LUMES Masters Thesis
Date: June 2008

Factors Influencing the Development of Local Renewable Energy Strategies:

The cases of Lolland and Samsø Islands in Denmark

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Masters of Science Degree:
Lund University Centre for Sustainability Studies
Lund, Sweden, May 2008

Thesis for the fulfilment of the Lund University's Masters of Environmental Studies and Sustainability Science

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Acronyms

RE	Renewable Energy
BASS	Baltic Sea Solutions
CTF	Community Testing Facilities
DEA	Danish Energy Authority
DKK	Danish Crowns
EU	European Union
IPCC	Inter-governmental Panel on Climate Change
kWh	Kilo-Watt hour
LOKE	Lolland Energy Holding A/S
MW	Mega-Watt
ND	No Date (in case of reference)
SEC	Samsø Energy Company
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

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Abstract

Climate change is now one of the most significant challenges our planet has ever faced. The increasing emission of Greenhouse Gases (GHGs) into the Earth's atmosphere directly contributes to a series of devastating impacts affecting the entire planet. Furthermore, fossil fuel consumption is forecasted to remain the primary source of energy for a long time. In order to reduce GHG emissions and fossil fuel dependency, international and national strategies propose the increased use of Renewable Energy (RE) as an alternative. However, while some level of political will does exist, challenges persist and can be difficult to overcome, at all levels. This study addresses the non-technical barriers and the important factors which represent the key elements for the development of RE in two local settings. The study focuses on RE in Denmark, a clear example of a country with a high commitment and long experience in the development and implementation of alternative energy sources. It examines the successful development and deployment of local RE strategies and projects in two local (island) settings, Lolland and Samso. Furthermore, it explores the factors influencing RE deployment and it addresses the barriers which can obstruct the implementation of RE and some of the main actors involved at the local level. Finally, it explores some of the possible benefits obtained by the successful development of RE strategies at the local level. The purpose of the paper is to gain insights regarding the barriers and factors that influence RE development, so as to come up with concrete suggestions that can be utilized by other local regions in the developed world that wish to make a shift towards greater use of RE.

Key Words: Renewable Energy, Local Strategies, Development of Renewable Energy

Acknowledgements

In writing such words, I know this Swedish adventure will soon come to an end. While visions of polar bears did not manifest, other opportunities, far greater, did. To LUMES for provoking thought and for assembling a great group of students, not only as academic colleagues, but more so as friends; to thank you all, I would need a few pages. Al, Andrea & Theo…Thank you guys for all the help and support on this; to Torsten, Resh, Jen, Nacho, Fran, Theo, Laurent and all, I can't imagine living or learning without you. The roots for positive change come from the hope and respect we learn from those we admire most: *Muchas Gracias* Madre, Manuel y Charlie no lo hubiera logrado sin ustedes en ningun momento de mi vida. With such strong support behind me, I have courage to go ahead. And to Jenni, we have learned from each other and grown; thank you for challenging and supporting me – I hope I have done the same.

1. Introduction and Background

The increasing emissions of greenhouse gases (GHGs) into the Earth's atmosphere from fossil fuel burning, deforestation, livestock-farming and other human activities has resulted in complex climate variability leading to an imbalance in the globe's atmosphere, biosphere and oceanic ecosystems[1]. Climate change is already influencing sea level rise, agricultural yield, forest-cover reduction, water resources and phenomena such as storms, cyclones, landslides and floods (IPCC, 2007).

Because its effects are global, efforts to find a solution for climate change require global, national and local governmental action. Within the framework of strategies to reduce the production of GHGs, the energy sector is one of the most important, requiring a substantive shift in energy production from fossil fuels into renewable energy (RE). The actual and projected dependency on fossil fuels – accounting nearly for 80% of total energy requirements – and the environmental consequences attributable to their use suggest an urgent need to change our energy production patterns (IEA, 2006). The increasing global and local impact induced by these fuels has instigated policy and technical support towards the use of RE technologies as an alternative to reduce the threats (IPCC, 2007). Drastic changes are happening and the commercial viability of RE technologies is currently at a turning point; they are fast becoming attractive due to various environmental, social and economic reasons.

However, even though technologies to exploit RE are becoming more available, affordable and accepted, the overall process of developing them encompasses a series of challenges which have to be addressed in order to overcome potential obstacles that might hinder their wide dispersion (Geller, 2003; Mendonça, 2007; McCormick, 2007).

1.1 Climate Change

Climate Change is a global phenomenon directly attributed to anthropogenic GHGs emissions (Boyle, 2004: 10). Confirmation of this was mentioned in the 2007 Intergovernmental Panel on Climate Change (IPCC).[2] This report stated that a major contributor to climate change is carbon dioxide (CO2) since its atmospheric concentration has remarkably exceeded pre-industrial levels (ibid). Such concentrations suggest varying degrees of oncoming environmental, economic and social consequences (ibid). Unfortunately, CO2 emissions[3] are primarily derived from the main source of modern energy: that of fossil fuels. The use of such fuels, on which modern lifestyles are dependent, supports a variety of activities: electricity production, heating, transportation and different derived products.[4] Additionally, perspectives for the short- and medium-term do not forecast a reduction in the consumption of this energy source (IPCC,

[1] Scientists predict that if the current trends continue, it is expected that the concentration of greenhouse gases in the atmosphere will double by the end of the century and that this will have a profound impact on the social, economic and environmental aspects of all states and people (IPCC 2001a).
[2] *"Warming of the climate system is unequivocal….Changes in atmospheric concentrations of GHGs and aerosols, land-cover and solar radiation alter the energy balance of the climate system. Global GHG emissions have increased markedly due to human activities…"* (IPCC, 2007)
[3] Accounting for 56.6% of the share of GHGs in total emissions by 2004 in terms of CO2-eq (IPCC, 2007)
[4] The electricity sector and heating sector (in the case of Denmark) represents at large extent around the 40% of the total emissions (UNFCCC, 2005).

2007; IEA, 2006).[5] Accordingly, with the threat of climate change looming, governments, organizations, companies and individuals have begun to identify the necessity to direct their energy supply towards a different path.

1.1.1 International Participation – Kyoto Protocol

The environmental consequences instigated by climate change will trigger extensive economic and social impacts, in addition to environmental burden. These impacts call for international cooperation since they will involve and influence everyone (Carter, 2001: 225). The acknowledgment for urgent action pertaining to such trans-boundary[6] challenges has been part of the international agenda for several decades. As such, there are various international agreements and policy-adoptions regarding climate change, realized through a long process of growing scientific concern and evidence dating back to the 1970s. In 1992, the United Nations Framework Convention on Climate Change (see Chapter 2) was formed in order to face these challenges at the international level (Carter, 2001: 233).[7] For its purpose, a series of principles – not all of which were well-defined – were included. Real defined targets to reduce the emissions were not stipulated. As such, there was no clear binding clause in the document..

In 1997, member states of the UNFCCC[8] started negotiations on an international agreement to create a legally binding protocol. The *Kyoto Protocol* includes the basis of the convention but also commitment levels by which every country is allowed to release a certain amount of emissions for a set period. For the purposes of this study, the Kyoto Protocol provides the basis of action where parties seek to promote sustainable energy by supporting the development and use of renewable forms of energy (Article. 2, a (iv)).

1.2 Renewable Energy

Across the planet, different countries use different energy sources to meet consumption demands, industry and support public infrastructure (i.e. public transport, public buildings, etc.). As a result of the consequences created by the primary sources of energy – fossil fuels – and in order to minimize present and future contributions to climate change, there are a variety of recommendations coming from the scientific community, as well as other significant actors, who call for the development of alternative solutions (Commission Proposal COM (2000) 796 final; IPCC, 2007; Mallon, 2006). Amongst these, one mechanism by which to reduce GHG emissions – and especially that of CO2 – is the diversification and utilization of alternative energy sources that release far less (arguably even zero) GHGs. These energy sources primarily come from solar-direct and solar-indirect (hydropower, wind and bioenergy), and non-solar power, such as tidal and geothermal (Boyle, 2004). All of these have been exploited by humans, some for thousands of years and others only for a few decades (ibid).

[5] There is concern about a noticeable increase in CO2 emissions as global energy demand is projected to increase up to 37% by 2030 (IEA, 2005) and 50% by 2050 (Ragauskas, et al., 2006).These projections present a continuous reliance of use of fossil fuels as the primarily source of energy, accounting for nearly 80% of share of the total market (IEA, 2006).
[6] Which affects more than one locality, country or region
[7] The ultimate objective of the document produced was, the "*stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"* (Article 2, UNFCCC 1992)
[8] See Section 3.1 for the creation of the UNFCCC

However, various obstacles exist in developing such RE sources depending on energy source, implementation location, and technology available (Geller, 2003; Mendonça, 2007; McCormick, 2007). It is imperative to study how these can be overcome efficiently, since many positive impacts that can be obtained from (local) RE sources. Apart from dealing with GHG emissions, these also include improving energy supply and security, motivating local development and creating direct and indirect employment (Kelly, 2007).[9]

1.3 The Problem

Projections for the short- and medium-term do not forecast a reduction in consumption of fossil fuels in the world (IPCC, 2007; IEA, 2006). Actually, there is concern about a noticeable increase in CO_2 emissions (ibid). Global energy demand is projected to increase up to 37% by 2030 (IEA, 2005) and 50% by 2050 (IEA, 2006). These projections present a continuous reliance of use of fossil fuels as the primarily source of energy, accounting for nearly 80% of share of the total market (ibid).

For instance, the share of RE in the world calculated in total primary energy supply (TPES) accounted in 1973 for around 0.1% of the total and by 2005 the share increased up to 0.5%. Regarding share of electricity generation, RE accounted in 1973 for about 0.6% of the total and by 2005 for around 2.2% of the market[10] (IEA, 2007). The penetration of RE has not been as significant as it should be in the last fourth decades.

It becomes apparent that direct action must be pursued in order to mitigate climate change. Such action revolves around lowering GHG emissions; among other initiatives, such as reducing energy consumption, the substitution of conventional fuels for renewable ones appears as a one-way path. However there are significant problems that hinder the process of shifting towards a RE society. These problems revolve around the current institutional framework, the modern economic reality, the political circumstances and the lack of awareness from a large percentage of the population in the developed world (Wüstenhagen et al, 2007, McCormick Kes 2007, Gipe 1995, Goldemberg 1996).

1.4 Purpose of the paper

The aim of this research was to examine the important factors that contribute to the development of RE within local regions. Local communities are, in many cases, the strategic area of focus in order to develop RE projects. Therefore, in order to help the development of RE, the local setting should receive some guidance in order to deploy successfully its own resources through a series of strategies. This research focuses on local settings with high rates of production of RE. It identifies obstacles and opportunities connected to RE which have contribute for the development of RE in local settings. As mentioned above, although it is widely acknowledged that RE is necessary, the uptake and measures to develop RE has not

[9] The use of RE meets a wide range of energy needs, if and when the technologies overcome the obstacles for its use. Accordingly, the accomplishment of a wide range of benefits could be obtained at the local, regional and global if it has to attain the goal of sustainable development (Kelly, 2007).

[10] Includes geothermal, solar, wind, tide, wave energy, electricity and heat.

been sufficient, therefore this paper contributes to the general knowledge of developing successful RE strategies based on local setting contexts. The purpose is explicitly to provide information that can aid local regions around the developed world to initiate similar measures. The battle against climate change cannot be fought single-handedly; this paper aims to help local regions that have the potential, to create the institutional, economic and social framework of factors identified from the success stories of Lolland and Samsø. Contributing to the understanding of how local communities develop RE based on opportunities and overcoming of challenges which can portray a series of similar insights occurring in other communities.

In order to reach the stated aim, the main research question for this study is: **What are the important factors that are needed for the successful development and deployment of RE strategies and projects at the local level?**

In order to answer the main research question and achieve the purpose of the paper, the case study of two islands in Denmark is discussed. The following are secondary research questions:

- What are the main actors for the development of RE?
- What are the key constraints (challenges/barriers) involved in the implementation of RE?
- What factors influence the development of RE in Denmark?
- How has Lolland and Samsø developed and implemented RE strategies at the local settings?

1.5 Methodology

The research justification stems from an interest to study factors influencing the development of RE in order to reduce dependency on fossil fuels. To answer the research questions and the objective of this thesis, the research employed a qualitative research approach (Bryman, 2004) and a case study methodology. While qualitative research is sometimes considered soft social science research according to some, it can be hard-nosed, data-driven and outcome-oriented (Yin, 2003).

Firstly, a literature review was conducted. The literature followed a compilation and examination of official documents, academic literature, online information and different official statistics regarding RE. The literature helped identify the main challenges and barriers in RE development, as well as the significant actors who influence the process. Then, a general overview of the global and European perspective regarding RE is presented, as well as a discussion of the Danish reality regarding RE. The case studies (Lolland and Samsø Islands) are subsequently presented to understand the development of RE at the local setting.

As the purpose of this research is to contribute to the understanding on how these two localities (Lolland and Samsø) have developed strategies for the success of RE development. Contact with main actors in the field was carried to understand the reasons behind the actions taken to put in practice the utilization of local resources, and find the important factors influencing the development of RE in the localities.

The actors contacted for this research are as follow:

Contact with the Municipality of Lolland. In specific, with the department of Business Development of the Municipality in order to: understand the background and development of the island regarding RE.

Interview was carried with the Project Director to understand the perspective of the Municipality towards the exploitation of RE, and how the municipality is involved in the projects.

Contact with the company in charge of different projects on the island (Lolland). Interview with the director of the company, in order to understand how this actor has helped the development of RE strategies in the local setting. Interview with the technical expert was carried out, since this person has put in practice some of the projects and has experience the implementations. This was done in order to understand constrains (challenges/barriers) the projects have faced in the specific setting.

Contact and interview with the center in charge of agricultural/agro industrial activities of the island (Lolland) was realized to identified the challenges/barriers one of the projects the island is executing.

Contact and interview with local farmers and citizens was performed (Lolland Island), in order to understand the perspective of this actor regarding projects of RE. These interviews were elaborated to understand their reasons to use or change systems (heating and electricity) and have the perspective of the local actor which become directly or indirectly affected (positively and/or negatively).

In the case of Samsø, the Municipality was contacted and the interview was carried with the body of the municipality which was/is in charge of RE developments and implementation of the main project the island executed in the last decade. This was done in order to understand all the factors, obstacles and challenges the island faced during the years of development of RE and the implementation of the strategy.

The study uses qualitative research approaches, which attempts to describe the "how" and the "why" of the relationship or circumstances which stimulate RE implementation in the two island settings, as proposed by Yin (2003), who argued that a two-case study is preferable than a single-case design because more units of analysis lead to more insights of the studied area. After initial background research about the island situations was conducted, site interviews were performed in order to gain more insights of the situation. The interviews were conducted via a semi-structured format as recommended by Yin (2003). The interviews with various actors were conducted on two visits to Lolland Island. The list of specific actors who were interviewed, along with the rationale leading to the choice of interviewees, can be found in Appendix I, the list of questions presented to the different actors in the islands are listed in Appendix II, III, IV and V.

To complement information regarding Samsø island, review of secondary data was carried out, where pre-recorded interviews were available (a documented video of the project – (Stubkjær Leif, (ND), European RE islands. Miljø Media. (DVD))**,** in order to understand the process and how key actors were involved in the projects. (Interview questions in APPENDIX IV). The case study findings were subsequently compared to common barriers and factors that influence RE development described in the literature.

1.6 Scope and Limitations

This study focused on Danish initiatives undertaken to tackle climate change within the sector of RE development. While numerous technologies fall within this category, this thesis primarily refers to PV panels, windmills, solar heating, and biomass energy sources. Particularly it addresses such RE systems

within local (island) settings in Denmark. On Samsø Island, this refers to wind turbines, biomass, solar PV and thermal. Regarding Lolland, some of the RE projects on the island are discussed, as they presently stand. Economic particularities pertaining to RE technologies and cost are not included. In addition, the Danish Domestic CO2 Cap and Trade Scheme 2001-2004 is not discussed. Furthermore, while the author recognizes the importance of CO2 taxes at the national level for electricity and space heating, this thesis primarily addresses local factors influencing the development of RE strategies, in order to scope the study. Finally, the study only briefly mentions the liberalization of the electricity market (NORDPOL) as a consequence of the variability of prices in the energy market.

Concerning particular (practical-issue) limitations, they are as follows: obtaining documents and data in English (especially in the case of Lolland) was a challenge, while time constraints and contacting relevant persons for case study visits was quite difficult. It was possible to visit Lolland and interviews were conducted onsite. However, it proved more difficult to realize a visit to Samsø because of lack of answer from key informants, and thus interviews were only conducted via telephone.

2. Background

This chapter utilizes the related literature to identify the main actors which can be involved in local RE strategies, based on a series of socio-economic and environmental considerations. It provides information that will help answer the following questions: What are the main actors for the development of RE strategies? What are the key constrains (challenges/barriers) involved in the development of RE strategies?

2.1 Main Actors

Government

In a democratic state the government is ruled by the people and is responsible for the social *welfare* of a society, dependent on a set of institutions that constitute the state (Mallon, 2006). The role government plays is of vital importance for the deployment of RE. If RE technologies are left to participate in the open market as a product to compete with actual players, their possibility for survival may be questionable. The current set of distribution favors significantly traditional practices, such as fossil fuels, which have been heavily subsidized in the past years (ibid.). To propitiate this, the right incentives are required to place market signals, *market acceptance*, to achieve the aims market-related actors (suppliers-costumers) pursue. The government, through policy implementation, is responsible for an integrated strategy to enhance community acceptance (ibid).

Regional/Local Government

Regional and local government performs responsibilities at the root of the governmental structure and works directly with citizens. Regarding GHGs, it is responsible for the implementation of policies that affect at the direct level their emission: in the building sector (planning decisions), lighting of public

buildings or electric/heating services, etc. Local participation in climate policy is crucial as it can have an active role in mitigating global warming. Some challenges regional and local governments face are: the actual power they have to steer and operate local initiatives (which in some cases might not be enough) and a reduced economic capacity to implement measures (Mallon, 2006). An increase in their role as main actors for problem-solving solutions (development of RE strategies) can lead to tangible or materialized solutions.

Business

Companies operate with a clear rationale: "The *objective* of the *corporation* is to maximize stockholder (shareholder) value expressed either as *maximizing* long-run *profits*, growth or dividends" (Friedman and Miles, 2006: 3). Depending on the sector and size where a firm performs, their interests will influence different social and political spheres. Local companies can influence local governments, sometimes significantly. Large corporations have the capacity to influence at the local or national level. For instance, large players in RE have the advantages and capacity to push *market acceptance* of *technological transformation systems.* Additionally, capital corporations (banks) play a role in RE implementation. These corporations can participate as *prime market movers* and can be directly benefited by a new market niche. Some large banks offer credits for RE projects, for example: Citigroup and Royal Bank of Canada (REN21, 2006). Such actors can facilitate a *mainstream*[11] to propitiate market and socio-political acceptance.

Non Governmental Organizations

NGOs are referred as a wide range of non-governmental organizations, which can be differentiated by geographical terms of activities, interest issues, and types of activities. NGOs are non-profit and function as pressure groups (Betsill and Corell, 2008; Mallon, 2006). The role of these organizations can have different aims, examining at different sectors of the society. They can aim to protect the environment, or be economically-interested organizations, such as the International Chamber of Commerce[12] or the Global Climate Coalition (Betsill and Corell, 2008). In broader terms, NGOs represent the community, corporations and interest groups – with the rationale of *not making profit*, as opposed to corporations. These organizations function as pressure groups at all levels of society. They are of strategic importance as, in democratic societies, they can *lobby*[13] to influence the creation, change and adaptation of RE policies.

Local Communities

Many challenges related to the development of RE are found at the community level (Wüstenhagen et al., 2007). Such actors can be responsible for the mainstream of micro-generation technologies[14] and have the capacity to invest at different project-levels. Citizens can participate in (household) projects to reduce energy consumption or, at the collective level, in cooperatives to implement larger technological solutions

[11] The ideas, attitudes, or activities that are shared by most people and regarded as normal or conventional (*Oxford Dictionary of English 2005)*
[12] The first to be considered and accredited by the UN
[13] Practice of influence legislation, inducing or persuading politicians to act in favor or against legislation.
[14] PV thermal, PV panels, wind turbines etc. Any RE technology with the capacity to supply energy at small scale.

(i.e. wind turbines). Thus, direct and indirect consequences will affect this actor at different levels. At the local level, citizens (as key actors) influence the success of RE implementation, via grassroots movements (usually NGOs), or personal initiatives with community repercussions.

Academia

As will be explained in Section 3.1, the international scientific community is responsible for creating legitimacy and awareness of the problems caused by GHG emissions. This actor creates knowledge-based alternatives for discussions. Such a contribution represents to a large extent the element to persuade and transform policy at top-governmental level. Blegaa et al. (1977) mentioned that this actor played a significant role in the 1970s, influencing the Danish Government to incorporate an advanced energy plan for the time.

2.2 Local Matrix of Actors in Renewable Energy

According to the above discussion, a variety of actors can be identified to hold relevance in RE implementation. Their direct and indirect economic (as well as social and environmental) impact is described below:

Table 1 Main Actors Matrix

Actor	*Direct economic impact*	*Indirect economic impact*	*Environmental impact*	*Social impact*
• Government • Local/Regional Government • Business • NGOs • Local Communities • Academia (Scientific community)	Experienced by project developers, financiers, employees, fuel suppliers, landowners, citizens, farmers, and local municipality .	Are the stakeholders who will or could experience secondary financial impacts: as individuals, communities or countries as a hole, since the RE project could create a distributed cost	Are the issues related to climate change, species – specific, among others Such impacts are referred to the physical changes on biological activities and biodiversity.	Such as, landscape changes, infrastructural impacts as the one referred as aesthetics, visual effects etc. However, for the implementation of RE, the possibility of being affected takes place at the local, regional, national and even global level. Researchers, consultants and academics can have an important awareness of the problems and benefits caused by RE implementations.

Adapted from Mallon (2006)

According to the previous table, it should be re-emphasized that, at the local level, address and inclusion of actors is an essential element to generate pressure, create or change policy, engender changes at the structural level and influence the impact of RE development. Local governments materialize solutions and act at the root of the governmental structure with the capacity to have direct influence on decisions in partnership with citizens. They are responsible to portray the local benefits/outcomes of RE implementations.

NGOs as lobbying or pressure groups (at different levels) can represent a winning element of policy creation, delay, adoption or change. These stakeholders can help shape the possible outcomes of RE development and have the capacity to create social acceptance of RE innovation at the local and national levels. Community acceptance can act as the catalyst for small-scale RE technologies and, arguably, in some cases contribute as an *approver* of certain decisions. Leverage support from actors (at all levels) with

different power and influence can contribute to networks, and lead to more acceptance or even speed up the process of adoption of or innovation of RE technologies.

2.3 Renewable Energy Barriers

There are indeed many environmental (and other) opportunities to incorporating RE; however challenges persist at all levels. The following challenges exist at the international level: i) Expanding world population: forecasting an increase in energy consumption; ii) Fossil fuel consumption and correlated economic development requiring a gradual change to alternative energy sources (Geller, 2003*);* iii) Access to renewable technologies and their applicability (Mallon, 2006).

The process of dealing appropriately with these challenges is influenced greatly by a set of barriers that need to be overcome in order to successfully develop and implement a coherent RE strategy. Such (potential) barriers are listed in Table 2 below. Accordingly, to prevent or deter from such barriers, Wüstenhagen et al. (2007) suggested the concept of social acceptance of renewable energy innovation as a necessary part to incorporate the non-technical factors which can create obstacles related to the implementations of RE, described in Section 2.4.

Table 2 Renewable Energy Technology barriers:

Source	*Barriers to RE*	*Comments*
European Environment Agency (2001)	• Political and Fiscal • Legislative and Administrative • Financial • Information, ed. & training	Lack of political support. Appropriate framework. Long term financing. Final end user prices. Lack of practical support at the regional & local level.
Geller (2003)	• Limited supply infrastructure • Insufficient info & training • Lack of money or financing • Purchasing procedures • Pricing & tax barriers • Regulatory & utility barriers • Political obstacles	Lack of energy efficient products and poor quality of them. Lack of information among consumers and business. The know how to design or implement the technologies. Ownership structure for acquisition of energy saving devices. Not internalization of real costs. Tax policies hindering investments. Conflict of interests.
Mendonça Miguel (2007)	• Cost and Pricing • Legal and Regulatory • Market Performance	Subsidizing schemes for fossil fuel sources. Lack of assessment over future costs. Governmental preferences to large-centralized production. Investment risk and uncertainty.
McCormick (2007)	• Economic conditions • Know-how & institutional capacity • Supply chain coordination	Economic support at national and local level / risk. Knowledge of support schemes. Coordination of actors to share risk. Unrealized potential.

These sources indicate that three barriers can be described as the main factors obstructing the development of strategies for RE. These are:

1) Lack of Political support: Political Support (at the national and local/regional level) and know-how (of the citizens and local politicians) in order to develop the strategies which can foster deployment of RE. Along with the necessity of the understanding of the national political sphere, the necessity of local governments to take actions and decisions for the use of local resources can be found as a main obstacle for RE. At the same time, policies to encourage the use of RE is seen as a common issue for different technologies (Geller, 2003; Mallon, 2006; Mendonça, 2007).

2) Lack of Information, Education and Awareness: There seems to be a significant lack of knowledge regarding the solutions, of education regarding climate change issues, and of awareness about the existence of alternatives to become self-sufficient with the appropriate use of RE sources. This is a predominant key issue to focus on when considering the development of RE strategies and delivery of solutions. Information provided to governments (national or local) or citizens regarding the threats of climate change but also about the various co-benefits that arise from the use of RE can induce the use of the local resources. This factor can influence the increase of use of RE while appropriate strategies to develop RE could (and should) incorporate this factor. This could be facilitated by the formation of networks or partnerships among producers and/or consumers in order to exploit resources (allowing them to know about opportunities for funding or technologies) (McCormick, 2007; European Environment Agency, 2001)

3) Lack of funding or economic conditions: The lack of financial mechanisms or financial schemes to support the deployment and use of technologies is considered one of the main barriers, according to the literature. This is augmented by the current status quo and its systemic conditions which have capitalized on the use of fossil fuels for decades. However, there are significant examples of the feasibility of changing this process. National economic supportive schemes have developed large RE markets; good example would be the case of windmills in Germany and Spain (Geller, 2003; Mallon, 2006; Mendonça, 2007).

In order to overcome these barriers, a theoretical framework needs to be developed that will aim to facilitate understanding of their influence. This will be accomplished in this study by utilizing the concept of social acceptance, discussed further on. The political challenges can be understood within the framework of socio-political acceptance of RE, citizen participation can be viewed as an issue of community acceptance, while economic considerations are a part of how the new market of RE is accepted within the financial system of current times. All these will be discussed further as the barriers RE faces.

2.4 Social Acceptance of Renewable Energy[15]

Several issues that pertain to energy have attracted widespread debate from many different actors involved in the process, not the least from the public. Social acceptance seems to be an important variable that dictates whether technologies are adopted or not.[16] Social acceptance factors play a role in relation to the potential risks of a technology's use; in which hostility towards large plants, projects and storage facilities may be expressed by ordinary citizens (Colombo, 1984). These non-technical factors represent issues that can significantly shape the pre-debate and subsequent implementation of a particular project (Carlman, 1982; cited in Wüstenhagen et al., 2007). Two main conditions that influence this process, especially in relation to RE, is how firstly they are accepted or even encouraged as an alternative at the national level and how the

[15] Wüstenhagen et al. (2007) state that there is not one specific definition describing social acceptance; but many definitions persist. Hence it becomes difficult to define in absolute terms. However, Wüstenhagen et al. state *social acceptance* in RE implementation encompasses three primary elements: socio-political acceptance, community acceptance and market acceptance.

[16] Nuclear plants and the storage facilities required are an example in which social acceptance has played an important role (ibid). But some factors related to the acceptance of projects slowed down the adoption of nuclear technologies in some countries. Denmark did not adopt the energy plan that included the use of Nuclear energy (Blegaa et al, 1977)

process of adoption is carried out at the local level (Wüstenhagen et al, 2007). In both cases, public opinion acts as a mediator that can significantly affect whether a given proposal is actually implemented or not.

2.4.1 Socio-Political Acceptance

McCormick (2007) defined socio-political issues, which include the process of how actors (individuals and organizations) make decisions, resolve conflicts, form partnerships, respond to government policies and engage with public issues. Such issues correspond to a combined connection between the nature of related policies, power[17] and the public. Political issues regarding the interests of powerful actors in the form of coalitions amongst strong interest actors contribute extensively to the adoption (or determent) of policies related to RE (Geller, 2003). This dimension of social acceptance can explain the differences between countries with high and low RE implementation, in which political will has already taken action (ibid). Within this element, acceptance of technologies and policies, the public level of acceptance of key actors, and policy-makers are components enhancing (or deterring) effective RE policy development.

2.4.2 Community Acceptance

Deciding whether to adopt a framework that benefits or hinders RE development affects primarily two main actors in the process: local residents and the municipality. Wüstenhagen et al. (2007) stated that the debate of the Not In My Back Yard (NIMBY) syndrome takes place; regarding wind turbines, factors include the visual impact, noise, landscape-visual density and even reflex impact from turbines blades (Gipe, 1995). This is an area where consultation and inclusion of local residents is crucial to succeed in implementation. Geller (2003) included the barrier of *insufficient information and training* as a reason of unawareness of RE options, benefits or financing opportunities. In this barrier to RE development, lack of credible information to costumers and possible investors is an important variable.

To achieve the benefits obtained by a sound RE strategy, a successful overcoming of such barriers should be addressed. Examples of windmills projects in England or new implementation in Germany (Wüstenhagen et al, 2007) reflect the social, economic or political challenge of adopting RE.[18] Accordingly, many of the barriers that hinder RE diffusion occur at the local level. It can be concluded that the non-technical barriers which appear exist first and foremost due to the lack of inclusion of the local people.

2.4.3 Market Acceptance

From a technological innovation systems perspective, the acceptance of technologies in the energy market focuses on networks, institutions and firms' perceptions and strategies (Jacobsson and Johnson 2000). Following this, Wüstenhagen et al. (2007) maintained that smaller-scale RE (micro-generators, solar thermal and PV panels, small wind turbines, etc.) take a perspective of diffusion of innovation. In this

[17] Power can be defined as: "A relationship among social actors in which one social actor, A, can get another social actor, B, to do something that B would not have otherwise done" (Mitchell et al, 1997; 869)
[18] Regarding bioenergy systems, the EU projections for 2010 seems to not accomplish the targets of implementations proposed of around 145 Mtoe. where many non- technical factors are considered (McCormick, 2007).

dimension of social acceptance, consumers take different roles as directly or indirectly physically impacted. Directly impacted consumers may align with the concept of market acceptance, as a decision to develop a project will have a local economic impact and will directly affect their livelihood, if implemented in their own residences (for instance, as a privately-owned windmill). In the analytical framework presented by Jacobsson and Johnson (2000), technological innovation and in particular the diffusion of RE technology can be attributed to the actors involved in the process and their competence. Such actors influence a project technologically, financially and/or politically.

2.5 Potential Benefits of RE adoption

While this research addressed overcoming of barriers to RE implementation, it also recognizes that benefits exist. RE implementation can have a variety of benefits: i) *environmentally*, the reduction or elimination of emissions contributes enormously to the objectives of reducing global warming, while it also aids into lowering the concentration of pollutants in the atmosphere; ii) *economically*, the energy security provided by localized energy sources, as reinforced in EU documents, can lead to different benefits: the creation of jobs, reduced dependence on external energy sources, and development of a market with long-term perspectives (Mallon, 2006); additionally many localities promote sustainable development based on the exploitation of RE; finally iii) *socially*, benefits such as the interaction of the community can create a sense of union, and networks that can have an important role in the locality; moreover, the increased quality of life resulting from a cleaner environment enhances well-being of citizens.

2.6 Summary of literature findings

Actors: Identifying the key actors that influence the development of RE is an important part of understanding the key constraints (challenges/barriers) and opportunities involved in the process. The literature indicates that a particular set of actors hold similar but also differentiated objectives, capabilities and level of influence regarding RE. National, Regional and Local governments have the capacity to place the necessary factors which can influence the process through appropriate national or local policy; economic or financial conditions that can stimulate the decisions to create strategies to implement RE. On the other hand, this actor can give information, education and awareness to the population in order to adopt RE solutions. Other important actors are local business, NGOs, citizens and academia which can influence the local government to create knowledge and the basis for the deployment of local RE. At the same time, business and citizens can accept being directly or indirectly economic impacted and social impacted at different levels which can influence the community acceptance issue discussed above.

Barriers: In conclusion, the main barriers that need to be addressed in order to reduce the obstacles to develop RE strategies are: i) Lack of political support, ii) Lack of information, education and awareness, and iii) Lack of funding or economic conditions.

Political support is a complicated issue. Political issues regarding the interests of powerful actors, including industries, have a high influence, for instance in sitting decisions. Coalitions among companies

with strong interests-investments in fossil fuels and derivate products can contribute extensively to the adoption of policies related to RE (Geller, 2003). On the other hand, interests of industries influencing decisions of governments with possible advantages obtained by the use of RE can create a basis for changes in policy supporting RE exploitation along with scientific support (academia and scientific community). On this sphere, the national and local/regional government can create the know-how (of the citizens or companies) in order to develop the strategies which can foster deployment of RE. Along with the necessity of the understanding of the national political sphere, the necessity of local governments to take actions and decisions to use of local resources can be found as a main obstacle for RE.

Knowledge, information and awareness are vitally important aspects of RE development. They can be used as the main medium to highlight the benefits deriving from RE, while pointing out the feasibility of their development. For instance, lack of knowledge regarding the payback time of new system(s) can affect the adoption of RE. Citizens can act as small-scale prime movers stimulating the strategies and the market of RE to expand. This barrier is closely related to the lack of political support regarding RE.

Finally, economic issues are the main force which drives (or can stales) RE development. If political will subsists, availability of funding for RE projects can be established in order to put in practice and carry out the development of RE. On the same line, information about funding can motivate investors, entrepreneurs, companies and citizens to adopt RE solutions (Mendonça 2007).

Therefore, networks of information, coalitions among strong actors at different levels (national or local) demonstrate that if coordination and focus on RE development is presented, political support is presented along with transparent and long term economic conditions. Fulfillment of RE strategies to achieve self-energy sufficiency can be reached.

3. Renewable Energy Policies

This chapter describes the politics surrounding RE at the global, national and local levels, describing the process of adoption of the Kyoto Protocol, followed by the RE policy in the EU. It portrays the challenges and barriers which RE faces and explores the different levels of acceptance required for the implementation. This section helps to understand which factors influence the development of RE in Denmark.

3.1 Global Politics of Renewable Energy

The growing global consumption of energy around the world, access to energy supply, the impacts of energy use and global speculation regarding current and future energy availability have made energy trends one of the most discussed environmental issues within the past decades (IEA, 2006). Under such circumstances, in which traditional availability of fossil fuel energy is influenced by access to a pre-existing

supply, there exists a growing demand to explore other sources of energy. As such, this argument has now entered the energy politics of many countries and at a global geopolitical level.[19]

As a consequence of the Arab-Israeli War in October 1973, an energy crisis and subsequently economic problems emerged in Europe. This led some countries, including Denmark, to incorporate strategies and policies to face the rising prices of fossil fuels (Europa, ND). In the 1980s and 1990s, a slow consensus started to build within the scientific community to legitimize[20] (at the political level) the emerging evidence pertaining to climate change (Carter, 2001). In order to construct a scientific consensus, the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) created the IPCC in 1988 (ibid). This body attempted to create a confident and well-researched source of information which granted legitimacy in the field of environment and energy science (Carter, 2001).

In the first report published in 1990, the scientific community recommended taking political action in which the political strategies at the global level could be implemented with the aim to encourage the use of RE to combat climate change – at both the national and local levels. One such strategy was the creation of the Global Environment Facility (GEF), and the creation of the United Nations Framework Convention on Climate Change (as a global framework) by the World Bank, UNEP and UNDP in 1991 (GEF, 2007; Elliot, 2004). A key priority of the GEF just after its creation was the adoption of climate change "mitigation" and "adaptation" [21] strategies. The UNFCCC entered into force in 1994. Two and a half years (of international negotiations) later, the Kyoto Protocol established the basis to incorporate measures for the future reduction of CO2 emissions within the international arena. However, when the moment for ratification[22] came, some nations decided not to: most notably the case of USA. Strong lobby efforts against ratification came from the Global Climate Coalition[23] (GCC) (Vig, et al, 2004). The USA aside, many nations, including the EU as a whole[24], have ratified the protocol. To achieve the negotiated targets, market-based mechanisms were proposed to help Annex I parties meet their goals.[25] The Protocol entered into force in 2005, with *legally binding* targets and an agreement of 5.2% overall reduction target of emissions for 2008-2012. Within the agreement, the EU adopted a target of reducing its emissions by 8% (Carter, 2001).

3.2 Regional Renewable Energy Policy – European Union

In recent history, Europe has emerged to become the second largest energy market in the world (Commission Proposal COM (2000) 796 final). However, the main characteristic of this market has been a

[19] For example, Brazil has relied on the production of ethanol from sugar cane already since the beginning of the twenty century. However, as a consequence of the high prices of oil in the 1970s, a strong shift in politics emerged, influencing investments in this sector, creating the foundations for an ethanol market

[20] Legitimacy refers to a "generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and definitions" (Suchman (1995), cited in Bissett 2007;20)

[21] The term mitigation refers to the "stabilization of greenhouse gas concentrations in the atmosphere", adaptation is: to "develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods" UNFCCC (http://unfccc.int/adaptation/items/2973.php)

[22] After sign of the Protocol, nations must ratify it within their own political bodies in order to be adopted.

[23] Uniting the oil, coal, automotive industries, amongst others

[24] The EU ratified the Kyoto Protocol in May 2002 (Council Decision 2002/358/EC). Within the Protocol, the EU has redistributed, amongst its members, the "Burden Sharing Agreement". This differentiates the reduction targets among the (at the time) EU15 members

[25] Emissions Trading, Joint Implementation and Clean Development Mechanism

robust dependency on imported fossil fuels. At the present time, around 50% of energy requirements in Europe are fulfilled by imports and projections prospect dependence of 70% to satisfy the demand (ibid).[26]

Dependence on fossil fuels most probably will continue and uncertainty of prices and supply may be questionable in the future. Thus, to counter this trend, EU nations have proposed and implemented national and regional mechanisms to minimize dependency on fossil fuels focusing on the following areas: *security of supply*, *climate change combat* and leadership in *renewable energy markets*. Following international directives, the EU has adopted several proposals.

In 1997 the *Community Strategy and Action Plan* (Commission Proposal COM (1997) 599 final) aimed at promoting the exploitation of renewable energy resources within the EU, avoiding a continuous dependency of imported fossil fuels[1] and conflicts at the global level, while the *Campaign for Take-off* aimed to support local renewable energy production. In 2000 the proposal *Towards a European Strategy for the security of energy supply* (Commission Proposal COM (2000) 796 final) was formulated with the aim to reduce the strong actual and future dependence on imported sources of energy, foster investment to deal with the (assumed) coming energy demand in the region and promote RE as a host of strategies to combat climate change and achieve energy-security. Finally, in 2007 the *Renewable Energy Road Map* (Commission Proposal COM (2006) 848 final) stipulated action against climate change, reduce fossil fuel dependence and the clear promotion of RE. Other proposals regarding specific RE are in discussion among EU countries, but the ones mentioned before are relevant regarding RE in a broader context. According to these proposals, if the EU Member-States adopt the legislative and economic policies related to RE, the new target to achieve 20% of energy coming from RE sources by 2020 can be achieved (Wüstenhagen et al., 2007)[27].

3.3. Denmark and Renewable Energy

This section discusses briefly the Danish Energy Strategy implemented already in the 1970s and following energy plans adopted in the last decades. It describes key factors and actors of the energy plan in relation to RE and portrays the role RE plays in the country's energy production. Also included is the approach Denmark has taken to comply with the Kyoto Protocol and the actual situation of the emissions target.

3.3.1 Danish Approach towards RE

In 1976 the Danish Government, as a consequence of the oil crisis of October 1973[28], launched a *long-term* Energy Plan: 1975-1995. It expected a projected increase of energy demand in the future and the probable instability of energy markets. In such a plan, nuclear energy was to play a large role in the new Danish proposal, accounting 23% of the total primary energy of the country (Blegaa, et al., 1977). At the

[26] The origin of the imports is as follows: Oil (crude & products) 30% from Russia, 18% from Norway, 10% from Saudi Arabia, 8% from Libya and 35% from others. For natural gas, 50% Russia, 23% Algeria, 22% Norway and 5% others (Commission Proposal COM (2000) 796 final)
[27] Target proposed on the third meeting of the Conference of the Parties to the Kyoto Protocol (COP/MOP-3)
[28] Where the prices of fossil fuels had a strong impact in the market cost of energy

same time, an alternative plan was proposed by Danish universities to focus on decentralized units (via local energy) for district heating and power, through the use of solar energy (thermal) and wind energy (ibid).

The disadvantage of the university plan to exploit alternative energies was that the required estimated investment to implement these alternatives represented a higher cost[29] (Blegaa et al., 1977). However while the exploitation of alternative energies required a larger front investment, it did not have the problem of *dependency* on foreign technology or energy sources, such as nuclear fuel. Conversely, the advantages of implementing an alternative energy plan were supported due to an important increase in employment that was needed at that time in Denmark (ibid).[30] In addition, an important factor was the intervention from other stakeholders. Two Danish NGOs were established in the 1970s[31], raising concern amongst civil-society and rallying support against nuclear power (Meyer, 2007). Along this, the pre-existing development of a 200 kW wind turbine (1959-1969) offered an option for the new energy plan (ibid). The debate came to an end in 1985, when nuclear energy was taken out of the Energy Plan in Denmark (ibid, Nielsen, et al, 1999). An important comment that can be made on this issue is that if Denmark had been successful in the development of the nuclear power technology and the development of the small turbine was not materialized, it is arguable that the government could have implemented the nuclear plan.

Regarding heat, by 1979 an act called the Heat Supply Act had the objective to develop the district heat sector in the country. By 1990, Energy Plan 2000 was released aiming at "efficient, reliable and economical supply of energy" (OECD, 1999, 9). Such a plan "was published by General Worker's Union and used as public debate on the future of energy in Denmark" (Lund, 1999, 431) In this new plan RE support was emphasized, as well as the need to reduce GHGs via targets to reduce 20% of emissions by 2005 through CO2 taxes (ibid). By 1992 a Carbon Tax legislation provided supporting subsidies for given renewable energies. By 1996, Energy 21 introduced targets for a GHG reduction of up to 50% by 2030[32], increasing RE penetration by 35% (ibid), through the use of designated governmental resources.

3.3.2 Key Elements in the Danish Energy Plan

The Danish Government has implemented different strategies to promote RE technologies. Meyer (2007) attributes four different factors for the success[33] of Danish wind energy technology: i) the choice of the technology; ii) formality on the national policy plan; iii) the economic support system utilized in the form of subsidies; and iv) the ownership structure of a technology.

The *1975-1995 Energy Plan* was characterized by different elements. One important element was the time period; it presented consistency in the long-term to motivate investors to invest in the adoption of a technology (in this case of wind turbines). Another element of the strategy was the economic support

[29] Investment estimations of the nuclear proposal was US$ 7.48 billion and the investment of the renewable energy proposal was estimated around US$ 8.99 billion - Calculated directly from corresponding levels in Danish currency at an exchange rate of 6 Dkr = 1$ usd (Blegaa, et all, 1977).
[30] In addition to those characteristics, RE had the characteristic of being a flexible supply system with the possibility to place the devices in small scale units, besides large nuclear energy plants, and the benefit to develop an internal market (Blegaa, et all, 1977).
[31] The *Organization Against Nuclear Power* (OOA, 1994) and *Organization for Renewable Energy* (Meyer, 2007)
[32] Compared to 1988 emissions
[33] Today represents more than the 18% of the production of electricity

structure: economically-supported mechanisms via a direct subsidy for 30% of equipment cost, supported for ten years (1979-1989). This decreased to 10% by 1989 and disappeared in 1992/1993 with the implementation of a feed-in tariff[34]. This tariff was introduced as a consequence of a disagreement amongst utilities and wind power producers – a grid connection disagreement – that was not seen as an issue when the alternative plan was proposed (Mendonça 2007). On the other hand, the ownership structure portrayed an element ready for the deployment of the technology. Community-owned windmills gave the possibility to local people to invest – distributing the risk of the investment – to implement devices all around the country creating the perfect framework for community acceptance of decisions to build turbines.

The government created incentives and support to technological innovations through which citizens (in the form of individuals or cooperatives) adopted the technology. This element could have been the stimulating factor for market and community acceptance. Some research suggest this factor (i.e. ownership) provided a basis for success in wind projects as it created a distribution of wealth, and portrayed a sense of ownership. And in the case of cooperative structures, it stimulated the formation of acceptance networks of the decisions to place the devices (McLaren, 2007; Meyer, 2007; Wüstenhagen, 2007).

The key component used to support the RE development and implementation is the Public Service Obligations (PSO). PSO was introduced in 1998 in connection with the liberalization of the energy market and in substitution of the previously mentioned direct subsidy for the purchase of RE technologies. These services are designated, according to DEA (2007a), to satisfy public interests (supply security and subsidies for environmentally-friendly electricity)[35]. This tax is collected via consumer electricity bills per kWh of consumption, which clearly defines the purpose of its use: to subsidize RE electricity.

3.3.3 Danish Support for Renewable Energy and its Penetration

RE political-economic support mechanisms of the Danish Government for RE are as follows:

(Onshore) Wind turbines connected to the grid: (DEA, 2007b)

- Turbines connected prior to 1999 receive a remuneration of 60 øre/ kWh until full-load hour allowance[36]. Thereafter, a remuneration of 43 øre/ kWh after the turbine is 10 years old. A premium of 10 øre/ kWh is introduced and regulated by the market price of electricity, with a maximum of 36 øre/ kWh.
- Turbines installed 2000-2002 receive a remuneration of 43 øre/ kWh until a full-load hour allowance of 22,000 or until the turbine is 10 years old. A premium of 10 øre/ kWh is introduced and regulated by the market price until the turbine is 20 years old, with a maximum of 36 øre/ kWh paid to the producer.
- Turbines installed 2003,2004 and 2005 receive a maximum remuneration of 36 øre/ kWh.

The actual situation for other technologies is as follows:

[34] Feed in tariff is a model or support scheme for RE where the producer of RE receives a set rate per kWh of electricity produced along a period of time, determined by different factors as the age of the equipment, technology and size of the installation. In Denmark, the inclusion of a fixed *premium* mechanism involving feed in tariff was implemented. This mechanism favors producers of RE giving them a bonus above the electricity price in the market (Mendonça 2007).

[35] For more info: http://www.energinet.dk/da/menu/Marked/Tariffer_priser/El+-+Tariffer/PSO-tariffen/Specifikation+af+PSO-tariffen/Specifikation+af+PSO+tariffen.htm

[36] Hours of allowance: 25000 – Capacity of the device 0<200 KW of capacity, Hours of allowance:15000 – Capacity of the device 201<599 KW, Hours of allowance:12000 – Capacity of the device 600<* KW.

Solar: (DEA, 2007b)

- Solar electricity production – PV (connected to the grid): the producer receives 60 øre/ kWh for 10 years and 40 øre/ kWh for 10 years. Regarding private installations, subsidies were granted under the program SOL 300 and SOL 1000[37]. The government focuses now on research and development.
- Solar heating was subsidized until 2002 and new incentives are not presented.

Central Heating Plants: (DEA, 2007b)

- District heating plants are not required to pay the CO2 tax.

By 2005, RE and waste incineration represented 16% of energy sources for the gross energy consumption (DEA, 2008). Wind power production accounted for 19% of total electricity supply in 2007.[38] However, after 2001-2002 when policy shifted, from a strong subsidy-supported system towards a free-market condition, there was less support granted for RE projects, in the case of wind turbines. Thus, the market penetration did not increase (Meyer, 2007). Such factors suggest that the new strategy does not create the necessary incentives for a strong continuous deployment of RE (wind energy) as had happen in the past decades. At the same time, there is a lack of financing for solar PV-panels and solar-heating.

Regarding new (and large) RE implementation projects, especially offshore wind turbines, the Danish Parliament supported the Liberal-Conservative Government's proposal of a target to produce energy from RE of up to 20% by 2011 (Minister of Foreign Affairs of Denmark, 2008). The new strategy focuses on a tendering system[39] (ibid). Such a system is seen as problematic for the deployment of RE. The criteria are based on price condition (other elements are included), but uncertainty remains as to the future prices in the energy market. This represents a risk to investors and probable low profits do not stimulate decisions to invest. Such problems have been seen in the United Kingdom during the 1990's where implementation was not significant in comparison to other countries with other systems as Spain (Lewis & Wiser, 2007).

3.3.4 Denmark and the Kyoto Protocol

The target adopted by Denmark (within the EU) for the Kyoto Protocol is a 21% reduction of emissions compared to 1990 levels (Danish Ministry of the Environment, 2005).[40] Nowadays, the strategy to fulfill the targets is based on cost-effectiveness. The economic support for RE changed in 2000 and the subsidy structure was reduced for incoming decisions. In the years that followed, different directives from the Danish Government have emphasized this type of approach towards target reduction. The Danish Government approved the Law No. 493 on June 2004, regarding CO2 targets, to make use of flexible mechanisms (see Section 3.1). In the first statement it mentions: "The objective of the law is to bring about a cost-effective reduction of the greenhouse gas CO2 by means of negotiable allowances" (Law No. 493,

[37] National large scale demonstration projects - 10 years period from 1998-2007
[38] Such large production of energy was due to good wind conditions throughout the year
[39] Such a strategy refers to the launch of an auction system where companies realize projects through competitive price biddings
[40] The base year is in discussion to adopt different emissions target as consequence of large electricity imports, exchange of electricity and climate variations in 1990 (Danish Ministry of the Environment, 2005). The emissions base year corresponds to around 69 Mt CO2-eq (without correction of electricity imports in 1990) and 77.5 Mt CO2-eq (including correction) but some forecast suggests that Denmark is not going to comply with the EU target based on the internal measures adopted. By 2003, Denmark emitted around 73 Mt CO2-eq, by 2004 around 68, by 2005 about 63 and forecast suggests that by 2010 the emissions will be approximately 59 – 62 Mt CO2-eq or even higher (Danish Ministry of the Environment 2005).

2004) The reasons, coming from the economic basis, have a very low cost in comparison to the cost of implementing RE solutions/technologies which could follow a more expensive trend for the society (i.e. Danish citizens). In economic terms, it could be convenient to acquire CO2 credits. The price per CO2 tone in other countries is approx. 5-8 €/tone outside Denmark (Lund, 2006, 2328) while in terms of wind turbines, the cost for reducing emissions is around 39 €/tone[41] in Denmark (Danish Ministry of the Environment 2005, 66). Accordingly, while historically Denmark has been progressive in implementing RE policies that support the energy sector, in recent years, policy and economic support have shifted, drawing into question how Danish RE will appear in the future and if or when additional policy will be enacted (Meyer, 2007).

In conclusion, the factors influencing the development of RE in the EU and Denmark are as follows: At the European Level: Issues of climate change, the increase of oil prices and energy security. In Denmark: Issues of climate change, the increase of oil prices and energy security, intervention of the public (NGOs) affecting the political direction of the energy sector, the inclusion of the plan proposed by the academia/scientific community towards the use of local resources. Moreover, the political acceptance reflected by the subsidies given for the exploitation of the technologies, the economic system adopted for RE and the inclusion of CO2 taxes, which stimulate the RE market for its deployment.

4. Findings and Implications: Lolland and Samsø Islands

This chapter begins with a brief description of Lolland Island, and presents a timeline by which RE was implemented. It depicts key actors, relevant at the local level in charge of RE deployment in the region. In the same manner, this chapter describes strategies utilized for RE projects, as well as challenges facing the island and (potential) benefits obtained. The same structure is presented for Samsø Island. This section answers the following question: How has Lolland and Samsø developed and delivered RE strategies at the local level?

4.1 Lolland Island

Lolland Island is located in southern Denmark, part of the Danish archipelago, Zealand. In 2007, seven municipalities integrated to form Lolland Municipality. Lolland encompasses 1,243 square kilometers with a population of about 68,000 inhabitants. The island's main economic activities today are agriculture, basic metals manufacture, fabric metal production, as well as trade and tourism. The energy sector is seen as a strategic area of growing significance by which, via the use of local resources, the island could foster economic growth as well as reduce its own CO2 emissions (BASS, ND).

[41] 275 DKK/ tone of CO2 - Exchange rate 1€= 7DKK

4.1.1 Employment and Industry

The city of Nakskov, where 1/3 of the population of Lolland is located, suffered high impacts from the 1986 closing of the harbor, the food processing industry and other factories resulting in a large crisis in the area carrying a devastating reduction of labor force. Figures showed unemployment of 35% among skilled workers and of 40% among unskilled workers according to Leo Christensen the Project Director, Business Development, Lolland Municipality. This resulted in a social disruption of emigration and a strong dependence on national subsidies. At this time any new projects encountered a series of deficiencies, revolving around a lack of skilled and unskilled labor. This social problem called for strong political decisions and support in order to reduce the problematic trend. By 1998, the municipality adopted plans to reindustrialize the city and help surrounding municipalities to increase job opportunity and revitalization of the region. According to Leo Christensen comments during a personal interview, it was at this time that the municipality made the decision to focus on the environment. The first plan of the municipality was to increase the local government taxes by around 3% (Statistics Denmark, 2008), to create funds to develop the island. The municipality adapted and remodeled the harbor to offer transport logistic services for heavy industries which now have located their activities on the island.

Following recent history, Lolland has entered a new stage of development, with a vision of achieving local prosperity. Accordingly, the new strategy of the island attempts to foster development via the use and deployment of local resources with a high emphasis and focus on RE.

4.1.2 Phase 1: Renewable Energy Strategies in Lolland

The exploitation of wind for the production of electricity has taken place in the island in the last three decades as shown in Fig 1. The island already covers the local consumption of electricity from RE but regarding heating a large part of the boilers on the island are still running on oil. The situation is as follows:

4.1.3 Actual Situation of Renewable Energy in Lolland

Electricity

Lolland is one of the regions in Denmark in which the use of turbines to produce electricity was connected to the grid already in the early 1980s. Since then there have been important increases in the number of sitting decisions[42] in the area. These include the implementation of the first offshore wind park in Vindeby[43] in 1991, formed by 11 turbines of different capacities. After the offshore implementation, a large increase of turbines was located on-land, as shown on the graph below (Figure 1). In 2003, the creation of the Nysted Offshore Wind Farm (Rødsan) owned by DONG Energy, and E.ON Sweden, gave the opportunity to the island to generate more electricity from RE than was required on the island. According the Danish Energy Authority (2008) and Green Energy Lolland-Falster, the total annual electricity generation is

[42] Sitting decision refers to the placement of a windmill or other RE project
[43] First offshore wind farm in the world

around 1,150,000 MWh, whilst actual consumption is around 750,000 MWh. In this area, 92% of the electricity generated comes from wind energy, 4% from biomass, < 1% from biogas and 4% from waste.

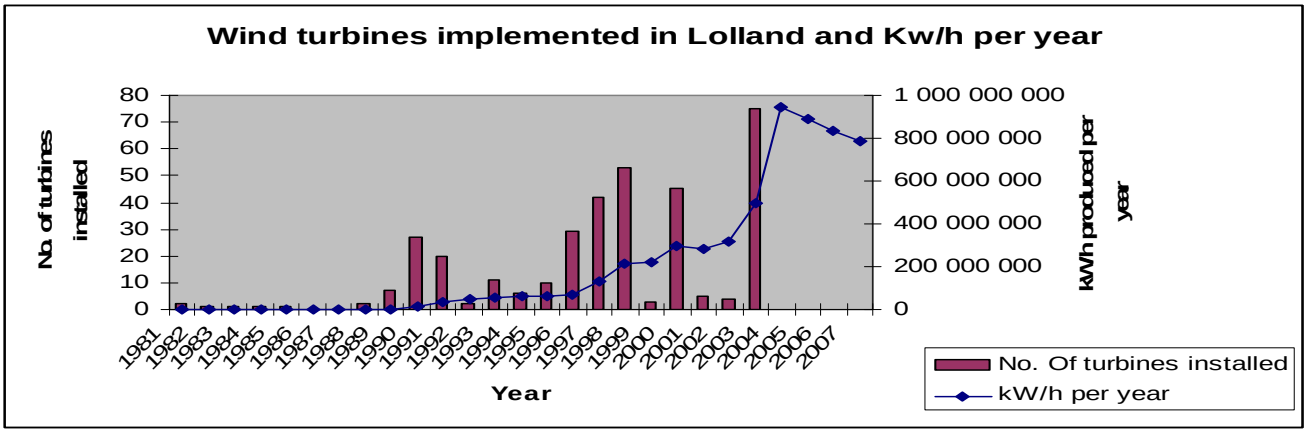

Figure 1 Implemented Wind Turbines in Lolland
(Source: Danish Energy Authority, 2008)

The main factor supporting the development of wind mills in the island of Lolland has been the advantage of the geographical location of the island with excellent wind conditions (BASS, ND), the subsidies given by the government at the beginning of the deployment of the technology (windmills) (see Section 3.3.3), the benefits obtained by the feed in tariffs during the 1990's to 2000 – 2002 (see Section 3.3.3). Approvals from the municipality were given in order to support the local economy and follow regional plans for the development of the technology.

Heating

Regarding heat, Lolland has local heat generation provided from RE. This accounts for approximately 70% of the required island's consumption and covered about 10,095 dwellings in 2007 (Statistics Denmark, 2008). As in many areas in Denmark, the major part of the centralized heating system is located in the largest cities of the regions. According to Leo Christensen, the cost to connect small remote communities or farms to the system is very expensive. In Lolland about 7,998 domestic boilers have not been adapted or replaced. Most still run with oil, contributing to the island's CO2 emissions. On the other hand, the process of conversion and establishment of the District Heating Plants is recent and is as follows:

Table 1 District Heating Plants in Lolland

Location	*Establishment or change year from Fossil Fuels to RE*	*Type of fuel*
Rødbyhavn District Heating Plant (DHP)	1998	Straw
Rødby DHP	2000	Straw
Holeby DHP	2000	Straw
Maribo DHP	2000	Wood pellets
Søllested DHP	2000	Straw
Nakskov DHP	2004	Straw , Wood-chips, Diverse

(Source: BASS, ND)

The average price on the island for using oil is around 1,23 DKK per kWh, including the disadvantage of being an imported product. The price from straw (a local resource) is around 0,65 DKK per kWh, and of wood pellet (a local resource as well) 0,54 DKK per kWh (BASS, ND; 27).

Data from BASS (ND) and interviews with owners of oil-running boilers indicated that the consumption of oil per dwelling corresponds to an average of 2,200 – 3,000 liters per year. The price per 1,000 liters of oil for heating in May 2008 was approximately 8,300 DKK (not including VAT).[44] Therefore, the total consumption is estimated at 17,155,600 liters of oil for heating per year for dwellings. This is an opportunity for the project of rapeseed oil (explained in the next section), which can supply the rest of the heating systems which are using oil at the moment.

4.1.4 Phase 2: Renewable Energy Strategies in Lolland

In 2007, the company *BASS*[45] proposed a series of projects to the local municipality under a strategy and action plan referred to as 'Green Energy Lolland-Falster'. In this plan, BASS described how to comply with national energy and emission targets and additionally, via the use of internal mechanisms, to achieve (economic) benefits through RE. Within BASS's plan, the following RE proposals are presented:

- Need for alternative energy supply (RE) that by 2015 will result in at least 90% of energy for heating supplied by RE.
- Focused RE business development aimed at creating at least five-energy related companies and 400 new jobs relating to RE in the island. (In a personal interview, Gunnhild Utkvitne mentioned that this number could be higher by 2015.)
- Marketing of energy activities on the island. The strategy here was to accept at least 10 national and international investors interested in RE in Lolland.
- Encourage local activities to embed energy activities in the island by 2010, through the creation of at least three new education programs related to RE technology, the establishment of which could inspire citizens to participate in energy activities.
- Promote savings in energy consumption by 2020. The target was to reduce by 25% the total energy consumption on the island.

One key element of this document was that the Green Energy Lolland-Falster was initially conducted under the study of local groups interested in or directly working with energy. The research revealed the interest of voluntary associations and other stakeholders as craftsmen, teachers, municipal groups – Agenda 21 and statutory boards for housing to promote the use of the local resources (BASS, ND). Following the proposals, the actual RE strategies adopted by Lolland Municipality which are in the process of implementation are the following projects:

[44] Prices obtained from SEAS-NVE [May, 2008]from: http://www.seas-nve.dk/privat.aspx
[45] BASS is described in detail under the section of Stakeholders in this chapter

Community Testing Facilities (CTF)

CTF is a concept or platform by which full-scale testing and demonstration projects of RE technologies or products are tested and implemented. According to Gunnhild Utkvitne, this concept fosters plans to incorporate elements to cooperate and collaborate amongst three key stakeholders: Authorities, Industry and Academia.

Lolland Municipality offers the opportunity to companies, academia and research centers to develop projects to improve, innovate and test RE technologies. At the same time, the objectives of the CTF offer the opportunity to create eco-industries [46] and financial incentives to business to work with CO2-neutral technologies. Therefore, the development of Public Private Partnership(s) (PPP) is an element by which to join the following objectives of the municipality:

- Increase local renewable electricity generation by 50% by 2010 (Wind)
- Convert heat generation to 90% RE by replacing fossil fuels with vegetable oil boilers by 2015
- Reduce electricity consumption by 25% compared to 2004 levels
- Perform an annual energy performance audit for the entire region
- Improve energy efficiency in publicly owned buildings, commercial and industrial facilities

The local economic mechanism used to support the projects is LOKE A/S which is described in the stakeholders Section in this chapter (see Section 4.1.5).

Hydrogen Community

The Hydrogen Community is project coordinated by BASS. It is aimed to develop hydrogen as the means by which to store excess energy generated by windmills. It works as a residential fuel-cell via Combined Heat and Power (CHP). The demonstration plant, which is the first stage of the process, is located in the city of Nakskov and has run without any major disruptions or inconveniences since May 2007. The second phase of the process, is taking place in Vestenskov. At the moment, the construction of a network to supply five houses with hydrogen-sourced energy has been finalized (Jesper Krogh, 2008).

Prior to the establishment of this project, information campaigns were carried out in the community. According to Jesper Krogh, the decision to start the project was not expected to pose any inconveniences at the community level, since citizens were motivated and excited to participate in an innovative project and had the opportunity to become known as the first hydrogen community in Europe. Full information was provided to the citizens regarding the benefits and risks of implementing the project. The campaigns carried out in the community reflect the high interest of the citizens, numbered by people interested in the project. The stakeholders for this development are the Municipality, BASS, and the company IRD Fuel Cells (technology developer). This project also involves DRUP, an economic support provided by the Danish Energy Authority, which makes regional funding for such projects available, as well as support from LOKE

[46] The eco-industry concept refers to industries with interest in RE development in the islands (Leo Christensen, 2008).

A/S (as the local funding stakeholder). Once more, in this project local participation was of paramount importance in its fruition, demonstrating that a sustainable solution revolving around increased use of RE requires public acceptance that is fostered through education, participation and commitment.

Rapeseed Oil

In 2004, a project to establish a local production of rapeseed oil was proposed by BASS and The Green Center. These invited local farmers as well as the municipalities in Lolland-Falster to create a rapeseed mill in the region. The Green Center (in charge of the union and development of rural districts based on agricultural/agro industrial activities), together with BASS, helped to form the alliance between the farmers and the DLG (the largest feeding-stuffs company in Denmark) to establish the new organization. Cooperation between the municipalities and farmers was required to facilitate the plan's success. Accordingly, to acquire the production of oil for heating purposes; this cooperation, in particular, provided the fuel for non-centralized heating systems. From the economic perspective, the proposal involved an investment system by which 50% of the capital was provided by local farmers and the rest by DLG. The organization created is referred to as Rapsol I/S and is currently located in the community of Bandholm. The relation between Rapsol I/S and the buyer (municipality) has so far functioned well. Therefore it becomes clearly apparent that another key to success is close co-operation between different actors. A sustainable solution requires the representation of actors which function within the spheres of economy, politics and civil society, in this case business, the municipality and local farmers. Since the interaction between those actors is extremely important, it must be analyzed further.

4.1.5 Main Actors in Lolland

The following main local stakeholders play significant roles regarding the development of RE projects. Interviews conducted in the field helped come up with specific players that were of importance in this particular setting. The stakeholders discussed include those most involved in the island's projects. Many other specific and key stakeholders participate in specific projects, but were not included in this research.

Municipality

Regarding the development of RE projects, the municipality's Department of Business Development focuses on the development of these projects. The municipality has a strong environmental commitment and looks forward to comply with CO2 neutrality targets, while its economic growth is based on the exploitation of local resources. The energy sector, and in particular RE, is seen as a fundamental element for economic growth of the island. Internal policies (see Policies in this chapter) are driven by the municipality's vision to comply with national targets set by Denmark within the framework of the Kyoto Protocol. The Municipality hires the company BASS in order to develop some projects on the island. Lolland Municipality also launches frequent public hearings in order to keep a close contact with the population and to keep them informed about the activities developed on the island. Regarding the interviews, the municipality seems to be more

focused on the development of business more than on inclusion of the general population. The municipality is mainly economically minded.

Baltic Sea Solutions (BASS)

BASS is the representation of a public network of cities and regions within the Baltic Sea Region. This company, which in many senses acts as an NGO[47], plays an active role in the fulfillment of the island's process of developing RE. BASS is a project-development organization whose objective is to develop innovative approaches to reach sustainable development.[48] The strategies used by BASS are based on the exploitation of local assets: human, natural, geographical or economic. This company opened its offices in 2004 in Lolland with the aim to create partnerships with other municipalities and regions in order to overcome common challenges in the Baltic Sea Region. Several projects of the municipality are carried out by this company, as feasibility and technical analysis. The owner of this company is the owner of the sugar plant in Saxkjøbing (a local city) which is an important actor with power on the island since it represents one of the largest historical predominating industries on the region.[49] The political weight this actor has on the community and with municipality was perceived as a key driver for the materialization of sitting decisions.

LOKE Holding A/S

The Lolland Energy Holding A/S (Lolland Kommune Energiholding A/S) is the result of the sale of shares of the electricity company (energy E2) owned by the municipality in Nakskov. The total amount obtained by the transaction was 85 million DKK (Lolland Energy Holding A/S, ND). The Lolland Municipality decided to use the money for projects related to energy efficiency (intelligent energy solutions). LOKE was created in 2006 and is the financial mechanism of the municipality. It works as a co-financing company with the objective to create growth and development in the municipality. The financial strategy is based on loans. LOKE´s capital is divided in three categories: i) financing new technology projects; ii) supporting existing/traditional RE technologies[50]; and iii) financing feasibility studies for future investments. LOKE is managed partially by BASS, the director performs the same position in both organizations.

Citizens / Farmers

As mentioned in Section 2.1, citizens can be influenced in direct and indirect ways by RE projects. Based on interviews, it became evident that citizen involvement of farmers has been crucial in the development of projects on the island in many ways. In the past decade, land owners (especially farmers) and cooperatives-investors have been those who erected wind turbines all over the island. Both the municipality and the business of the area recognize citizens as a vital part in the process of developing RE. Public

[47] BASS is both a company and an NGO, according to its legal status
[48] Development that looks to meet present needs without compromising future generations (Brundtland Report). The ideology of the company involves the care of the environment at the same time as creating economic growth (Gunhild Utkvitne, BASS).
[49] BASS is financed by Baltic Sea Region INTERREG III B Neighbourhood Programme for the period 2007-2013 (see http://www.bsrinterreg.net/programme.html)
[50] The term traditional is referred to proved technologies such as wind, solar and biomass in some cases.

acceptance of wind turbines, for instance, is quite high in the region, facilitating the process. Large market opportunities in the region were observed, for example in micro-generator technologies and oil-based boilers for heating, facilitated by the desire of the local populace to embrace new, innovative technologies and put them to practice. The local population is essentially the backbone of the process, aided by the institutional and economic framework created by the relevant government and business authorities. The participation process which is sought after by all the other actors – who realize the importance of public acceptance – is an incremental aspect of the success stories of RE diffusion in Lolland island.

4.1.6 Driving forces for the development of Renewable Energy

Public Private Partnerships

According to Leo Christensen, the municipality aims to develop synergies amongst private investors and the public sector, by inviting companies or private investors with interests on develop RE projects co-investing and sharing the risk of the projects with the municipality. Such an approach focuses on the supply of energy from a new biogas plant which attempts to establish partnerships amongst farmers of the community, large industries and the municipality. Public Private Partnerships minimize the economic risk on behalf of the municipality, while aid in the creation of a beneficial environment for investors. The lower taxes and aid in the implementation process, as well as the minimization of administrative barriers for private investors provided by the municipality is crucial in attracting foreign or local investment, which is a stated strategic goal of the Lolland municipality. This model of action and the underlying dynamics should be replicated in other parts of the developed world, enhanced in legitimacy by the increased participation of the public in information awareness. As in all cases where PPPs are involved, issues of transparency and conflicts of interest are of significant importance and must be taken into consideration in the process. Therefore balancing and checking mechanisms must be formed. In the case of Lolland, checking comes to a great extent once more from public participation, aided by the municipality's decision to reveal all relevant information to the citizens, educating them in the process about the substantial economic benefits that appear out from investment. This characteristic, found throughout Denmark, is an important aspect that should be sought after in other developed countries wishing to promote RE.

Policies

The Lolland Municipality has established several policies that aim to promote diffusion of RE in the region. It has signed two climate change related agreements to reduce CO2 emissions. The first agreement, signed in October 2007 with Denmark's Nature Preservations Fund, calls on municipalities to achieve GHG reductions of 3% each year, until 2025. This agreement obligates the municipality to present an annual report in order to follow the state of emissions' reduction. The second agreement is called the "Transatlantic Climate Agreement" and was signed with the county of Santa Cruz, USA and the University of California. It commits the parties to joint-projects to reduce CO2, enhancing education and research on the island.

Regarding heating, the municipality offers to pay 50% of the connection to the central heating system if a residence is located in the area. Local projects are financed using LOKE A/S which disposes 15-20% of the capital to co-finance new RE technological projects. Also, 75-80% of the capital is aimed into developing more traditional and existing technologies within RE technologies. Finally, 5% is directed to feasibility studies to stimulate projects with benefits in order to achieve the main goals of the holding.

4.1.7 Benefits of Lollan's Strategies of Developing Renewable Energy

Apart from the obvious benefit of decreased GHG emissions through the development of RE, several other advantages exist which can act as driving forces that can urge other regions of the developed worked to adopt such policies. These will be presented, as are already manifested in the island of Lolland.

Wind: Local benefits are already obtained by the implementation of wind turbines across the island, in particular as farmers and land-owners have the opportunity to place the devices. Besides offshore implementations, the total number of on-land windmills[51] accounts to 274, with capacities from 15 KW to 3 MW (DEA, 2008a). The actual structure of ownership is complex and diverse; many are owned by some cooperatives and others by individuals. But what is possible to relate is the amount of kWh sold to the grid[52], providing the individual citizens or the cooperatives they form with substantial direct and indirect economic gains – augmented by the low maintenance cost of wind turbines. The region has acquired self-sufficiency in electricity production which provides it with energy security and independence. Moreover, the shift to wind production has resulted in substantial gains in air quality, with reduced pollutants being emitted.

Heating systems: Owners of heating plants and farmers have directly benefited from the supply (especially using straw as raw material). Most of the privately-owned heating systems are owned by farmers. About 10,095 dwellings are connected to the central heating system (Statistics Denmark, 2008) accounting a reduction of heating expenses from oil of about 50% per household.[53]

Rapeseed oil: As a result of the integration of farmers with DLG, 40 farmers[54] joined forces to create a cooperative called Rapsol Avlerforening A.m.b.a. According to Claus Olsen (chairman of the farmers' cooperative), farmers have benefited by the implementation of the mill, and deliver 16,000 tons of seed annually[55]. Additionally, the co-investors of the plant, DLG, have the advantage to receive the byproduct of the oil, known as rapeseed cake, which is used in their factories to produce compound feed for farms. Market prices also play a role: the increase of the rapeseed price in the last years has favored the farmers economically, however the higher cost of the rapeseed could provoke speculation that this may be an incentive to sell their product elsewhere, perhaps off the island.[56] Another advantage of using rapeseed oil is that the rapeseed crop can be planted during winter time, acting as a cover crop against soil erosion.

[51] This number of turbines include only the ones connected to the grid
[52] Today this amounts for 3,526,189,335 kWh, while part of the income received is circulated into the local economy (Danish Statistics, 2008).
[53] Average consumption per household is around 2 500 litters of oil per year. The cost per KWh from oil for heating is around 1,23 DKK. The price per KWh using straw is around 0,65 DKK (BASS, ND)
[54] This represents about 3% of farmers
[55] The project started in 2007
[56] Thus, community facilities, now set up, may experience a shortage of supply or an increase in price in the future, (see later in this chapter). However, at the moment this is merely speculation.

CTF: The Community Testing Facilities, as an important part of the RE strategy of Lolland, provide various side-benefits as well. The new strategies regarding RE promote sustainability in the form of fostering economic growth through branding (promotion of the islands in international forums). This can create jobs, provide education opportunities and improve utility services – under the development of clean sources of energy. For the business sector, the opportunity to test products in a real environment provides better market opportunities. For the research community, the project offers the opportunity to conduct in-depth studies of the socio-economic impact of the new system or technology in a real environment. At the same time, its example of being a locality which produces all its energy requirements from local resources is attracting many other governments, communities and actors in the field of RE. By 2007, 12 interested investors had visited the island concerning energy-environmental affairs.[57] According to Leo Christensen, this can benefit the municipality politically, as it creates awareness and brings income in the form of taxes.

The significant side-effects of promoting RE constitute clear that this form of energy production can be beneficial for the municipality, the local citizens and business. They can act as yet one more incentive that can drive development of RE and should be communicated as such to other municipalities around the developed world, where potential lies to develop them.

4.1.8 Renewable Energy Challenges in Lolland

Economic and Institutional Barriers in Increased Wind Energy Production

Lolland island already covers its energy needs fully through RE. It also produces 50% more, which it sells to the Danish mainland. Within the framework of its strategic targets, the municipality decided on May 2008 to increase by 50% more its electricity production, so as to generate more revenues through selling it. This actual commitment to increase 50% electricity production generated by windmills is already attained. The offshore wind park, Rødsan II, was approved and realized under a tendering process.[58]

The municipality wishes to capitalize on the opportunity to increase production by onshore windmills as well. According to BASS (ND), there are opportunities to develop new implementations of on-land mills and the necessity to substitute actual devices with low capacity (i.e. lower than 600 KW). This could represent an opportunity to increase the production of electricity with windmills. The number of turbines on the island (with a capacity lower than 600 KW) is 100 (more than 1/3 of the total installation), which are already more than ten years old. According to Jesper Krogh many are already located in zones with favorable wind for higher production.

However, the institutional framework does not allow further expansion. Local planning restrictions of distance amongst devices or wind farms is 2.5 kilometers, and do not allow the implementation of new devices with impact on the landscape, something which acts as a hindrance to the project. It should be mentioned that the excess electricity production from RE would fulfill the needs of other locales which are

[57] Chinese Energy Delegation – Ministry of Foreign Affairs, USA Ambassador in Denmark (J.P. Cain), among others.
[58] The new farm will consist of 200MW production of electricity and is planned to start in operation by 2010-2011 (Danish Energy Authority 2008c). E.ON Sverige AB received the concession to develop the park offering the following bid: 62.9 øre (DKK) per KWh for 50,000 peak load hours.

currently dependent on fossil fuels. Another restriction that Lolland faces is that devices should be erected at least 500 meters away from residences. In order to overcome such problems, Leo Christensen suggested following the re-powering[59] (and replacing) scheme of older devices in Denmark. The already approved sites for turbines do not have to be in the municipality's planning process; they only need approval from the municipality. According to Christiansen, this will only require the impact assessment and the agreement with the grid-carrier to change the devices.

Moreover there are local inconveniences related to economic conditions, as was discussed in the community of Pårup. One windmill owner discussed a problem related to the new scheme with regard to the national government tariff received (see Section 3.3.3). He commented that the new price for electricity is not convenient to change the device, since the new investment will be higher. According to Meyer (2007), a new scheme without a convenient payback period of investment is potentially a reason why Denmark reduced windmill implementation in the last years. Since this expanded payback time has become a barrier in further expansion, the local municipality and Denmark as a whole should provide economic benefits that would lower the cost of the original investment reducing payback time. Another solution would be for the municipality to share the risk of the investment with citizens through its financial mechanisms or motivate the creation of cooperatives among citizens; although this might reduce the overall financial gains for the farmer, it would foster an environment of security that would promote the expansion of windmills.

Fortunately, no barriers regarding community acceptance were observed. Based on the findings within this community, acceptance for more windmill implementation was favorable regarding increased usage of RE. Residents stated their approval if a device is located with an appropriate distance from households, sufficient to not hear the noise produced by the devices. Visibility was not seen as an inconvenience, which can be assumed due to the large experience from early implementations. If the legislation which requires windmills to be placed far from houses is changed in order to allow for more land to be utilized by windmills, this might interfere with the citizens' acceptance of the devices. Therefore the main challenges are economic in nature and should be dealt in the way described.

Substitution of Oil-based Boilers for Heating

Rapsol I/S, the company/association of farmers which aims to produce rapeseed-oil and substitute traditional oil-based boilers, is facing different challenges. The municipality aims to fuel decentralized heating systems in schools and other municipal buildings. However, according to Birgit Hartvig from the Green Institute, there is decreased acceptance from some actors for this form of energy creating an obstacle for the adoption of the product. This lack of acceptance comes from increasing market prices of rapeseed. Indeed, according to statistics, prices have increased in the following way in the past years:

Table 2 Price of Rapeseed

Year	2004	2005	2006	2007	2008
Average price per year: DKK pr. 100 kg	175,6	147,8	172,2	205,2	266,3

(Source: Adapted from Statistics Denmark 2008)

[59] Change old devices for new ones with higher efficiency and higher production of KWh

The increase in rapeseed price indicates that this energy source cannot be viewed as sustainable. Although the price of oil soars much higher currently, some voices in the community raised concern regarding the necessity to adapt the devices to use rapeseed oil, since in the future the price of this commodity might be high and farmers might be more willing to sell their product elsewhere. The increase of use of rapeseed oil for biodiesel in other countries as Germany (European Biodiesel Board, 2008) could represent a future trend in prices. Moreover, rapeseed oil is subject to taxation in Denmark (Jørgensen et al. 2007). This becomes a limiting factor which delays the opportunity to create a new market.

Another option is the substitution of oil-based boilers with the capacity to use straw or woodchips. Local citizens are adopting this measure as an opportunity to reduce expenses in oil. Small communities and countryside houses/farms do not receive any economic incentive to change devices for environmentally-friendly ones and it is only up to them to change. Therefore, local strategies are necessary to achieve this change where citizens are responsible for the innovation. In the community of Stokkemarke the main reason of the five people interviewed to join or become part of RE projects (wind mills, solar PV, solar heating, biomass) was the economic benefits received. Therefore, since economic considerations are of significant importance, incentives providing a reason to shift to straw or woodchip consumption should be deployed.

Regarding biomass development a specific case is discussed: The community of Stokkemarke is comprised of 230 households with a population of 700 people. One of the farmers (John Rasmussen) has a 1 MW boiler, fueled by straw, which he produces himself. It provides heat to the school, the church and around 56 households in the community. Mr. Rasmussen invited the people of the community to hear about the possible benefits obtained by the implementation of a new boiler of 2.5 MW with the capacity to supply heat for another 100 dwellings. The benefits he is proposing are economic ones: when the residents connect to the new heating system, they will pay approximately 45% less under the price of oil.[60]

The backup of energy the actual boiler is using is oil and in the future, after the implementation of the 2.5 MW boiler, Mr. Rasmussen is not planning to use rapeseed oil at the moment. At the same time, he is the one providing the straw to fuel the system. This flexibility provides him with the availability to decide which fuel to use, which therefore will be the cheapest available. The implementation will start in the following months (July 2008). Most of the citizens agreed, however there have been some disagreements, leading to delays in the project. Interviews with two members of the community were carried out after the meeting with John Rasmussen to get to know some reasons why they had not signed his petition to join the central heating system he is proposing. The reasons obtained were mostly linked to conflicts within the community. They mentioned that the benefits of the project obtained by the implementation will be obtained by him (Mr. Rasmussen). They stated literally, “he is going to become richer”. For most of the citizens however, the reduction of prices by connecting to a new system has motivated them to support the project.

[60] Rasmussen will offer the price per KWh of 30-45 øre.

Signatures for the implementation have almost reached the necessary number to make the project feasible, according to Mr. Rasmussen.

What emerges from this practice is that economic considerations are of vital importance in the development of rapeseed oil, particularly because its price is projected to increase in the future. While the economic conditions of the product can be subject in the future to worldwide market fluctuations, the local municipality and active citizens can take action to provide incentives in order to make long term agreements to maintain the supply of the resource. When these cannot be provided, other similar fuels, such as straw or woodchips that come from the local community, should be preferred and the supply will continue to be local.

Increase of Electricity Consumption

One of the island's challenges which is included in the municipality's goals proposed by BASS is the reduction of energy consumption. Regarding electricity, Lolland has increased consumption in the past years from around 745.000 MWh/year in 2001 up to 775.000 MWh/year in 2005 (This number includes Lolland and Falster). The reasons are (according to the interviews), the increase of companies located in the island and the increased use of electric devices which came as a consequence of reductions in unemployment in the island, and increased level of affluence. The Department of Development in the municipality has been counting the number of items thrown in recycling stations, calculating that there has been an increase of electrical appliances in recent years.[61]

4.2 Samsø Island

Both Lolland and Samsø have experiences incorporating RE, albeit at different times and political environments in Denmark. Such internal (island) and external (national policy) influences are explained in the perspective of Samsø below.

Samsø Island is located in the north-west part of Zealand and east of Jutland, covering 114 square kilometers. It has a population of around 4,124 inhabitants and the main sectors of the economy are farming, fishing and tourism. Unlike the previous case treated above, the energy sector was/is seen as a strategic area where under the use of local resources, the island could foster economic benefits and become 100% renewable and achieve total reduction of CO2 emissions (Jørgensen et al, 2007).

4.2.1 Employment and Industry

The island is mostly dependent on the production of vegetables and fruits mainly for exports. Also, the island receives income from tourism, with about half a million visitors per year. As Lolland, Samsø Island is on a new stage of development, with a vision of achieving local prosperity. Accordingly, the

[61] According to the municipality, the company SEAS-NVE is in charge of the project related to reduction of consumption in households. A group of 20 people works directly with this issue and offers to the community different alternatives or tips on how to reduce consumption: newsletters to citizens with tips to reduce energy bills, loans to acquire an electric meter to measure household consumption, planning and overviews for future reductions of energy consumption.

implementation of a project to become 100% renewable was started in 1997 and now the island has achieved its commitment. The process through which this success was realized will be further studied, so as to understand the advantages and disadvantages that have surfaced and how problems were overcome, so as to come up with recommendations for other local regions of the developed world.

4.2.2 Renewable Energy Strategies in Samsø

In 1997, Samsø Island won a prize to become a self-sufficient island based on RE. This competition was launched under the Energy 21 (see Section 3.3.1) Strategic Plan of Denmark. This seeks to accomplish a target of 35% of energy coming from renewable sources by 2030. The project's main target was to develop and present a locality where the use of RE can become a reality in a specific community and reduce the emissions of CO2 with economic and social benefits experienced therein. The strategy involves becoming 100% renewable within a period of 10 years, reducing energy consumption by 10%, ensuring high levels of participation in the community and the use of innovative forms of financing. Throughout this process Samsø has emerged as an example of local RE development that should be followed by other places in the world.

In order to realize the project the Samsø Energy Company (SEC) was established by the municipality of Samsø on behalf of the island and included many stakeholders. According to an interview with Soren Hermansen, such a proposal meant that the interests of all parties were to be represented without necessarily undermining the basic needs of the local community.

With such clear targets presented above, the Samsø Energy Company presented the plan based on the following technologies.

Land-Based Turbines

The plan of the company estimated a consumption of electricity of around 29,000 MW/h per year after 1997. The study realized by Samsø Wind Energy estimated that the implementation of eleven 1 MW turbines was sufficient for the requirements of the island (Jørgensen et al, 2007). Organizations of meetings (public hearings) were realized with the population to inform citizens about the projects, create acceptance of the proposed implementations and convey the necessary knowledge about the benefits for using RE. At the same time, one purpose of the meetings was to look for possible investors or interested parties among the community (Stubkjær Leif, ND). The project for the purchasing of the turbines began and the ownership structure was set up to give as much benefits as possible for the community. According to Hermansen, the scheme adopted aimed to give the (public) opportunity to the residents to participate in investment, as a requirement of the project. The plan followed the following structure: nine of the eleven turbines proposed were offered to one owner per piece, with the condition that they should allow space in their land to locate two more windmills owned by the citizens who had purchased shares of the remaining turbines. The land-owners accepted the proposal and the shares were offered to the public. Participation in the scheme required the investment of 3,000 € up-front to be able to purchase a share of the turbine. Therefore 430 shares were sold (ibid). On the other hand, one of the turbines owned by one individual received the support of the

municipality for the grant application to the bank. According to Hermansen, the interest rate of the loan was very low as the municipality participated as guarantor.

Offshore Turbines

The Samsø Offshore Wind Co was another company formed to ensure community ownership of the project (Jørgensen et al, 2007). The project, comprising of eleven turbines, was realized by 2003, giving the opportunity to Samsø to become a 100% RE Island[62] where 10 turbines where located. Søren Hermansen, as responsible of the project, invited Shell Oil Company to participate in this project, but the oil company placed the condition to become the only owner of the infrastructure. Since part of the plan proposed by the municipality included the condition to benefit the community to large extent, the decision from the SEC was to not include Shell as part of the implementation, according to Søren Hermansen.

PV-Panels

Subsidies for the implementation of PV panels were jointly provided by the Danish Energy Agency and the municipality. Three households in Samsø are currently using a 20 square meters solar panel. At the same time, the Samsø Energy Academy integrated 100 square meters on its roof. The constraints involved in this kind of technology are the higher prices per kW/h obtained, and only those interested in the technology or the environment are expected to adopt the solution (Jørgensen et al, 2007). The important aspect of the PV-panel implementation was not that much the electricity produced by them, but the fact that the municipality provided for free the know-how and technical advice to the citizens interested in adopting it.

Central Heating Systems

The main characteristics of the plans to invest in RE are based on central heating plants involved in the participation of active local citizens. Søren Hermansen commented that the aim was to motivate communities to change their actual systems and look forward to reduce the price of heating. The interest to use local resources was considered the main driver for local farmers of the community who had the opportunity to supply the raw material (straw) to the plants. Moreover, local citizens gain the substantial benefit of reducing the price of heating by oil-boilers, especially since the price of oil has had large repercussions in their income. Therefore, along with reducing the emission that come from the burning of fossil fuels, the economic side-gains acted once more as a significant driver in persuading the locals to adopt the scheme.

[62] The island's plan included the reduction of CO2 from transportation, and the implementation of offshore windmills was calculated to offset the emissions from the transport sector (PlanEnergi and Samsø Energy Academy, 2007).

4.2.3 Actual Situation of Renewable Energy in Samsø

Electricity

Unlike Lolland, few turbines had been implemented on the island before the realization of the main plan. After the approval of the impact assessment, the sitting decisions took place in three different clusters on the island, where the best available sites to build the turbines matched the efficiency and the ownership structure proposed (Figure 3). Land-based turbines were erected in 2001, and offshore turbines in 2003.

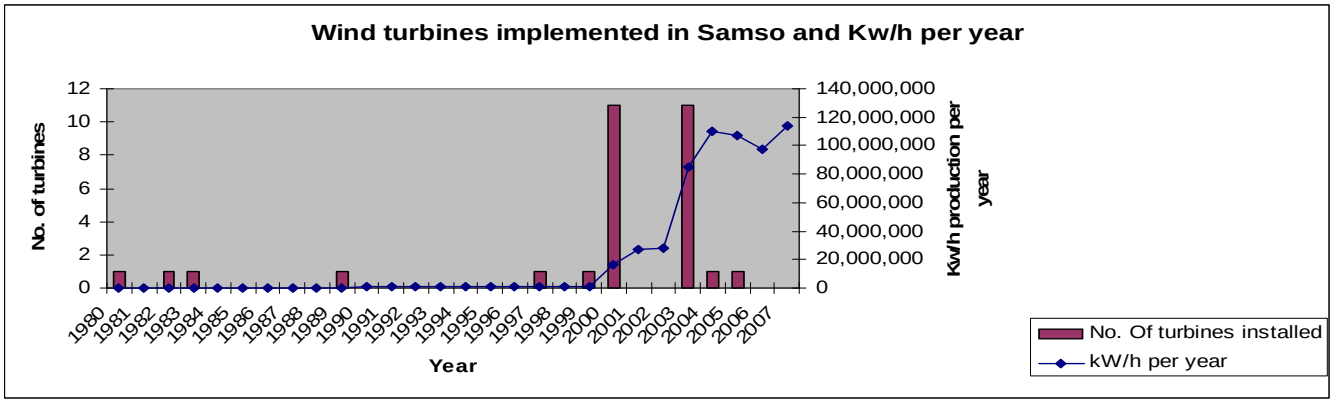

Figure 2 Wind Turbine Implementation in Samsø
(Source: Adapted from Danish Energy Authority, 2008)

Heating

Renewable energy accounted for about 65% of heating in Samsø by 2005 (Jørgensen et al., 2007). As in the previous case, the major part of the centralized heating system is located in the largest communities of the island and the cost to connect remote communities or farms to the system is very high. On the island many individual installations have domestic boilers and have not been adapted or replaced and must still run with oil and contribute to the island's CO2 emissions. As in Lolland, the process of the conversion and establishment of the District Heating Plants is recent and is as follows:

Table 3 District Heating Plants in Samsø

Location	*Year establishment*	*Type of fuel*	*Strategy*
Tranebjerg	1994	Straw	The company NRGi offered a scheme to citizens to get connected by a low fee of 80 DKK. The municipality of Samsø guaranteed the mortgage.
Nordby-Mårup	2002	Wood chips and solar heating system	To inform the community about island RE projects, a group of interested citizens went door to door to motivate residents to join the project.
Onsbjerg	2003	Straw	Private Owned plant and grant provided from Danish Energy Authority
Ballen-Brundby	2005	Straw	Cooperative system, SEC made the proposal

(Source: Jørgensen, et al. 2007, Stubkjær Leif, ND)

4.2.4 Main Actors in Samsø

As in Lolland, the following local main actors were identified regarding the implementation of RE in Samsø as a result of the interviews conducted and the matrix defined in Chapter 2. The actors included in this section are those who were involved in all the projects on the island.

Municipality

Samsø Municipality took the opportunity of the prize as a strategy to receive subsidies for the island and have the opportunity to become 100% renewable. The commitment of the municipality to implement RE and reduce CO2 emissions is embedded in the project realized and the achievements obtained. The key actor established by the municipality directive was Samsø Energy Company; responsible in large part for the achievements of the island. The municipality decided to act as the main informant that would diffuse information to the public, as part of the strategy to increase local participation. It also provided various economic benefits that would act as incentives for further development of RE by individuals.

In order to facilitate understanding of RE and to aid follow-up of the projects, the municipality established the Samsø Energy Academy in 2007. It was intended to act as a center where the distribution of knowledge is generated for visitors and local citizens. The center is managed by Søren Hermansen, the ex-project leader of Samsø Energy and Environment Office and a member of the board of Samsø Energy Company. Topics about energy and the environment are discussed in the center, and if citizens have concerns about how to implement RE, the center helps them with know-how and alternatives.

Samsø Energy Company

The company was formed by representatives of the municipality, the farmers' association (representing 100 farmers out of 130 on the island), Samsø Energy and Environment Office and the island's Commercial Council (where the Tourism Sector represents a large source of employment, besides farming). This stakeholder represented the key-union to develop the project. It acted as the main hub of interaction between the various main actors. A platform of communication was established, in order to ensure that the proposed measures possessed significant acceptance by the different aspects of the community. Once more, the success story of Samsø indicates that social cohesion and cooperation were important aspects that should be replicated in other places wishing to follow Samsø's example.

Citizens

The inhabitants of Samsø played a vital role in the implementation of the projects. High rates of participation were required to motivate the neighbors to join in the projects and in order to create trust to investors in wind mill projects, making them part owner of the devices. In the case of heating systems, citizens participation as well made the projects feasible. Citizens' participation was enhanced through the creation of financial incentives and through information awareness campaigns that aimed to clearly convey the various side-benefits which stem from adopting the projects.

4.2.5 Driving forces for the Development of Renewable Energy

National economic support and the project's innovative ownership structure handle project proposals managed by the director of the actual Samsø Energy Academy[63]. This was instrumental in the success of the sitting decisions. Also, the financial schemes proposed for the community to adopt RE helped the citizens to avoid carrying high economic burdens and to be able to adopt and be part of (and even accept) the proposals. This was realized through political support and subsidies from Samsø Municipality. The institutional framework initiated by the municipality was of particular significance in the development of the project. This was communicated effectively to the citizens through information awareness campaigns and public meetings. Therefore it becomes clearly apparent that all the pillars of sustainability were utilized in the foremost in order to bring forth a beneficial result. Economic measures, institutional practices and social cohesion acted as the main driving forces in order to protect the local environment, help mitigate GHG emissions and develop a RE strategy that also helped in creating increased well-being for the local citizens.

4.2.6 Benefits of Samsø's Strategy for Developing Renewable Energy

Samsø had substantial economic, social and environmental benefits from developing its RE strategy, in many cases similar to that of Lolland, for instance in air quality. Firstly, offshore windmills brought major benefits to owners and the municipality in terms of direct economic impacts obtained from the sale of kWh where recovery of investment is expected to give benefits to the community (Stubkjær Leif, ND). [64]

Secondly, according to Søren Hermansen, only one firm has provided maintenance for the inland windmills; the rest of the structures receive maintenance from a supplier on the mainland. The only benefit is a direct economic impact obtained by the sale of kWh under the feed-in-tariffs (see Section 3.3.3).[65] These benefits are distributed to the nine individual owners of the windmills and to the 430 residents and shareowners of the other two windmills.

Thirdly, in terms of heating plants, the change from oil to straw and wood-pellets has benefited farmers and local citizens as a consequence of the reduction in price. This money is considered to give benefits to the local economy (Stubkjær Leif, ND).

Fourthly, regarding PV panels, the number of households that implemented the solution is very low. The Samsø Energy Academy implemented the largest part of the panels on the island for its own electricity. According to Søren Hermansen, benefits were perceived by the carpenters and installers of the project.

Finally, the island has increased considerably the number of visitors interested in RE, therefore boosting its tourism income. The island was already a tourist center for summer houses, but due to the implementation of the projects, tourism has been enhanced.

[63] Actual office in charge of projects and diffusion of knowledge related to RE in the island
[64] In 2007, the economic benefited obtained corresponds to the sale of 83,905,874 kWh of electricity to the grid (Danish Statistics, 2008).
[65] In 2007, corresponded to around 114,400,000 kWh (Danish Statistics, 2008).

4.2.7 Renewable Energy Challenges

The island faces the problem of substituting oil-based boilers for heating. According to Jørgensen et al. (2007), summerhouses on the island account for around 800 units. Lack of interest was shown during the periods of promotion to motivate them to be part of the project to change their systems. Jørgensen et al. (2007) described that visits were offered to the households in order to explain about solar heating systems, but the number of households deciding to change was not significant. This process is still under way, but no economic support is provided at the moment. This inconvenient suggest that the owners of summerhouses did not showed interest maybe according for the short periods of time they spent on the island. Therefore, economic convenience is not expected to be received.

Another major challenge is to reduce electricity consumption. At the beginning of the plan, the target to reduce consumption was placed at 10%, but consumption has not decreased. The assessment suggests that even thought changes in electrical items on the island was a big part of the implementation, the purchase and use of more devices has had an opposite effect in the consumption patterns. The consumption of energy has been stable: around 24.000 MWh/year has been consumed every year since 1997. The target of reduction has not being achieved, but for instance conversely than Lolland, the consumption has not increased.

4.3 Summary

As presented in the previous chapters, the driving factors for the development of RE in the case of Denmark include: the search for security of supply, self-sufficiency along with the possibility to use local resources. At the local level, in the case of Lolland, the economic perspective stands as the main driver for change, followed by improved environmental benefits. In the case of Samsø, the driver for the development of the strategy was the national government support through the prize offered to become a 100% renewable energy island. Therefore, economic perspective was also the main driver.

5. Discussion

This chapter discusses the important factors used in the localities for the successful development and deployment of RE strategies and projects, and suggests recommendations for other local regions around the developed world to implement similar measures.

According to the literature review, the main actors which are needed for the development of RE are National and Local governments which have the capacity to motivate the necessary factors which are: appropriate national or local policy; economic or financial conditions, which stimulate the decisions to create strategies for RE; and information, education and awareness to the population in order to adopt RE solutions. The other main actors found in the literature are: businesses, NGOs, citizens and Academia which can influence the local government to create basis for the deployment of local RE. At the same time, business and citizens must accept incurring direct or indirect economic and social impacts.

As the previous chapter has shown, both case studies of Lolland and Samsø have successfully developed and deployed RE strategies and projects. In the case of Lolland, the main actors are: the

Municipality through RE policies, Baltic Sea Solutions (BASS) for the development of RE projects, LOKE Holding A/S for providing project funding, and the citizens/farmers who have participated in the deployment of the projects. In Samsø the main actors are: the Municipality through deployment of the projects, Samsø Energy Company, for bringing together the main actors in the community, and the citizens/farmers who have participated in the projects.

As was evidenced by the case studies, the main actors identified in the literature review are present in Lolland and Samsø and play an important role in the development of the strategies. Other actors that are presented in the literature review, for example academia and NGOs, were not addressed because in the interviews they were not perceived as having played a large role on the two islands for the development of the actual strategies. However, the literature states that the main role that these actors have is to influence and drive governments to consider RE, in the cases of the two islands, as mentioned before, the main drivers that led to RE were economic reasons. According to this, at the local level, the strategies utilized by the main actor influencing the development of RE, has been the coordination with other main actors with significant influence at the local sphere (economically or socially). Literature holds that, at the global level, large companies have influenced negatively and positively the decisions of governments in order to use, invest or act on favor regarding RE. On these two islands, clearly was presented the union or link among these main actors (Municipality – Business) which have portrayed a key element for the development of the projects.

Regarding RE barriers, according to the literature review, the barriers presented are i) Lack of Political support; ii) Lack of Information, Education and Awareness; and iii) Lack of funding or economic conditions. Concerning the cases of Lolland and Samsø Islands, the literature review and the interviews conducted, the following discussion points for overcoming the barriers at the local level were observed and identified as highly relevant for the success of RE.

5.1 National Factors for the Development of RE.

The important factors are the formalization of RE in the national policy plan and an efficient economic support system. The following points were identified from the discussion of the Danish national approach to RE.

- Political support for the development of technologies included in the Danish Energy Plans in which direct subsidies supported the development of RE (see Section 3.3.2 and 3.3.3).
- National commitment with ambitious international agreements for the reduction of CO2 emissions and increased use of RE within its energy sector.
- Public Service Obligations (PSO) as a specific tax for funding the actual development of RE as well as, research and development of technologies. PSO also concerns the security of supply which is seen as one of the most problematic concerns in the EU. The clarity of the purpose of such a tax, grants an element of transparency to support the development of RE strategies (see Section 3.3.2).

5.2 Local Factors for the development of RE

At the local level, five elements were identified as key factors for the development of RE: i) Political support; ii) Local economic strategy; iii) Inclusion of the community, iv) Distribution of benefits to the community; and v) Networks. These are discussed below.

5.2.1 Political Support

Politically determined visions and objectives are clearly defined in proposed RE strategies to stimulate the creation of economic activities, as well as environmental benefits, through the exploitation of local resources. In the case of Lolland, the Development Department (with business and development as top priority) focuses on RE or companies interested in such for production processes. This represents the internal mechanism of influence (focus on business development) for the municipality, which to a large extent defines the decision of the municipality to realize projects determining future possible economic activities. As such, this enhances the necessity to join economic objectives with environmental ones.

The driver for the island to change its RE policy was its negative social and economic development in recent decades; therefore, as a matter for survival, the economic element was the driver. Thus, the inclusion of environmental goals (i.e. reduction of CO2 emissions), along with the use of local resources for energy, required local political acceptance in the municipality. At the same time, the benefits obtained by the municipality are usage of local energy sources, international visits of interested investors, tourist and researchers - all of which increase the visibility of the activities in the community.

In the case of Samsø, the main driver was the economic incentive from the prize it won in 1997 to become a self-sufficient island based on RE. The local political support in the island suggests that the principal strategy that worked was the combination of stakeholder partnerships and the local policy adopted to benefit and support/encourage participation of citizens.

Both proposals for RE include formal targets, diversification of RE technologies and the inclusion of targets not only for production but also to address consumption. In the case of Samsø, the participation of the community was mentioned in the proposal, while in the case of Lolland it was not as presented below.

Lolland	*Samsø*
• Increase local renewable electricity generation by 50% by 2010 (Wind) • Convert heat generation to 90% renewables by replacing fossil fuels with vegetable oil boilers by 2015 • Reduce electricity consumption by 25% compared to 2004 • Perform an annual energy performance audit • Improve energy efficiency in publicly owned buildings, commercial and industrial facilities	• Become 100% renewable within a period of 10 years (by 2008) by implementing Land-Based Turbines, Offshore Turbines, PV panels and Central Heating • Reduce energy consumption by at least 10% • Ensuring high level of participation of the community • The use of innovative forms of financing

Another important factor included in the proposals is that distribution of the benefits can be seen in Samsø Island, where the use of innovative financing schemes gave the opportunity to a large part of the population to be part of and receive benefits from the projects. In Lolland this part was not included, but according to the interviews, direct economic benefits are obtained by the possible creation of employment in the future.

5.2.2 Local Economic Resources

According to the literature, economic challenges to support RE represent an important barrier for the deployment of technologies. Therefore, the necessity for national support is required. At the same time, local economic strategies can contribute (according to this research) to eliminate such barriers.

The municipality, acting as guarantor in Samsø, has lobbied to obtain preferred interest rates with the local bank to support the feasibility of RE projects. Therefore, local government support determined the viability of RE. This was necessary to support the purchasing of onshore and offshore privately-owned windmills. Conversely, the distribution of economic costs for the acquisition of the other two onshore windmills (owned under the scheme of 430 shares) enabled the acquisition without the need to proceed with a loan. However, the necessity to organize and motivate the citizens to buy shares resulted in project delays.

In Lolland, the local capital-focus on development of the community is LOKE A/S. LOKE A/S focuses on projects with benefits to the community, based on the exploitation of local resources. It represents the economic catalyst to develop RE projects on the island. At the same time, the inter-link among the director of BASS – whom performs the same position in LOKE A/S – suggests the possibility to reduce administrative dilemmas at the moment to request loans to the Holding. On the other hand, the inter-link among the two companies could represent some issues related to conflict of interests which if not well handled, could lead to transparency concerns.

Therefore, the interaction amongst BASS, LOKE A/S and the municipality helped each actor to overcome RE barriers by achieving political support (Municipality) and “know-how” (BASS) and deal with lack of funding (LOKE A/S).

This security of funding instills confidence for new companies who may desire to test or develop new products. For academia and research institutes, this creates a valuable reality field (i.e. interaction with already established systems) – often a missing element to develop new technologies (Gunhild Utkvitne, 2008). This co-financing body distributes economic risks amongst the municipality and the parties involved in the projects, putting together the Public Private Partnership synergy. On the other hand, banks are considered, in many cases, a key element for the support and development of a new industry (Jacobsson et al., 2000). While this perspective is more focused on new project developments, these actors can contribute to support the development and adoption of technologies. These institutions can work as facilitators of economic conditions for the projects in the community. In the case of Samsø, reduction in the interest rate for the projects through this synergy resulted in the capacity for onshore windmills to be purchased.

In Lolland, besides LOKE, banks can represent an element for development of RE technology, according to the concept of technological innovation. Currently a local bank on the island (Lolland Bank) does not have any special support mechanisms to offer loans or specific credit supporting any RE proposal. This type of loan was granted when the national government backed high support (i.e. before 2000 – see Section 3.3.3) through feed-in-tariffs. Since then no requests for the financing of windmills have been

presented in the bank (in this case, Lolland Bank) and the conditions to grant a loan to citizens fluctuate purely under market and credit conditions.

5.2.3 Inclusion of the Community

Hearing processes have been used in both cases. This way to communicate the projects to the citizens generates public discussion regarding the future plans in the municipality and can contribute to the improvement of the projects. This structure of dissemination of information represents to a large extent an important element for adoption/acceptance and a potential path to reduce barriers at the local level such as community acceptance, as discussed in Section 2.4.3. As a result, it gives the opportunity to generate new ideas, and involve local actors who can participate in projects or adopt measures to reduce CO2 emissions.

In the case of Samsø, this element was used to inform and update the citizens about existing and new projects pertaining to create a 100% RE Island. This gave the opportunity to find investors and interested actors (social or economically affected) in the development of the island. Therefore, the projects which included the capacity to generate jobs and involve the community where lobbied by interested actors.

Lack of information and knowledge regarding applicability of RE alternatives can be a potential barrier. Therefore, at the local level, if the government provides the necessary information – as in the case of Samsø – to know how to invest in a RE solution, the possibility for citizens to get involved and invest in RE can be realized. This was the case particularly in the heating plants in Samsø, where the adoption of RE solutions was done by informing the local citizens about the possible benefits obtained to adopt local heating systems and reduce oil expenses within the community.

5.2.4 Networks

Geller (2003) suggested that companies with strong interest-investments in fossil fuels have the capacity to form coalitions to lobby and shape policies to support their interests. At the local level, the formation of coalitions or networks can foster the adoption of RE implementation and help to reinforce political support and create solutions to barriers.

The formation of the company-network, in the case of Samsø, represented the key structure to deploy RE. The network aimed to obtain as much benefits as possible (mainly economic, with environmental benefits) at the community level. The actors involved at the Samsø Energy Company joined the interests of the Farmers Association, the Commercial Council of the Island and the Municipality. Therefore, the participation of a large part of the interests of the community suggests it could have been a factor to help to create community acceptance for the implementation of the projects. In Lolland, before the establishment of BASS, no local association or company was focused on energy-related issues. After the presentation of the paper Green Lolland-Falser, the union among interested parties reached a level to influence and propose projects to the municipality. This influence gave shape to the adoption of the key objectives of CTF, which can be seen as the political acceptance (at the local level) to support the projects.

5.3 Benefits obtained by the RE development at the local level

As presented in the last chapter, the following benefits – apart from the overarching goal of reducing GHG emissions, are perceived and in some cases already achieved on the islands:

- Cost per kWh for heating which is around 50% lower than the prices of oil.
- Market opportunities as the case of implementation of rapeseed oil in the community
- Self-sufficiency in electricity production which can be seen as the main objective on the national and EU policies. This point highlights the importance of energy security and independence of supply of energy
- Promotion of the island on international forums, which can be seen as opportunities for the island to receive investors (economic growth) and receive tourism
- Selling of excess of electricity produced
- Blue collar workers in the construction phase of some RE

Such benefits were considered in some of the interviews as crucial for the continuous development of the island. Economic benefits by receiving part of the energy services (heating), income obtained by the national support (on this specific cases, subsidies, feed in tariffs and tax exemptions). Environmental the reduction of pollutant emissions. Social, the promotion of the island on international forums with further tourism impact and therefore employment benefits.

5.4 Conclusion and Recommendations

The factors presented above have been derived from the analysis of two particular local cases in Denmark, however the intention here is that these factors are necessary to develop and deploy successful RE strategies and projects across local regions in the developed world, taking into consideration the particular circumstances and context of local settings. Extrapolating from the Danish perspective regarding RE and in specific from these two local settings, this research concludes that the crucial/important factors for the successful development of strategies and deployment of RE in the local setting (integrating the concept of Social Acceptance of Renewable Energy) are as follows.

The dynamics presented in these two cases can delineate a series of important issues surrounding RE implementations and identify the factors, problems and opportunities in relation to RE, at the local level.

Political factors

- Socio-Political acceptance:
    - Formality of targets (national and local government)
    - Creation and/or coordination of local key actors
    - Information, Education and Awareness (political level)

Economic and Know-how factors

- Market and Community acceptance at the local level
    - Economic conditions fostering deployment of RE
    - Information, Education and Awareness (community level)

In the case of Lolland and Samsø, the political support at the national and local level has been an important factor for the development of RE. This support and commitment can represent a key element to combat issues of climate change (reducing the use of fossil fuels), energy security (developing localities with self-sufficiency of fuels), which is possible to a large extent as was demonstrated in the cases.

The Danish government, responsible for the welfare of the society, established the right conditions in order to deploy different technologies, this process took place as consequence of: The necessity to reduce dependency on foreign technology or energy sources. Long term vision looking forward to an important increase in employment needed at that time in Denmark, and in addition, an important factor was the intervention from other important actors. Academia, helping to develop an alternative energy plan and Danish NGOs raising concern amongst civil-society and rallying support to RE.

The main characteristics of the adoption of RE at the national level are: It has formally incorporated the use of RE into the national plans, including long-term consistency and important incentives. Such as in the case of wind, this has been done giving the economically necessary support. The strategies used include subsidies, which in the case of windmills last for around 14 years. Also, feed-in tariffs have been a key driver, since the subsidies are not given anymore, the results of which demonstrate the large penetration into the internal market of electricity (up to 19% in 2007). These incentives (strategies) have affected the local actions, which following national targets and realize the advantages that local exploitation of resources can bring. Political stability (with long-term thinking) at the national level is necessary for the success of RE and local commitment accepting the integration of national strategies.

On the other hand, the strategies at the local level, emerge as a consequence of the creation and coordination of main actors. In the cases of Lolland and Samsø, the creation/participation of a key actor with high influence linking local government and key areas of the community have contributed significantly to the development of the projects. This actor (BASS in Lolland and SEC in Samsø) in both cases, worked as coordinator of projects and proposer of strategies which has been the catalyst for implementations.

The creation of the key actor in the case of Samsø (SEC) which defined the strategy to follow and was responsible for creating the network among the key stakeholders, which could contribute to the success of the project. This includes, to a large extent, the citizens and interested parties, who, otherwise, could have represented an obstacle for the success of projects. In Lolland, BASS has worked as a coordinator and consultant for the municipality.

Regarding Market and Community acceptance, in the two cases, the strategy that contributed to the clear success and realization of the projects and sitting decisions, is the link between community and municipality (at large extent in Samsø and with key stakeholders in Lolland). This link can help to reduce the barrier: lack of information and awareness regarding RE solutions and the possible negative for the acceptance of the projects in the future. This can be determined as inclusion; this strategy of inclusion can enhance projects with regards to: time to develop the projects, investment required to implement the projects and success on

the implementations. The inclusion of the community or the inclusion of important actors was found as crucial for the success of the projects.

Opportunities were found in Lolland where contact with the citizens was realized on this research. Following the strategy in Samsø, what can be integrated is a common center of information for citizens where technical expertise can be given. Therefore, if the local government enhances the link between authority and citizens, case by case, higher production of RE can be achieved and market acceptance can be increased.

At the local level, the acceptance of the technologies by the citizens was found as a matter of Awareness and Information. This barrier can be easily overcome by just presenting the right information to the community. This is the case of Samsø, where information was clearly and transparently given to the citizens. Along with this, there is the establishment of the financial strategy working as the driver in the projects. This strategy helps to link the community and market acceptance in the local setting.

Following the lines above, in order to support other developments of RE in local settings, important questions should be presented to other localities as: How strong is the link between the local government and the citizens regarding information and economic support (from national and local government) towards RE? How clear and formal are the targets of RE implementation in the communities? And, is there a specific/responsible stakeholder or main actor driving the process in the local setting?

Therefore, based on the literature review and the case studies, the recommendations for the successful development and deployment of RE strategies and projects at a local level are as follows:

- Political support, both at the national and local level, in the form of economic support, knowledge and information.
- The creation of a local plan with focus on the use of local resources for energy purposes including specific targets in time and high commitments. Outlining specific project details (such as timing, site, costs etc.). Moreover, make the targets and the possible solutions available to the public in order to receive insight for local or external actors, which can contribute to improving the quality and effectiveness of the projects.
- Ensure access to reliable economic resources with long-term perspectives in order to ensure the success of the projects and create confidence among investors and the community.
- Create networks among the main actors in the community with interests in RE in order to not undermine the interests of all the community.
- Create a forum or platform for community involvement and diffusion of information, in the form of a company, organization or network in order to keep informed of advances, obstacles and findings of potential or possible trends the projects could face in the future.
- Finally, take the risk to become 100% self-sufficient with local resources

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APPENDIX I – List of interviewees

Municipality: A member of the Department of Business Development was interviewed to understand the background and development of the island, looking at reasons as to why the municipality is focusing on RE as a platform for development.

Persons Interviewed

- Leo Christensen (Project Director, Business Development, Lolland Municipality) Personal Interview on March, 2008 (Interview questions in APPENDIX I)

BASS: A variety of interviews were held at this company which focuses on the development of the island and is one of the main actors in charge of proposals and project coordination. Thus, interaction and interviews were considered relevant to understand the island's current RE investments and strategies.

Persons Interviewed

- Gunnhild Utkvitne (Director, BASS) Personal Interview on March, 2008
- Jesper Krogh Jensen (Energy and Environment, BASS) Personal Interview on March, 2008

(Interview questions in APPENDIX I)

Grønt Center, Lolland: This center is in charge of rural districts and agricultural/agro industrial activities. This stakeholder was also important in identifying some challenges to a particular RE project.

Person Interviewed

- Birgit Hartvig, Director, (Grønt Center, Lolland). Telephone Interview on March, 2008

(Interview questions in APPENDIX II)

Two Local Farmers and Citizens: Semi-structured and structured questions were conducted with citizens, in order to understand the perspectives of windmill owners, rapeseed producers and the general population. (March, 2008) (Interview questions in APPENDIX III)

Lolland KlimaX 2009: In addition to the conducted interviews, this researcher attended a Lolland KlimaX 2009 organized by BASS, that offered key insights as to how this project was to progress in the future. This allowed information accumulation, sight visits and targeted interviews at the conference.

In the case of Samsø, stakeholder interview was carried out via telephone. No visit to the island was possible due to lack of response from informants. The interview via telephone was semi-structured. This interview was presented to one of the main local actors involved in the creation and development of the strategy of RE on the Island:

Samsø Energy Academy: Søren Hermansen was in charge of the project to make Samsø a 100% RE island. Thus, to understand the development of the island implementation, the interview examined the reasons as to how the company-municipality-associations developed the project.

- Søren Hermansen (Director, Samsø Energy Academy) Telephone Interview in April, 2008

Appendix II – Questions Lolland Municipality & BASS

Interview topic:

- Renewable Energy Strategies
    - Sub-topics:
        - *Implementation process (features and barriers)*
        - *Stakeholders*
        - *Benefits of renewable energy implementations (socio-economic)*

- Please, can you describe the process of implementation of renewable energies?

- What do you consider are/should be the preconditions to implement a renewable energy project?

- Can you explain how the policies and funding mechanisms to encourage the implementation of renewable energy technologies work at the local level?

- Which are the main barriers the implementations of the projects have faced?

- How have you are/or planning to communicate the projects to the citizens?

- How do you create networks (group of citizens or companies)?

- What are the facilities to the citizens and companies to motivate them to implement/invest in renewable energies?

- How are these facilities promoted?

- For you, who are the stakeholders in a project of renewable energies?

- Who elaborates, and how is created, the planning process utilized for the implementation of renewable energies?

- What are, and how are given, the facilities to the citizens and companies to motivate them to implement/invest in renewable energies?

- Is the implementation of renewable energies as the mean or tool to achieve economic growth?

- What other non-economic aspects are going to be obtained? Positive

    - Employment (number and years) (400 is it the minimum goal?)
    - Investments
    - Energy security (90% will be reached in heating?)
    - Local and regional development
    - Health
    - Other?

- Are local resources (people) utilized or mainly imported from other islands?

- How is it created knowledge among the citizens about the benefits obtained for the implementation of renewable energies?

- How many companies were create / are planned to be created for the implementations of renewable energies?

APPENDIX III – Questions Grøn Center Lolland

Interview topic:

- Renewable Energy Strategies: Rapeseed oil

- Please, can you describe the process of implementation of the project Rapsol I/S?

- How did the Center participate in the project?

- Which are the main barriers the implementation of the project has faced?

APPENDIX IV - Questions to the community

Date: _____

Name: _____

- Do you know about renewable energies? For example wind, solar, etc.
- What is your main reason to implement renewable energies?

  ☐ Economic benefits

  ☐ Take care of the environment

  ☐ Policy requirement

  ☐ Other

- Would you accept a wind turbine in your back yard? (If you are owner of one, have you think about change the device for one with more capacity?)
- Would you accept a wind turbine near your house or place of work?
- Would you cover the roof of your house with solar panels to produce electricity or for heating?
- Do you use oil or straw or other product for heating your house?
- Would you change your heating system for one that uses RE?
- Do you think the government is giving you the facilities (money and knowledge) to use or implement renewable energies?
- What benefits have you received, or you are expected to receive, from implementations of renewable energies?
  - Economic (Employment, indirect benefits, self sufficient energy supply)
  - Social (health, interaction with the community)
- Have you reduced energy (electricity or heating) consumption in your house?
- Do you know what the alternatives for doing that exist?
- Do you know about any percentage or goal reduction of energy consumption the municipality is looking for households?

APPENDIX V – Questions Samsø Energy Academy

Interview topic:

- Renewable Energy Strategies
    - Sub-topics:
        - *Implementation process (features and barriers)*
        - *Stakeholders*
        - *Benefits of renewable energy implementations (socio-economic)*

- Please, can you describe the process of implementation of renewable energies?

- What do you consider are/should be the preconditions to implement a renewable energy project?

- Can you explain how the policies and funding mechanisms to encourage the implementation of renewable energy technologies work at the local level?

- Which are the main barriers the implementations of the projects have faced?

- How have you are/or planning to communicate the projects to the citizens?

- How do you create networks (group of citizens or companies)?

- What are the facilities to the citizens and companies to motivate them to implement/invest in renewable energies?

- How are these facilities promoted?

- For you, who are the stakeholders in a project of renewable energies?

- Who elaborates, and how is created, the planning process utilized for the implementation of renewable energies?

- What are, and how are given, the facilities to the citizens and companies to motivate them to implement/invest in renewable energies?

- Is the implementation of renewable energies as the mean or tool to achieve economic growth?

- What other non-economic aspects are going to be obtained? Positive

    - Employment (number and years)
    - Investments
    - Energy security
    - Local and regional development
    - Health
    - Other?

- Are local resources (people) utilized or mainly imported from other islands?

- How is it created knowledge among the citizens about the benefits obtained for the implementation of renewable energies?

- How many companies were create / are planned to be created for the implementations of renewable energies?