W) -Island of the Azores Archipelago -Part of the Macaronesia chain of islands 1,430 km West of Portugal -3,900 km East of North America
Area	447 km^2
Population	approximately 14,108 people
Pop. Density	~ 32 people per square kilometre
Climate	Subtropical
Topography	-Mountainous (Maximum altitude of 2,351 metres) -Coastal cliffs -Stark volcanic landscapes, lava rocks -Seabed volcanic and active, steep, deep
Municipalities	-3 municipalities, several small villages
Landscape	-987 hectare UNESCO "Landscape of the Pico Island Vineyard Culture" protected site -Farmland with protected forest lands, rural
Political status	-Part of Portugal -Autonomous region -EU Outermost Region (OMR)
Energy System	-Isolated -Cannot connect to continent, neighbours
Economy	Agriculture, fishing and tourism
Transformation	-Past: imported fossil fuels to produce 100% of energy via a diesel-fired plant -Now: import fossil fuels to produce 80-85% of energy at diesel-fired plant; 15- 20% wind
Role of citizen involvement	-?
Who had initiative?	-Shift started by utility company EDA -Choose to develop away from fossil fuels to save money via technology on islands where it is deemed to be most cost effective to do so
Time needed	?
Actors	Many (see figure 29)

4.11. COMPARISON OF THE DIFFERENCES IN THE TRANSITIONS AND MODELS OF THE ISLANDS OF EL HIERRO, SAMSO AND PICO

Moving on from having considered the stakeholders involved in Pico's transition and the characteristics Pico possesses, here a brief examination of the differences between Pico and Islands of El Hierro and Samso has been carried. This has been done to see what the similarities and differences are between them. The major points have been summarised in table 7 below.

Table 7 – Differences between the island energy transitions of El Hierro, Samso and Pico

El Hierro	Samso	Pico
-In isolation with no link to another island or mainland electricity grid -Reverse Hydro-Wind Pump energy system with Thermoelectric backup -Sustainable development plan -Master plan: 100% Renewable Energy Project -Green Entrepreneur driven -Bottom-up mobilisation -Citizen involvement	-Connected to mainland grid -Heating needs due to cold northern climate -Wind turbine energy system with district heating plants for heat energy -Master Plan: Renewable Energy Island Project -Green Entrepreneur driven -Bottom-up mobilisation -Citizen involvement	-In isolation with no link to another island or mainland electricity grid -No master plan -No grassroots citizen initiated plan/project -No commitment to shift to 100% renewables -No timeline for shift -Top down initiative from utility company EDA and governments (EU to local) -No green entrepreneur driver -No citizen involvement

Through an examination of table 7 above, it is possible to compare and recognize that differences exist between the three energy transitions of the islands of El Hierro, Samso and Pico. First, both El Hierro and Pico are far and isolated from any other electricity grid or island, while Samso is connected to a mainland electricity grid due to its close location to one. Because of this, Pico may opt to adopt a reverse flow hydro-wind pumped storage system like the one that already exists on El Hierro. It may also maintain its central thermoelectric plant as backup in the event that hydro energy runs out before the wind can recharge it.

Furthermore, Samso, being more north and colder, has needed to address its home heating needs. This is something it has done through 4 district heating (straw bale and biomass) plants that are supplied by local farmers. This is different than on El Hierro or Pico as neither has or will need to address centrally supplied heating for their populations.

In addition, the drivers of the shifts on the respective islands have been different. This is as a green energy entrepreneur and champion initiated the shifts on both El Hierro and Samso. On El Hierro, the shift was initiated by the island president, who created and implemented a sustainable energy plan through the island government and by consulting Islanders. On Samso, a local teacher drafted and submitted an energy plan to a national government competition and then gained the support of local residents (through lobbying, educating and forming energy cooperatives) to have the Island designated “Denmark’s Renewable Energy Island”. With residents driving the change, they were able to pressure the government of the island to commit to the shift and make the island renewable energy powered.

On Pico, however, no green entrepreneur or champion has emerged to successfully push for and create a 100% renewable energy plan/project for the Island. With the exception of the environmental engineer of the municipality of São Roque do Pico, who has pushed for increased energy efficiency measures in the town such as LED lighting and smart grids, only the engineer of the municipality Lajes do Pico has proposed a project which could increase renewable energy on Pico. This is the proposal for a gravity fed water pipeline running from the Lagoa de Paul down to the town below. With EDA, a hydroelectric turbine may be placed in the mid-section of this pipeline to also generate electricity while the water is being piped down for drinking water. This is a far cry from El Hierro, however, where a lower artificial lagoon was created and hooked up to wind turbines to allow a second reverse flow pipeline to pump water back up to the lagoon so as to act as a battery and energy back up for times of no, low, or very strong wind. On Pico, no proposal has been put forth for a similar system to that which exists on El Hierro. This is despite the fact that the island possesses the conditions to support such a system.

To date, the shift on Pico has remained top down, being driven primarily by EDA as part of their large vision of saving money and reducing their costs of fossil fuel imports. While claiming to have a global plan for the Azores, they admit no plan exists for Pico itself. In fact, it has been suggested that Pico is not being considered in the near future for any significant renewable energy projects, as other islands in the Archipelago have been deemed more cost effective to convert first. In combination with EDA, the various levels of government have supported top down implementation of renewable energy on Pico, as the Euro2020, Portugal2020, and Azores2020 plans have all supported experimental renewable energy projects on the island and have provided funding for them. Examples include the Cachorro experimental wave energy plant and the Terras Do Canto wind park on Pico (EURO2020, 2000; PORTUGAL 2020, 2011; AZORES 2020, 2014).

Lastly, no master plan or renewable energy project has been drafted for Pico specifically. While renewable energy makes up part of the Azores2020 project goals, no government plan or project to transition Pico to 100% renewable power (and thus to a renewable energy paradigm that is fossil fuel free) exists (EURO2020, 2000; PORTUGAL 2020, 2011; AZORES 2020, 2014). Other projects, such as the "Green Islands Project", being driven by MIT Portugal and other partners (EDA, EDP, EFACEC, GALP energia, Martifer group, SGC energia, and the University of Porto) have aimed to make the Azores Islands a living laboratory to test new renewable energy solutions and reduce fossil fuel independence, mitigate greenhouse gas emissions and create jobs and engineering possibilities. The result is their proposed "Azores Green Islands 2018", where guidelines such as 75% renewable electricity production have been set, but again, however, no specific plan for Pico has been drafted by this project. To date, the Island of Flores and the Island of Graciosa have been focused upon. Also, the engineering company Younicos, based out of Germany, has also committed to experimenting with solar – wind battery connected farms on Graciosa, but has no plans to do the same on Pico (DA SILVA, in MARIN *et al.*, 2005; GREEN ISLANDS PROJECT, 2017, SNIECKUS, 2010, EDA, 2017).

In conclusion, all three islands compared in this study have different energy systems and have approached their energy transitions in different ways. That is, different models and different drivers have carried these transitions through. Pico, possessing more in common with El Hierro then with Samso (that is, not connected to mainland electricity grid and possesses similar geography), could try to follow the change model that was adapted by them. This would require a drive from the grassroots citizen-led island level campaign, the opposite of the top down approach that has implemented some renewable energy on the island so far.

In summary, this section outlined the stakeholders of the energy transition on Pico. Also, the links that exist between them were shown. Lastly, a comparison of Pico Island to the Islands of El Hierro and Samso was presented. This was done in order to show the similarities and differences that exist between the islands. It remains to be seen if Pico Island may imitate the models of the other islands or if it must develop its own for a renewable energy transition. This is something that requires further study. Next, the results from the 10 face-to-face interviews and the 120 questionnaires that were conducted on Pico are presented in part 5.

PART V │RESULTS

5. CASE STUDY RESULTS

5.1. QUALITATIVE STAKEHOLDER INTERVIEW RESULTS

In this section a brief summary of some of the responses from the 10 face-to-face qualitative interviews and the 120 questionnaires that were conducted on Pico Island are examined.

Starting with the face-to-face interviews, some of the responses to each question on renewable energy are presented next. These responses include those from three groups of stakeholders that were interviewed: administrators, businesses and consumers (see methodology). These included: 1 - Director of the wine cooperative CVIP - Consumer; 2 – Director of Resiacores recycling plant - Business/Consumer; 3 – President of Madalena Municipality - Administrator; 4 – Manager of Hotel Caravelas - Consumer; 5 – Manager of Agricultural and Environmental Development - Administrator; 6 – Regional director of the Environment Department and Natural Parks – Administrator; 7 – Director of the honey cooperative Flor de Incenso – Consumer; 8 – Forestry Service manager & viticulture program manager – Administrator; 9 – Chief Engineer of the Electricidade dos Acores EDA thermoelectric Plant – Business; 10 – São Roque municipality environmental engineer – Administrator.

Below, as well as throughout this section, the response of each participant is indicated by the number before the response. For example "1)" indicates a response from interviewee 1. Fourteen questions were asked to each of the participants in the interviews (see annex I). The responses to these questions are presented below.

Starting with question 1"What comes to your mind when renewable energy is mentioned? *(O que vem à sua mente quando se menciona a energia renovável?)*" responses included the following: Respondent number 1) Modern, environmentally friendly, calm; 2) Do not have combustible sources which are not reusable - wind, solar, hydroelectric, waves; 3) improves our quality of life, takes advantage of what nature has to offer (wind, sea), are more environmentally friendly, important for environment and ecosystem; 4) Energy sources that do not harm the environment much, are neither oils nor gas; 5) Clean energy sources without any costs/impacts to the environment; 6) Do not originate from fossil fuels, use does not imply the destruction of resources at our scale; 7) energy government should invest more in and worry about, as one day there will be no more non-renewable energy to use; 8) Energy that is not an exhaustible resource, it is renewed automatically; 9) Contribute to mitigating global warming, use means less money is exported from the country; 10) Endless source of energy, doesn't negatively impact the environment, a clean energy.

Next, responses to question number 2 "Do you think the current way of producing energy for Pico is good or bad? Why? (*Você acha que a maneira atual de produzir energia para o Pico é boa ou ruim? Por quê?*)" included: 1. *Fossil Fuels* - 1) 80% produced using diesel - the worst thing that we have available; 2) Pico's large fault is producing energy through fossil fuels, guarantee a constant energy supply; 5) Pico's energy from fossil fuels to power generators, this is not ideal; 6) Current form is not ideal, very high percentage of energy from burning fossil fuels – are costly and polluting, must not be dependent on these; 8) a great error that most of it is produced from diesel fuel - an exhaustible energy that is very environmentally polluting; 10) biggest source of energy is thermoelectric powered by fossil fuel resources;

2. *Wind Energy* – 2) Part of Pico's energy is from the wind. Increasing this is difficult because it requires batteries and the thermal plant cannot just turn off and stop when there is wind, thus, the connection between the two energies must be improved to guarantee can serve the Island's needs; 3) already exists; 5) We have some wind power – turbines; 7) is completely underexploited as we have loads of wind almost all the time, we should have more; 8) we already have it on Pico and it has great potential; 10) EDA places wind energy in the distribution network, more can be explored as island has a lot of wind - potential to grow a lot.

3. *Wave Energy* – 2) Wave plant served only as a test plant to show we can have some result; 3) plant did not run so well and should have been better taken advantage of; 4) is a better form of energy we could take advantage of as has not been developed as it could be; 7) completely underexploited; 8) pity plant is not working because we could take advantage of the waves given our location and the characteristics of our island.

4) *Solar Energy* – 2) it may be integrated into the system; 4) we could have it although we have little sun; 10) we have some sun although not a high sunshine index, we could better use solar energy.

5) Geothermal – 10) because Island is isolated it can't be connected to other Islands which have it already;

6) *Renewable Energy* – 1) we have to illuminate image of Pico its nature and good environment; 2) Renewable energies are uncertain, an island cannot source from the outside to overcome this uncertainty; 3) Only option for Pico is to find a series of renewable energy alternatives; 4) We could take advantage of these; 5) there could be a larger slice of it on Pico, gradually increasing, moving in this direction; 6) Share has been increasing in recent years, should increase to at least half of what we need as we can produce more renewable energy here; 7) Energy is good only because it is necessary; 9) Pico's isolated electrical system can be improved if equipped with energy storage technology. The capital available for investment is applied on a regional basis and not just on a given island; 10) Pico should be able to produce more. Incentives are needed, home equipment needs to be more energy efficient to see a greater adoption of these by the population.

Also, responses to question number 3 varied. Question 3 "Are you open to a paradigm shift in energy production via the implementation of renewable energy on Pico? (*Você está aberto para uma mudança de paradigma na produção de energia, a partir da implementação de energia renovável para no Pico?*)" was answered with the responses that follow:

1) We have these; 2) Yes, it only makes sense. Solar panels could give energy but are very high investments that require subsidies to be adopted. Elderly resistant, but get more behind it when you talk about it; 3) Yes, absolutely. I am perfectly open and available, as a citizen or the mayor, to do everything possible to put into practice this process of transitioning to renewable energies; 4) Yes, I am in favour of renewable energies, we have already adopted solar hot water heating here in the hotel, which saves us a lot of money as was almost 50% of the expenses we had; 5) Completely, the Azores have the natural conditions that can allow for good results, everyone is open and willing to adapt to implement renewable energy on Pico; 6) Yes, it makes perfect sense to change that paradigm; 7) Yes, open I am, depends on investment. People have to understand expensive investments pay off over the long run, but I'm lazy to apply this technology at home; 8) Yes, any change to preserve our environment - to guarantee leaving a better world for our children, whether it be via the implementation of renewable energy on Pico or any other part of the world, I think it is a project that must be embraced; 9) Yes; 10) Yes, I am completely open to this - at home, if an investment fits within the family budget, and at the municipality, already implemented urban lighting project to reduce consumption, expansion requires a link between entities such as EDA and PT.

Again, responses to question 4 of the interviews varied in length and content. The question "Are you aware of what are the future plans / energy strategies for the Island? For example, is there a political energy strategy? *(Você está ciente de quais são os planos futuros / Estratégias Energéticas para a Ilha?* e.g., existe uma estratégia de energia política?)" yielded the following responses: 1) I have never seen plans to use the wind, the sun, waste to produce energy. I just know of the wave plant that was very expensive, closed and which they plan to reopen one day; 2) I have no knowledge, I do not know, I do not have any idea; 3) We do not have one, I have not seen a global one for the Azores, there is no strategy; 4) I do not know what is programmed for our island - joint renewable energy for example; 5) I have no official knowledge of what the authorities have envisaged. I imagine it is to increase production of renewable energies; 6) I don't know one. All I know is we have wind power, wave power - a pilot project that failed and was abandoned, and now proposal for hydro power from a lagoon - would significantly increase the amount of renewable energy on Pico; 7) I do not think there is a strategy. In elections all candidates talk about renewable energies and the wave plant and propose investment in it - but later talk dies down after elections...it dies there; 8) I have no idea what the plans or energy strategies are for the island or what strategies are being outlined in political terms. I know that all governments tend to use non-polluting energies; 9) Given my position, I have information of these plans. There is a strategy at the level of the Azores but unfortunately not one for Pico; 10) I am not aware of a political strategy in this area. Wind energy will increase significantly, because the wind is here, there is already investment by the electricity company in it, so it is only necessary to replicate what has already been done, as this is easier than implementing a new one.

As well as the previous questions, question 5 had many responses. Question 5. "Do you have a power plan (for example, in your county)? What are your future energy plans? (*5. Você tem um plano de energia (e.g. em seu concelho) - quais são os seus futuros planos energéticos*)?" responses included: 1) We do not have a plan; 2) There is not one here - an energy plan / We have some equipment connected all day, therefore it is difficult to reduce energy consumption. Also, people work at night until midnight; 3) I do not have one, nor have I seen a strategy from the regional government of the Azores (institution responsible for this matter) - an energy policy for Pico or a global strategy for the Azores, …it does not exist, / If I had such an energy plan I would like it to allow us to plan, for example, a retrofit our lighting to decrease consumption; 4)

Yes, we have solar hot water heating, but no budget now for electricity generating solar panels; 5) Not that I have knowledge of, doesn't exist, thus, nothing definite. Maybe eventually; 6) Um ...not sure. Here we have done some small actions in order to reduce consumption - substitute for materials we spend on - turn off the computers when leave, monitor monthly energy use; are replacing all the bulbs with LED bulbs to consume less; 7) I have no idea ... I suppose at the municipal level - legally must exist but they will say people can consult it if they want, but they won`t expose it or speak of it. I doubt that anyone who is not an employee of EDA or a city councillor has even the slightest notion that this exists; 8) Not sure. I think there would have to be out there a plan in terms of the future; 9) There is a strategy at the level of the Azores and not only for Pico; 10) We have a municipal plan in Sao Roque. Following our pilot public lighting project, plan is to gradually remove old and go to new LEDs with remote management. In addition, we have a strategy to save energy in the water supply by using new more efficient water pumps. In this way, we are indirectly in line with the renewable energy transition.

Besides the previous questions, question 6 had many responses. Question 6 "Does Pico have adequate environmental conditions to support / produce renewable energy? (*O Pico possui condições ambientais adequadas para apoiar / produzir energia renovável?*)", yielded the varying responses: 1) Yes, all energy production can be from the sea, sun, wind, geothermal; 2) Yes, I think so - we have a lot of wind, waves, also, we have sun, probably have enough here; 3) I believe that yes, be it the energy of the waves, or the wind, also other options - solar panels; 4) I believe that yes, water heating can be done via solar energy, we have that experience and it works! Values are still high, return does not compensate for investment we are going to make; 5) Yes, I think Pico has the conditions for that. At least in the part of wind energy have enough conditions for this, and wave energy is there, has potential although it has not produced; 6) Yes, between wind, water and solar there are conditions to explore these on the island. Geothermal potential as well, but not very viable because of low population (Pico/neighbours); 7) Of course, I think with the wind, waves and sun this should be taken advantage of; 8) Yes, Pico has the right environmental conditions to support and produce renewable energy. The wind, the waves - good orography and sea location so we can produce this type of energy; 9) There is already a wind power component of renewable energy production; 10) I think that in terms of wind energy we have a great potential to produce energy. Also, the municipality of Lajes do Pico intends to launch a mini-hydro, a very interesting prospect.

Coupled with the previous questions, question 7 “Does Pico Island have all the capital needed to control and allow this change to happen? (A ilha do Pico tem todo o capital necessário para controlar e permitir que essa mudança aconteça?)” had many responses. These included: 1) Depends, there are many subsidies from governments - regional government. No candidate understands and knows renewable energy and none wants to; 2) Capital, in terms of money, that level of money I think does not exist. A very high initial investment is required for many batteries and very expensive energy innovation systems; 3) Pico does not have it. At the municipal budgets we all talk a lot about renewable energies, but when time to put it into practice are no connections/links in place for this to happen, therefore paradigm change can only happen if there is a radical change in the politics of the regional government as only they can change this, the islands will follow, right now I cannot see that this change can/will happen; 4) Yes, money - the region needs to support this investment… it is a big investment in the beginning but then later it ends up being compensated for; 5) Almost guaranteed no, it does not have it, because it is a way of production that is expensive as these are recent technologies and Pico does not have the capital to implement a production method from one day to the next; 6) Everything depends on the entities that invest in these types of energies. The public energy strategy is defined by the government of the Azores together with EDA, it is not decided at the political level of Pico, it always depends on capital and authorizations outside the island; 7) If there is political will we can have the capital. We can get financial investment via subsidies of the EU as they exist for this and value renewable energy and environmental protection. But, the politicians go to get subsidies for farmers who vote and not for renewable energy; 8) Pico cannot think in isolation. The strategy should be at the regional level, adapting the most appropriate measures for the characteristics of each island. It will always be a strategy fixed at the regional level - because if we think in isolation there is no chance to make this change; 9) It has the human capital, but may lack financial capital or political will at the local level; 10) In financial terms, it would have to be a regional government big investment shared by community funds to ensure that they are sustainable and benefit the population and the environment. The municipalities have some funds to invest and the new operational plan, PO2020, has enough funds and has priorities in this area of renewable energy to help out.

Furthermore, question 8 “Is your Government / Administration / Department / Ministry ready for this change? (*O seu Governo / Administração / Departamento / Ministério está pronto* *para esta mudança?*)" had many responses. These included: 1) Yes, if an idea, offer comes along, we are not going to say no. In our warehouse we use 80% of our energy within the 4 weeks of grape harvest. Also, every year we have to apply ever more solvent. A great problem for us is to make a warehouse energy image of making and selling energy; 2) Since we are new, renewable energy investment is not possible right now because we already have very high investments. Also, the facility belongs to the regional government, we only operate it, therefore, we cannot make changes to a space that is not ours; 3) I am ready to make this change. I do not know if the other governments are as they have the signs but not the links in place to make this happen. I am open to bridge politics, culture, social views and economics to make this change when others can; 4) Inside our company we have seen a return on investment on the changes we have made; 5) We are not prepared for this. Our office has no way of producing or self-sustaining ourselves energetically as we receive outside energy, whether it is renewable or not; 6) Yes, there is a desire here for a change in that direction, yes. We here are a peripheral service - a branch of the regional department of the environment. In general, the government of the Azores is interested in increasingly investing in renewable energies; 7) No matter how much they say yes, no matter how much they talk about it in electoral campaigns, they are just interested in votes. They are just not ready, it's not because there are not conditions, it is because they do not want to give themselves the job of investing around; 8) We are. We are in the mood for this change. There has to be political will and a definition of a clear and objective strategy; My Pico forestry service department is not very focused on the energy part, but it is focused on the environmental preservation part and the rules for that preservation to happen; 9) Not only are we ready, but we (EDA) have been the main driver of this change; 10) We are ready and we are sensitive and attentive to these issues. For example, our investment on Avenida do Mar and Jardim Municipal, although very small and a prototype, shows this.

In addition, question 9 "Who do you think has a major/important role in switching to renewable energy on Pico? (*Quem você acha que possui um papel preponderante/importante na mudança para energias renováveis no Pico?*)" had varying responses. These included: 1) It must be EDA, they sell electricity. I have no idea about the regional governments plan, investments, subsidies and distribution strategy; 2) Entities, such as governments, municipalities, parish boards, institutions, elites, and person-by-person, the people ... that is, us all; 3) Regional Government of the Azores; 4) Regional Government of the Azores as although private individuals or companies have to make this investment, the regional government must be the main one; 5) On Pico, like in other less developed places, there must be a great responsibility on the part of the government administration. There is no such thing as a business 'decision' that can lead the process; 6) It will be a mixture between the municipal governments, the government of the Azores and companies/business world (of the Azores or outside companies interested in investing). Also, the scientific world, universities, can have experiments/pilots here of new technologies that are appearing; 7) First, it's the politicians, and second, it's companies... EDA, is the company responsible for interest in renewable energy, and providing these services and they want to make money. If there is political will, there is pressure on the company that provides electric power; 8) I think it's really the politicians who have the decision, it's the government. They are the ones who have to take the decision to adopt the strategies at that level; 9) The Regional Government (through EDA), local authorities and private investors; 10) The regional government, local authorities, non-profit institutions, and technicians. The Regional government and city councillors have a duty to inform that renewable energy exists, what can be done, what the benefits are, how much it costs and the strategies to be followed in this area.

Likewise, question 10 had numerous responses. Question 10 "Who will drive this change to renewable energy on Pico? (*Quem vai impulsionar esta mudança para energias renováveis no Pico?*)" had the following responses: 1) It must be an institute or company with knowledge and an idea that can define what the network should be and the evolution path of producing energy, of adding or not; 2) EU via subsidies - external aid because at the local level the people and government do not have the money to invest in a change to renewable energy installations; 3) The regional government of the Azores and us -municipalities - could do a few things more; 4) It needs to be everyone because this pointing the finger at the details - belongs to the companies, everyone has to do a reinforcement for this; 5) Electricity company - EDA, management of the government. It will have to pass through them always, to have assembly; 6) It will have to be a strategy of the Regional Government; 7) The younger people because I think they're so much more (aware of this)... maybe because they're told this is important. Also, immigrants, live here and come from outside with a different consciousness (awareness), because locals don't even want to know about this; 8) It will always go through the regional government, it is them who determines, because we do not have private groups, private companies, that are installed and that may eventually make this type of decision; 9) it would probably continue to be EDA alone or in partnership with public or private entities and also some private investor(s), Given the economies of scale of an island with the size and population of Pico; 10) The regional government with others. In the case of individuals, there must be co-financing of investments as people do not have the capacity to invest in these technologies.

Likewise, question 11 “Is everyone aware of this change? (*Todos estão conscientes dessa mudança?*)” had the following responses: 1) No. 10% of the residents maybe mind/care about renewable things; 2) No. There are not many people who think this is a joke and do not think about the potential that truly exists, a lot of people are not minimally pointed in that direction; 3) I do not know, I am not sure; 4) Yes; 5) I hope so, I expect the younger generations, at least they already come with other mentalities and other environmental consciousness’s; 6) No, not all of them. It is something that more and more people are becoming aware of. With the elderly populations this message is hard to come by; 7) I think very few people are aware that we have to change and even fewer people are willing to change; 8) Yes, more and more people are worried about the environment, are worried about how we are going to leave (things for) our children. I think everyone is united in this change and I think that on the day that there are decisions in this sense, I think that all we're going to hug; 9) I believe that there is still a need for a deeper and broader debate on the multiple implications of this change, including the enabling role of partnerships between public and private bodies; 10) No, unfortunately I think very few people are aware of this need for change. There is little awareness; municipalities also have their role and responsibility in this area.

Likewise, question 12 “What difficulties or resistances will this change encounter? *(Quais as dificuldades ou resistências que esta mudança irá encontrar?*)” had the following responses: 1) There is no consciousness, a lack of education, a lack of money, poverty and utilities are too cheap and subsidized; 2) First is a lack of capital to invest, second is technologies/solutions that produce too little, third is resistance from people as the technologies are inferior to fossil fuels and need to demonstrate their efficiency and worth; 3) Issue of trying to change one of the most inverted populations that we know, resistance from the older generation - some understand idea, others need to be sensitized to the issue. I do not see much resistance to this change; 4) Biggest difficulty will be the investment that needs to be made in the beginning, then devolving this information by word of mouth of the people as what the people say is the best devolver of this; 5) It will be above all on the economic level - raising the cost of production and investing in creating the conditions to be able to produce; 6) The big problem is economics, as long as it becomes economically attractive this change can surpass the economic issues as sooner or later this shift in paradigm will happen for it is inevitable; 7) First is supply - those who are not interested in the change do not care to see it happen; EDA staff will delay change as won`t be able to change the equipment (change poles, change wires, and so on). Second, is the people themselves, as it can be more expensive people will have some resistance. Thirdly, it's political - the relationship between politics and the corporate lobby of EDA which has a monopoly ...between the two there's going to be serious resistance; 8) Initial cost - costly to implement and to secure financing. Less of a problem is resistance by the people caused by their mentality; 9) Eventually some resistance from environmental organizations will result. Also, there is also a need to form partnerships between various entities, for example, for applications for EU funding of projects in this area; 10) In global terms, the greatest resistance will be around oil - oil owners have a lot of weight and pull in the world, it is not in the interest of renewable energy to overlap with oil interests; In the Islands the financial issue will be the biggest barrier because interested people when they hear about prices, they have other priorities. Geothermal will be the financial issue.

Likewise, question 13 “How do you think a shift from fossil fuels towards renewable energy will affect/impact the Pico landscape? *(Como você acha que uma mudança no uso de combustível fóssil para as energias renováveis, afetará/impactará a paisagem do Pico?*)” had the following responses: 1) The image of Pico will be much better than it already is and this will contribute to tourism growth. Pico´s image can be half associated with nature, environment, mountain, other things, and half with renewable energy production. Tourists will like this idea – renewable energy production is a great and friendly promo, and a great thing of image production; 2) The thermal power plant probably has small impact both on the environment and visually as its waste materials are few and its emissions are dispersed into the air/environment, so people do not end up seeing this directly at the factory. A wind park or a large solar park, however, is going to have a large visual impact for the population, but can conciliate everything, for it's not going to have a big impact; 3) We always end up having an environmental impact that is significant (even if trying to minimise it), and for the landscape it is obvious there will be some positive aspects; 4) Creation of a size/dimension that does not affect the landscape would be ideal, clearly it will always do so, but this always has to have some study associated with it so that it does not affect the landscape; 5) Decreasing the use of fossil fuels can have a positive effect on the landscape even though its impact is not very noticeable as its by-products do not result in any kind of shock; 6) There will surely be a landscape impact with this paradigm shift. Wind power changed the landscape as it required putting up wind towers, electric cables, cutting vegetation, all had a visual impact. The proposed lagoon project will require impermeating a lagoon - a landscape and ecological impact associated with it. We only have a clean landscape without any human construction. What we have to do... when making such a decision we always have to balance and weigh the pros and cons, and the benefits we will have as to 'decrease' environmental pollution, landscape impact, but the benefits that come from it may be greater than this landscape impact we have; 7) It's obvious that it will always affect the landscape, but usually EU rules exist for ensuring the impact is small. The biggest concern should not be the alteration of the landscape but the exhaustion of what exists; 8) Pico and everyone would benefit from this shift as the landscape on Pico just has to win; 9) The impact may not be excessive if appropriate measures are taken; 10) Fossil fuel use has a cumulative impact over the years. Shifting to renewables means we stop polluting the atmosphere and we have a better environment - a direct relationship, so to speak.

Likewise, question 14 “How do you think the landscape will affect this change? For example, the selected energy types? (*Como você acha que a paisagem afetará esta mudança? por exemplo, os tipos de energia selecionados?*)” had the following responses: 1) People want to protect the visual aspect of the landscape, will not like the wind turbines or solar panels. Geothermal, I do not know; 2) Can only install things where they can be profitable - a wind park in a windy zone, a solar panel park near the coast where there is a high insolation index, therefore the landscape will be affected in this sense; 3) Landscape will affect types of energy selected to be used, we can see what kind of energy we are going to use where, then we see the impact it creates - collective impact. We cannot mount solar panels in the historic center for example as this would change it, landscape itself affects location of renewable energies; 4) Affects what are the types of energy. Wind energy already exists and doesn`t affect the environment-landscape. Wave energy has practically no impact. Solar panels can be located on buildings (only certain ones in protected zones) and in largely habituated parts because they do not have a large effect on the landscape; 5) The equipment itself, such as wind turbines, affect the landscape. Solar panels are sometimes found in smaller productions like on houses and have a negative impact on a different landscape (man-made landscape); 6) I do not think the landscape affects the types of renewable energy selected... because when we are talking about wind, the landscape adapts does it not?... I do not see how the environment will have an impact on energy! If we move on to this type of energy, whether wind or water, a construction on the ground or a wind tower increase or artificializing the landscape will inevitably impact the landscape; 7) I do not know, it's a thing that a person does not even imagine ... if people use 3 or 4 turbines on the high plains of the Island to generate energy from the wind above, will it greatly change the island and affect many kilometers of land?; 8) Pico´s landscape still has the potential to produce/contribute a lot more renewable energy. Example, firewood harvested from the recovery of the abandoned vineyards program can be connected to the project of a pellet factory in Santa Luzia; 9) the current technologies and types of energy that can be implemented on Pico will not be overly conditioned by the landscape unless the impact of these projects on protected areas or biosphere reserves is considered to be excessive; 10) We live on islands that are limited in terms of land spaces, renewable energies imply the use of large areas of land, significant areas for their installation. Therefore, landscape affects renewable energies, and they are not negative but do have a significant impact on the landscape.

5.2. QUANTITATIVE SURVEY QUESTIONNAIRE RESULTS

Next, responses from the 20 questions of 120 questionnaires that were conducted on Pico Island are presented here. Questionnaires were administered and information collected from the 17th of April up until the 9th of May. These questionnaires provide information which allows for quantitative analysis for this study (see annex II).

Starting with the profile of those who filed out the questionnaires, their ages ranged from 13 to 66 years of age, with the median age being 32 years of age, and the average age being 35 years of age. The gender with which the participants identified was male – 48 (40%) and female - 72 (60%), therefore there is not a full gender balance in the responses. The nationality of the participants was mostly that of Portuguese (111), followed by Italian (2), Canadian (2), Cabo Verdean (1), French (1), German (1), United States (1), and with dual Portuguese - Canadian nationality (1). The maximum level of education possessed by the respondents included:

elementary school (3), high school (58), undergraduate university (21), masters (0), doctorate (0), post-doctorate (0). Those that did not respond to this question totalled 35 participants.

The work positions held by the respondents included: administrator, administrative technician, aesthetician (2), assistant administrator, assistant operator, baker, bartender/server (6), boss, businessman, businesswoman, business consultant, cashier (6), civil construction worker, civil servant, cook, coordinator of delegation, commercial clerk, commercial assistant (2), customer service representative, distributor (3), doctor, firefighter, front desk clerk (4), hairdresser/barber, housekeeper (2), home helper, individual business manager, intern, journalist, librarian (2), manager (4), managing partner (4), merchant, museum assistant, pharmacy assistant, physiotherapist, salesman, police officer (4), publishing director, public agent, receptionist (3), retiree (4), skipper (3), student (3), saleswoman (2), salesman (4), senior technician, sales, secretary, store manager, shop assistant (2), technical assistant (2), tourism clerk (2), tour guide, writer - editor – translator, and whale watcher.

Of the 3 municipalities that exist on Pico, those to which the respondent's residence corresponded included: Madalena - 50 (60%), Sao Roque do Pico - 39 (46.8%), Lajes do Pico - 30 (36%), and Horta, Faial - 1 (0.83%). Within these 3 municipalities, 17 of their 17 associated civil parishes are being lived in by the respondents in addition to 1 who lives in Horta, Faial. These included: Horta (1- Faial Island), Bandeiras (3), Candelária (12), Calheta de Nesquim (0), Criação Velha (4), Lajes do Pico (19), Madalena (25), Piedade (3), Prainha (6), Ribeiras (3), Ribeirinha (1), Santa Luzia (1), Santo Amaro (0), Santo António (8), São Caetano (3), São João (5), São Mateus (2), and São Roque do Pico (25).

Now, starting with question number 1 "In your perspective, how is electricity produced on Pico? (*Na sua perspetiva, como é produzida a electricidade no Pico?*)", responses included:
1) I do not know - 22 (18.33%); 2) Wind Energy/Turbines/Mills (lone response) – 11 (9.2%); 3) Fossil Fuels (lone response) – 30 (25%) (Naphtha, Diesel, Combustion, and Thermoelectric); 4) Central Power Plant (lone response) – 13 (10.83%): (not clear if knew how it is produced); 5) Solar Energy (lone response) - 1 (0.83%): (Solar panels); 6) Wave Energy (lone response) – 0 (0%); 7) Thermoelectric and Wind Energy (Actual reality of Pico's production) – 29 (24.16%); 8) Mix of Non-Renewable + Renewable Energies – 10 (8.33%); and 9) Other – 4 (3.3%) (See figure 30 on the next page).

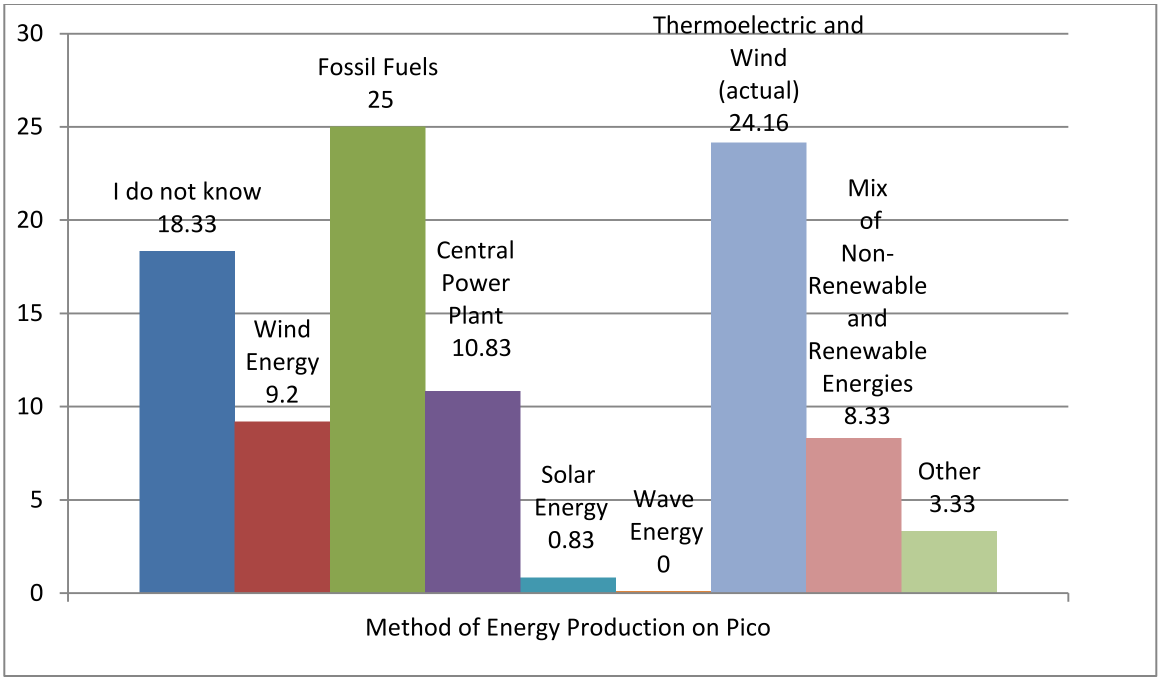

Fig. 30 – Percentages of participant responses to question 1 "how is energy produced on Pico?"

Question number 2 "What is the % of family spending on energy? That is, of all the expenses that it has, what is the % disbursed / spent on energy? (Approximate value) (*Qual a % dos gastos familiares que dedica à energia? Isto é, de todos os gastos que faz, qual a % desembolsada/gasta para a energia? (valor aproximado)*)" yielded the following respones:

For 63 participants (52.5%), the percentage came to 20.53-20.99% (low value of estimates and high value of estimates respectively). This means that energy accounts for approximately between 20.5-21% of their family's monthly expenses. 48 participants (40%) did not respond to this question with a percentage, while 9 participants (7.5%) responded "I don't know". This question was also answered as a monetary value (in Euros) by 57 (47.50%) of the participants and it was calculated that an approximate amount of 85.8-86.7 Euros per month is spent on energy.

Question number 3 "Do you use Gas (natural gas, propane, butane, liquefied petroleum) to heat your water? ☐ Yes ☐ No (*Você usa Gás (Gás natural, propano, butano, gás de petróleo liquefeito) para aquecer a sua água?☐ Sim☐ Não*)" yielded the following results: Yes - 103 (85.8%), and No - 17 (14.2%).

Question number 4 “Are you willing to make some investment to use more renewable energy? ☐ Yes ☐ No (*Está disposto a fazer algum investimento para usar mais energias renováveis? ☐ Sim ☐ Não*)” yielded the following results: Yes - 79 (65.8%), No - 39 (32.5%), and no response – 2 (1.6%).

Question number 5 “What do you do to save energy? (*O que você faz para economizar energia?*)” yielded the following responses: 1) Lighting (Turn off lights when not being used/use natural light/use LED bulbs/decrease light intensity) - 43 (35.8%); 2) Solar (panels for hot water and/or energy) - 5 (4.16%); 3) Water (Save water, reuse water, reduce use and consumption, reduce showers) - 8 (6.66%); 4) Appliances (Turn off, disconnect, use less, use energy efficient ones) - 30 (25%); 5) Selective hour electricity use (utilise local utility company tariff rate plan hours - 15 (12.5%); 6) Laundry (hang the laundry outside to dry) - 1 (0.83%); 7) Transportation (walk or use public transit) - 2 (1.66%); 8) Reduce energy consumption (reduce use, maximize usage, ensure efficiency and savings) - 12 (10%); and 9) Do nothing (are taking no action to save on energy) - 4 (3.33%).

Question number 6 “What is your perception about renewable energy? ☐ Positive ☐ Negative ☐ Neutral (*Qual é a sua percepção sobre a energia renovável? ☐ Positivo ☐ Negativo ☐ Neutro*)” yielded the following responses out of 118 participants who responded to the question: Positive - 110 (91.6%), Negative - 0 (0%), and Neutral - 8 (6.66%).

Question number 7 “Have you implemented any kind of renewable energy? ☐ Yes ☐ No. If so, what type? For example, solar, wind, other? And where? At home? At work? Transportation? (*Você já implementou algum tipo energia renovável? ☐ Sim ☐ Não Se sim, de que tipo? Por exemplo, solar, eólica, outro? E onde? Em casa? No emprego? No transporte?*)”. Answers included: Yes - 25 (20.83%) and No - 95 (79.16%). Of those 25 that answered yes, responses included: Solar - 17 (14.16%), Wind and Solar - 4 (3.33%), Geothermal - 1 (0.83%), heat recovery system - 2 (1.66%) and Heat pump - 1 (0.83%). Also, 16 (13.33%) said they installed these at their home, 1 (0.83%) on a tourist resort and 1 (0.83%) on a mobile property.

Question 8 “Is it important to switch from fossil fuels to renewable sources? ☐ Yes ☐ No ☐ I do not know (*É importante mudar de combustíveis fósseis para fontes renováveis? ☐ Sim ☐ Não ☐ Não sei*)” was responded to in the following way: Yes - 111 (92.5%), No - 1 (0.83 %), and I do not know – 8 (6.67%).

Question 9 “Can renewable energy provide 100% of Pico's electricity? ☐ Yes ☐ No ☐ I do not know (*A energia renovável pode fornecer 100% da eletricidade do Pico? ☐ Sim ☐ Não ☐ Não sei*)” was answered in this way: Yes - 41 (34.16%), No - 20 (16.66%), I do not know – 57 (47.50%) and no response - 2 (1.66%) (see figure 31 below).

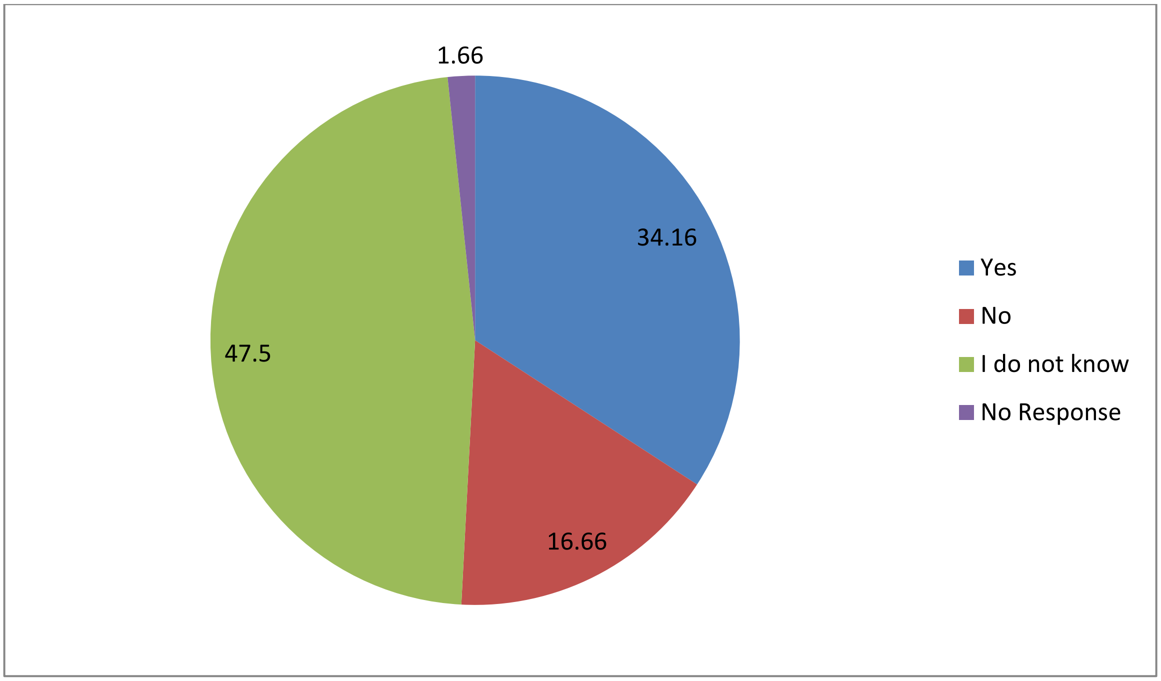

Fig. 31 – Percentages of responses to question 9 “can renewables provide 100% of Pico’s electricity?”

Question 10 “Will a shift to renewable energies lead to conflict at Pico? ☐ Yes ☐ No ☐ I do not know (*Uma mudança para energias renováveis levará a conflitos no Pico? ☐ Sim ☐ Não ☐ Não sei*)” was responded to as follows: Yes - 24 (20%), No – 48 (40%), I do not know - 47 (39.1%) and no response - 1 (0.83%).

Question 11 “Will everyone agree on this transition? ☐ Yes ☐ No ☐ I do not know (*Todos estarão de acordo sobre essa transição? ☐ Sim ☐ Não ☐ Não sei*) had the respondents give these answers: Yes – 15 (12.5%), No – 42 (35%), I do not know - 62 (51.6%), and no response - 1 (0.83%).

Question 12 “Who will benefit most from a shift to renewable energy production? (*Quem se beneficiará mais diante de uma mudança para a produção de energia renovável?*)

was answered as: 1) I do not know - 7 (5.83%); 2) Human Population – 73 (60.83%); 3) The Environment – 37 (30.83%); 4) Consumers – 20 (16.66%); 5) Businesses -Renewable Energy Vendors – 12 (10%); 6) Other beneficiaries – 10 (8.33%): (The Rich (1), The adults (1), the government (1), Farmer (1), market (1), fisherman (1), public health (1), Engineers (1), Teacher of the professional school of Pico (1), The export lobby's such as Oil (1)); and 7) Other responses that are not clear – 2 (1.66%).

Question 13 “Who benefits the least from a shift to renewable energy production? (*Quem se beneficiará menos diante de uma mudança para a produção de energia renovável?*)” was answered with: 1) I do not know – 15 (12.5%); 2) The companies that produce energy/electricity / EDA – 30 (25%); 3) No one – 10 (8.33%); 4) The oil & gas/fossil fuel companies and vendors – 45 (37.5%); 5) The population – 14 (11.66%); and 6) The Economy – 3 (2.50%).

Question 14 “Do you think a change to renewable energy on Pico can benefit you? How? (*Você acha que uma mudança para energia renovável no Pico pode beneficiar você? De que modo?*)” was answered as: 1) Yes – 56 (46.66%); 2) No – 6 (5%); 3) I do not know - 9 (7.5%);
4) Will benefit economically - 59 (49.16%); 5) Will benefit environmentally – 35 (29.16%);
6) Will benefit health -1 (0.83%); and 7) Other - 11 (9.16%).

Question 15 “Do you think a change to renewable energy on Pico can harm you? In what way? (*Você acha que uma mudança para energia renovável no Pico pode prejudicar você? De que forma?*)” gave forth these responses: 1) Yes – 7 (5.83%): Responses to question “In what way” included: Perhaps because it can cost a lot of money to use them, if we only depend on solar panels and there is no sun for a few days, I think that year would be harmful, the lack of competent technicians to solve the problems of equipment, at the financial level probably yes, economical, possibly at the price - increasing; 2) I do not know – 8 (6.66%); and 3) No – 95 (79.16%).

Question 16 “What difficulties or resistances will this change encounter? (*Quais as dificuldades ou resistências que esta mudança irá encontrar?*)”subsequently yielding the following: 1) I do not know - 18 (15%); 2) Cost / Financing / Money availability - 34 (28.33%); 3) Installation-Technical difficulties / maintenance issues / nature-climate challenges – 20 (16.66%); 4) Education / People’s mentality / Culture change – 20 (16.66%); 5) Lack of political/people’s will – 3 (2.5%); 6) Dominant fossil fuel paradigm’s resistance to change - 9 (7.5%); 7) None – 1 (0.83); and 8) Other responses – 7 (5.83%).

Question 17 “Will this change create a positive Pico image? ☐Yes ☐ No ☐ It will stay the same (*Esta mudança vai criar uma imagem positiva do Pico? ☐ Sim ☐ Não ☐ Permanecerá a mesma*)” was answered as: Yes - 108 (90%), No – 0 (0%), It will stay the same - 10 (8.33%), and no response - 2 (1.66%).

Question 18 “What do you think your perceptions of Pico will be after the change? They will…☐ Improve ☐ Decrease ☐ Stay the same (*Como você acha que serão as suas percepções sobre o Pico após a mudança? Elas vão… ☐ Melhorar ☐ Diminuir ☐ Permanecer as mesmas*)” was responded to as: improve – 104 (86.66%), decrease – 0 (0%), stay the same - 14 (11.66%) and no response - 2 (1.66%).

Question 19 “What types of energy production do you want/prefer that Pico use to produce its Electricity in the future? (*Que tipos de produção de energia você quer/prefere que o Pico use para produzir sua eletricidade no futuro?*)” yielded the following responses: energy from...Wind – 75 (62.50%), Solar – 46 (38.33%), Wave – 33 (27.50%), Hydroelectric – 7 (5.83%), Geothermal – 4 (3.33%), Thermoelectric – 1 (0.83%), I do not know – 8 (6.66%), and other responses – 16 (13.33%)(responsed with renewables (8), electricity (1), best option for the environment (2), most economic/cheapest option (3), Yes (1)) (see figure 32 below).

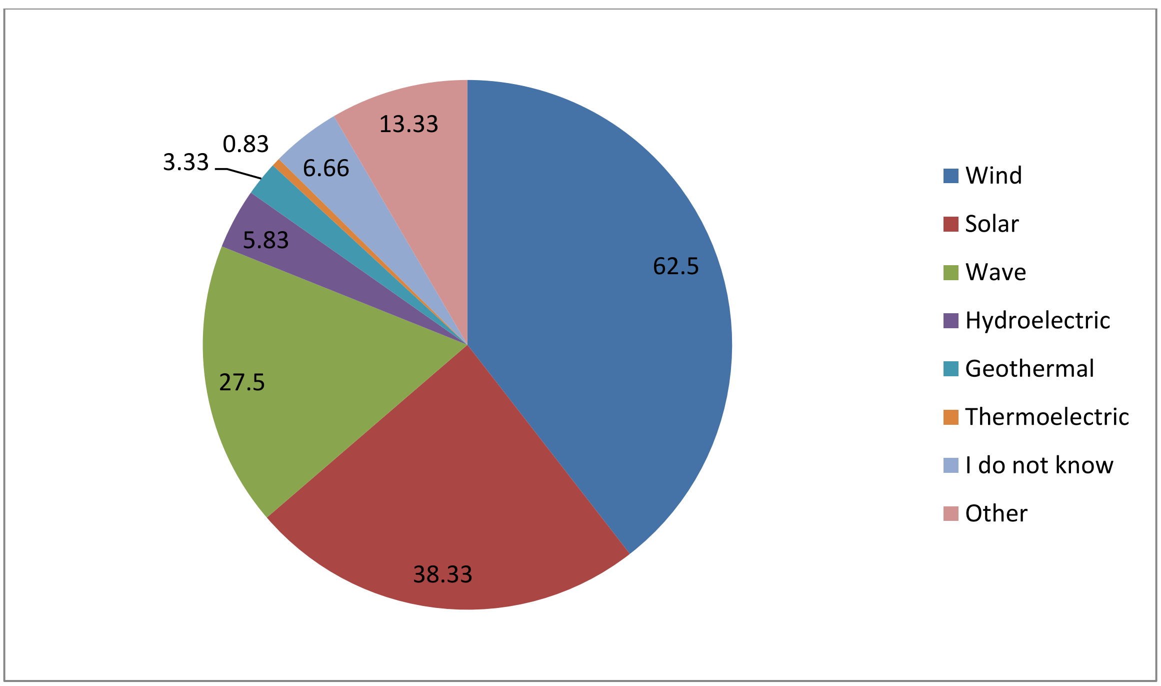

Fig. 32 – Percentage of responses to question 19 “what types of energy do you want Pico to use to produce its electricity in the future?”

Question 20 "Are you willing to promote renewable energy on Pico? ☐ Yes ☐ No ☐ I do not know (*Você está disposto a promover energia renovável no Pico?☐ Sim☐ Não☐ Não sei*)" yielded the following responses: Yes - 80 (66.66%), No - 3 (2.5%), I do not know - 36 (30%) and no response - 1 (0.83%).

Now that the results found in both the 10 face-to-face interviews (qualitative) and the 120 questionnairres (quantitative) have been presented, an analysis of these results is carried it in the following discussion section in part 6.

PART VI │DISCUSSION

6. DISCUSSION OF CASE STUDY RESULTS

6.1. DISCUSSION OF QUALITATIVE INTERVIEW RESULTS AND QUANTITATIVE QUESTIONNAIRE RESULTS

The results presented in the previous section clearly addressed the objective questions of this study. Here, an interpretation of the results is presented, as the responses from the previous section will now be discussed and will be connected to the objective questions of this study.

For each of the objective questions, each is started with an analysis of the results from the qualitative interviews, each of which possessed 14 questions that were answered by 10 participants. Each of their responses helped to address the objective questions. It must be noted that to indicate which quote came from which stakeholder, brackets were used after the quote and the number of the stakeholder who gave the quote was placed between them.

Following an attempt to address each objective research question with the results from the qualitative interviews, an attempt is made to do the same using the quantitative results from the 120 questionnaires that were conducted on the island.

Lastly, a secondary analysis of the questionnaire results is conducted where anomalies and differences between responses from different groups of respondents is presented.

Research question 1: Is the change to a renewable energy paradigm possible?

Starting with the qualitative interview questions, first examined is question number 1. Here, responses related to objective 1. This is as responses were positive with respect to renewable energy, thereby suggesting that a change to renewable energy is desirable and therefore possible.

For example, all 10 responses to this question describe renewable energy in a positive light, thereby suggesting it is positive and desirable to switch to it. For example, it is presented as being positive for the environment (for example, they are “environmentally friendly”(respondents 1 & 3), “important for environment and ecosystem” (3), “do not harm the environment much (4), “Clean energy sources without any costs/impacts to the environment” (5), “does not imply the destruction of resources at our scale” (6) “contribute to mitigating global warming” (9), and “doesn’t negatively impact the environment”).

In addition, renewables are also presented as being positive economically, as for example, they "take advantage of what nature has to offer" (1), are "energy government should invest more in" (7), and their use "means less money is exported from the country" (9).

Furthermore, some of the interviewees describe fossil fuels as being undesirable (for example, they are "not reusable" (1), "one day there will be no more non-renewable energy to use" (7) and they are an "exhaustible resource" (8)).

These responses suggest that stakeholders possess a positive opinion of renewable energy and a recognition of the negative drawbacks of fossil fuels. This suggests that a shift to renewable energy is desirable for Pico.

Next, moving to interview question number 2 "Do you think the current way of producing energy for Pico is good or bad? Why?" responses also related to objective number 1. Responses demonstrated that most interviewees knew how energy on the island was produced (as 6 of them cited fossil fuel production and 6 wind energy) and that they agree that the current way of production is bad as it is not good or ideal and it could be better. Here, the stakeholders interviewed acknowledged the negative impacts of fossil fuels (for example, they are "the worst thing that we have available" (1); "Pico's large fault" (2), "is not ideal", "are costly and polluting", "must not be dependent on these" (6), "a great error", "exhaustible energy that is very environmentally polluting" (8)).

In addition, the stakeholders indicated that the use of renewables should be increased on the island (for example, *wind*: "is completely underexploited...we should have more" (7), "it has great potential" (8), "potential to grow a lot (10)"; *waves*: "has not been developed as it could be" (6), "completely underexploited (7); *solar*: "we could have it" (4) "we could better use solar" (10)).

The responses above clearly show that the majority of the stakeholders interviewed felt that changing the current paradigm and shifting to renewables is possible. However, not all are in agreement, as stakeholder 2 was sceptical and stated that "renewable energies are uncertain, an island cannot source from the outside to overcome this uncertainty", while stakeholder 7 stated "Energy is good only because it is necessary". Overall, however, the rest felt that it is possible and advantageous to switch to having more renewable energy on Pico, as was evidenced by the following quotes: "only option for Pico is to find a series of renewable energy alternatives" (3), "we could take advantage of these" (4); "there could be a larger slice of it on Pico" (5); "should increase to at least half of what we need as we can produce more renewable energy here" (6); Pico should be able to produce more (10).

Similarly, moving to interview question number 3 "Are you open to a paradigm shift in energy production via the implementation of renewable energy on Pico?", responses clearly demonstrate that yes, all stakeholders interviewed believe a change to a renewable energy paradigm on Pico is possible as they are open to such a shift. For example, responses included: "Yes, we have these" (1), "Yes, it only makes sense" (2), "Yes, absolutely" (3), "Yes, I am in favour of renewable energies" (4), "Completely, the Azores have the natural conditions that can allow for good results" (5); "Yes, it makes perfect sense to change that paradigm" (6); "Yes, open I am" (7), "Yes, I think it is a project that must be embraced" (8); "Yes" (9); "Yes, I am completely open to this" (10).

In summary, with respect to research objective question number 1, all the stakeholders interviewed believed the change to a renewable energy paradigm is possible.

In addition, the quantitative results obtained from the survey questionnaires also show that participants believed the change to a renewable energy paradigm is possible on Pico. This was evident in the results obtained from questions 9, 19 and 6. For example, question 9 "Can renewable energy provide 100% of Pico's electricity?" yielded the results of Yes - 41 (34.16%), No - 20 (16.66%), I do not know – 57 (47.50%) and no response - 2 (1.66%). Thus, 47.5% were unsure if all of Pico's energy could be supplied by renewables, but 34% believed that yes, even 100% renewable energy on Pico is possible, while only 16.6% believed 100% was not possible.

With question 19 "What types of energy production do you want/prefer that Pico use to produce its electricity in the future?" was very telling as only 1 respondent (0.83%) wanted thermoelectric fossil fuel energy for Pico in the future, while another 3 wanted the cheapest option. All the other participants wanted renewable energy to power the island in the future (for example, Wind – 75 (62.50%), Solar – 46 (38.33%), Wave – 33 (27.50%), Hydroelectric – 7 (5.83%), Geothermal – 4 (3.33%), renewables - 8 (6.66%), and the best option for the environment (2)(1.66%). Thus, these results clearly demonstrate that participants believed this change is possible.

Furthermore, question 6 "What is your perception about renewable energy?" also demonstrated an openness and belief in renewable energy as results included: Positive - 110 (91.6%), Negative - 0 (0%), and Neutral - 8 (6.66%).

Lastly, respondents to questionnaire question number 16 demonstrated that great difficulties and resistances will be encountered by this change. This was as responses to question 16 “What difficulties or resistances will this change encounter?” included: 1) I do not know - 18 (15%); 2) Cost/financing/money availability - 34 (28.33%); 3) Installation - technical difficulties/maintenance issues/nature-climate challenges – 20 (16.66%); 4) Education/people’s mentality/culture change – 20 (16.66%); 5) Lack of political/people’s will – 3 (2.5%); 6) Dominant fossil fuel paradigm’s resistance to change - 9 (7.5%); 7) None – 1 (0.83); and 8) Other responses – 7 (5.83%). The difficulties and resistances that participants feel will exist with this shift may possibly delay the shift, however, the shift itself is still possible according to the responses of both interviewees and respondents, as renewables are seen as being both positive and possible for Pico.

To conclude, the stakeholder interviews that yielded qualitative results and the survey questionnaires that yielded quantitative results, both affirm that for research question number 1, the vast majority believe that a change to a renewable energy paradigm on Pico is possible. Most stakeholders did, however, acknowledge that certain drivers and factors must come together to allow this shift to happen, a point which ties into research question number 2. Also, respondents to the questionnaires demonstrated that great difficulties and resistances will be encountered by this change, possibly delaying such a shift, but despite this, a majority of them indicated that such a change on Pico is possible.

Research question 2: Who has a role in this and who will drive this change?

Moving on to research question number 2, the responses from the interview questions 4, 5, 8, 9 and 10 addressed this question. Responses identified who the stakeholders are that can drive this shift in paradigm forward.

Starting with interview question number 4 “Are you aware of what are the future plans/energy strategies for the Island? For example, is there a political energy strategy?” saw a number of the interviewees identify the stakeholders whom they felt must drive this change. This was the case even as all the participants (except the stakeholder who worked for the electricity company of the Azores (EDA)), acknowledged they had never seen nor were aware of any energy plan for Pico Island. Stakeholders identified “the authorities” (5), “the municipality of

Lajes" (6), "candidates" (politicians) (7), "all governments" (8), "Electricity of the Azores (EDA)" (9), and "the electricity company (EDA)" (10).

Next, taking a look at interview question number 5 "Do you have a power plan (for example, in your county)? What are your future energy plans?" who has a role in driving this change is also identified to some degree. This is as while the interviewees acknowledge that they themselves have no energy plan (either for their place of work or residence) on Pico (the only exception being stakeholder 10 - an engineer with the Municipality of Sao Roque), they did have an idea as to who should be driving this change and who should have a plan for Pico. For example, responses included: "the regional government of the Azores, the institution responsible for an energy policy for Pico or a global strategy for the Azores" (3), "the municipal level", "EDA", "city councillor" (7), and "municipality of Sao Roque" (10), were identified.

Furthermore, with question number 8 "Is your Government/Administration/Department/Ministry ready for this change?" some of the interviewees suggested who were the stakeholders that should drive the change while they themselves conceded that they themselves are not ready and that they should be prepared with a plan of their own to further this change of paradigm. The stakeholders identified included: the CVIP wine cooperative (1), the regional government (2), the municipality of Madalena (3), other governments (3), our company (hotel), the government of the Azores (6); the government ("There has to be political will and a definition of a clear and objective strategy") (8); Electricity of the Azores (EDA) ("we (EDA) have been the main driver of this change") (9); and the municipality of Sao Roque ("we are ready and we are sensitive and attentive to these issues") (10). This recognition that the government (for example, municipal and regional government of the Azores) must be a main driver, acknowledges a belief that the change must be top-down initiated. Furthermore, the fact that EDA is recognized indicates that the monopoly industry player should also initiate this shift in a top-down centralised manner. Only the responses which mention private businesses/entities as being part of the change imply a grassroots or bottom-up local driving of this shift.

Moreover, interview question 9 "Who do you think has a major/important role in switching to renewable energy on Pico?" yielded responses that directly answered research question 2. Here, the stakeholders identified included: *Government* ("governments, municipalities, parish boards" (2), "Regional Government of the Azores" (3), "Regional

Government of the Azores" (4), "the government administration" (5), "the government administration with a mixture between the municipal governments" (6), "First, it's the politicians" (7), "the government" (8), "The Regional Government (through EDA), local authorities" (9), The Regional government and city councillors, local authorities" (10); *Private companies* ("Electricity of the Azores (EDA)" (1), "companies have to make this investment" (4), "companies/business world (of the Azores or outside companies interested in investing)" (6), "secondly, it's companies... EDA, is the company responsible for interest in renewable energy, and providing these services and they want to make money." (7); *Institutions* ("institutions" (2), "the scientific world/universities (can have experiments/pilots here of new technologies that are appearing)" (6), "non-profit institutions" (10)); *Elites* (2); *The people* ("us all" (2), "private individuals have to make this investment" (4); *Investors* ("private investors" (9)); and *Technicians* ("and technicians" (10)).

Here, we see that a principal stakeholder identified was government. The regional government of the Azores was identified as it is believed it is them who: "must be the main one" (4), "have a great responsibility like in other less developed places" (5), "[must be them because] "There is no such thing as a business 'decision' that can lead the process" (5), "[must have the political will as] If there is political will, there is pressure on the company that provides electric power" (7), "I think it's really the politicians who have the decision, it's the government. These are the ones who have to take the decision to adopt the strategies at that level" (8), "have a duty to inform that renewable energy exists, what can be done, what the benefits are, how much it costs and the strategies to be followed in this area" (10).

Second, private companies were noted, as mostly EDA, was cited as they are "the company responsible for interest in renewable energy and providing these services and they want to make money." (7). Companies were followed by elites, institutions, the people, investors and technicians. This suggests the private sector has to provide the capital to allow for this shift to occur, and needs to do so in partnership with governments that will help finance the shift and will provide the political will, plan and the sensitizing needed so that the people are included in the shift and thereby allow the shift to occur.

Similarly, interview question 10 "Who will drive this change to renewable energy on Pico/" yielded responses that directly answer research question 2. Here it was revealed that the stakeholders should be: *Companies/Institutes* ("It must be an institute or company with knowledge and an idea that can define what the network should be and the evolution path of producing energy, of adding or not" (1), *The EU* "EU via subsidies - external aid because at the local level the people and government do not have the money to invest in a change to renewable energy installations" (2), *Government* "The regional government of the Azores and us - municipalities - could do a few things more" (3), "It will have to be a strategy of the Regional Government" (6); "management of the government. It will have to pass through them always, to have assembly" (5), "the regional government, It will always go through the regional government, it is them who determines, because we do not have private groups, private companies, that are installed and that may eventually make this type of decision" (8), "The regional government with others" (10), *Electricity of the Azores (EDA)* "Electricity company – EDA" (5), "EDA, it would probably continue to be EDA alone or in partnership with public or private entities and also some private investor(s), Given the economies of scale of an island with the size and population of Pico" (9), *The people in general* "It needs to be everyone because this pointing the finger at the details - belongs to the companies, everyone has to do a reinforcement for this" (4)), "there must be co-financing of investments as people do not have the capacity to invest in these technologies" (10), *The Youth* "The younger people because I think they're so much more (aware of this)... maybe because they're told this is important" (7), and *Immigrants* "immigrants, live here and come from outside with a different consciousness (awareness), because locals don't even want to know about this" (7).

Turning now to the questionnaire results, questions number 20 and number 4 identified who will drive this change. Starting with question number 4 "Are you willing to make some investment to use more renewable energy?" yielded the following results: Yes - 79 (65.8%), No - 39 (32.5%), and no response – 2 (1.6%). This indicating perhaps that the individuals of Pico themselves feel they need to be open to helping and being the drivers of this change. In addition, question number 20 "Are you willing to promote renewable energy on Pico?" echoes this, as it yielded the responses: Yes - 80 (66.66%), No - 3 (2.5%), I do not know - 36 (30%) and no response - 1 (0.83%).

In summary, research objective question number 2 revealed that among interviewees great consensus existed with respect to who the various stakeholders that will drive this change should be. These include the: *Government* (authorities, politicians, city councillors, the municipalities, the regional government of the Azores), *Electricity of the Azores (EDA)* energy utility company, *Private sector businesses/companies* (for example, CVIP wine cooperative, Hotel Caravelas), *Institutions (for example, universities), Private entities* (for example, investors, elites), *The European Union (EU), Technicians, The people in general* (everyone), *The Youth*, *Immigrants*, and *public entities*. Also, the questionnaire results revealed that the individuals of Pico need to be a part of driving this change. It appears clear that awareness exists that this change cannot be driven in isolation, but rather only through collaboration between different entities at all levels. This was something that was addressed and acknowledged on both Samso and El Hierro, as there grassroots groups and local citizens were mobilized to work with governments and outside funding initiatives to create a renewable energy plan and to guarantee the successful transition to a near 100% renewable energy paradigm.

Research question 3: Does Pico Island have all the capital to control this change?

Besides objectives 1 and 2, objective question number 3 was responded to by the interviewees. The responses from interview question 7 directly addressed this question. Also, responses from interview question 6 touched upon this objective.

Starting with question 6 "Does Pico have adequate environmental conditions to support/produce renewable energy?" yielded responses that demonstrate that all interviewees feel Pico possesses the physical capital, that is, the environmental conditions necessary to allow this shift of paradigm to occur. Responses included: "Yes, the sea, sun, wind, geothermal" (1); "Yes…wind, waves, sun" (2); "…yes, energy of the waves, or the wind, solar panels" (3); "yes, water heating can be done via solar energy" (4),"Yes, … Pico has the conditions for that - wind energy…wave energy" (5), "Yes, between wind, water and solar there are conditions" (6);"of course, …with the wind, waves and sun" (7),"Yes, Pico has the right environmental conditions …wind, the waves - good orography and sea location" (8), "…already a wind power component" (9), "wind energy… also, the municipality of Lajes do Pico intends to launch a mini-hydro" (10). Thus, by being able to potentially draw upon various energy sources, it was believed by all stakeholders interviewed that Pico has the environmental capital needed.

In addition, looking at question 7 "Does Pico Island have all the capital needed to control and allow this change to happen?" responses directly addressed the issue of the economic capital (for example, money) that is needed for this shift to occur. Responses included: "Depends, there are many subsidies from governments - regional government" (1), "that level of money… does not exist" (2), "Pico does not have it" (3), "the region needs to support this" (4), "Almost guaranteed no, it does not have it" (5), "it always depends on capital and authorizations outside the island" (6); "If there is political will we can have the capital" (7), "The strategy should be at the regional level, adapting the most appropriate measures for the characteristics of each island" (8), "lack financial capital" (9), "In financial terms, it would have to be a regional government big investment shared by community funds to ensure that they are sustainable and benefit the population and the environment" (10). These responses suggest that all interviewees agree that Pico alone does not have enough money or financial capital necessary to allow this shift in paradigm to occur.

Despite a belief Pico does not have enough financial capital, many agree that the potential is there for Pico to secure this economic capital because it can be supported from governments and entities at the regional, national and international (for example, EU) levels. This is as interviewee number 7 stated "We can get financial investment via subsidies of the EU as they exist for this and value renewable energy and environmental protection", while interviewee number 8 stated "Pico cannot think in isolation … it will always be a strategy fixed at the regional level - because if we think in isolation there is no chance to make this change". Here interviewee 8 reveals that a top-down government approach must be implemented, revealing that the Island functionaries do not think of Pico Island as existing in isolation, but rather, they think of Pico as part of an archipelago of Islands where the greatest power comes from the centralised regional government in Ponta Delgada on the Island of Sao Miguel. This perhaps reflects in part a mentality of dependence on the State, for example, as there exists a belief of not being able to independently secure energy self-sufficiency or to exist sustainably without financial support from the outside. It may also point to a historical pattern where the Island is used to receiving funds for projects that come from outside governments and entities such as the government of the Azores and the EU. This sentiment was echoed by interviewee 10 who stated "10). The municipalities have some funds to invest and the new operational plan, PO2020, has enough funds and has priorities in this area of renewable energy to help out", with the PO2020 program being a national level program that is part of the EU funded EURO2020 program as referenced in the Azores 2020 program.

Furthermore, interviewee number 9 of EDA shed light on the concept of human capital by stating that Pico "has the human capital", and suggested that just the financial capital is lacking along with political capital, because there is a lack of “political will at the local level”. Thus, in conclusion, according to interviewees, financial and political capital appears to be lacking on Pico, while the environmental capital needed for this shift in paradigm is not.

At the same time, the quantitative questionnaire results suggest that Pico has the environmental capital and human capital needed. In support of the notion that Pico possesses the human capital needed are the results from question number 4 “Are you willing to make some investment to use more renewable energy?”: Yes - 79 (65.8%), No - 39 (32.5%). These results suggest that a majority of the people on Pico are willing to invest in this technology/shift. Meanwhile, results from question 5 “What do you do to save energy?” also suggest that the human capital exists as only 4 participants (3.3%) said they do nothing to save energy, thus suggesting that the people are aware of energy efficiency and issues and thus they may be open to participating in a renewable energy shift. Lastly, with respect to the Island’s environmental capital, question 9 “Can renewable energy provide 100% of Pico's electricity?” with the results: Yes - 41 (34.16%), No - 20 (16.66%), I do not know - 57 (47.50%) and no response - 2 (1.66%), suggests that only a minority (16.6%) feel the environmental capital does not exist for Pico to shift to 100% renewable energy.

All and all, the qualitative interview responses revealed that with respect to objective question number 3, Pico does not possess enough capital to allow a shift in energy paradigm to exist. That is to say, Pico alone does not have enough financial capital (money) or political capital (political will) necessary to allow this shift in paradigm to occur. Despite this, Pico does have the human capital (people, skilled technicians) and environmental capital (renewable energy sources) needed to allow the shift to occur. The quantitative results support the argument that Pico possesses the human capital and environmental capital needed for this shift to occur.

Research question 4: Is everybody aware of this change?

Moving onto research question number 4, responses from interview question number 11 directly addressed this question. Responses demonstrated that stakeholders were divided, as 6 believed that ‘No’ everyone is not aware of this change, while 1 ‘did not know’ and 3 others believed that ‘Yes’ everyone was aware of this change, as for example, “everyone is open and willing to adapt to implement renewable energy on Pico” (5). Thus, the interviewees did acknowledge that they felt that at least a certain percentage of the population was aware of this (for example “10% of the residents maybe” (1), that all of the population of Pico should be aware of this and that much work needs to be done to ensure that this results. Some mentioned this consciousness is growing, as for example “younger generations, at least they already come with other mentalities and another environmental consciousness” (5), and “more and more people are worried about the environment” (8)). Some, however, are less optimistic as they don’t believe that the will to become aware exists as “very few people are aware that we have to change and even fewer people are willing to change” (7), and some also feel that the elderly present a resistance to this change as “with the elderly populations this message is hard to come by” (6).

Questionnaire responses mirrored this division. This is as starting with question number 1 “In your perspective, how is electricity produced on Pico?”, the question had many varying responses that included: 1) I do not know - 22 (18.33%), 2) Wind Energy/Turbines/Mills (lone response) – 11 (9.2%), 3) Fossil Fossils (lone response) – 30 (25%); 4) Central Power Plant (lone response) – 13 (10.83%); 5) Solar Energy (lone response) - 1 (0.83%); 6) Wave Energy (lone response) – 0 (0%); 7) Thermoelectric and Wind Energy (Actual reality of Pico’s production) – 29 (24.16%); 8) Mix of Non-Renewable + Renewable Energies – 10 (8.33%); and 9) Other – 4 (3.3%). These results clearly point to the fact that many residents on Pico are unaware of how electricity is actually produced on the island (22 – 18.3% clearly don’t know), while only 29 (24.16%) actually know (that it is produced with thermoelectric and wind energy). This high degree of a lack of awareness of how energy is produced on Pico suggests that the residents are not all aware of the transition to renewable energy that is taking place on Pico.

Furthermore, survey question number 8 “Is it important to switch from fossil fuels to renewable sources?” with the results - Yes - 111 (92.5%), No - 1 (0.83 %), and I do not know – 8 (6.67%), suggest that the majority are aware that fossil fuel energy production is negative and that a switch away from it is necessary. However, this does not indicate that they are conscious that such a switch is happening on Pico.

Also, questionnaire question number 11 “Will everyone agree on this transition?” with the answers: Yes – 15 (12.5%), No – 42 (35%), I do not know - 62 (51.6%), and no response - 1 (0.83%), suggest that everyone is not aware of the shift. This is because more than half of the respondents said they did not know if everyone would be in agreement for such a shift. Such a lack of agreement suggests not everyone is conscious of the shift and therefore they could not be able to agree on a shift they are not aware of or know nothing about.

In summary, these results suggest that a concentrated mobilisation program of outreach/engagement is needed to educate the population and to get them on board with supporting and being a part of this change for a shift to 100% renewable energy on Pico. This would overcome the issues of "no consciousness, a lack of education, a lack of money, poverty and the fact that utilities are too cheap and subsidized" (1). Without this, a lack of awareness and as a result resistance by locals will help ensure that such a shift either does not take place or is slow in becoming realised – two things that were acknowledged and addressed on the Islands of El Hierro and Samso where a renewable energy transition was able to happen within 10 years.

Research question 5: Who will benefit more?

Next, considering objective number 5 "Who will benefit more" was not directly addressed by any of the questions in the interviews. Indirectly this was suggested by the interviewees in question 10, as the entities stated who they thought would drive this change to renewable energy on Pico. Some of these actors were presented in way that suggested they would be the one who would benefit from such a change. These included: The EU (international level), The regional government of the Azores (regional level), the municipalities (island level), companies (for example, electricity of the Azores (EDA)), institutes (for example, universities), the youth, the people in general, and private individuals who invest in this technology.

Considering the quantitative survey results, however, questions 12 and 14 do directly suggest who may benefit more from a shift to renewable energy. Starting with question 12 "Who will benefit most from a shift to renewable energy production?" responses included: 1) I do not know - 7 (5.83%); 2) Human Population – 73 (60.83%); 3) The Environment – 37 (30.83%); 4) Consumers – 20 (16.66%); 5) Businesses - Renewable Energy Vendors – 12 (10%); and 6) Other beneficiaries – 10 (8.33%): (The Rich (1), The adults (1), the government (1), Farmer (1), market (1), fisherman (1), public health (1), Engineers (1), Teacher of the professional school of Pico (1), and the export lobby's such as Oil (1). (See figure 33 on next page).

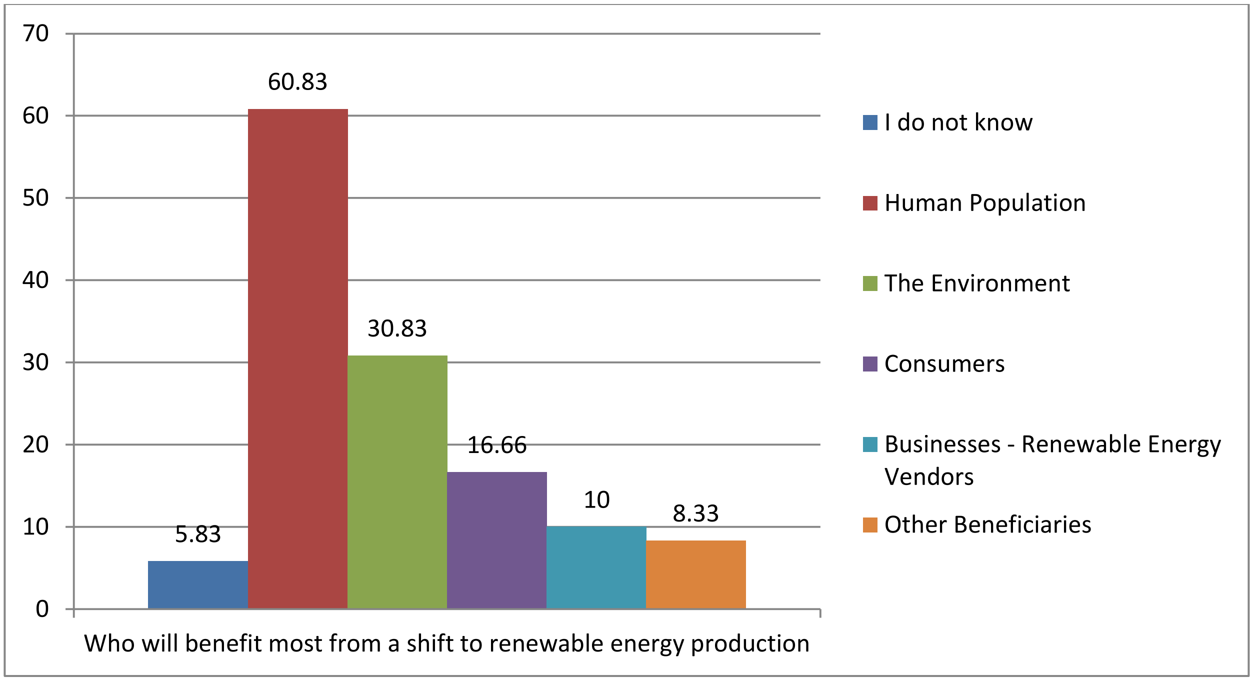

Fig. 33 – Percentage of participant responses to survey question 12 - Who will benefit most from a shift to renewable energy production?

In addition to the above, less than 50% of respondents in question 14 "Do you think a change to renewable energy on Pico can benefit you? How?" believed that they would benefit from this shift: Yes – 56 (46.66%); 2) No – 6 (5%); 3) I do not know - 9 (7.5%). Of those that thought they would benefit, they believed they would benefit: economically - 59 (49.16%)), environmentally - 35 (29.16%) and health wise - 1 (0.83%)).

Although not explicitly stated, these actors may benefit in the following ways: Governments may benefit financially over the long run and in terms of climate change and emission commitments, as well as in terms of energy security. Companies stand to benefit financially over the long run as they may attain control over the energy needed to produce the electricity that they sell (or use), while institutes can gain knowledge and expertise in designing and applying technology, that is, technological know-how. Lastly, people get guaranteed clean, safe energy that potentially has a lower cost and a lower environmental impact and carbon footprint (although that is not guaranteed and should not be taken as a given, for as was noted in part I, renewable energies also have a negative environmental impact associated with them and are not the 'panacea' or 'cure-all' they are often presented as being).

In summary, according to the qualitative stakeholder interviews, it is the EU, the regional government of the Azores, the municipalities, companies, institutes, the youth, the people in general, and private individuals (who invest in this technology) that may benefit from this shift. According to the quantitative questionnaire results, those who will benefit more include the people in general (human population), consumers, businesses (renewable energy vendors), the rich, adults, the government, farmers, the market, fisherman, public health, engineers, teachers the export lobby's (Oil lobby) and themselves. Understanding how these different actors stand to benefit could prove to be instrumental in ensuring a renewable energy transition on Pico. This is as such information could be used to make an argument for drafting an energy plan for the Island. Such a plan is something which is currently lacking on Pico (was not the case on El Hierro and Samso) and the presence of one could ensure the capital and commitment that is needed (from the grassroots on up to the EU level) to ensure that this transition happens on Pico.

Research question 6: Who will benefit less?

Similar to objective question number 5, objective question number 6 “Who will benefit less?” was indirectly answered in the interviews. This was done mainly through question 12, “What difficulties or resistances will this change encounter?”. The resistances that were identified were believed to most likely come from: *1) People*, as “people view the technologies are inferior to fossil fuels and need to demonstrate their efficiency and worth” (2), “Issue of trying to change one of the most inverted populations that we know, resistance from the older generation - some understand idea, others need to be sensitized to the issue” (3); *2) Consumers and businesses*, as their resistance to invest in costly technology exists, as renewables can be more expensive and are not always cost effective; *3) Electricity utility company staff (EDA staff)*, will be resistant as it is not in their best interest to transform the Island’s electricity network and infrastructure; *4) Politicians*, as they may resist the work load that is required to sensitize the population and collaborate with EDA who has a monopoly; *5) Environmental organizations*, as new energy projects and infrastructure will impact the island’s environment; and lastly *6) Oil interests*, as “In global terms, the greatest resistance will be around oil - oil owners have a lot of weight and pull in the world” (10) and they will resist this change.

At the same time, the quantitative results obtained from questions 13 and 15 of the survey indicate who will benefit least from this shift. Being directly addressed by question number 13 “Who benefits the least from a shift to renewable energy production?” responses included the following: 1) I do not know – 15 (12.5%); 2) The companies that produce energy/electricity/EDA – 30 (25%); 3) No one – 10 (8.33%); 4) The oil & gas/fossil fuel companies and vendors – 45 (37.5%); 5) The population – 14 (11.66%); and 6) The Economy – 3 (2.50%).

In addition, a very small minority of respondents felt that they themselves would benefit least from the shift, as indicated by question 15 “Do you think a change to renewable energy on Pico can harm you? In what way?”. Here, only 7 respondents (5.83%) answered yes, as they believed they could be impacted: economically (for example, by having to pay a higher unit price for energy if produced by renewables), through power outages/shortages (due to the fact that renewable energies such as wind and solar are not always constant and thus if not paired with storage devices such as batteries, consumers may suffer periods of shortage of supply) and by a lack of competent technicians to solve installation/equipment issues.

Thus, based on these responses, it may be concluded that there was agreement that the people, consumers, businesses, politicians, EDA staff, environmental groups, and oil companies are those who will benefit less, according to the stakeholders interviewed. This implies that those who must either pay for or finance this shift, or those that must be the drivers on the ground of this shift (of either the physical transformation or the mental and cultural transformation that this shift in paradigm requires) are the ones who will benefit less. Working with these actors and incorporating them into the development of a plan and in the transition of the shift will be key if the transformation is to result and be successful. This is as this was something which the cases of El Hierro and Samso did and showed that it can lead to a successful shift.

Research question 7: What individual and collective geographies and landscapes will this change (re)build?

Continuing with an analysis of interviewee results, next let us consider objective number 7. This question was best answered by interviewees through their responses to interview question number 13 “How do you think this change affected/will affect the landscape?”.

According to the interviewees, the collective geographies and landscapes this change will rebuild are those of the current carbonscape landscape that exists on Pico. A number of the stakeholders acknowledged that fossil fuels are having a negative impact on the land, the island

and globally, even if these impacts are not always visible. Interviewees also suggested that changing the paradigm away from fossil fuels may have a positive impact on the environment. For example, responses included “The thermal power plant probably has a small impact both on the environment and visually as its waste materials are few and its emissions are dispersed into the air/environment, so people do not end up seeing this directly at the factory” (2), “We always end up having an environmental impact that is significant (even if trying to minimize it)” (3), “Decreasing the use of fossil fuels can have a positive effect on the landscape even though its impact is not very noticeable as its by-products do not result in any kind of shock” (5), “Fossil fuel use has a cumulative impact over the years.” (10). Going along with this decrease in the use of fossil fuels would imply a decrease in the fossil fuel infrastructure which dots the island, thereby diminishing the carbonscape infrastructure on Pico and thus Pico’s dependence on fossil fuels.

Furthermore, the collective geographies or landscapes this change has built/will build are also referred to by the interviewees. They mention how renewable energies will and do also impact and transform the landscape of Pico in negative ways, even though this change may bring about less negative consequences overall then the current paradigm does. For example, responses included: “A wind park or a large solar park, however, is going to have a large visual impact for the population, but can conciliate everything, for it's not going to have a big impact” (2), “for the landscape it is obvious there will be some positive aspects” (3), “a size/dimension that does not affect the landscape would be ideal, clearly it will always do so” (4), “The equipment itself, such as wind turbines, affect the landscape. Solar panels are sometimes found in smaller productions like on houses and have a negative impact on a different landscape - man-made landscape” (5), “There will surely be a landscape impact with this paradigm shift. Wind power changed the landscape as it required putting up wind towers, electric cables, cutting vegetation, all had a visual impact. The proposed lagoon project will require impermeating a lagoon - a landscape and ecological impact associated with it. We only have a clean landscape without any human construction” (6), “It's obvious that it will always affect the landscape” (7).

Acknowledging that these impacts stated above will result, some suggested how this paradigm shift can maximize the benefits and minimize the impacts associated with it. For example, “we always have to balance and weigh the pros and cons and the benefits we will have as to 'decrease' environmental pollution, landscape impact, but the benefits that come from it may be greater than this landscape impact we have" (6), "usually EU rules exist for ensuring the impact is small" (7), "the impact may not be excessive if appropriate measures are taken" (10), "the landscape on Pico just has to win" (8), "Shifting to renewables means we stop polluting the atmosphere and we have a better environment - a direct relationship, so to speak." (10).

In summary, these results suggest that the stakeholders interviewed understand that there is a negative impact associated with both a fossil fuel paradigm and a renewable energy paradigm, as both alter the landscape and contribute environmental and visual pollution. Despite this realization, there seems to be hope and optimism that this shift in paradigm can be beneficial and that it can have less of an impact than the current energy paradigm does. This change will alter the carbonscaped landscape of the island and shift it towards a renewable energy powered landscape. This will require altering the land in both visual and physical terms as in addition to the fossil fuel infrastructure that exists, new renewable energy production sites and infrastructure (such as cables, towers and pipelines) will need to be constructed. Sensitizing the population, minimizing impacts and pollution and ensuring public consultation throughout this process will be key to ensuring the success of any planned transition.

Conversely, awareness existed among both interviewees and survey participants that the landscape of Pico is also going to affect the energy selected in this shift. By first looking at interview question number 14 "How do you think the landscape affected this change? For example, the selected energy types?" stakeholder responses demonstrated that many understand that the landscape will affect the shift of paradigm by affecting the types of energies that are selected to be used and where they are able to be sited/located. For example, the question had the following responses: "People want to protect the visual aspect of the landscape, will not like the wind turbines or solar panels" (1), "Can only install things where they can be profitable - a wind park in a windy zone, a solar panel park near the coast where there is a high insolation index" (2), "Landscape will affect types of energy selected to be used, we can see what kind of energy we are going to use where, then we see the impact it creates - collective impact. We cannot mount solar panels in the historic center for example as this would change it, landscape itself affects location of renewable energies" (3), "Affects what are the types of energy" (4), "Pico's landscape still has the potential to produce/contribute a lot more renewable energy. Example, firewood harvested from the recovery of the abandoned vineyards can be connected to the project of a pellet factory in Santa Luzia" (8), "the types of energy that can be implemented on Pico will not be overly conditioned by the landscape unless the impact of these projects on protected areas or biosphere reserves is considered to be excessive" (9), "We live on islands that are limited in terms of land spaces, renewable energies imply the use of large areas of land for their installation, therefore, landscape affects renewable energies" (10).

Here, we see in the responses that an understanding exists among stakeholders that the environmental conditions must be right at a given location and the given land use in that location must permit the type of renewable energy that is selected to be applied there. This reflects an awareness of siting issues, as stakeholders seem aware such energy projects must be profitable, reduce their pollution (environmental and visual) impact, and have to respect current land uses and zoning requirements (for example, the historic center that is protected and the UNESCO world biosphere reserve of Pico vineyards, along with protected nature areas and ecological preserves/geoparks).

Some stakeholders, however, did not believe that landscape affects energy, as they stated "I do not think the landscape affects the types of renewable energy selected... I do not see how the environment will have an impact on energy" (6), and "I do not know, it's a thing that a person does not even imagine" (7).

In summary, an understanding that landscape will affect the shift of paradigm by affecting the types of energies that may be used and will affect where they are able to be sited/located is important. The geography and land uses of the island will affect the energy that is selected and where it can be located, thereby affecting the landscape and how it is built/rebuilt. Awareness of this means a tolerant, flexible and problem solving resolve may be developed by those involved in the transition to the allow the shift to successfully take place.

Research question 8: Will this new paradigm possibly change the outside image of the island, shifting it towards a more positive perception?

Next, objective 8 is considered as it relates to the results. Objective 8 was addressed throughout the interviews as almost all agreed this shift would create positive image of Pico. This was best summed up by stakeholder number 1's response:

> The image of Pico will be much better than it already is and this will contribute to tourism growth. Pico´s image can be half associated with nature, environment, mountain, other things, and half with renewable energy production. Tourists will like this idea – renewable energy production is a great and friendly promo and a great thing of image production, we have to illuminate the image of Pico - its nature and good environment" (Stakeholder 1, 2017).

However, despite this optimism, one stakeholder remained sceptical - stakeholder number 2 - who believed that the shift could change the perception of the island towards a more negative perception. This is as they feared that tourists (and locals alike) do not want to see renewable energy infrastructure (such as wind turbines and solar panels) dotting the natural idyllic landscape of the Island. Thus, the new paradigm could possibly change the outside image of the island by shifting it towards a more negative perception (as opposed to a more positive one) if it is deemed to cause visual pollution, damage the natural landscape, damage nature habitats and alter current land uses on the Island.

Turning to the quantitative questionnaire results, objective question number 8 was directly addressed by questionnaire questions number 17 and 18. Starting with question number 17 "Will this change create a positive image of Pico?" an overwhelming number of the respondents seemed to think so. This was as 108 (90%) stated 'Yes', 0 (0%) stated 'No' and just 10 (8.33%) said 'it will stay the same'. This suggests that, at least among the residents of Pico, a strong belief exists that such a change will benefit the Island's image as it will shift it towards a more positive perception.

In addition, question number 18 reinforces this notion, as it asked "18. What do you think your perceptions of Pico will be after the change?" and was responded to as follows: They will improve – 104 (86.66%), decrease – 0 (0%), stay the same - 14 (11.66%) and no response - 2 (1.66%). Again, here, we see that the great majority feel the shift will improve the image of the island.

In summary, almost all agreed this shift would create positive image of Pico. The residents of Pico believe that such a change will benefit the Island's image as it will shift it towards a more positive perception, that is, the shift will improve the image of the island. This improved image linked to renewable energy is something which may be capitalized on by the Island as it continues to open up to tourism and is becoming increasingly more dependent on it. Being able to market itself as a green island, environmentally friendly and sustainable with a healthy quality and standard of life can not only help tourism, but can also help attract new immigrants to the Island while helping it retain current ones. Gaining recognition for this image and projecting it through international awards and media sources can help the island achieve a shift to 100% renewable energy, as the case of Samso Island has shown.

6.2. DISCUSSION OF CROSS ANALYSIS OF QUANTITATIVE SURVEY RESULTS

Next, a discussion of a secondary analysis of the quantitative results from the questionnaires will be discussed. This secondary analysis was conducted in order to see if anomalies or great differences existed between the respondent groups and the responses given. This was done for nationality, gender, rural versus urban, age group and education. Responses to the questionnaire questions 1 through 20 were filtered using Microsoft Excel software program to see if any great differences in responses over questions existed.

Nationality

First, nationality was filtered to see if there existed a difference in responses between individuals from different countries. Portuguese was the predominant group accounting for 111 of the respondents. Of these, responses varied across all questions. Second, there were 2 Italians, 1 Canadian, 1 French, 1 German, 1 Cape Verdean, 1 citizen of The United States of America, and 1 Portuguese-Canadian. No 100 percent consensus or equal response existed for any question among all participants. The most pronounced divergent responses were produced by the U.S. citizen, as they were the only one to give no response for questions 12 through 20. Also, they gave either negative, unaware responses or were the lone divergent response in many questions, as in question 1 they gave an ‘I don’t know’ response, question 4 – no response, question 5 – no, and question 8 and 9 an ‘I don’t know’ response. For question 6 all answered “positive” except the U.S. citizen (“neutral”). This perhaps suggest a high level of being unaware of the energy situation on Pico, that is, how the energy is produced, how much it costs and the need for a shift to renewable energy for the Island. Second in diverging answers was an Italian participant, the only one to answer ‘Wind’ in question 1, ‘No’ in question 3 and 10, ‘Yes’ in question 7 and 11 and ‘I don’t know’ in question 14. This suggests that they are not as familiar with how energy is produced on Pico, how they use energy at home, renewable energy and potential issues with an energy transition on Pico.

Male versus Female

Second, gender was filtered to see if there existed a difference in responses between male and female respondents, out of the 48 males (40% or total respondents) and 72 females (60% of total respondents) who participated in the questionnaires.

It was found that across questions 3, 4, 6, 17 and 18 ratios of responses did not vary greatly between the genders.

For question 1 some large differences existed with responses to how energy is produced on Pico. Responses included: I don't know - 22 (Male 4, Female 18), Wind Energy Alone – 11 (Male 1, Female 10), Fossil Fuels Alone – 30 (Male 10, Female 20), Plant Alone – 13 (Male 4, Female 9), and Thermoelectric & Wind – 29 (Male 23, Female 6). This demonstrates that out of the participants, men were much more aware of how energy was actually produced on Pico (gave 23 of 29 correct responses, woman just 6) while only 4 said they didn't know while 18 woman said they didn't know. Also, many women only sited wind, 10 times more than men did

Also, for Question 5, large differences existed for some responses as to how participants save energy (for example, Lighting - 43 (Male 14, Female 31), Selective hour electricity use - 15 (Male 4, Female 11)), which may mean woman are more conscious about doing things to save energy around the household then men are.

Next, for question 7, men responded as having implemented renewable energy already much more then woman did (Yes - 25 (Male 18, Female 7), No – 95 (Male 31, Female 64)), thus suggesting greater awareness of renewable energy and renewable energy technologies, as well as know how to install/apply them.

In addition, responses were relatively even except for 'I do not know' across many questions: question 8 (Male 1, Female 7), question 9 (Male 13, Female 44), question 10 (Male 14, Female 33), question 11 (Male 17, Female 45), question 19 (Male 0, Female 8), question 20 (Male 11, Female 25).

The results above suggest women more so then men tended to be less aware (for example, of a need to switch away from fossil fuels and their associated negative impacts, of renewable energy potential on the island, of potential conflicts associated with a change in energy paradigm, and of if people are willing to agree with a shift in energy paradigm on Pico.

This trend held true for question 12: I do not know - 7 (Male 0, Female 7), but here we see woman responding twice as much as men to say that the ‘Human Population’ (73 (60.83%); Male 26, Female 45) and ‘The Environment’ (37 (30.83%); Male 10, Female 24) while men responded more for Businesses - Renewable Energy Vendors (12 (10%); Male 9, Female 3).

For question 13, again woman responded more to ‘I do not know’ (15 (12.5%); Male 4, Female 11) and to ‘The companies that produce energy/electricity / EDA’ (30 (25%); Male 9, Female 21) and ‘No one’ (10 (8.33%); Male 3, Female 7), while men did more to ‘The oil & gas/fossil fuel companies and vendors’ (45 (37.5%); Male 26, Female 19). Again suggesting here woman are less aware of who will benefit less, but did cite energy companies more while men referred to oil companies more. This perhaps suggesting a focus on cost of energy as opposed to energy production for men.

Responses for question 14 were just about even except for 4) Will benefit economically (only) - 47; Male 16, Female 31, and 8) Environmentally & Economically – ; Male 6, Female 12. This suggests a stronger economic and environmental focus held by the female respondents.

Next, looking at question 16,“What difficulties or resistances will this change encounter? We have differences with: (1) I do not know – 18; Male 7, Female 11, 2) Cost / Financing / Money availability – 34; Male 13, Female 21, and 4) Education / People’s mentality / Culture change – 20; Male 5, Female 15. Again, woman responded more to ‘I do not know” showing less awareness perhaps, but did respond more to money and education/culture change, perhaps showing a greater awareness of cost of energy and the need to education people for an energy shift.

Here, we have seen throughout the responses consistently, that women were more likely to acknowledge a lack of awareness or knowledge when it comes to energy questions on Pico. This may in fact be due to many of them not knowing and them not being afraid to acknowledge this. Meanwhile, men may actually either know because they have a greater awareness of energy issues on Pico, or they may be less open to admitting that they do not know the answer to a question.

Rural versus Urban

Next, a secondary analysis is done considering responses of rural versus urban areas of Pico. Since the scale of the Island of Pico is very small, here an urban area is defined as a township capital which has a population of greater than 1,000 people. On Pico, this includes the towns of Madalena, Lajes do Pico and Sao Roque do Pico. For this study a rural area is defined as parish with a population of less than 1,000 people. On Pico this refers to the 14 rural parishes found on the Island that possess a population of less than 1000 people. By applying these definitions, an urban to rural comparison of responses was able to be carried out. Here, the three regional capital towns represent the urban areas of Pico (66 respondents) and were compared to the 14 parishes that represent the rural areas of Pico (54 respondents).

First, questions where responses were nearly even or no two responses were separated by a difference of greater than 6 replies, included questions number 1, 2, 8, 10, 11, 14, 16, 17,

Next, for question number 3, responses included: Yes (Rural 46, Urban 58), No (Rural 8, Urban 9). Here we see more urbanites using gas to heat their home water then rural residents.

Moving to question number 4, responses included: Yes (Rural 30, Urban 49), No (Rural 22, Urban 18). Here we see a much larger proportion of urbanites willing to invest in renewable energy. This may be due to them spending a lot of money on hot water and energy, as perhaps their energy and water usage is greater than in rural areas and thus they feel a greater need to do something to reduce their expenses. Also, living in a more urban setting they may be more aware of and exposed to these technologies, or may know more people who have successfully applied them already, making them more open to investing in them.

Also, question number 5 yielded responses that were mostly even except with respect to: Lighting (Rural 22, Urban 29), Reduce Energy Consumption (Rural 4, Urban 11). This demonstrates a difference in what urban versus rural people do to economize energy at home, with urban dwellers focusing more on lighting and reducing energy use. This may be due to higher energy costs, rural people saving energy in other ways, or more awareness of the importance to save energy.

Again, question 6 yielded responses: Positive (Rural 48, Urban 62). Here we see more urban participants held a positive view of renewable energy then rural participants. This, perhaps signalling a greater awareness among urban participants when it comes to renewable energy.

As well as the above, question 7 yielded responses: Yes (Rural 8, Urban 17), demonstrating twice as many urban participants have already implemented some type of renewable energy then rural ones had. Most common among these was Solar (Rural 6, Urban 15). This perhaps showing that urbanites on Pico implement more solar hot water heating units then rural residents do, something which again may be linked to awareness, or, that may be related to economics, as perhaps urban dwellers have more resources to spend on such technology.

Coupled with the above, question 9 yielded varying responses: Yes (Rural 18, Urban 10), No (Rural 10, Urban 25), I do not know (Rural 25, Urban 32). Here, we see rural respondents believing almost twice as much as urban respondents do that Pico does have the environmental conditions/capital needed to produce 100% of its energy from renewables, as urban respondents more than twice as much think it is not possible. This perhaps reveals a greater connection and awareness of the environmental conditions that exist on Pico and of the current renewable energy projects that exist in the rural spaces of the Island being possessed by rural residents. That is to say, urban dwellers may have less of a connection and awareness of the actual environmental conditions that exist in rural areas of the Island.

Furthermore, question 13 was responded to evenly except for response to Oil & Gas companies (Rural 16, Urban 28). Here, urban participants demonstrate that they see that fossil fuel companies will lose, perhaps in terms of business and sales, with a switch to renewables, something less acknowledged by rural participants.

Also, question 15 yielded the responses of 'No' (Rural 39, Urban 52), demonstrating urbanites fear this change will affect them more then rural residents do. The reason for this is hard to infer as one would suspect rural residents may be more opposed to this as they may be more likely to potentially come into contact with these renewable energy plant constructions and suffer more from environmental and visual pollution as well as land use conflict. Perhaps if thinking from an economic perspective, urban participants think this change may negatively impact them.

Besides the others, question 17 yielded the response of Yes (Rural 45, Urban 62), where more urban than rural participants felt this shift will improve the image of Pico. This sentiment was mirrored by question 18 where the response rate showed: Improve (Rural 45, Urban 60). Perhaps from a marketing perspective, urban participants see this as beneficial for Pico's image.

Also, question 19 gave responses that included: Wind (Rural 32, Urban 43) and Wave (Rural 9, Urban 24). While the rest of the responses were even, urban participants expressed that they would prefer to see more wind and wave energy, much more so then rural participants. This perhaps has to do with the fact that rural residents are more likely to be affected by or to resist renewable energy plant constructions as they may suffer more from the landscape impact and visual pollution, as well as competing uses for the same land, with respect to wind and wave energy.

Finally, question 20 revealed the following results: Yes (Rural 30, Urban 50), No (Rural 0, Urban 3), I do not know (Rural 23, Urban 13). Here we see that urban participants are much more open to promoting renewable energy on Pico then rural participants are, as rural participants seem very undecided. The reason for this is not clear.

Age

Furthermore, age was analysed. The ages of the respondents was filtered to see if there existed a difference in responses between individuals from different age groups. These age groups included: 1) 0-18 years of age (3 respondents), 2) 19-30 years of age (46 respondents), 3) 31-50 years of age (54 respondents), 4) 51-65 years of age (14 respondents) and 5) 65+ years of age (1 respondent).

Starting with questions number 1-4, 6, 12 and 20, no great differences between responses existed, as ratios between groups were in proportion (for example, yes to know of a ratio of 2:1 across all groups) and no great anomalies existed. Also, certain questions showed no pattern nor great differences between responses, as was the case for questions 13, 16, 17, and 18.

Moving to question number 5, there existed greater differences between groups with respect to what kind of actions they take to reduce energy consumption at home. While the first option across all age groups was ‘lighting’ (except from group 5 - 65+ years), second option for group 2 (19-30 years of age) and group 3 (31-50 years of age) was ‘appliances’ while responses were more spread out for the other age groups.

As well as the above, question 7 yielded responses: 2:1 ratio of ‘No’ to ‘Yes’ for groups 1) 0-18 years of age, 4) 51-65 years of age and 5) 65+ years of age, while, for group 2 (19-30 years of age) and group 3 (31-50 years of age) ratios of almost 4:1 (36 No, 10 Yes) and 5:1 (45 No, 9 Yes) existed. This suggests the two groups that have perhaps the most knowledge of renewable energy (as they are young to middle aged adults) and who possess the resources to implement it (as are working age adults) have not done so at a ratio of 4 or 5 to 1, unlike in the other groups. This is something perhaps that could be explored further.

Going on to question 8 yielded responses were proportionate, except the lone ‘No’ answer belonged to group 1) 0-18 years of age. A bit surprising, as one would expect this age group, being a school aged group, to be more aware and conscious of the importance to move away from fossil fuels to renewable energy sources. Perhaps telling of the importance placed to this topic in the educational curriculum.

Coupled with the above, question 9 yielded the responses: Yes (0-18 (2), 19-30 (16), 31-50 (17), 51-65 (6), 66-100 (0); No (0-18 (1), 19-30 (7), 31-50 (10), 51-65 (2), 66-100 (0); I do not know (0-18 (0), 19-30 (23), 31-50 (25), 51-65 (6), 66-100 (1). Here, group 2 (19-30 years of age) and group 3 (31-50 years of age) were the most unsure, as they selected 'I do not know' the most, while the other groups selected 'yes' the most. This suggests that the groups of working aged adults must be better educated and informed of the renewable energy potentials on the island if the shift is to occur.

Furthermore, question 10 had group 1 (0-18 years of age) as the lone group that selected 'yes', this change will lead to conflicts. This either suggests the other groups are confident that such a transition would be accepted and allowed by all, or that the younger generation is better informed about the challenges that such a shift can encounter. These results were mirrored in question 11.

Similarly, question 14 yielded various responses: for groups 1 and 2, 2:1 ratio for will benefit economically to will benefit environmentally (2:1 and 24:13), while groups 3 and 4 were near even with 5:7 and 5:7 respectively. Thus, the younger generations focused more on economic benefits, while the older ones focused more on environmental benefits. Something which one would expect to be the opposite but was not the case here.

Also, question 15 yielded the responses where group 1 answered 'No' 3 and 'Yes' 0 (3:0 ratio, while group 2 answered 'No' 30 and 'Yes' 11 (nearly 3:1 ratio). This contrasted with group 3 – 46 'No', 3 'Yes' (approximate 15:1 ratio) and group 4 – 11 'No', 1 'Yes' (11:1 ratio). Thus, for the age groups 31-50 and 51-65, a strong feeling that the shift will impact them negatively exists. This is perhaps because they see a shift as being both costly (in terms of impacting them economically) and altering the landscape, whereas this is less a concern for the younger groups of 1 and 2.

Moving to question 19, responses were nearly the same in terms of ranking what type of energy participants would like to see in the future on Pico (for example, wind first, solar second, wave third, and so on). However, the sole anomaly was with age group 3 (31 - 50 years of age) who selected the category 'Other' type of energy 11 times, perhaps demonstrating that they are open to more options then what is just normally offered as renewable options on Pico.

Education

Finally, an analysis with respect to level of education was conducted. The groups of basic education (elementary school) (3 respondents), secondary education (secondary school) (57 respondents) and superior education (post-secondary) (26 respondents) were compared.

First, questions that followed a similar pattern of responses across the three groups, and therefore possessed no great differences between responses (as ratios between groups were in proportion) and no great anomalies were identified. This refers to questions 2, 7, 10, 11, 12, 13, 15, 17, 18, 19,

Starting with question number 1, responses followed a similar pattern and ranking across the three groups. The only anomaly was with group 2 (secondary education) whom selected 'thermoelectric and wind' (actual way energy is produced on Pico) the most, with fossil fuels (alone) coming second (the most selected option for groups 1 and 3. This suggests group 2 secondary education level participants were slightly more aware of how energy is actually produced on Pico.

Next, for question number 3, all 3 groups followed the same pattern with all selecting 'Yes' more than 'No': Yes (Basic 2, Secondary 52, Superior 20), No (Basic 1, Secondary 6, Superior 7) (ratios of 2:1, 8.6:1 and 3:1).

Moving to question number 4, responses included an anomaly with Group 1 (basic education) as only they selected 'No' more than 'Yes' (Yes (Basic 0, Secondary 38, Superior 20) No (Basic 2, Secondary 16, Superior 6)). Perhaps making sense, as being younger and most likely not yet working or paying for energy, they are unlikely to make an investment in renewable energy.

Also, question number 5 yielded responses in which patterns were nearly the same across participants, with them selecting the categories of lighting, appliances, selective hour electricity use and reduce energy consumption the most. Only group one selected water and laundry instead of the last two.

Again, question 6 yielded responses in which all groups followed a pattern with positive first, negative no responses. Only anomaly was with neutral, where only group 2 selected neutral, and did so 5 times. Perhaps this can be attributed to group 2's larger sample size. This same pattern held fro question 8, where only group 2 with its larger respondent pool selected 1 'No' and 6 'I do not know' while the other 2 groups never selected either.

Unlike the above, question 9 yielded responses that varied greatly. These results included: Yes (Basic 1, Secondary 18, Superior 10), No (Basic 2, Secondary 5, Superior 6), and I do not know (Basic 0, Secondary 33, Superior 11). Here, group 1 selected 'No' first, and groups 2 and 3 selected 'I do not know' first (but with group 2 doing so at a ratio of 2:1 to the response 'Yes' with group 3 nearly split between the two). This indicates a high level of uncertainty between not just the groups, but also within the groups themselves. This may be indicative of a need to educate the population on Pico on what the potentials of renewable energy for the Island actually are.

Similarly, question 14 yielded various responses that varied with the results: Yes (Basic 3, Secondary 6, Superior 2), No (Basic 0, Secondary 1, Superior 1) and I do not know (Basic 0, Secondary 4, Superior 4). Here group 1 selected 'Yes' exclusively (100% of the time), group 2 selected 'Yes' first, 'I do not know' second and 'No' last, while group 3 selected 'I do not know' first, 'Yes' second and 'No' last. This suggest group 1 with basic education feel the most strongly about the notion that a change to renewable energy will benefit them. Meanwhile, group 3 feels the opposite, that a change to renewable energy will not benefit them.

Next, question 16 gave the answers saw the groups respond and rank responses in the same order, except for group 1 where 100% (3 respondents) indicated they 'do not know'. This suggests members of the population with a basic education level are unaware of the potential resistances this change can encounter and perhaps they should be sensitized to these.

Lastly, question 20 revealed again that group 1 respondents responded 'I do not know' 100% of the time, thereby suggesting what was mentioned above, that need for sensitizing them is needed.

In summary, in this section a discussion of the results collected from the qualitative interviews and the quantitative questionnaires has been presented. From these, it has been possible to gain a greater sense of the openness and preparedness of the population on Pico to a renewable energy transition. Overall, residents seem open to this shift, and they acknowledge that all these forms of energy (fossil fuels or renewables) in one way or another, alter landscapes and interfere with Geography, something that may be studied further. In the next section, conclusions from the comparative analysis, stakeholder interviews and the 120 questionnaires are presented.

7. CONCLUSION

In conclusion, the purpose of this study was, through an energy geography lens, to examine the shift to a new energy paradigm on Pico Island. In order to do this a paradigm shift from fossil fuels to renewable energies was examined on three islands of the EU, then, for the case study Island of Pico, stakeholder interviews were conducted and questionnaires were administered. This allowed for a greater understanding of how such a shift of energy paradigm can occur and it illustrated what are the associated impacts and issues that go along with it.

The field of energy geography has been applied to this study. This is as a ‘geography of energy’ exists due to the fact that energy and geography are tied together as various energies transform the landscape in various ways, while the landscape also transforms energy. Geographers can study this new energy paradigm, for it possesses many spatial and geographical issues, and they, sitting in the middle of various disciplines in the social sciences, possess the toolbox to do this.

Therefore, a geographic lens is needed to understand the reasons why these changes are occurring as well as the implications of them. Geographers can interpret and explain energy infrastructure, energy patterns, decisions, impacts (on stakeholders and the environment), energy-society relationships, global energy trade networks and socio-technical (energy) transitions. Furthermore, geographers can add innovation to studies on energy by adding advanced spatial decision-support for energy planning and technology implementation. Also, they can offer an understanding of how this new energy paradigm will lead to a new landscape, a new way of living with the landscape and a new spatial pattern.

Using an energy geography lens, in this study it was seen how a shift in energy paradigm involves energy changing and impacting the landscape, and in turn, the landscape changing and impacting energy. In fact, all forms of energy, whether they be fossil fuels or renewables, alter the landscape, and conversely, are themselves affected by the landscape. Thus, energy interferes with geography and geography interferes with energy. It is for this reason that energy may be studied by geographers.

This study shed light on the ongoing renewable energy transition of Pico Island in the Azores by conducting: 1) an examination of two EU islands (Samso and El Hierro) that have already undergone a renewable energy transition to a near 100% renewable energy paradigm and then comparing them to Pico Island; 2) 10 qualitative face-to-face interviews with a number of important stakeholders who are aware of the external and internal contextual conditions on Pico Island and their interactions; and 3) administering 120 questionnaires to the general public on the island to gain a quantitative insight into the renewable energy transition on the Island**.**

Results from these analyses were then linked to the objective research questions of the study. These included the following: 1. Is the change to a renewable energy paradigm possible? 2. Who has a role in this and who will drive this change? 3. Does Pico Island have all the capital to control this change? 4. Is everybody aware of this change? 5. Who will benefit more? 6. Who will benefit less? 7. What individual and collective geographies and landscapes will this change (re)build? 8. Will this new paradigm possibly change the outside image of the island, shifting it towards a more positive perception?

Responses to these above questions were gained by this study. These included: 1) a change to a renewable energy paradigm on Pico is possible (almost all believe that it is possible, positive and they are open to it); 2) who has a role and will drive this change on Pico are - the Government (authorities, politicians, city councillors, municipalities, the regional government of the Azores, the EU), Electricity of the Azores (EDA) energy utility company, private sector businesses/companies, institutions (for example, universities), private entities (for example, investors), technicians, the people in general (such as everyone, youth, immigrants) and public entities; 3) Pico does not possess enough capital to allow a shift in energy paradigm to exist (that is, financial capital – money, or political capital – political will) despite possessing the human capital (people, skilled technicians) and environmental capital (renewable energy sources) needed; 4) everybody is not aware of this change; 5) those who will benefit more are – the government (the EU, the regional government of the Azores, the municipalities), companies/ businesses (renewable energy vendors), consumers, institutes, private individuals (investors), the market, public health, the people in general (the human population, the youth, the rich, adults, farmers, fisherman, engineers, teachers) and the export lobby's (Oil lobby); 6) those who will benefit less are: the people, consumers, businesses, politicians, EDA staff, environmental groups, and oil companies; 7) The individual and collective geographies and landscapes this change will (re)build include: the types of energies that are selected and where they are able to be sited/located will affect and impact the landscape, and conversely, the geography, landscape and land uses of the island will affect the type of energy that is selected and where it can be located (be built/rebuilt); 8) this new paradigm will change the outside image of the island, shifting it towards a more positive perception, as this shift would create a positive image of Pico.

In conclusion, while not being a comparative study between three islands, this study has studied one island by looking at the example and experiences of two other islands that possess more advanced renewable energy transitions than that of the case study island - Pico. This allowed for insight into how advanced Pico's transition actually is and offered perspective into understanding the different angles of these shifts. It was concluded that these islands have different energy systems and models that have been adopted, as they possess different geographies and have had different drivers for their respective transitions. Pico, possessing more in common with El Hierro then with Samso (that is, it is not connected to a mainland electricity grid and possesses a similar geography), could perhaps try to adapt the model that was applied by El Hierro to itself. This, however, may be a bit utopic, as it would most likely require: 1) greater management of energy consumption on the Island, 2) the shift to be driven by grassroots level citizen-led groups, 3) a bottom-up approach that is opposite to the top-down approach that has been tried to date on Pico, and 4) the development of a model that fits Pico's reality.

It remains to be seen be seen if Pico Island may follow or adapt the models of the other islands to itself or if it must develop its own model for a renewable energy transition. This is something that requires further study. Such a change in paradigm does seem possible for Pico, as the vast majority of participants believed such a change was possible, that it would be positive for Pico and its image, and they are open to seeing it happen. What is certain is that this shift will bring with it impacts and conflicts, as the landscape affects energy and energy affects the landscape. How, if and when Pico will achieve a 100% shift of paradigm remains to be seen.

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ANNEX

ANNEX I - Stakeholder interview questions used for the Pico case study qualitative analysis.

INQUÉRITO SOBRE ENERGIA RENOVÁVEL NA ILHA DO PICO
UNIVERSIDADE DE COIMBRA
Dissertação de Mestrado em Geografica Humana, na área de especialização em Geografia Humana, Planeamento e Territórios Saudáveis, oreintado pelo Doutor João Luís Jesus Fernandes, apresentada ao Departamento de Geografia e Turismo da Faculdade de Letras da Universidade de Coimbra.
2017

UNIVERSIDADE DE COIMBRA

Mark Joseph Soares

GEOGRAFIA HUMANA E NOVOS REGIMES ENERGÉTICOS -
O CASO DE PICO ISLAND, AÇORES

ENTREVISTA SOBRE ENERGIA RENOVÁVEL NA ILHA DO PICO
Agradeço a sua participação nesta pesquisa sobre a mudança para a energia renovável no Pico.

Seção 1: Perfil pessoal:
Data da entrevista: ___/___/___
Idade: ____
Sexo: ☐ Masculino ☐ Feminino
Nacionalidade: ____
Nível de Ensino: ☐ Ensino Médio ☐ Bacharelado ☐ Mestrado ☐Doutorado ☐ Pós-Doutorado
Posição de trabalho atual e local de trabalho: ______________________________
Residência atual: Concelho: ____________________________________
Freguesia: ____________________________________

Seção 2: Questões de Energia Renovável:
1. O que vem à sua mente quando se menciona a energia renovável?

2. Você acha que a maneira atual de produzir energia para o Pico é boa ou ruim? Por quê?

3. Você está aberto para uma mudança de paradigma na produção de energia, a partir da implementação de energia renovável para no Pico?

4. Você está ciente de quais são os planos futuros / Estratégias Energéticas para a Ilha?
(e.g., Existe uma estratégia de energia política?)

5. Você tem um plano de energia (e.g. em seu concelho) - quais são os seus futuros planos energéticos)?

6. O Pico possui condições ambientais adequadas para apoiar / produzir energia renovável?

7. A ilha do Pico tem todo o capital necessário para controlar e permitir que essa mudança aconteça?

8. O seu Governo / Administração / Departamento / Ministério está pronto para esta mudança?

9. Quem você acha que possui um papel preponderante/importante na mudança para energias renováveis no Pico?

10. Quem vai impulsionar esta mudança para energias renováveis no Pico?

11. Todos estão conscientes dessa mudança?

12. Quais as dificuldades ou resistências que esta mudança irá encontrar?

13. Como você acha que uma mudança no uso de combustível fóssil para as energias renováveis, afetará / impactará a paisagem do Pico?

14. Como você acha que a paisagem afetará esta mudança? por exemplo, os tipos de energia selecionados?

ANNEX II – Renewable energy questionnaire for Pico Island case study quantitative analysis.

INQUÉRITO SOBRE ENERGIA RENOVÁVEL NA ILHA DO PICO
UNIVERSIDADE DE COIMBRA

Data da entrevista: ______/________/________

Idade: ____

Sexo: ☐ Masculino ☐ Feminino

Nacionalidade: ____

Nível de Ensino: ____

Posição de trabalho atual e local de trabalho: ____

Residência atual: Concelho: _____________________Freguesia: _________________________

Secção 2: Conhecimento e Percepção das Energias Renováveis

1. Na sua perspetiva, como é produzida a electricidade no Pico?

____

____

2. Qual a % dos gastos familiares que dedica à energia? Isto é, de todos os gastos que faz, qual a % desembolsada/gasta para a energia? (valor aproximado)

____

____

3. Você usa Gás (Gás natural, propano, butano, gás de petróleo liquefeito) para aquecer a sua água? ☐ Sim ☐ Não

4. Está disposto a fazer algum investimento para usar mais energias renováveis? ☐ Sim ☐Não

5. O que você faz para economizar energia?

6. Qual é a sua percepção sobre a energia renovável? ☐ Positivo ☐ Negativo ☐ Neutro

7. Você já implementou algum tipo energia renovável? ☐ Sim ☐ Não

Se sim, de que tipo? Por exemplo, solar, eólica, outro? ________________________________

E onde? Em casa? No emprego? No transporte?______________________________________

8. É importante mudar de combustíveis fósseis para fontes renováveis? ☐ Sim ☐ Não ☐Não sei

9. A energia renovável pode fornecer 100% da eletricidade do Pico? ☐ Sim ☐ Não ☐ Não sei

10. Uma mudança para energias renováveis levará a conflitos no Pico?☐ Sim ☐ Não ☐ Não sei

11. Todos estarão de acordo sobre essa transição? ☐ Sim ☐ Não ☐ Não sei

12. Quem se beneficiará mais diante de uma mudança para a produção de energia renovável?

____

13. Quem se beneficiará menos diante de uma mudança para a produção de energia renovável?

____

14. Você acha que uma mudança para energia renovável no Pico pode beneficiar você?

De que modo? ____

15. Você acha que uma mudança para energia renovável no Pico pode prejudicar você?

De que forma?____

16. Quais as dificuldades ou resistências que esta mudança irá encontrar?

17. Esta mudança vai criar uma imagem positiva do Pico? ☐Sim ☐Não☐Permanecerá a mesma

18. Como você acha que serão as suas percepções sobre o Pico após a mudança? Elas vão…

☐ Melhorar ☐ Diminuir ☐ Permanecer as mesmas

19. Que tipos de produção de energia você quer/prefere que o Pico use para produzir sua eletricidade no futuro?____

20. Você está disposto a promover energia renovável no Pico? ☐ Sim ☐ Não ☐ Não sei