Food and Fuel?

Exploring the Role of the Common Agricultural Policy in Promoting Energy Crops

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Abstract

Identifying the critical factors for the promotion of energy crops within EU-15, this thesis focuses on identifying the various measures under Common Agricultural Policy for the promotion of dedicated energy crops.

The main critical factors relate to energy crops identified are:

- Land Availability
- Perceptual challenges
- Ecological issues
- Resource Competition, and
- Policy development

The findings show that for the promotion of energy crops there are no drastic changes required in existing Common Agricultural Policy. Some of the measure identified here already exists, but not for energy crops. The need is to make these measures available for energy crops with the required modifications, in addition to other supplementary support measures. Further, it was realised that there is a need of harmonisation between energy and agricultural policy.

Executive Summary

The present energy policy of the European Union reflects three main areas: secure energy supply, environmental protection and competition. Currently, the European Union's own energy supply covers barely half of its needs. This dependence on energy import is expected to reach 70% by the year 2030. To reduce its dependence on import of energy supply and to fulfil other environmental obligations such as greenhouse gas reduction under the Kyoto Protocol, the European Union set a target to double the share of renewable energy sources (i.e. from 6% to 12%) in its gross inland energy consumption by 2010.

Among renewable sources of energy, biomass is expected to play a significant role in achieving these targets. On condition that effective measures will be taken it is expected that the present share of bioenergy (i.e. 44.8 Mtoe) can be tripled by 2010 (i.e. 135 Mtoe). In achieving this target energy crops are expected to contribute one third (i.e. 45 Mtoe) of the energy expected from biomass sector. Energy crops differ from other renewable energy resources in a sense that the targets are set under energy policy while the tools to achieve them are in the common agricultural policy. Consequently, the growth of energy crops is effected by several factors.

The availability of land for growing energy crops is the prime factor for the promotion of energy crops. The use of agricultural land whether set aside or arable is mainly based upon the opportunity costs associated with its different uses. Unless benefits of growing energy crops are greater or at least equal to other crops, it will not be a priority among farmers. The various changes in common agricultural policy after June 2003 reform such as single payment scheme according to which, in future direct aids will be independent of what a farmer produces (decoupling), and an additional aid of 45 €/hectare for energy crops grown on main agriculture land are the clear policy signals to increase the uptake of land use for growing dedicated energy crops. As these measures are very recent their effect on market is not very evident.

Second critical factor for the promotion of energy crops includes difference in perceptions. On the side of farmers this exists because of existing farming traditions, lack of knowledge about energy farming, unknown future market, loss of flexibility, and other actual and perceived risks of growing energy crops. The major challenge persists on the farmers' side is the lack of business perception. On the side of energy sector, these perceptual challenges include uncertainty about the future of these projects. This uncertainty is because of short term policy goals and changing proprieties with change in government.

Energy crop plantations are believed to provide both environmental opportunities and challenges. Environmental impacts of biomass plantation, to a great extent, depend upon the selection of species and management practices. Provided due care is taken, energy crop plantation can provide environmental benefits such as reduction in greenhouse gas emission, erosion, reduced nitrification of ground water, reduced use of agrochemicals, and for the treatment of contaminated sites.

Further, unlike other renewable sources of energy, energy crops face a dual competition. On one hand it competes with conventional energy resources on terms of energy prices and secondly with other biomass resources such as agriculture and forest residues.

The growth of bioenergy is further hampered by the political disparities. In case of biomass it is considered that the playing field is not level. They operate in a scenario or frame-work which was originally constructed for conventional fuel resources and hence favours them. In market, bioenergy competes with other conventional sources which were established decades ago with high subsidies and have recovered their establishment cost. Whereas in case of

bioenergy the final price of energy has to include this initial establishment cost which makes it comparatively costlier. Further, the exclusion of externalities, both negative and positive, in various fuel prices incline the market in favour of conventional fuels. These different factors have different sources of origin and so do the mechanisms to influence them. The various provisions identified under common agricultural policy for the promotion of energy crops include:

- Establishing an intermediary organisation
- Expansion of energy crop subsidies
- Energy crops as rural development measures

One way of promoting energy crops through common agricultural policy is establishing an intermediary organisation such as producer's group under respective common market organisations for various food crops. The role of this organisation as a mediator or facilitator would be to provide farmers security about availability of buyers and minimum income. On the other hand to the processors it will provide guarantee about continuous supply of energy crops. The role of this institute can be supplemented by activities such as research and development related to energy crops and providing farm advisory services to avoid negative environmental impacts associated with poor energy farm management practices. This kind of organisation can further help in overcoming concerns related to equipments or machinery required for energy farming by providing these machines on rent to the farmers.

Secondly, extended subsides for the initial establishment of energy crops under different provisions such Single Payment Scheme, compulsory cross compliance and modulation will reduce the high financial need for farmers in the early part of the production period. These establishment supports should not be permanent and reduce gradually, as with time the production of energy crops should be economically feasible without specific subsidies. However, it can be a very efficient measure to push the development and to reduce farmers' risk in the initial phase where a learning process is taking place and the risk of mistakes and failures is high.

Thirdly, the energy crops can be supported by common agricultural policy under the rural development measures. Supporting bioenergy plants under rural development plans will not only provide guarantee of continuous buyers, but will also help in creating jobs by promoting businesses related to bioenergy plants. The promotion of energy crops in areas having some physical or environmental constraints is also an option to maintain agriculture land in these areas. Further, a part of money generated as a result of compulsory modulation scheme can also be allocated for the development of energy crops under rural development plans.

The results of the research shows that to promote energy crops, there are no drastic changes required in the present common agricultural policy structure. Some of the measures identified already exists, but not for energy crops. The need is to make these measures available for energy crops with the required modifications, in addition to other additional support measures. Further, there is a need of harmonisation between energy and agricultural policy was realised.

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1 Introduction

1.1 Background

Energy security – the continuous availability of energy in varied forms, in sufficient quantities, and at reasonable prices – has several aspects. For any economy, an unreliable energy supply results in both short- and long-term costs in terms of loss of welfare and production, and the adjustments taken by consumers to mitigate their losses because of unreliable energy supplies. In last few decades the concerns related to security of energy supply for the EU have augmented for a number of reasons; the shifts in oil and gas prices, market reforms, deregulation and political instability in some main supplier countries(Goldemberg & Johansson, 2004).

One way to improve energy security is diversified supply – both geographically and among various primary resources. The renewable energy sources (RES) such as wind, biomass, solar and hydro are among the answers to diversified supply of energy. The market for these renewable sources of energy depends in part on the future demand for energy services: heating and cooling, lighting, transportation, and so on. This demand, in turn, depends on economic and population growth and on the efficiency of energy use.

Renewable sources of energy currently contribute approximately 14% in the world primary energy mix. Biomass individually contributing around 11% to worlds primary energy mix and it is the major contributor among various renewable sources (Hall, Rosillo-calle, Williams, & Woods, 1993; Ronger, 2000). In developing countries biomass for energy purposes accounts for about 35 % of total (Ronger, 2000). This explains why biomass is often associated with developing countries and perceived as fuel of the past. But biomass resources are abundant in most parts of the world.

What is Bioenergy?

Bioenergy is the energy contained in "Biomass". Biomass means any plant-derived organic matter available on a renewable basis.
(European Commission, 2002)

Introduction of large scale plantation of energy crops in combination with the use of agriculture and forestry wastes and residues could make biomass a substantial contributor in the global energy mix. The expected role of biomass in the future energy supply of industrialised countries is based on two main considerations:

- With agriculture food yield increasing at a rate faster than population growth rate (Ronger, 2000), the amount of surplus agriculture land will be the potential resource base available for biomass plantations, and

- The development of biomass production, collection and conversion systems to create biomass-derived fuels that can substitute for fossil fuels in existing energy supply infrastructure without contributing to greenhouse gases.

In the European Union, renewable sources of energy contribute 6% of total energy consumed in member countries. Figure 1-1 below shows the individual contribution of these renewable sources. Biomass contributing 62% of total renewable energy is the biggest renewable energy source. The use of RES in EU for primary energy has been increased about 3% in the last decade (OOP of EC, 2002, p.9-11). Among all the renewable sources, the maximum growth has been seen in the sector of wind energy. One of the reasons for this growth is the fast

developing wind energy technology. The average weight of wind turbines has halved in last five years.

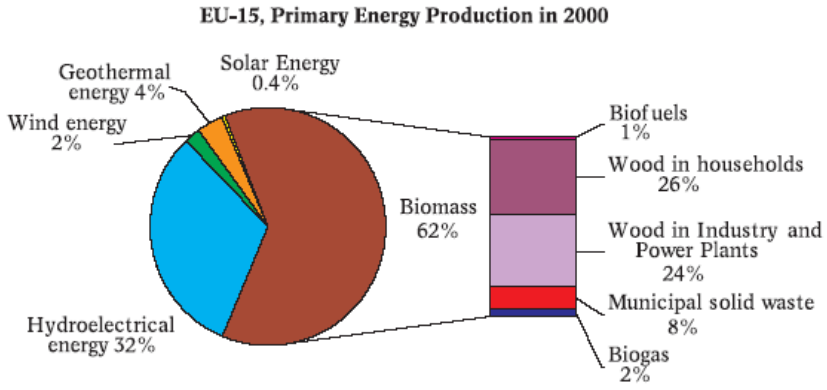

Figure 1-1: Contribution of individual RES in EU's Primary Energy Production

Source: (Office for Official Publications of the EC, 2002)

European Union has a target to double the share RES in gross inland energy consumption by 2010. Since the option of large hydropower plants in the union are already by and large exploited, while the photovoltaic are not yet competitive, the additional supply must come mainly from wind and biomass. In achieving this target, biomass is considered to play a significant role. The share of bioenergy in the EU's total energy consumption is projected to rise from current 3.2 % to 8.4% by 2010.

1.2 Research Problem

In the European Union[1], the economy and society which is steadily demanding more and more energy is essentially based on fossil fuels (oil, coal and natural gas). Immensely dependent on the import of these fossil fuels, the EU's own resources covers barely half of its energy needs (COM(2002)321final). With an estimated 1-2% rise in energy consumption per year this amount is expected to reach 70% by the year 2030. This insecurity about future energy supply, increasing dependence on energy import and fluctuating oil market prices has diverted the attention towards renewable sources of energy within EU member countries.

It would be simplistic and wrong to conceive security of supply merely as a reason for reducing import dependency and boosting domestic production. Security of supply calls for a wide range of policy initiatives, inter alia, diversification of sources and technologies and without ignoring the geopolitical context and its implications.

The EU's obligation to reduce its greenhouse gas (GHG) emissions by 8% from 1990 levels by 2008-2012 under Kyoto Protocol commitment add to the importance of the environment dimension and sustainable development in its energy policy (European Environment Agency, 2001);Green paper COM(2000)769 final). Further, these renewable sources being indigenous are also important for the reason of social and economic cohesion. Development of these indigenous sources of energy contributes to job creation - predominantly among the enterprises related to renewable energy sector, and also regional development.

[1] European Union in this research means EU-15 countries. New member countries to EU are not included in this research.

In the backdrop of all these, the commission in its White Paper "Energy for the future: Renewable sources of energy" sets a target to double the present contribution of renewables in the European Union's gross inland energy consumption by 2010. The contribution of bioenergy, in the community strategy and action plan, is considered imperative to achieve this target of 12 %. On condition that effective measures will be taken it is expected that the present share of bioenergy of 44.8 Mtoe can be tripled by 2010. This additional estimated bioenergy use of 90 Mtoe is expected to be derived from agricultural, forest and forest industry residue, waste stream as well as from energy crops.

Energy crops are expected to contribute 45 Mtoe i.e. one third of the energy expected from biomass sector[2]. For energy crops to be a major contributor availability of land is the central issue, along with crop productivity and fresh water resources (Hall et al., 1993). Since, in European Union the land use for various agriculture purposes is majorly governed by Common Agricultural Policy, it will play a significant role in achieving the target set for energy crops.

Consequently, the objective of this thesis is to establish the current situation concerning the production of energy crops in member countries, and identify the role of CAP in the increased energy crop production in European Union.

To achieve these objectives will include answering the following questions:

1. *What are the critical factors for the promotion of energy crops within the European Union?*

2. *How can energy crops be promoted through the 'Common Agricultural Policy'?*

1.3 Research Justification

For energy crops to contribute land availability is the central issue. Recent CAP reform replaces most of the direct aid payment schemes with Single Payment Scheme (SPS). According to this scheme, direct payment to farmers will be independent of what they grow. Under this circumstance the crop which is more profitable will out-compete the other one. Energy crops, when compared to food crops, are new field and have relatively immature market that makes the conditions unfavourable for energy crops. These are some of the concerns which make it worthwhile to look in to the matter more deeply how CAP can facilitate the uptake of energy crops in member countries.

There have been some efforts at EU level, such as European Energy Crop Overview (EECO) projects, to asses the potential of energy crops. The main objective of this project was to improve the access to existing information on the production, processing and utilisation of energy crops, and to enhance the integration of research, development and implementation activities on energy crops (BioMat Net, 2004). The emphasis of project being more on economic and technical potential had very little or no focus on the intervention of CAP to support energy crop.

Similarly, the projects such as Altener or THERMIE funded by EU, focuses on information dissemination and knowledge sharing through demonstration projects. So far, there have not

[2] Communication from the Commission (26.11.1997) on – Energy for the future: renewable sources of energy – White Paper for a community strategy and Action Plan – COM(97)599 final

been many efforts in identifying the role of CAP in promoting energy crops. Further, this research also makes sense as CAP has undergone two major reforms - 'Agenda 2000' and 'June 2003', after many of these projects were conducted and is different in many ways it used to be. Further, most of the studies currently available (Paine, 1996; Roos, 1999; Rosch, 1999) talks about the critical factors associated with biomass in general and are conducted at global level.

The research is an attempt to identify the strengths and weaknesses in existing policy mechanisms related to the development of energy crops. The research findings are expected to assist decision makers in the efforts to develop a comprehensive action plan for bio-energy promotion.

1.4 Research Methodology

This research is an exploratory study that follows a qualitative approach. Reason for adopting this approach was the necessity of research to illustrate the current policy measures for energy crops under CAP and legislations on energy, and establishing current market scenario/trends related to energy crop production in various member countries. The background information gathered here was more of foundation work in identifying the factors influencing the energy crop plantation. Identifying these factors also requires considering the views of various stakeholders involved in the whole process chain. This information gathered by reviewing literature and by interviewing stakeholders was analysed in the backdrop of current relevant legislation to achieve the overall research objective. The following sections details the way in which the research has been designed and explains the approach that was followed to achieve each objective.

1.4.1 Research Design

To accomplish the research objective, the first step was to devise a logical framework that could be used as a research plan and as a way to structure the thesis work. Figure 1-2 shows the frame-work followed during the research. In order to gain inclusive understanding of the situation, an eclectic approach was taken rather than concentrating on one conventional area. The work is divided into two areas, data collection and analysis. These two areas evolved simultaneously during the later part of the thesis, as further research was needed to answer the questions raised during analysis process.

Initial analysis started with the collection of background information. Various policies and literature were read closely so that a clear understanding of the main factors can be attained. The critical factors presented here is not a comprehensive list. The main factors were selected based on the analysis of the arguments and how strong the arguments were in each case when they were compared. Once identifying the main factors, concerned people in each field were contacted again to discuss each of these factors in more detail. After identifying and categorising these critical factors, a thorough analysis of various supports and provisions under CAP was conducted again to identify the various measures under CAP to promote energy crops.

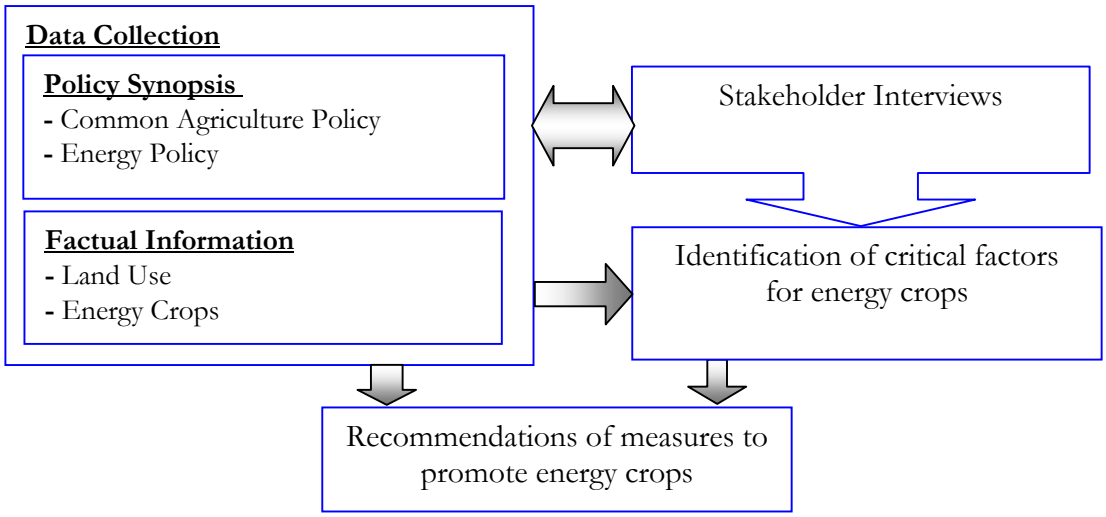

Figure 1-2 Methodological approach

1.4.2 Data Collection

The data collection concentrates mainly on the use of secondary sources. The primary sources were used more for the verification or clarification of the information gathered through secondary sources. The whole data collection process was broadly distinguished into two sections.

In the first section information collected is mainly related to various policy measures. The information collected here is about Common Agricultural Policy and the various energy and related policies at the EU level. The main source of information here is the web site of European Union. In addition to this, where ever required information was also gathered through World Wide Web search of relevant sites.

The information collected in the second section contains the data related to various land uses and energy crops. In addition to web based resources, the data here was also collected from various research findings, periodic survey reports and studies conducted by EU and other international organisations such as Food and Agriculture Organisation of the United Nations (FAO). Wherever possible data collected in this section is verified through primary or secondary sources to check the authenticity.

Interviews were conducted in order to establish the most up to date position as situations can develop rapidly and the information is not always available in a text form. Knowledge base at bioenergy Network of Excellence (NoE) under a project at International Institute for Industrial Environmental Economics was also used for collecting data.

1.4.3 Stakeholder Interviews

In order to make the interview process more effective, a basic understanding about the energy crops and related concerns was established before starting interviews. Because of the diversity among stakeholders in energy crop production and its use, interviews were conducted by using a semi-structured[3] format. This approach facilitated in an interactive and free flow discussion

[3] In semi-structured (also called as focused) format the interviewer introduces the topic and then guides the discussion by asking specific questions.

during the interviews. To ensure that discussion is relevant, sample questions were sent to all the interviewees before conducting interviews. A *snow balling*[4] technique was followed during the interview process.

Acknowledging the diversity among stakeholders, to get a diversified picture, it was found imperative to interview persons holding different interest in whole chain. Therefore, the people interviewed include farmers growing energy crops, their representatives (farmer's associations) such as Agrobränsle, and private institutes such as AEBIOM working in the area of bio-energy, research institutes and energy producing companies using biomass for generating energy. A list of people interviewed is attached as a part of bibliography.

The interviews were conducted in two stages. In the first stage, while collecting background information, interviews were aimed to confirm and clarify the gathered information. Where as, in the second stage (i.e. analysis part) interviews conducted were relatively more structured. Interviewees were asked specific questions relevant to their work area or specialisation. Due to the geographical spread of interviewees, majority of interviews were conducted via telephone.

1.5 Scope and Limitations

This research focuses on the terrestrial option to produce biomass within EU-15 countries. Aquatic biomass is excluded because of the consideration that the knowledge about their availability and productivity is still limited. The reason why only EU-15 countries are considered not EU-25 for this research is the unavailability of inclusive data about new member countries, which makes it difficult to compare the data with existing member countries. Consequently, the impacts of EU enlargement on energy crop are not included in this research.

The body of policy, known as CAP is huge and it was realized that it would be impossible to cover all the aspects of policy that alone uses 50% of the EU budget. So a rationalisation was made in order to make the thesis workable. The portion of CAP dealing with livestock management was not included in the research.

The primary biomass grown on land can be distinguished into two main categories: residues, e.g. forest and agriculture residue, and energy crops. Here in research our focus will be on biomass from dedicated energy plantation on arable land only. But, as energy crops information often exists in the context of biomass in general, biomass topics and goals will be included to the extent necessary.

During the research it was found that the term energy crop is not very well defined at EU level. Some common examples of energy crops are short rotation wood (e.g. willow, poplar, or eucalyptus), sugar or starch containing crops (e.g. sugarcane or maize) or herbaceous grasses (e.g. switchgrass and miscanthus), oil seed crops (e.g. soybean and sunflower), and some food crops (e.g. wheat). Even though in this research we do not specifically talk about any particular type of energy crop, but the crops which are already used for food purpose and can also be used for generating energy are not included in this research. The reason for this exclusion is their long establishment as food crops.

[4] Snow balling is an interview technique wherein you asked your interviewee for further relevant contacts for collecting information.

In this research the focus is on identifying the non-technical factors for the promotion of energy crops within EU-15 countries. Regarding technical issues it is considered that the technologies to convert energy crop into desirable energy forms are either available or can be made available when required.

The data or figures used in this research - related to various land uses and its availability, and energy sources and consumption – is the latest data available on the EU web site. In some cases more recent data was available, but the incomprehensiveness of the same made it difficult to use for comparison purposes. In the analysis, a timescale of 6-7 years was chosen due to the fact that the renewable targets set under commission's white paper are for the year 2010 and the existing budget for the CAP has been agreed to period 2006.

While collecting the data it was found that, as not many member countries have experience in growing energy crops such as SRC, most of the examples collected are from countries such as Sweden, Finland or Denmark. Also, Sweden being the location of research, it was easy to contact and meet persons concerned in Sweden.

1.6 Outline

Chapters 1: This chapter presents the objective of this thesis and rational behind it. Further, it presents the methodology used to conduct this research and the scope and limitation of it.

Chapter 2: The chapter is broadly divided into two sections. Section one provides a broader perspective about the CAP, its development over the period of time and various elements and measures under CAP for energy crops. The second section of the chapter provides a snapshot of information related to energy and related policies, various regulations and brief about community supports available for renewables.

Chapter 3: This chapter contains factual information about different land uses in member countries. The information related to the agriculture land includes land classification and its distribution for various purposes. Further in the chapter, information provided is related to the European experience with energy crops.

Chapter 4: This chapter based on information gathered in previous sections provides an approximation about the type and amount of land required in future to achieve the energy crops target set under the white paper.

Chapter 5: This chapter, based on information collected so far, responds to the first research question. It contains the critical factors for the promotion of energy crops within EU-15 countries.

Chapter 6: The information gathered here is a response to the second research question. It has information related to CAP's role in promoting the energy crops.

Chapter 7: This chapter presents the concluding remarks and areas of possible further research using this thesis as a base.

2 Agriculture and Energy: Policy Synopsis

Elucidating the agricultural and energy policies in the EU, this chapter provides information about various measures and provision taken under these policies for the promotion of dedicated energy crops.

2.1 Common Agricultural Policy

Agriculture is one of the leading policy areas in the European Union. The Common Agricultural Policy, CAP, embracing almost 90% of all agriculture output, accounts about half of the EU's annual budget – something like € 40 billion as payments to agriculture. Agricultural sector, however, employees only around 3-5% of total population of member countries and its contribution to the GDP of the EU is of same magnitude, 3-4% (Wickman, 2003).

The history of the CAP goes back to the basic Rome Treaty of 1958, which under article 39 makes explicit provision for a Common Agricultural Policy (European Commission, 2003a; Nilsson, 2000). The main objectives of CAP set out in Article 39 of the Treaty are as follows (European Union, 2004):

- To *increase productivity* by promoting technical progress and ensuring the rational development of agricultural production;
- Thus to ensure a *fair standard of living* for the agricultural population;
- To *guarantee a secure supply* of food;
- To ensure *reasonable retail price* to consumers.

In addition to article 39 other articles in the Treaty which have a bearing on the CAP and on its future development trends includes (Nilsson, 2000):

- Article 110, which requires the community to contribute to the harmonious development of world trade, especially by reductions in trading restrictions; and
- Article 130r, which makes environmental protection a component part of the community's other policies, including the CAP.

This initial structure of CAP stayed remarkably unchanged for a long period in spite of other extensive political changes in the EU. By the 80s this resulted into almost permanent surpluses of the major farm commodities, some of which were exported (with the help of subsidies), others of which had to be stored or disposed of within the EU. These measures had a high budgetary cost and did not always serve the best interests of farmers. Growing concerns among the consumers and taxpayers relate to these surpluses augmented the need to bring reforms in CAP.

The first CAP reform, known as Mac Sharry reforms, took place in 1992. This reform involved reducing support prices and compensating farmers by paying them direct aids. Several rural development measures were introduced, notably to encourage environmentally sound farming. Production limits helped reduce surpluses. This reform brought some important changes in to CAP such as introduction of set-aside scheme, an early retirement

scheme for farmers and introduction of environmental policy (European Commission, 2003a; Nilsson, 2000).

Second reform of CAP known as 'Agenda 2000' reform reinforced the move to make farmers more reliant on the market and improved incentives to farm in an environmentally sensitive way. They added a major new element – a comprehensive rural development policy encouraging many rural initiatives while also helping farmers to diversify, to improve their product marketing and to otherwise restructure their businesses. The budget available to the CAP was set out for the period 2000 to 2006, thus allowing farmers to plan ahead with more certainty. The budget was also capped to reassure taxpayers that CAP costs would not escalate (European Commission, 2003a).

As agreed in Agenda 2000, in June 2003 a mid-term review of the application of the Agenda 2000 CAP took place. This reform represents a complete change in the way the EU supports its farm sector. The key elements of June 2003 CAP reform includes single payment scheme (partial and full decoupling), compulsory cross-compliance, modulation, support for energy crops, strengthening rural development policy etc. (European Commission Directorate General for Agriculture, July 2003).

2.1.1 Single Payment Scheme

A single payment scheme (SPS) will replace most of the current direct aid payments to farmers. Under this scheme, payment to farmers will be independent of what a farmer produces (*Decoupling*), but will be subjected to 'compulsory cross compliance' with environmental, food safety, animal and plant health and animal welfare standards, and farm land conditions(European Commission Directorate General for Agriculture, July 2003).

The amount of payment will be calculated on the basis of direct aids a farmer received in a reference period (2000-02). A major aim of the SPS is to allow farmers to be more market oriented, rather than taking decision on the basis of subsidies provided by CAP. The SPS comes into force on January 1, 2005, but member states may delay implementation up to 2007 at the latest (*full decoupling)*. However, member states may decide to maintain a proportion of direct aids where they believe there may be disturbance to agricultural markets or abandonment of production as a result of move to SPS (*Partial decoupling)*(European Commission Directorate General for Agriculture, July 2003).

Member states may grant an 'additional payment' to support agricultural activities that are important for the protection and enhancement of the environment or for improving the quality and marketing of agricultural productions. These additional payments may use up to 10% of the funds that are available for a certain sector included in the SPS in a member country concerned.

2.1.2 Set Aside Land

The concept of compulsory set-aside land was introduced as a part of 1992 CAP reform to control the output of certain crops by taking land out of production and compensating farmers for their loss of income. Producers receiving area payments are subjected to an obligation to set aside part of their holding from production, for which they receive compensation amounting to the aid granted for cereals. No set-aside requirement is imposed on small producers whose claim for area payment is below 12 tonnes of cereals(European Commission, 2001). Since its inception this rule has been modified on many occasions. The

main ones being adjustment to the rate of compulsory set-aside, introduction of voluntary set-aside and introduction of fixed as opposed to rotational set-aside.

To compensate farmers for their loss of income Arable Area Payment Scheme (AAPS) was introduced. Under this scheme, farmers could claim support payment based on the size of area used to grow applicable crops. However, to qualify these payments the set-aside land must be managed so that it can be brought back in to agriculture production whenever required.

Before Agenda 2000 reforms, the amount of compulsory set-aside land used to be decided by EU and respective member countries. The basis of this being the level of production and EU stock, compulsory amount of set-aside land used to vary from year to year. But, under Agenda 2000 reform this amount of set aside land has been fixed as at least 10% of arable land till 2006[5] (Mr. Lars Erik). So far there were no conditions from EU about the rotation of set-side land. Farmers were allowed to keep the same land under set-aside land year after year, or select a different area after each year. But, under June 2003 CAP reforms there are consideration for the rotation of set-aside land (European Commission Directorate General for Agriculture, July 2003).

June 2003 CAP reforms changes the method of set aside payment. From now onwards farmers, within the single payment scheme, will receive set-aside entitlements calculated on the basis of historic references (year 2000-02). The set-aside entitlement will be calculated by dividing the three-year set aside average amount by the three-year average number of hectares set aside. These entitlements will be activated only if they relate to eligible hectare put into set-aside. Hectare eligible for set-aside entitlement includes holdings taken up by Arable land except areas under permanent crops, forests, permanent pasture and area used for non agriculture activities. Organic farmers may be exempted from set-aside obligations (European Commission Directorate General for Agriculture, July 2003)

Regarding the use of set-aside land, this can be left fallow or used for growing non food crop with industrial uses or to produce materials for the manufacture of products not intended for human or animal consumption. The land can not be put to any non-agriculture use that brings any returns, except for small-scale charitable fund raising events. In the latest CAP reform the Member states are authorised to pay national aid up to 50% of the cost associated with establishing multiannual crops intended for bio-mass production on set-aside land.

The commission regulation (EC) No. 2461/1999 provides a list of materials with their intended uses which can be grown on these set aside lands. In order to get set aside entitlements the raw material grown on set aside land should be covered by contract with collector or first processor. Under this rule collectors or first processors are obliged to deposit a security to their respective authority to ensure that the raw material purchased will be used as intended for.

In case of annual crops, the payment in respect to set aside land is paid to the farmers before the raw materials are processed. Whereas in case of biennial or SRC, payment is made each

[5] On the basis of a commission's proposal the minimum amount of set-aside rate for cereals from production in the marketing year 2004/05 has been reduced from 10% to 5%. The measure is intended to offset the effects of the drought in Europe which principally lead to a serious reduction in European Community cereals stock, which dropped from 209 million tonnes in 2002 to 184 million tonnes.

year on the conditions that relevant authorities are assured that all relevant conditions will be met.

2.1.3 Energy Crops Aid

To support energy crops the commission has proposed an aid of 45 €/ha for energy crops. This will apply for a maximum area of 1 500 000 ha. The aid will be granted in respect of area whose production is covered by a contract between the farmers and the processing industry except where the processing is undertaken by the farmer on the holding. (Ruoff, M.R. 2003, p-3). In case the area for which aid is claimed exceeds the maximum guaranteed amount, the area per farmer for which aid is claimed shall be reduced proportionally in that year.

According to council regulation No. 1782/2003[6], the areas which have been used for energy crop scheme may not be counted as set aside for the following set aside requirement:

- Under "*Regionalisation and single payment scheme*" where any farmer in the region concerned shall receive set-aside entitlements

- Where areas which are neither put to any agriculture use nor used for any lucrative purpose other than those accepted for set aside land may be counted as being set aside.

- Where farmers applying for the area payment have an obligation to set aside a part of their land from production and will receive compensation for this obligation.

2.1.4 Rural Development Policy

The agreements reached during Agenda 2000 CAP reform established a sustainable framework for the future of rural areas in EU. The new rural development policy aims to improve integration between the different types of EU assistance, helping to ensure smooth and balanced development in all European rural areas (European Commission Agriculture and Rural Development, 2003).

Agenda 2000 established the maximum amount available for rural development spending under EAGGF-guarantee fund over the period 2000-06[7]. This allows farmers to plan ahead with more certainty and reassure taxpayers that CAP costs would not escalate (European Commission, 2003a).

This fund has an annual average ceiling of € 4.3 billion for rural development including the four accompanying measures. For rural development measures included as part of structural fund programme within objective 1 regions, member states choose what proportion of overall structural fund to use for rural development actions supported by EAGGF-guidance section. Table 2-1 shows the overview of rural development programming types and community financial support 2000-06.

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[6] Council regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers and amending Regulations (EEC) No 2019/93, (EC) No 1452/2001, (EC) No 1453/2001, (EC) No 1454/2001, (EC) 1868/94, (EC) No 1251/1999, (EC) No 1254/1999, (EC) No 1673/2000, (EEC) No 2358/71 and (EC) No 2529/2001.

[7] http://www.europa.eu.int/comm/agriculture/fin/index_en.htm.

Table 2-1: Overview of rural development programming type and community financial support

	Number of programmes	**Co-financed by EAGGF section**	**EU contribution (€ billion)**
Rural Development programmes	68	Guarantee	32.9
Objective 2 programmes with RD measures	20	Guarantee	
Objective 1 programmes with RD measures	69	Guidance	17.5
Leader + programmes	73	Guidance	2.1
Total	**230**		**52.5**

(Source: European Commission, Agriculture and Rural Development)

After June 2003 reforms, RDP offers a 'menu' of 26 measures[8]. These measures can broadly be classified as; Investment in farm businesses, Agri-environment measures, Human resources - young farmers, early retirement and training, less favoured areas and areas subjected to environment constraints[9]. Member states according to their specific needs and rural areas have flexibility to choose the relevant measures from this menu. The EU contribution to the financing of these measures varies depending on the measures and the region concerned.

June 2003 reforms introduced a *compulsory modulation scheme*, switching of fund from production to rural development, which member states may use to finance the rural development measures financed under EAGGF 'Guarantee' section. Under this scheme farms receiving over € 5 000 a year in direct payment will have those payment reduced by 3% in 2005, 4% in 2006 and 5% from 2007 onwards. Every member state will receive at least 80% of the modulation fund generated from its farmers (European Commission Agriculture and Rural Development, 2003; European Commission Directorate General for Agriculture, July 2003).

2.2 Energy Policy

Development of RES in European Union is primarily driven by the concerns related to its increasing dependence on import for energy supply and climate change. Promotion of RES, however, is also considered important for developing national industries, creating jobs and development of rural areas. Many of these renewable energy sources are abundantly available, albeit they make a very small contribution of less than 6% to the EU overall gross inland energy consumption[10]. Appendix 2 shows the share of RES in each member country. The section below shows the major energy policy measures in EU.

[8] June 2003 reform added a new series of measures in to rural development menu, increasing the number of measures from 22 to 26 with effect already in 2003.

[9] Detailed information about these rural development measures can be gained from http://www.europa.eu.int/comm/agriculture/rur/index_en.htm

[10] Communication from the Commission (26.11.1997) on – Energy for the future: renewable sources of energy – White Paper for a community strategy and Action Plan – COM(97)599 final

2.2.1 Policy Context

This section explains the various energy policies within the EU, their objectives, current status and evolution over the period of time.

2.2.1.1 White Paper on Energy Policy

This White Paper entitled "An energy policy for the European Union[11]" sets out the broad principle underlying the design of energy policy in the EU. According to this, energy policy must form part of the general aims of the Union's economy policy based on market integration, deregulation, limiting public intervention to what is necessary to safeguard the public interest and welfare, sustainable development and economic and social cohesion. In addition to these, the three main objectives of this energy policy are:

- Improved competitiveness of the EU economy,
- Security of energy supply[12], and
- Environmental protection

These objectives set under the White Paper are considered to help in addressing the central policy issues such as job creation, boosting overall productivity of the EU economy, protection of the local environment. The energy policy will further help in achieving the Kyoto Protocol commitments.

2.2.1.2 White Paper on Renewable Energy

Following the 'Green paper on renewable energy[13]' the white paper[14] on renewables set an ambitious overall EU target of doubling the share of renewables from 6% to 12% by 2010. This target was based on the most ambitious "best practice" scenario of the "TERES II" study, using SAFIRE, an energy policy simulation model (Jansen & Uyterlinde, 2004). Presenting a community strategy and action plan to achieve this target, the white paper implies each member state to encourage the increase of RES according to their own potentials. The white paper stresses, though, that this overall objective is a political, not legally binding, tool. Table 2-2 shows set of indicative estimated contribution from each renewable energy source as well for each market sector are outlined, as projection of one way in which overall desired growth can be achieved.

Table 2-2: Estimated contribution for different renewable energy sources in 2010

Type of Energy	**Installed capacity**	
	1995	**2010**
Wind	3 Gwe	40 GWe

[11] Communication from the Commission of 23 April 1997 on an overall view of energy policy and actions COM(97) 167 final - Not published in the Official Journal.

[12] The concept of security of supply appears in the article 100 of Treaty on European Union, which calls for an exercise of reflection over the diversification of the various sources of supply.

[13] Communication from the commission – Energy for the future: renewable sources of energies – Green Paper for a community strategy COM(96)579 final. Its objective was to identify the objectives, obstacles and the means to be deployed relating to the growth of renewable sources of energy.

[14] COM(97)599 final

Hydro (Large)	83 Gwe	91 GWe
Hydro (Small)	10 GWe	14 GWe
Photovoltaic	0.03 GWe	3 GWe
Biomass	45 Mtoe	135 Mtoe
Geothermal: el.	0.5 GWe	1 GWe

Source: (Jäger-Waldau & Ossenbrink, 2004)

Main features of the action plan are: 1) Internal market measures: fair access for renewables to the electricity market, fiscal and financial measures, new bioenergy initiatives for transport, heat and electricity, 2) Reinforcing community policies, 3) Strengthening co-operation between Member states, and 4) Support measures: targeted promotion, market acceptability and consumer protection, better positioning of RES in market and Renewable energy networking

The white paper proposed a campaign for take-off to promote the implementation of large scale projects in different renewable energy sector. This has been discussed in more detail under section 2.2.4.

2.2.1.3 Green Paper on Energy Security

In November 2000, the Commission adopted a "Green Paper towards a European strategy for the security of energy security[15]". The Green Paper was the response to an observable fact: Europe's growing future energy dependence. The Green Paper highlighted the interdependence of Member States regarding the issues of combating climate change and for the completion of internal energy market. It stresses the importance of conceiving a European energy policy with internal energy harmonisation within the Union. The Green Paper outlines the basic structure of a long term energy strategy, according to which:

- Taxation measures to steer demand towards better controlled consumption which is more respectful to the environment.

- Introduction of financial measures (aid, tax deduction or financial support) to achieve targets set under Green Paper on renewable energies. One way suggested was to finance the development of renewable energies through profitable conventional energies.

2.2.2 Legal Instruments

The main instruments of the European commission to increase the use of renewable sources are Directives promoting renewable energies in different sectors. In this following section briefly described are the main directives, already in existence or proposed, within the EU for the promotion of renewable sources of energy, specifically bio-energy.

2.2.2.1 Directive on the promotion of electricity produced from renewable sources in the internal energy market

As shown in Figure 2-1, the directive sets the indicative targets for each member state. But, the member states have freedom until 2005 to choose the kind of measures and incentives they want to use to reach these targets. Member states are obliged to publish its progress report, for the first time not later than 27 October 2003 and thereafter every two years. The commission, no later than 27 October 2005, has to present a report based on the experience

[15] Green Paper of 29 November 2000 "Towards a European strategy for the security of energy supply" COM(2000) 769 - Not published in the Official Journal

gained with the application and coexistence of different mechanism. If necessary the report should be accompanied by a proposal for a community framework with regard to support the scheme for electricity produced from RES to ensure that the targets for 2010 are met.

The directive requires the member states to specify the energy sources from which the electricity was produced, specifying the date and place of production. The directive also regulates the grid access and obliges the member states to ensure a non-discriminating treatment of electricity generated from the renewable sources.

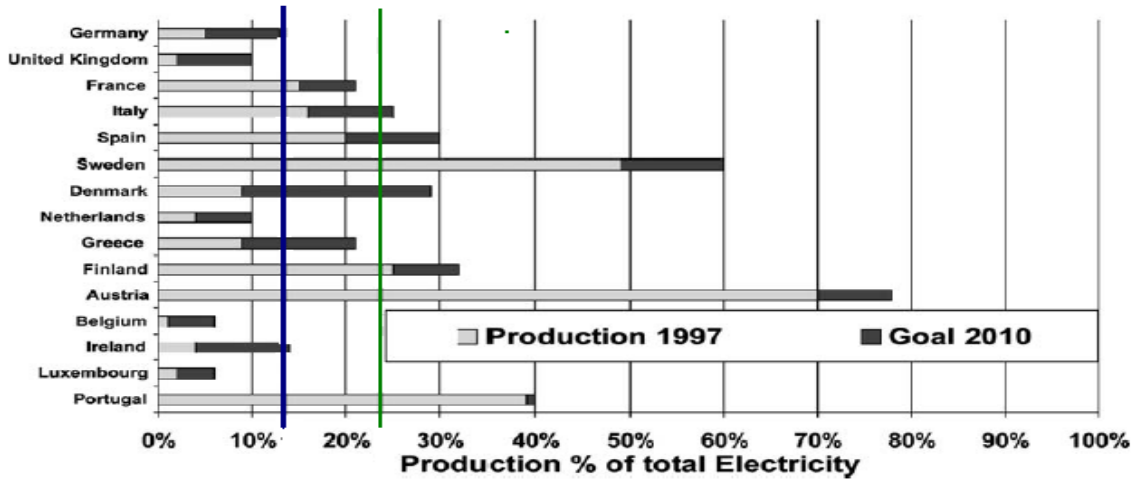

Figure 2-1: Indicative renewable energy targets for producing electricity

[*The dark line is 1995 (12%) and the light line is 2010 (22%) Source: (Jäger-Waldau & Ossenbrink, 2004)*]

2.2.2.2 Directive on the promotion of the use of biofuels or other renewable fuels for transport

Providing a list of products which should be considered as biofuels, the directive requires each member state to set national indicative targets to ensure that a minimum proportion of biofuels and other renewable fuels are placed on their market. On the basis of energy content a reference value of 2% of all petrol and diesel for transport purpose placed on their markets by 31 December 2005 and 5.75% by 31 December 2010 was calculated for as target (European Commission, 2004e). Starting in 2004, the member states have to report to the commission before 1 July of each year, on:

- The Measures taken to promote the use of biofuels or other renewable fuels to replace diesel or petrol for transport purposes,

- The National resources allocated to the production of biomass for energy uses other than transport, and

- The total sales of transport fuel and the share of biofuels, pure or blended, and other renewable fuels placed on the market for the preceding year. Where appropriate, member states shall report on any exceptional conditions in the supply of crude oil or oil products that have affected the marketing of biofuels and other renewable fuels.

In their first report in 2004, the member states should indicate the level of their national indicative targets for the first phase and in 2006 the targets for the second phase. Starting from 31 December 2006 and thereafter every two years, the commission has to present an

evaluation report for the European Parliament and the Council. The report should describe the progress made in the use of biofuels and other renewable fuels in the member states. On the basis of this report, the commission shall submit, where appropriate, proposals to the European Parliament and to the council on the adaptation of the system of targets. If the report concludes that the indicative targets are not likely to be achieved, these proposals shall address national targets, including possible mandatory targets, in the appropriate form.

2.2.2.3 Directive for greenhouse gas emission allowance trading within the community

The directive establishes a scheme for greenhouse gas emission allowance trading within the community in order to promote reduction of GHG emission in a cost-effective and economically efficient manner. The directive requires each Member state to develop a three year national plan starting from 1st January 2005 and a five year plan starting from 1st January 2008 stating the total quantity of allowances that it intended to allocate for that period and how it proposes to allocate them. The transfer of these allowances was made possible between: the persons within the community, and persons within the community and persons in the third countries, where such allowances are recognised.

From 2008, member states may apply emission allowance trading to activities, installations and GHG which are not listed in Annex I of this directive, provided their inclusion is approved by the commission. The member states may allow operators of installations carrying out same activity may form a pool of installation. For the implementation of this directive, Member states should bring into force the necessary laws, regulations and administrative provisions.

2.2.2.4 Directive on the promotion of co-generation on a useful heat demand in the internal energy market

This directive[16] modelled to some extent on the Renewables Electricity Directive, aimed to ensure that incentives are provided only to efficient CHP systems. For the purpose the directive has to provide a definition of CHP Quality and CHP Certification. Member states will be required to set national targets in accordance with the EU-wide CHP target from1997. Issues concerning the grid access, cost of connection as well as streamlining administrative procedures have to be addressed. The CHP directive will cover technologies ranging from small-scale CHP in the residential and tertiary sectors to industrial CHP and CHP with district heating, with special provisions to promote small-scale CHP and renewables CHP.

2.2.3 Support Measures

This section provides a quick synopsis of various support instruments available at community level for the promotion of renewable energy sources.

2.2.3.1 Campaign for Take-Off (2000-03)

Started in 1999, the campaign for take-off (CTO) was aimed to promote the implementation of large scale projects in different renewable energy sector and to disseminate a clear signal for greater use of renewable energy sources. One of the most important vehicles used under CTO was the concept of the "Renewable Energy Partnerships" between the Commission and

[16] COM(2002)415 and COM(2003) 416

promoters of renewable energy programmes, projects and initiatives[17]. These Partnerships provided a tool to encourage and enhance the visible commitment of public authorities in regions, cities and municipalities, industries, agencies and universities. These renewable energy Partners become Partners in the successor Campaign (Manage Energy, 2004).

2.2.3.2 Campaign for Sustainable Energy (2004-07)

The Campaign for Sustainable Energy[18], a successor initiative of campaign for take off, is starting in mid 2004. This initiative will embrace both energy efficiency and renewable energy. This campaign will provide indicative sector specific targets, an extended series of promotional tools and will allow Partners to join the common effort of implementing programmes and initiatives in Europe and beyond (European Commission, 2004e).

2.2.3.3 Intelligent Energy – Europe programme (2003-06)

Intelligent Energy - Europe (EIE) is the Community's support programme for non-technological actions in the field of energy, precisely in the field of energy efficiency and renewable energy sources. Its aim is to support sustainable development in the energy context, making a balanced contribution to achieve the general objectives of security of energy supply, competitiveness, and environmental protection (Art. 1 of the programme Decision) (European Commission, 2004c). The programme is structured in four fields SAVE, ALTENER, SREER and COOPENER[19].

Actions or projects supported in the framework of the EIE programme will be committed to remove market barriers to the increased use of energy efficiency and renewable energy sources. In contrast to the 6th Framework Programme for Research and Technological Development (FP6) the EIE programme will not support costs related to investments in technologies. However many of the actions will have a link to one or more energy efficiency and/or renewable energy technologies (European Commission, 2004d).

2.2.3.4 The Sixth Framework Programme (2002-06)

The strategic and policy objectives of this research programme into sustainable energy system[20] include reducing GHG and pollutant emission (Kyoto), increasing the security of energy supplies, improving energy efficiency and increasing the use of renewable energy. The short to medium term goal of this programme is to pave the way for the introduction of innovation and cost competitive renewable and energy efficiency technologies into the market as quickly as possible through demonstration and other research actions aiming at the market, for example innovative policy packages, financing mechanism and user/consumer acceptance.

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[17] A detailed information about renewable energy partnerships can be obtained from http://www.europa.eu.int/comm/energy/res/campaign_for_take_off/index_en.htm

[18] Details about campaign for sustainable energy is available on http://www.europa.eu.int/comm/energy/res/campaign_for_take_off/index_en.htm

[19] More details about Intelligent Energy- Europe programme can be obtained from European Commission web site http://www.europa.eu.int/comm/energy/intelligent/index_en.html

[20] A detailed information about sustainable energy system work programme can be obtained from European Commission web site http://www.europa.eu.int/comm/dgs/energy_transport/rtd/6/call_3/doc/2004_tren_3_workprog_61_en.pdf

The medium and long term research objective of this programme is to develop new and renewable energy sources, which are both affordable and clean and which can be well integrated into a future sustainable energy supply. The total amount available for RTD on sustainable energy system is approximately € 890 million, spread over the period of four years of the programme.

3 Agriculture and Energy Crops: Factual Information

Comprising the review of past and current trends, and practices in the area of agriculture and energy crops, this chapter presents the various uses of agriculture land within the member countries. Further, the information presented is about different energy crops and illustrates the experiences of different member countries with energy farming.

3.1 Land Use

To avoid ambiguity while reviewing it is found important to have a clear understanding of the various terms used to define the land uses. For the purpose, the classification used by Eurostat for the LUCAS project[21] has been used during this research.

- **Land Area** is the total area[22] excluding area under inland water bodies (major rivers and lakes).

- **Agricultural Land** is the sum of Arable land, Permanent crops, and Permanent pastures and Meadow.

  - **Arable Land** is the land under temporary crops, temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years) e.g. wheat, rice, potato etc.

  - **Permanent Crops** is the land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest e.g. wine yards, SRC.

  - **Permanent Pasture and Meadow** is the land used permanently (five years or more) for herbaceous forage crops, either cultivated or growing wild.

- **Forests and Wood land** include land under natural or planted stands of trees, whether productive or not.

- **Other uses** include land used for residential, commercial, transportation and for leisure purposes.

- **Unused land** is the land without any apparent or specified uses such as fallow or bare land and mountains etc**.**

The total land area in EU-15 member countries is about 3 234 295 Km^2[23]. According to a survey conducted in 2001, under LUCAS project, three types of land use accounts for more than 90% of this area: agriculture, forestry and unused. Urban areas cover 5% of the territory and leisure and water areas around 4% (European Commission, 2003c).

[21] LUCAS was a pilot project launched by Eurostat in close co-operation with the Directorate General of Agriculture and the Joint Research Centre to support policy formulation

[22] Total Area is the total area of the country.

[23] 1 Km^2 = 100 hectares (3 234 295 km^2 = 323.43 million hectare)

3.1.1 Agricultural Land

Agriculture, with almost 40% of the territory, is the leading type of land use in the member countries. From under 10% in Sweden and Finland, it rises to a maximum in Denmark and UK, where almost two third of the territory is used for agriculture purposes. Portugal and Austria falls between these two extremes, with approximately one third of the territory given over to agriculture. In all other member states, around one half of the land is used for agriculture purposes (Bruyas, Kayadjanian, & Vidal, 2002). Table 3-1 shows the individual share of arable land, permanent grass and meadow, and permanent crop among agriculture land use in each member states, and amount of set aside land for the year 2000.

Table 3-1: Amount of agriculture land available in each member country and its uses for different purpose

Member States	**Utilised agriculture land**[1] (1000 ha)	**Arable Land**[1] (1000 ha)	**Permanent grass land and Meadow**[1] (1000 ha)	**Permanent crops**[1] (1000 ha)	**Set-aside land**[2] (1000 ha)
Belgium	1 394.00	866.00	507.00	20.74	20.10
Denmark	2 645.00	2 474.00	161.00	9.63	181.54
Germany	17 152.00	11 830.00	5 114.00	207.70	845.75
Greece	3 583.20	1 976.30	605.30	1 002.00	93.87
Spain	26 158.40	12 368.00	9 368.40	4 952.00	2564.16
France	27 856.30	18 419.30	8 316.00	1 122.00	1226.70
Ireland	4 443.90	1 109.40	3 333.00	1.60	16.16
Italy	13 069.00	7 308. 40	3 414.40	2 346.00	552.94
Luxembourg	127.50	62.00	64.40	1.40	1.65
Netherlands	2 027.80	1 010.00	985.00	33.60	26.47
Austria	3 388.20	1 401.40	1 916.20	70.60	108.89
Portugal	3 863.10	1 762.00	1 390.00	712.00	103.80
Finland	2 218.70	2 188.20	26.10	4.30	181.23
Sweden	3 073.20	2 697.00	373.00	3.60	289.00
UK	15 798.50	6 403.00	9 358.00	38.00	506.00
Total	**126 503.00**	**71 875.00**	**44 931.80**	**9 995.20**	**6 688.26**

1) Source: (European Commission, 2003b; Food and Agriculture Organisation, 2004)
2) Area set aside under different set-aside schemes for arable land, Source: (European Commission, 2003b)

According to the results of the 1999/2000 farm survey conducted by commission there were around 6.8 million agriculture holdings in the EU-15 at that time, some 0.6 million lower than in 1995. For EU-12 this decline in holdings is about 1.6 million or 20% in last decade. This decrease was driven by large falls in the number of holdings in Italy, France, Spain, Portugal and Germany (European Commission, 2003b). Albeit there was slight decrease in number of holdings, about 8%, in the EU-15 since 1995, the overall area allocated to agriculture had changed very little (European Commission, 2003b).

The main uses of UAA in 1999/2000 were approximately 57% for arable land, 35% for permanent grassland and meadow, with the remaining 8% used for permanent crops. Of the total arable land area the major portion of land was used for the production of cereals, around 52%, forage plants 20%, industrial plants 9% and root crops 4.5% with some 7 million hectare (i.e. 10%) left as fallow land (European Commission, 2003b). In case of permanent crops the greatest area was utilised for olive plantation, about 43%, followed by vineyards which account for 31% of area. Fruits and berry plantation accounts just under 2 million hectares and some .05 million to citrus plantation. Figure 3-1 shows the difference in different agriculture land use and forest land use in EU-15 for last decade (1991-2000).

Figure 3-1 shows the changes in different agriculture land use pattern from 1991-2000. The utilised agriculture area generally remained stable in most of the member countries except in France, Greece and Italy where it has raised noticeably. While the total utilised agriculture area has decreased in Germany and Spain. As such there is no clear evident showing the effects of increasing farm size on land productivity. But, it is considered that large farm size will result in improved farm management because of the possibilities to adopt more mechanise approaches, which otherwise was not possible. The total production cost is also believed to decrease at larger farm as the cost of some fix variables such as cultivating and harvesting machines will remain more or less same.

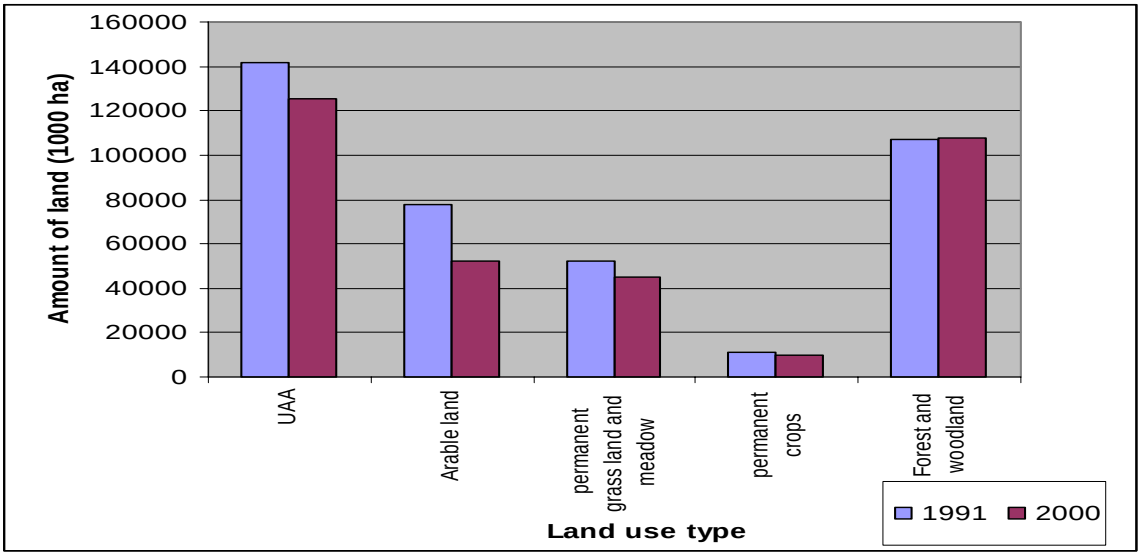

Figure 3-1: Agriculture and forest land use pattern in EU-15 in last decade (1991-2002)

Source: (Bruyas et al., 2002; European Commission, 2003b, 2003c; Food and Agriculture Organisation, 2004)

According to agriculture statistics presented under European Commission's quarterly bulletin, in the first quarter of 2003, the index of prices of agriculture products in EU-15 was -5.7 % lower than in the corresponding quarter of 2002. This decrease in output index was due to a

significant fall in the prices of crop products (-7.1%), combined with a fall in the prices of animal and animal products (-4.0%). The price fall ranges from -12.7% in Denmark to -1.7% in Portugal. For crop products, the 7.1% lower price index includes 10.8% downward changes for cereals and rice, 21.3% for root crops and 8.0% for fresh vegetables. This decline in price index ranges from 14.3% in Belgium to 3.0% in Luxembourg. The only rise was observed in Portugal (0.6%) while there was virtually no change in Ireland (European Commission, 2004a).

3.1.2 Forest and Wood Land

Forest and wood land is the second main land use in member countries, with one third of the land. From the various land use surveys, such as LUCAS, it has been noticed that higher the use of land for forestry in a member state, the lower the proportion of land used for agriculture. In Sweden and Finland, forestry accounts for over half of the territory. Whereas in the remaining countries forestry accounts for over 10% of total land area. Table 3-2 shows the amount of land marked as forest and wood land (Food and Agriculture Organisation, 2004). The statistics presented under European commission's quarterly bulletin shows that the amount of forest and woodland had not changed very much in last decade.

Table 3-2: Amount of Forest and woodland for the year 2000

Country	**Amount of land (1000 ha)**	**Country**	**Amount of land (1000 ha)**
Belgium	617	Italy	6 861
Denmark	455	Netherlands	375
Germany	10 740	Austria	3 886
Greece	3 599	Portugal	3 666
Spain	14 370	Finland	21 935
France	15 341	Sweden	27134
Ireland	659	UK	2 794

Source: (European Commission, 2003b; Food and Agriculture Organisation, 2004)

3.1.3 Unused Land

Almost one fifth of the territory (19%) is classified as being without apparent use. The distribution of this unused land varies considerably between the member countries. Unused area occupies a large part of Portugal (30%) and of Greece (38%) of the country. For Spain, Austria, Finland and Sweden the proportion is also high with a rate greater then 21%, more than 17% in Italy and 11% in France (European Commission, 2003c).

3.1.4 Other Land

Only 9% of total territory is covered by uses of land other than agriculture and forestry. This category also includes urban areas, water areas, waste treatment and leisure land use. Grids with urban uses are most numerous in Belgium and The Netherlands (European Commission, 2003c).

3.2 Energy crops

A whole range of fuels from biomass exists and interest in each one depends on their local availability, and the energy needs of that country. The grouping includes dedicated energy crops (e.g. short rotation crops, non wood cops such as miscanthus); traditional food crops used for energy (e.g. cereals, oil seed crops); agriculture residues (e.g. straw, rice hulls, tea, coffee and cocoa waste); and forestry residues. The large variety of raw material and treatment procedures offers a lot of options. Using different biomass energy conversion technologies these raw materials can be converted into heat, electricity and fuels. In this section we will discuss in brief about various characteristics of different dedicated energy crops in Europe.

3.2.1 Variety

In Europe, a large number of crops have been investigated for their potential use as energy crops. However, only a few have reached beyond the level of R&D and have become commercialised and grown on larger areas (Venendaal, 1997). Main examples on large scale commercial energy crop production are the production of oil seed crops for bio-diesel in France, Germany, Austria and Italy, and the production of willow for heat and power in Sweden. These examples differ basically in that liquid fuel crops such as rape and sunflower are well known crops in agriculture due to their use for food and cattle feed purposes, while the production of willow has to be developed in all aspects from breeding to harvesting methods(Lewandowski, 2000).

3.2.2 Climate

In addition to market availability, the selection of energy crop also depends upon the climatic conditions of plantation area and their potential yields. Crops like Cynara, sorghum and eucalyptus are only grown in the most southern parts of Europe. On the other hand, Reed Canary Grass is the crop best adapted to the cold climate of Finland and northern Sweden, while willow and rape can be grown in most countries of northern Europe. Miscanthus is grown throughout the more central parts of Europe, however, as far apart as Denmark and Sicily. Further, the availability of resources such as water seems to be the major limiting factor to energy crop production, especially in southern Europe, but also in countries such as Sweden and Denmark. The perennial crops with a long growing season have the highest water use. As water, like energy, is a limited resource, the best utilization of available water resources should be analysed(Lewandowski, 2000).

3.2.3 Yield

Regarding energy crop yield, a very high yields of 30-40 odt/ha/yr have been registered for crops like sorghum, Miscanthus and Arundo donax in central and southern Europe, but this is only measured in small research plots and has often required irrigation. On the other hand, in Sweden current net yield of willow under commercial conditions is estimated to be 8-10 odt/ha/year and in many cases even less (BioMat Net, 2004). This indicates the wide range within which the realistic yield level of solid energy crops in Europe can be found. The yield

levels are further influenced by the time of harvest. With Reed Canary Grass and Miscanthus the full biological yield can be harvested in autumn, or harvest can take place in spring when the leaves are lost. By spring harvest yield is decreased by 25-50 %, but the fuel quality is increased since the biomass is dry and can easily be stored and organic matter and nutrients are recycled to the soil. This means that the optimal production strategy, apart from the yield level, also depends on the fuel requirements of the energy sector and on ecological considerations.

3.2.4 Cost

According to the results of the project entitled "European Energy Crop Overview" (EECO), the basic costs of energy crop production and delivery to a plant falls in the range of 34-86 ECU/odt. In Spain, in some cases, the costs of producing Cynara under non-irrigated conditions were found as low as 24 ECU/odt. These calculations do not include land rental and profit for the farmer (BioMat Net, 2004).

The profitability of using dedicated crops for producing energy in compare to fossil fuels depends on the then market price of fossil fuels. In current scenario, the increasing trend in the market price of fossil fuels and decrease in the price of bioenergy, because of increased learning and improved technology, have narrowed this price difference. In some countries taxes on fossil fuels have also helped in levelling these price differences.

The production of rape for energy utilization, even though not economically profitable (BioMat Net, 2004), has several rationales but basically indicates that European farmers do have interest in producing crops for energy purpose. However, they need stability about the CAP regulation which they find in an annual crop such as rape, they need a well established market, and they prefer to use well-known technology. Cost reduction is one of the major ongoing R&D task in new energy crops, and there seem to be good opportunities for reduction by the development to higher yields with lower costs. Illustrative are the results on willow in Sweden: by combining programs on fundamental biological and environmental R&D, and more applied programs as well, high-yielding clones with good tolerance to frost, pest and rust have been developed (BioMat Net, 2004).

4 Provisions and Potential of Energy Crops

Based upon the amount of land required for achieving energy crop targets, this chapter provides a snapshot of different provision for using land for growing energy crops and the potential amount of energy supplied within respective provisions.

The amount of energy expected from energy crops under the White Paper on renewable sources of energy is 45Mtoe i.e. 1881 PJ[24]. The total amount of land required to achieve this target depends upon the yield and energy content of crops used. As we saw in previous chapter, depending upon type of energy crop and climatic conditions, there is variation found among the yield and energy contents. For this thesis, to calculate the amount of energy supplied by energy crops an average productivity of 10 oven dry tonnes (odt) per hectare per year at 20 gigajoules per tonne[25] has been used (Thomas B Johansson, Kelly, Reddy, & Williams, 1993). With 10 odt/he, to reach the target of 45 Mtoe a total of 9.4 million hectare of land will be required (i.e. approximately 14% of current arable land in the EU).

To achieve this target an approximation has been carried out regarding the type and amount of land that will be required in the future. This approximation of different land requirement will facilitate in identifying the associated critical factors for growing energy crops. For the approximation it is assumed that set aside land will always be the first preference for growing energy crops and then it will be arable land, if required.

As shown in Table 4-1, Column 2 presents the country specific information about their current gross inland energy consumption in the year 2002. Column 3 shows the contribution of bioenergy to that sum. Because of the inexistence of data about energy crops contribution in the total bioenergy contribution, the figures used for bioenergy contain contributions from all possible biomass resources. During the research it was also found that not many member countries have specific targets for energy crops.

Column 4 presents the current amount of arable land available in each member country. Because of the unavailability of comprehensive data about each member state, the figures for the year 2000 are used. Based upon the amount of arable land available in each member state, Column 5 presents the expected amount of set aside land available in the future. To calculate the amount of set aside land available in the future, it is assumed that the rule of 10% arable land as compulsory set-side land will remain the same and the total amount of set aside land will not vary to a great extent (European Commission Directorate General for Agriculture, 2004).

Column 6 presents the potential energy supplied by energy crops grown on different amounts of set aside land. While discussing the availability of set aside land it is assumed that there is very little or no chance that 100% of set aside land will be used for growing energy crops. Some farmers may be more interested in leaving their land fallow or using it for other purposes. So to estimate the contribution from energy crops grown on set aside land two different scenarios were considered. First the potential contribution was calculated when 75% of set aside land is used and then for 50% of set aside land. These figures provide a rough estimation of agriculture land requirement under different scenarios. Later in the table column

[24] Calculated for an average productivity of 10 oven dry tonne (odt) per hectare per year at 20 gigajoules per tonne

[25] Figure here for energy crop productivity and their energy content are the ones presented in Table L: Biomass energy supplies from plantations for "A renewable-intensive Global energy Scenario" (RIGES) page 1093. The figures used here are average figures and actual amount can vary from them.

7 presents the potential energy supplied by energy crops grown on 5% and 10% of remaining arable land i.e. total arable land minus set aside land.

The figures about current biomass contribution show that at present there is no direct relation between total share of bioenergy and the agriculture land available in each country. Countries like Sweden, Finland and Portugal, when compared to France and Spain, have less arable land, but have relatively high bioenergy contribution. One reason for this is the existence of large forest and woodland area in Sweden and Finland. Further, in between France and Spain, even though the agricultural area is more or less equal, but there is big difference in bioenergy contribution. These variations in bioenergy contributions are also because of different national priorities.

On EU level, if it is considered that in near future there will be no drastic changes in the energy crop yield and their energy contents, even 100% of set aside use will not be sufficient to fulfil the energy crop targets. In order to fulfil the target for energy crops an additional amount of land, other than set aside, will be required. If it is expected that at least 50% of set aside land will be used for growing energy crops then 718.75 PJ of energy will be available from energy crops grown on set aside land. With similar yields and energy content of energy crops, to get the remaining 1162.25 PJ of energy, approximately 5.8 million hectares of additional land will be required.

As shown in the Table 4-1, if distributes proportionately among EU, an additional 10% of arable land (excluding set aside) will be required to achieve the set targets. The additional amount of land required in each member country will depend upon the percentage of set aside land assigned for energy farming and their national energy crops targets, if any. As discussed later, the land availability for growing energy crops depends on many factors. These factors vary among different member countries and so do the measures to improve these factors and need attention at both the national and community level.

Table 4-1: Potential energy crops contribution under different land use provisions

Member States	Current Gross Inland Energy Consumption (PJ)	Current Contribution of Bioenergy (PJ)	Arable Land (1000 ha)	Set-aside Land (1000 ha)	Potential Energy Supplied by Energy Crops on Set aside Land (PJ)		Potential Energy Supplied by Energy Crops on Arable Land (PJ)	
(1)	(2)	(3)	(4)	(5)	(6)		(7)	
					75%	50%	10%	5%
Belgium	2 197.40	26.96	866.00	86.60	12.99	8.66	15.58	7.79
Denmark	829.30	81.20	2474.00	247.40	37.11	24.74	44.54	22.27
Germany	14 366.00	296.50	11 830.00	1 183.00	177.45	118.30	212.94	106.47
Greece	1 243.00	41.63	1 976.30	197.63	29.70	19.80	35.6	17.80
Spain	5 429.30	174.52	12 368.00	1 236.80	185.55	123.70	222.62	111.31
France	10 926.20	446.80	18 419.30	1 841.93	276.30	184.20	331.54	165.77
Ireland	633.50	7.40	1 109.40	110.94	16.65	11.10	19.96	9.98
Italy	7 254.40	65.50	7 308.40	730.84	109.65	73.10	131.54	65.77
Luxembourg	166.30	1.90	62.00	6.20	0.90	0.60	1.12	0.56
Netherlands	3 269.00	68.64	1 010.00	101.00	15.15	10.10	18.20	9.10
Austria	1 285.00	166.41	1 401.40	140.14	21.02	14.01	25.22	12.61
Portugal	1 084.40	118.63	1 762.00	1 76.20	26.43	17.62	31.72	15.86
Finland	1 469.00	287.42	2 188.20	2 18.82	32.85	21.90	39.40	19.70
Sweden	2 151.30	345.60	2 697.00	2 69.70	40.50	27.00	48.54	24.27
UK	9 369.00	95.14	6 403.00	6 40.30	96.05	64.03	115.26	57.63
Total	**61 671.30**	**2 220.63**	**71 875.00**	**71 87.50**	**1078.30**	**718.75**	**1293.76**	**646.88**

1) Data Source about energy consumption (column 2) and biomass contribution (column 3): (European Commission, 2004b)

2) Data source about arable land: (European Commission, 2003b; Food and Agriculture Organisation, 2004)

5 Critical Factors for promoting energy crops

Despite the importance of energy crops mentioned in EU energy policy, not much progress has been seen in this sector. Still in its infancy and carried out more on experimental or research level, the establishment of energy crop production as a routine agro-industrial activity and is believed to be affected by numerous attributes. In this chapter emphasis is on the establishment of critical factors specifically associated with energy crops and in the context of EU-15. These critical factors include both barriers and promoters.

5.1 Land Availability

As we saw in previous chapter, Availability of land is one of the major factors for the promotion of energy crops. This availability of land is influenced by many direct or indirect factors. Past trends show that land uses are primarily driven by economic forces. It is wise to consider that in a free market, the land use will depend upon the opportunity cost associated with particular land use. Farmers will grow a crop which can bring them maximum benefits, than whether it is food crop, energy crop or some other industrial crop. Further, agriculture land availability for different purposes will depend upon the total amount of land required for the food production, which in turn depends upon population growth, different diets and food production systems.

In EU, the plantation of energy cops is generally talked about in the context of set-aside land. Growing energy crops on set aside land is considered as a solution to land competition between food and energy crops, and on the other hand can be an alternative source of income for the farmers(Hall et al., 1993; Ronger, 2000). This is worth considering that in case of set aside land there will be no competition with food crops, but there will be competition with other industrial crops which are grown on set aside land. This includes the biomass used directly as a feed stock for material end-use option like pulp and paper, but also as feed stock for the petrochemical industry. But, as noticed in the preceding chapter, provided no drastic changes take place regarding yield and energy content of energy crops, set aside land will not be enough to meet the targets set. To achieve these targets additional arable land will also be required.

In this section while considering different land types for energy crops, emphasis has been given to two types of land; set aside land and arable land. To identify the critical factors associated with the availability of these lands for growing energy crops, they have been discussed in detail below.

5.1.1 Set-aside Land

Set aside land is considered to be the most appropriate for growing energy crops in the EU. Set aside land for growing energy crops can be divided into two categories, compulsory and voluntary. If energy crops are grown on compulsory set aside land, there are no additional benefits available for the farmers except the payment agreed under set-side entitlements. Whereas, in case of voluntary set aside land, energy crops are also eligible for an additional aid of 45€/ha available for energy crops. In case of multiannual crops grown on set aside land, compulsory and voluntary, with an intention for bio-mass production, member states are authorised to pay national aid up to 50% of the cost associated with their establishment. It is believed that energy crops will only be grown on this land if:

- The revenues generated are more than the opportunity cost associated with the use of this land, and

- The revenues generated are proportionate to the hardship and resources involved in energy farming.

Currently, the farmers get the same acreage payment for set side and main agriculture land. With these differences in income of growing energy crops on different type of lands, voluntary set aside land are more favourable among farmers for growing multiannual crops where farmers have a possibility of getting up to 50% of their establishment cost. But, the opportunity cost associated with oil seed crops, because of increasing crude oil prices, is higher than many multiannual crops. Secondly in case of oil seed crops, it is easy for farmers to grow a crop they have tried before and which fits better with the crop rotation on other agricultural land, According to farmers, the economy in growing annual rotation crops in known and it is easy for them to respond to changing market suitability. (Wiborg, 2001).

Stability in the size of available set-aside land is another concern area. The rules related to set-aside area have been changing in previous years (Patyk & Reinhardt, 2000). Till 2000, the amount of compulsory set-aside land used to be decided by the EU and respective member country on the basis of food production and stocks. After 2000 reform the amount of compulsory set-aside land had been fixed as 10% of arable land. As of now this rule is applicable till 2006 only. Uncertainty about the minimum amount of set aside land in future provides no motivation to farmers to use this land for growing energy crops such as short rotation coppice which have longer rotation period.

Further, the regulations regarding the rotation of set-aside land have been changing in past. Currently there is no compulsion to rotate set aside land, but in last CAP reform there was an indication that the set aside land may have to be rotated in future. It might be the case that set aside land will not be suitable for growing energy crops with long rotation period such as SRC and perennial crops. The uncertainty about the future regulation regarding the rotation of set-aside land has added up to the uncertainties associated with the use of set aside land for growing energy crops.

5.1.2 Arable Land

In case of main agriculture land opportunity cost is even bigger and in order to make a shift from food to energy crops farmers need strong incentives. Table 5-1 shows the net income for growing different crops in Sweden. According to the information provided by a farmers cooperative known as Agrobränsle AB, net income to farmers in case of Salix grown on agricultural land is 166 €/ha/yr[26] for the first harvest and 295 €/ha/yr for the second harvest. This difference in income during first and second harvesting is because of two reasons. First the reduction in harvesting time and secondly, increase in productivity after first harvest.

In case of agriculture land used for growing different food crops, depending upon the quality of soil and climatic conditions, the net income has been presented for three scenarios: low, medium and high. The amount presented here is in Euro per hectare per year. These prices do not include the land rent as it is expected that it will remain more or less same in all the cases i.e. food or energy crops. The price information presented here for food crops is from skåne region of Sweden and is provided by lantmännen.

[26] Conversion factor used for converting Swedish Kronor in to Euro is 1 SEK = 0.108991 €

Table 5-1: Profit in growing different crops

Type of Crop	**Low** (€/ha/yr)	**Medium** (€/ha/yr)	**High** (€/ha/yr)
Salix[1]	166	-	295
Wheat[2]	63.22	219.73	386.00
Sugar Beet[2]	654.71	1 109.00	1535.80
Rapeseed[2]	8.83	168.00	342.90

1) *Source:* Agrobränsle AB

2) *Source:* lantmännen

Note: The price information provided here for food crops is from the Skåne, south part of Sweden. Whereas, in case of Salix price information is from eastern part of Sweden where the agricultural conditions are not as favorable as in Skåne region, which may lead to overestimation of profit associated with food crops.

In a free market, as expected after the adoption of Single Payment Scheme (SPS), farmers will grow what they perceive is more profitable. As seen above, when compared to wheat, sugar beet and rapeseed, the net income generated from energy crops is not very competitive in most of the scenarios. For the promotion of energy crops, this difference in net income needs to be eliminated at least. As shown in the Table 5-1 the profit of growing sugar beet is comparatively quite high, but the total production of sugar beet is controlled by placing a cap on maximum amount of land for which direct aid will be provided.

As the implementation of SPS regulation is in the hands of respective member country and can be delayed up to 2007, this can delay the promotion energy crops and hence will increase the susceptibility of meeting 2010 energy crop targets. Even though, after the implementation of SPS, direct subsidies will not discriminate among different crops, but there are other indirect supports for food crops that discriminate the land use for different crops. One such example is wheat; the EU secures farmer a certain minimum price for wheat, whereas there is no similar guarantee of a minimum price for energy crops.

In case of energy crops grown on main agriculture land, there is an additional aid of 45€/ha is available for the farmers. This aid will be granted in respect of areas whose production is covered by a contract with processing industry except where the processing is undertaken by the farmers on the holding. As the market for energy crops is relatively new and immature in compare to food crops, continues availability of buyers, both in near future and long terms, is considered as a major factor influencing the choice of farmers to adopt energy farming. Farmers need long term contracts for purchase of their overall expected production.

This conditional aid of 45€/ha is applicable for a maximum of 1.5 million hectare land. In case the area for which aid is claimed exceeds the maximum guaranteed amount, the area per farmer for which aid is claimed shall be reduced proportionally in that year. As we saw previously, if it is considered that 50% of available set aside land will be used for growing energy crops, an additional amount of land, approximately 5.8 million hectare, will be required to achieve the targets set for energy crop. This cap of maximum € 67.5 million as aid for energy crops definitely obstructs the uptake of energy crops as main crop.

Another aspect influencing land use is their legal status. In case the farm is not owned by the farmer, the leasing period is considered as a constraint for farmers to grow energy crops with a long production period as in the case of perennial or short rotation coppice. There are not many farmers willing to sign a leasing contract for a period of 10-15 years. The main reason for this reluctance is periodic changes in land rent. In case of a long leasing period, owners will not be able to be benefited by increasing rents.

If it is considered that all these factors mentioned above will be overcome and there will be land available in the future for growing energy crops, another question emerges is whether farmers will be willing to enter in to a field which is relative new for them and whose stability is still not proven to a larger extent.

5.2 Perceptual Challenges

Public perception, in the success of any energy source, is as essential as the policies supporting its introduction and wider use. A good understanding and strong public backing is important to bring down the cost as a result of increased adoption rate. According to a study conducted for EU, public perception about bioenergy, being cross sectoral issue, highly depends on national or even local contexts and differs between groups of people and regions. These differences in perception are about; perceived benefits of an increased use of bioenergy, regarding past experiences and success, and the trust in organizations and actors who promote bioenergy (Rohracher, Bogner, Späth, & Faber, 2004). Moreover, the study illustrates that a very small percentage (8% of people surveyed) of the general public has knowledge about bioenergy and even fewer knows about different biomass resources. In this research to identify the perceptual challenge associated with energy crops the agricultural and energy sector have been taken into consideration.

5.2.1 Agricultural Sector

Farmers show resistance to adopt any new crops that have uncertain markets, yield and paybacks. They want reliable demand for their crops before they invest money to plant that crop. Main reasons for farmer's confrontation to energy crops farming includes; 1) Traditions 2) lack of knowledge about energy farming, and 3) Risk involved in growing energy crops.

5.2.1.1 Traditions

For an agricultural farmer choosing perennial or SRC crops for energy is a structural change. This structural change in case of oil seed crop, because of its long establishment as food crop, is of fewer problems. Depending upon the type of energy crops, this change is to be supported by required infrastructure to be successful. The infrastructure required includes machines for cultivating, harvesting, and slicing the energy crops, drier and area to store energy crops, if required.

Regarding the possibility of using same equipments as for food crops, there are different opinions found among different peoples. In case of small size farms where cultivation and harvesting is done manually, this is not considered as an issue. Whereas in case of larger farms a need for specialised machines have been realised. For example, in Enköping, Sweden initially the machine for harvesting sugar cane, with little modification, was used for harvesting some Salix plantation. But, the weight of machine made it impossible to harvest energy crops when the soil was wet or damp and farmers had to wait for the soil to get dry (Mr. Eddie Johansson).

The willingness of farmers to invest in these specialised machines is found to be low. Reason for this low willingness is as most energy crops, except oil seed crops, require less number of cultivation and even lesser number of harvesting for SRC. Another problem associated with this structural change is the problem of sunk investment. This switch to energy farming will make most of the investment futile that farmers have already done in machines for planting food crops. Unlike food crops, at present these machines are also not readily available in market for rent.

Some of these problems related to structural change are even bigger when the energy crops are to be grown on the set aside land. Farmer's willingness to make investments just to grow energy crops on set-aside, which are generally not very big, is even fewer than main agriculture land. But, in case of set-aside land farmers have opportunity to get 50% of their investment as stated under CAP.

5.2.1.2 Knowledge

As seen in the preceding chapter, there is a great amount of variation found among energy crops in terms of their susceptibility to different climatic conditions and yields. Diverse species requiring different climatic conditions grows better in different seasons. Some species grow better in southern part of Europe (e.g. sorghum and eucalyptus) whereas, some are well adapted to cold climate (e.g. Reed Canary Grass). Further, energy crops differ from traditional food crops in terms of their requirement of water for irrigation, nutrients, pesticides, and herbicides to support their growth and have different plantation cycle.

Lack of knowledge about energy crops and energy crops farming may lead to selection of wrong crop species, which in turns will lead to lost of production and environmental damages. This has been a case in Sweden where lack of knowledge about energy crops among farmers resulted in production losses and therefore restrains other farmers to practice energy crop farming (Mr. Erik Herland). This lack of knowledge among EU farmers has been an influential factor in the uptake of energy crops.

5.2.1.3 Risks

A significant problem involved in the plantation of energy crops is the risk that farmers must take due to unknown future markets. Energy crops especially SRC having long production cycle reducing the flexibility of farmers to switch to other more profitable crops. Farmers are more likely to invest in energy crops only after a clear demonstration of economic gains that can compensate for their loss of flexibility (Mr. Herman Arosienius). Further, some farmers are dependent on regular cash-flows, and cannot easily sustain a transition to the more delayed and irregular cash-flows associated with long rotational energy crops.

Even though current projections and scenarios assume a large expansion of energy crops, but the question is how reliable these scenarios are. Does it make sense for farmers to make a long term investment based on these expectations? Currently it seems that a major portion of the risk associated with energy crops is concentrated in the hands of farmers. This risk needs to be divided among various stakeholders and more towards those who are best able to deal with the risk, through their ability to assess the risk, reduce it or mix it with other risks.

5.2.2 Energy Sector

Conversely to farmers, energy producers want a guaranteed and continuous supply of biomass before making capital investment to build new facilities (Launder, 2002). In addition to the

guarantee of continuous fuel supply the reasons why energy companies show less interest in investing in bioenergy projects includes 1) uncertainty about future renewable energy policies, 2) economy of scale, and 3) investments.

5.2.2.1 Uncertainty

In the EU, presently only three member countries Denmark, Finland and Netherlands are the ones having renewable energy targets beyond 2010. Moreover the renewable energy targets set under white paper are in the form of soft laws. The member countries have no legal binding to achieve these targets. This short term vision of current renewable energy policies and related targets in EU provides no motivation to energy providers for investing in these high cost low return bioenergy projects.

The current political system adds up to uncertainty associated with the future of bioenergy projects. Even though, there are some regulatory and economic instruments available in market specially to promote the use of bioenergy, but the availability of these instruments over a long period itself is a question. The fear of change in these instruments with change in government and their priorities makes these low return bioenergy projects less attractive. For example, the change of Danish government at the end of 2001 resulted in radical changes of Danish renewable energy policy. Government economic support for the development and demonstration of renewable energy systems has been abolished to a large extent. Instead the development is supposed to rely on the commercial market (Thomas B. Johansson & Turkenburg, 2004). This uncertain future of bioenergy plants because of short term vision and diverse priorities of policy makers discourages the producers in investing these high investment low return projects (Mr. Gustav Melin).

5.2.2.2 Scale

Economy of scale is perceived as an obstruction in promoting of plants using energy crops. The low energy density[27] of energy crops makes it economically unviable to transport them over long distances (Paine, 1996). This low energy density and the dispersed nature of energy crop production imply that the conversion of energy from energy crops should be carried out in close vicinity and at dispersed installations (Hall et al., 1993). Further, the size of these plants highly depends upon the availability of raw material within certain radius.

Currently, these small scale decentralised energy plants when compared to larger scale conventional energy plants are still not cost competitive in short to medium terms. But, in case of any accidents or problems these small scales energy plants provide more energy supply security in compare to one big plant.

5.2.2.3 Investment

Financial barriers to the use of biomass for energy are of great importance. The degree of these barriers varies according to the state of development of biomass in the country concerned and on the particular technology being considered. For example, in Austria, where wood fired stoves and district heating are both widespread, there is very little risk associated with the installation of new stoves or development of new projects. Similarly, biomass for heat

[27] The solar energy conversion efficiency of biomass production is very low (less than 1%). The amount of energy produced from one tonne of wood is 8 gigajoules, which is very less in compared to coal (28 GJ), mineral oil's (42GJ), Liquefied natural gas (53GJ) (Hall et al., 1993)

and power being a common concept in Nordic countries facilitates in getting finance for these projects. However, in the UK, where very little heat is produced from biomass, investors perceive it as high risk. Getting finance for these projects is also a problem as the benefits associated with these projects tends to have wider scope, i.e. are spread out widely on the society whereas, the costs tend to have a narrower scope. Because or these actual or perceived risks, the investor are either not interested in investing these high risk projects or it results as high interests rate.

Secondly, according to set aside rules, the collector or first processor of energy crops need to deposit some caution money with respective authorities. This caution money is to ensure that all collected amount of biomass will be processed as agreed upon. This amount depends upon the amount of collected raw materials. In case of small scale decentralised energy providers this investment is considered as potential constraint.

5.3 Ecological issues

Energy crop plantations are believed to provide both environmental opportunities and challenges. Environmental impacts of biomass plantation, to a great extent, depend upon the selection of energy crop species and management practices. The species selected should match to the plantation site with respect to water requirements, its seasonality, drought resistance, soil pH, nutrition, as well as susceptibility to herbivores and pests (Hall et al., 1993).

Greenhouse Gases: As energy crops are considered as carbon neutral, its use for producing energy results in the reduction of release in CO_2 emissions into atmosphere. Moreover, plantation of perennial and short rotation coppice reduces the GHG emission from arable land through i) accumulation of soil carbon in mineral soil, ii) reduced carbon dioxide emissions from organic soil, and iii) reduced nitrous oxide emissions caused by the use of fertilisers (Borjesson, 1999a; CADDET, 1998). In case of mineral soil the GHG emissions reduce by 0.5 tonne C/ha yr whereas for organic soil it is considered to be 7 tonne C/ha yr. Also, nitrous oxide emission caused by the use if fertilisers is estimated to be reduce by 0.04 tonne C CO_2-equivalent/ha yr (Borjesson, 1999b). The effect of energy crop on other GHG is estimated to be insignificant.

Nutrients: Energy crops require less fertiliser compared to food crops which leads to reduce the environmental problems such as nitrification of ground water, saturation of soil with phosphate, eutrophication, and heavy metal flux of soil (Turkenburg, 2000). Energy farming, providing better recycling of nutrients, reduces the leaching of nutrients to ground water. But, the nutrients removed from the soil during energy farming needs to be replenished in a way or another. In Austria and Sweden, some of these nutrients are replenished by recycling of ash from energy plants and sludge from municipal waste water treatment.

Water Use: Biomass production is not only land intensive. Depending upon the energy crop species, C_3 or C_4[28], it requires abundant water resources. Water requirement is inversely proportionate to the water-use efficiency (WUE), measured in milligrams of CO_2 fixed in photosynthesis per gram of water transpired. WUE is highly variable among plants types, typically ranges from two to six milligram of CO_2 per gram of H_2O (Johansson T.B, et al. 1993). This range represents water requirement of 300 to 1,000 tonnes per tonne of dry

[28] C4 plants are so called because the first product of photosynthesis is a 4-carbon sugar and grows best in relatively hot climates, whereas in C3 first product of photosynthesis is a 3-carbon sugar and they grows well in temperate climate.

biomass. Thus, biomass production at high productivities will be limited to regions with abundant rainfall or alternative water resources(Uffe Jorgensen & Schelde, 2001).

Erosion: The potential for erosion control will be an important criterion in selecting the plantation species. Erosion tends to be significant during the year following planting. Thus, annual herbaceous crop like sorghum will be less favourable in compare to annual agriculture row crop and SRC or perennial grass crops, for which planting is not very frequent.

Biological Diversity: Biomass plantations are often criticised because the range of species they support is much narrower than for natural forests. But, this criticism would be more relevant if a biomass plantation replaces a forest. However, this would not be relevant if biomass plantation is established on degraded or barren land, which was out of production. In this case, the restored land would be able to support more biological diversity than was possible before restoration. If biomass energy crop were to replace monocultural food crops, the effect of the local ecosystem would depend up on the plantation crop species chosen (Johansson T.B, et al. 1993).

Agrochemicals: In case of SRC pesticides and herbicides are used only during the establishment year and the year after harvesting. At these stages, application is necessary to allow saplings to become established and reduce the weed production. Whereas, in case of perennial grasses and oil seed crops the application of pesticides and herbicides is more than SRC, but still less compared to food crops (CADDET, 1998; Turkenburg, 2000; Uffe Jorgensen & Schelde, 2001).

Compared with other renewable energy projects, bioenergy projects are likely to have large environmental impacts for the reasons they are land intensive. Because bioenergy systems interact extensively with their environmental and socioeconomic surroundings, they will necessarily transform their surroundings. Therefore management practices are a key factor in the sustainable production and use of biomass. Yet very little is known about managing large scale energy plantation (Ronger, 2000). If biomass plantations are to play major role in the EU energy economy, strategies are needed for achieving and sustaining high yields over large areas and long periods while maintaining their environmental impacts.

5.4 Resource Competition

Unlike other renewable sources of energy, an energy crop faces two fold competitions. On one hand it competes with conventional sources of energy on terms of energy prices. This competition, to an extent, is abridged by setting specific renewable energy targets such as for electricity and biofuels at community and national levels. The increasing trend in the energy prices has also improved the economic viability of bioenergy. But, the dilemma is that the directives for the promotion of renewable energy don't discriminate between different types of renewable sources. This results as the promotion of any specific source with lowest energy cost. This tendency harms the promotion of bioenergy which, at present, in compare to other RES such as wind energy are still not very cost competitive.

Secondly, energy crops compete with other biomass sources for energy such as agriculture and forestry residue, and use of certain food crop for generating energy. But, this is also a reality that the existed use of these alternative biomass resources for generating energy has also helped in the establishment of energy crop. For example in Sweden one of the reasons for the extended energy crop farming is the existence of buyers, which were earlier using other biomass resources such as forest residues for generating energy (Mr. Gustav Melin).

The use of energy crops for generating heat and electricity very much depends upon the price and availability of its substitutes. It is considered that agriculture and forest residues being cheaper than the energy crops will always be the first choice of energy providers. But, the continuous availability of these residues in required quantity and at affordable prices is of concern. For example, in case of CHP plant at Enköping, Sweden, in order to ensure the smooth operating of plant, the biomass input includes around 75% of residues and remaining part as energy crops (Mr. Eddie Johansson). It is considered that this competition will lead to various contracting practices and gradual learning, which ultimately will reduce the cost of bioenergy.

5.5 Policy Development

On the policy side there has been a continuous pressure for increased exploitation of bio-energy in the EU. Even after this policy pressure bioenergy have not penetrate to the desired level in European energy system. As shown in Table 4-1, biomass contributes 3.6% to the gross inland energy consumption of EU. Following calculations of AEBIOM, within the European Union presently 92% of the bioenergy is utilised for heat generation, 7% to produce electricity and 1% for the production of biofuels. Appendix 3 shows the various targets/ policies for the development of RES in each member state. In order to identify the critical factors associated with various energy policies, they are divided into three categories[29]; 1) policies for establishing markets, 2) policies for expanding financing options, and 3) policies for developing capacities.

5.5.1 Policies for Establishing Markets

In competition among conventional and renewable sources for energy, it is often referred that the playing field is not level. Renewable sources compete in a scenario which was originally built for conventional sources. The two major factors that bias current market against the establishment of bioenergy and hence energy crops are; 1) subsidies, and 2) externalities.

5.5.1.1 Subsidies

Currently, there is no agreed definition of energy subsidies among EU member states. Appendix 4 shows different types of energy subsidies available in EU. At first stage, the promotion of bioenergy is hampered by the subsidies provided for the construction of energy plants using conventional fuels such as coal and nuclear energy plants. In most cases these plants have recovered their capital cost and are in their grace periods. Whereas, in case of bioenergy the cost of energy has to cover the establishment cost also, this makes bioenergy less financially attractive.

The establishment of renewables in the EU is supported through regulatory support mechanisms such as 1) Fixed Feed in Tariffs, 2) Competitive tenders, and 3) Purchase orders. Member states, depending upon the conditions, can choose one or a combination of these measures. The success of these measures depends on fair payments, long term stability and balanced development. The major concern with these mechanisms is that most of time they treat all renewable energies as same, which goes against the energy sources having high energy cost. To promote energy crops these support mechanisms need to differentiate between different sources depending on their origin. For instance, in Germany and Spain, the feed in

[29] The categorization of polices is done based upon the recommendations made for renewable energy policy at "International Conference for Renewable Energies" in Bonn 2004.

tariffs for electricity generated from biomass are higher compare to other renewable sources. This step was taken to speed up the slow development of the biomass sector in these countries.

Long stability of these measures, such as in Germany and France where tariffs are made available for a period between fourteen and twenty years have proved to be good motivation for investors. On the contrary, in Italy, the uncertainty that characterises the future prices of green certificates, which is currently set by the grid operators and has changed three times since 2001 risks jeopardising investor's security.

5.5.1.2 Externalities

Governments have traditionally made planning decisions for new capacity based upon the lowest cost option between different technologies and fuels. This has tended to support more established fuel sector rather than sectors like bioenergy, which have higher capital cost but which may have other benefits in terms of diversifying supply and reducing import dependence and job creation and other environmental benefits. This exclusion of externalities provides incorrect signals to promote the use of less cleaner fuels. Table 5-2 shows the external costs of producing electricity in EU-15 using different sources. The cost presented here is in (€ bn/Yr).

Table 5-2: External cost of producing electricity in the EU 15

Energy source	Low range estimates	High range estimates
Solid fuels	25.6	46.2
Oil and gas	12.0	21.4
Nuclear energy	2.7	2.7
Renewables	2.0	2.7

Source: European Commission (2003), Eurostat

Most of the RES have significantly lower negative external cost than fossil fuels, and have similar immediate impacts to nuclear power, but without the same risk of accident. Exclusion of these externalities, positive or negative, in fuel pricing coupled with an inheritance of subsidies on the part of conventional energy (including nuclear energy) has resulted into higher energy cost from biomass compared to fossil fuels in Europe (Rösch, C. et al. 1999). In countries where these externalities have been added into the pricing mechanism have definitely helped in promoting cleaner fuels. For example, in Denmark and Sweden, where carbon and energy taxes have been introduced, biomass energy contributes substantially into heat and electricity generation (AFB-Net, 1999).

By reducing the high up-front costs of bio energy projects, capital based incentives remain a key element for the development of bio energy. However, by basing the support on offsetting the high costs of project capital, there is a risk of providing incentives mainly for the installation of bioenergy plants instead of for the actual bioenergy production. Therefore, capital support schemes should be time-limited and gradually substituted with production incentives once these are approaching market competitiveness.

5.5.2 Policies for Expanding Financing Options

Because of high fuel and operating costs, bioenergy plants have high up-front capital costs, but relatively low return rates. This high cost low return nature hinders the financing of renewable energy projects. Moreover, for bioenergy projects a guaranteed fuel supply is always required for non-recourse financing. Lenders wish to see experienced supply chains made up of suppliers with proven equipment and experienced operators. This unproven supply chain and relatively new technologies have added up the risks associated with these projects. On the other hand, biomass growers will not make investments unless they are confident that there will be markets for their products. With all these uncertainties financers are either not willing to invest in these projects or if they do the interest rates are quite high.

Therefore, policies imparting clear market signals and mechanisms that support bioenergy, both at national and community level are needed to provide assurance to the investors. The policies to establish plantations must be coordinated with policies aimed at launching bioenergy industries. Once the bioenergy industries are established, financing for biomass plantations could also be provided by the firms that will ultimately purchase the crops. In the interim, government financing might be necessary.

5.5.3 Policies for Developing Capacities

Government investment in research and development is justified in cases where it is difficult for individual firms to capture the benefit of new technologies or where the benefits are greater than can be measured in competitive markets such as in the case of bioenergy. Challenge in this is to manage research support so that the technological development is compatible with the needs of practical markets and can be quickly converted to commercial products. This may require joint public and private financing of research and development programmes.

There are some initiatives taken under Altener and THERMIE projects at community level to disseminate this knowledge among the farmers. In near future these efforts need to be intensified if the biomass sector has to achieve its target. Focus should be given to area specific understanding about the energy crops. In addition to this there is a need of more and more demonstration projects showing the feasibility and financial viability of bioenergy. These kinds of projects can only become attractive by a high certainty of a minimum expected income.

Further, the asymmetric treatment of the biomass demand and supply side in the programs aimed at development of the bio-energy sector is a major concern in the EU energy and agricultural policy. The supply of biomass does not seem to receive the same attention as the conversion technologies. In the worst case, this can lead to shortage of biomass feedstock when the conversion technologies are available.

Research, development and demonstration programmes to disseminate the required information and educating the various stakeholders are prerequisites for the development of bioenergy projects. The involvement of stakeholders, as in case of CTO, will definitely improve the success rate of these programmes. These programmes should emphases on issues like knowledge among farmers, improved financing schemes and minimising overall costs and other technical and non-technical issues comprising subjects like liberalisation and globalisation of renewable energy.

6 Measures to promote energy crop

In preceding chapter we saw the various factors influencing the promotion of energy crop such as land availability, perceptual challenges, ecological issues, resource competition and policy development. These different factors have different sources of origin and so do the mechanisms to influence them. In this chapter the focus is on identifying the various measures under CAP for the promotion of energy crops.

6.1 Role of Common Agricultural Policy

The factors influencing the promotion of energy crops lie at various levels in the supply chain. Figure 6-1 shows a simplified example of energy crop supply chain and associated critical factors. The critical factors mentioned here are the ones having links with CAP. From farmers perspective these critical factors can be summarized as availability of buyers on long term basis, minimum guaranteed and irregular income, knowledge among farmers about energy farming and infrastructure required for structural change. From the perspective of energy companies these factors can be summarized as continuous supply of energy crops, financing of projects, and quantity of supply which ultimately affects the scale of plants.

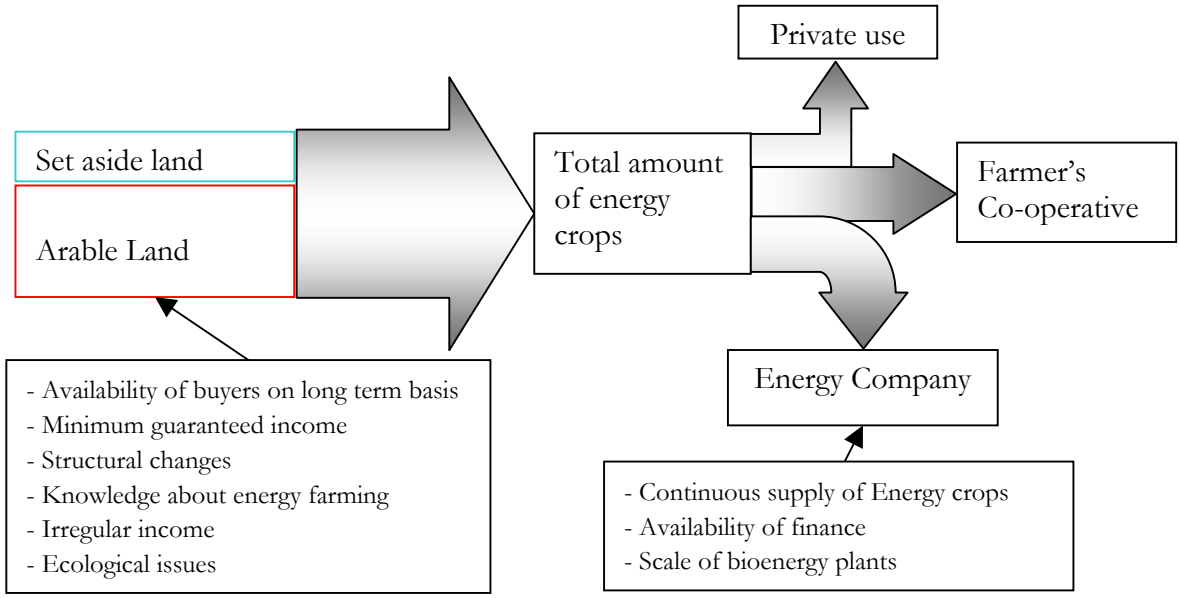

Figure 6-1: Energy crop supply chain and associated critical factors

Source: (Authors own)

As shown in Figure 6-1, the use of energy crops can be broadly divided into three streams[30]. A part of total production will be used by the farmers for their private use. A portion of remaining amount will be sold directly to the energy companies while remaining part will be sold to the farmer's co-operative. The significance of critical factors differs based on these streams such as in case of private use there are no concerns related to availability of buyers and income. Some of the possible means to overcome these factors, under CAP, includes:

- Establishing an intermediary organization

[30] Size of arrows does not represent the percentage flow in that direction.

- Expansion of energy crop subsidies
- Energy crop promotion as a rural development measure

6.1.1 Establishing an Intermediary Organization

Lack of an intermediary organization that can bridge the gap between energy crop farmers and processors is one of the reasons for the existence of most of these critical factors. This intermediary organization, by providing a common platform to farmers and energy companies, will help in discussing their concerns and reaching a situation which will benefit both. This concept of having intermediary organisations is not new for CAP. Many food crops are already supported by respective producers group under their common market organisation.

In case of energy crops, the role of these intermediary organisations will be some what different from common market organisations. As energy crops will be utilised more locally, there will be no immediate need to fix single price for whole European market and organising international trading of energy crops. The role of these intermediary organisations will include making contracts with farmers and energy companies, providing minimum income guarantee to farmers, filling knowledge gaps, and providing required infrastructure for structural change.

6.1.1.1 Establishing Contracts

The first task of such organizations will be to establish legally binding agreements with or between different actors. These contracts will help in overcoming the concerns associated with continuous demand and supply of energy crops. A contract with farmer(s) specifying the approximate amount of energy crops supplied at an agreed price will provide farmers guarantee of minimum income whereas, to energy company about guarantee of continuous supply. Similar contracts with energy companies will provide guarantee about continuous availability of buyers for energy crop produced. The institution with the help of these contracts will also be able to manage the balance between demand and supply energy crops.

Establishing these contracts is not as simple as it seems here. One dilemma with these contracts is their validity. Looking at the volatility of current energy prices, making long term payment agreements based on current markets may not be to farmer's advantage. On the other hand short term contracts, in case of SRC, provide energy providers an upper edge while negotiating the prices for second harvest. As farmers have already made investment in these crops they will not be left with much option other than continue with these crops. Obviously it can be argued that in such cases farmers can opt to grow something else. But, this will not be a good option as the profit of growing SRC is more during second harvest.

Secondly, the price for energy crops should be high enough to provide farmers enough incentives for growing energy crops, but at the same time low enough to promote the use of energy crops. Also the price for energy crops should vary depending upon its type and energy contents. It is believed that fixed price mechanism may reduce the demand of energy crops as processors would prefer other cheaper substitutes such as forest residue and waste from wood industries. This concern is correct to an extent, but an increase in price of these substitutes because of increased demand will balance the market. Further, the availability of these substitutes in many member countries is limited because of the availability of forest and related industries. Best approach in this case would be to make these price contracts more dynamic based on the market condition when they are signed. In order to avoid subjectivity related to the price, intervention of national authorities might be required.

6.1.1.2 Creating and Disseminating Knowledge

Supplemented by activities such as research and development programmes, and farm advisory services these organizations can be used as knowledge base for energy farming. This will enhance the knowledge among the producers related to various energy crops, their suitability to particular climatic conditions and farm management practices.

One such example is Agrobränsle, a farmer's co-operative in Sweden. This organisation not only works in the area of research about different energy crops species, but also makes contracts with farmers for cultivating and harvesting Salix on their farms. During the production period, this organisation provides necessary farm management advice to the farmers. On farmers side this practice reduces the risk of losing income because of lack of knowledge and poor farm management. These contracts also serve as demonstration projects for the other farmers. These kinds of advisory services provided by intermediary organisations can be financed by CAP[31].

Organizing knowledge dissemination programmes can help in overcoming the factors like knowledge gap among farmers and other environmental challenges attached with farm management practices. Further, such demonstration programmes if conducted as joint ventures among local farmers, energy companies and equipment supply firms, will help in enhancing the feasibility of such bio-energy projects.

6.1.1.3 Providing Infrastructure

The factors related to structural changes, such as need of cultivation and harvesting machines and other specialized equipments required for energy farming, can also be overcome by the intervention of such organizations. Instead of individual farmers needing to buy equipments, these machines can be bought by the intermediary organization and can be made available on rent to farmers. This initiative, by reducing the overall establishment cost associated with energy farming, will definitely improve the uptake of energy farming.

Such an institute can further assist in providing other sources of income to farmers. It can help farmers in making contracts with local municipalities to use sludge from waste water treatment plants in their energy farms at nominal price. Further, in case of young energy farmers, it can help them in getting jobs at bioenergy plants. But, the major concern related to the establishment of this institute is from where the money will come to fund all these activities.

Such intermediary organizations can be solely run by national or regional authorities, or can be a consortium of farmers and processors under the supervision of these authorities. The establishment of these groups will be more effective at national and regional levels. These authorities depending upon the local conditions and national bio-energy targets will be in best position to decide the energy crop prices.

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[31] Article 13 'Farm Advisory System' of council regulation (EC) No 1782/2003 has a provision under which member countries are authorised to finance such advisory services.

6.1.2 Expansion of Energy Crop Subsidies

Present agricultural policies are stabilized by a strong agricultural lobby, which has little interest in energy crops, and much prefers to maintain the present system of subsidies and protection for food production. This is quite natural, as farmers growing energy crops or lobbying in favour of such crops constitute a very small group within European agriculture, and are practically absent in some countries.

It is required to augment the subsidy for energy crops production initially to provide an impetus for establishing this as a new agro-industrial activity as done by Sweden. Sweden implemented a policy promoting the conversion of excess cropland to plantation of willow as an energy crop. The government supported this cropland by providing temporary subsidy to farmers for making the conversion. Courtesy of these temporary subsidies energy crop production in Sweden could increase by almost a factor of seven in just eight years. The amount of this subsidy has been decreased during the period as it is expected that after having gained a few years of experience, farmers will plant trees for energy without subsidies.

One way of providing additional support for growing energy crops is the extension of establishment subsidies available for growing multiannual crops on set aside land to arable land as done in England. Further, the cap of 1.5 million hectare land eligible for energy crops subsidy needs to be revised if energy crop targets are to be met. One problem in doing so is the fixed CAP budget for the year 2000-06. Providing these additional subsidies for energy crops will require reallocation of budget in other areas.

Further, additional price support can be made available for energy crops under the SPS where member states have authority to grant an 'additional payment' to support agricultural activities that are important for the protection and enhancement of the environment. These additional payments may use up to 10% of the funds that are available for a certain sector included in the SPS in a member country concerned.

Approval of energy crops use for fulfilling the requirements for maintaining unused agriculture land in good agriculture and environmental conditions will improve the uptake of energy crops[32]. This approval will also provide farmers an additional source of income from energy crops.

These extended subsidies will reduce the high financial need for farmers in the early part of the production period. But, the extension of some of these establishment subsidies should not be a permanent regulation, as with time the production of energy crops should be economically feasible without specific subsidies. However, it can be a very efficient measure to push the development and to reduce farmers' risk in the initial phase where a learning process is taking place and the risk of mistakes and failures is high.

6.1.3 Energy Crops as Rural Development Measures

Promotion of energy crops and related businesses under rural development measures can help in achieving some of the CAP goal such as diversification of agricultural activities and to multiple or alternative sources of income. This can be achieved by promoting energy companies owned by farmers or farmers co-operative. In addition to environmental benefits associated with energy farming and bioenergy, this initiative will help in improving the development of such regions. Though, energy plants in it are not so labour intensive, but it

[32] Article 3 'Cross Compliance' of council regulation (EC) No 1782/2003

will create possibilities for other related businesses, thus providing more job opportunities. An option of getting engaged or employed in these related businesses will promote energy farming among the segment of farmers who are eager to exploit their own labour as fully as possible on the farm and are averse to crops such as Salix that only require a small labour input. These initiatives will further facilitate is CAP's objective of integration between the different type of EU assistance under rural development plans.

But, the establishment of energy crop processing units is a multi sectoral issue. For these kinds of initiatives to be successful, the EU energy and agriculture policies need to be harmonised. After the ceiling of annual budget available under RDP, financing of these projects under CAP can have policy implications. These activities can be partly financed by CAP under the provision of 'Improving processing and marketing of agricultural products'[33]. Under this provision, such projects can get support up to 50% for objective 1 region and 40% for other regions.

Growing energy crops on the areas having some kind of geographical barrier such as hilly areas where crops requiring frequent cultivation and harvesting is not feasible, or areas with environmental constraints such as erosion can be an option to ensure continued agricultural land use and maintaining countryside under the provision for less favoured areas and areas with environmental restriction[34]. Further the use of energy cops can be promoted for the treatment of contaminated land.

As we saw, diverting fund towards the development of energy crops will require reallocation of fund for other measures. By the time these adjustments are made or budget is reallocated at community level, one option is that member states at national level can provide a part of money generated from compulsory modulation scheme for the promotion of energy crops as a part of their rural development measures. The required amount can also be provided from National reserves[35].

[33] Article 25 of Council regulation (EC) No. 1257/1999

[34] Article 13 of Council regulation (EC) No. 1257/1999

[35] Article 42 of council regulation (EC) No 1782/2003

7 Conclusions

This last chapter contains concluding remarks regarding the results from the research undertaken, answering the questions that the purpose posed. Finally, some areas which could be explored in future research projects are presented.

7.1 Concluding Remarks

The European Commission in its White Paper entitled "Energy for the future: Renewable sources of energy" has set target for the biomass contribution in the EU total energy consumption and so for the Energy crops. With the current progress achievement of these bioenergy targets seem to be unrealistic. In this thesis some of these critical factors are identified for the promotion of energy crops. Consequently, how Common Agricultural Policy can help in the promotion of energy crops.

The main prerequisite for bioenergy supply is availability of biomass resources. It is the cost of a particular biomass resource that will determine which biomass resource is competitive in the energy sector. The resource with least costs will be the first preference of bioenergy companies. In countries with large forest resources and related industries, energy crops may have to face stiff competition. But, the continuous availability of forest based resources over a long period in the required amount in itself is a question. Therefore it is wise to expect that, in the long terms, energy crops will play an important role as a biomass resource.

The strategy to promote bioenergy should be divided into two stages: short term and long term strategy. In the short term, focus should not only be on particular type of biomass, but should be on increasing bioenergy use. During the learning period the promotion of bioenergy needs to be supported with various market based instruments. In short term strategy the emphasis should be given on the eliminating factors such as financial constraints, lack of knowledge, political structure which hampers the establishment of bioenergy.

Once the awareness regarding bioenergy is raised and the markets are established, the long term strategy should focus on issues like reduction of bioenergy cost and making bioenergy economically viable without specific support. Based on the learning, in this phase the focus should be given on the promotion of any particular type of biomass resource such as energy crops or forest residue. Further in the long term focus should also be given on the promotion of multifunctional crops, which can be used for both food and fuel.

In context of energy crops, the recent measures taken under CAP for the promotion of energy crops are appreciable, but not sufficient. Energy farming being relatively new and having immature markets is still not very popular among farmers and need additional supports. Extended support at national or EU level will help in reducing the high financial need for farmers in the early part of the production period. But, this should not be a permanent regulation, as with time the production of energy crops, like any other crop, should be economically feasible without specific subsidies. However, it can be a very efficient measure to push the development and to reduce farmers' risk in the initial learning phase, which has high risk of mistakes and failures.

In order to achieve energy crop targets at the EU level, targets should also be set for each member state. Currently not many member states have specific targets for energy cops. Without knowing what they are trying to achieve it is difficult to analyse the adequacy of existing measures and what additional measures are required.

Policies for the promotion of energy crops needs to focus on both demand and supply simultaneously. Policies should be targeted to set up costs, encouraging innovation and reducing technology costs, provide large scale test facilities to close the gaps between production cost and market price. Also a clear communication strategy is needed, for technology and feedstock providers and potential users, and to improve public awareness and understanding of the biomass sector.

During the research it was realised that to promote energy crops, there are no drastic changes required in the present CAP structure. Some of the promotion measures identified already exist, but not for energy crops. The need is to make these measures available for energy crops as well with required changes. Promotion of energy farming needs harmonisation between CAP and energy policies. Further, the constraints such as reallocation of budget can be dealt with during the next CAP reform, which is due in 2006. The measures suggested here for the promotion of energy crops through CAP include:

- Establishing an intermediary organization,
- Expansion of energy crop subsidies, and
- Energy crop promotion as rural development measure.

7.2 Further Research

The areas which can be studied using this thesis as a base includes:

- This study does not include the enlarged Union. The expansion of the EU will change some of the factors bearing the availability of land. It would be worth while to study the effects of EU enlargement with respect to agriculture land uses.
- The next CAP reform is due in year 2006. Second area worth studying would be the policy implications of making energy crops production in the CAP more attractive/ feasible.
- Another area need to explore in depth is the expectations of farmers, what do farmers really need and the prioritisation of these needs in context of energy farming.

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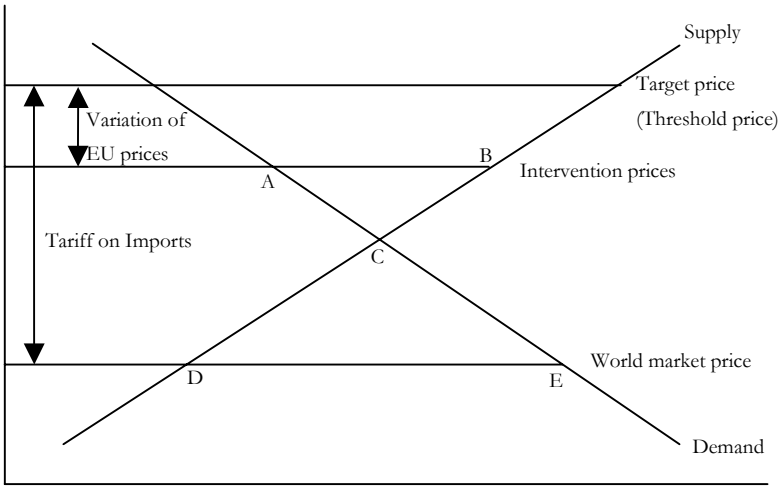
Abbreviations

bn	Billion
CAP	Common Agricultural Policy
CTO	Campaign for Take Off
CHP	Combined Heat and Power
EAGGF	European Agriculture Guidance and Guarantee Fund
EIE	Intelligent Energy - Europe
EC	European Commission
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GHG	Green House Gases
ha	Hectare
Mtoe	Million tonnes of oil equivalent
R&D	Research and Development
RES	Renewable Energy Sources
SPS	Single Payment Scheme
SRC	Short Rotation Coppice
UAA	Utilised Agriculture Area
€	Euro

Appendix: 1 Understanding the Functioning of CAP

The support system of CAP is based partly on a) import price regulation and partly on b) a variety of subsidies/supports to EU farmers. The price regulation and their impacts on the EU agricultural market can be best described with the help of an example. Though regulation details differ somewhat between different products, here it has been tried to explain a typical price intervention scheme, like that for cereals, which was the first to be put in practice (in 1967) and whose structure was transferred to other farm products.



Source: (Wickman, 2003)

The mechanism shown in diagram is based on three different price levels: *World market price* is the price at which most exchanges for cereals take place outside the EU, and the price at which foreign farmers are prepared to sell their products to EU consumers. In the free trade regime, the EU would see consumer demand at point E, in that case import would be D-E, and consumers will pay the world market price. But, it would not be the best position for EU producers. Farmers with production cost above that of the world market price would be unable to compete.

As an adjustment to the producer's interest, cereals are not offered at world market price in the EU. Instead a tariff (tariff on imports) is added to imported cereals which make the final import price equal to *target price* (also referred as threshold price). These import tariffs are normally set at a level to block all imports.

Intervention price is the price guaranteed to EU farmers- this is the lowest price that any EU seller of the cereals has to accept. As soon as he is offered a lower price, EU agricultural authorities, EAGGF, intervenes and but the surplus cereals at the level of intervention price, which shields EU farmers from foreign competition. As visible from the figure these intervention prices are also well above the domestic equilibrium price in EU. At intervention price level, consumers are willing to pay for an amount of goods at A, whereas producers supply at B resulting into over supply (B-A). Over time, the relative level of the intervention price has been falling somewhat. The price regulation policy is backed by a subsidy policy. There are producer subsidies, export subsidies and recently a number of environmentally motivated subsidies.

Appendix: 2 RES Share in the Gross Inland Energy Consumption of each EU Member State

Country	Gross inland energy consumption (ktoe)[1] (2000)	Gross inland consumption from renewables (ktoe)[1] (2000)	Share of renewables[2] on gross inland consumption, % (2000)
Belgium	57 161	731	1.3
Denmark	19 635	2 076	10.6
Germany	339 278	9 389	2.8
Greece	28 076	1 403	5.0
Spain	122 582	6 994	5.7
France	256 905	17 079	6.7
Ireland	14 029	258	1.8
Italy	175 639	12 273	7.0
Luxembourg	3 628	57	1.6
Netherlands	75 601	1 622	2.1
Austria	28 409	6 578	23.2
Portugal	24 131	3 131	13.0
Finland	32 619	7 799	23.9
Sweden	47 534	14 584	30.7
United Kingdom	229 969	2 620	1.1
Total	**1 455 196**	**86 594**	**6.0**

Source: Eurostat

(1) ktoe: thousands tonnes of oil equivalent (1 toe =41868 k Joule Net Calorific Value/Kg)

(2) Renewable energy includes hydroelectricity, biomass, wind, solar, tidal and geothermal energy

Appendix: 3 Targets/Policies for RES in each EU Member State

	RES Policy	Targets/Policies
Austria	Elektrizitätswirtschafts und organisationsgesetz – ElWOG (2000)	Obligation on operators of distribution networks to ensure that by 2007 4% of electricity comes from RES-E (excluding all forms of hydro). In addition, end-users or electricity traders located in Austria must ensure that 8% of their supply comes from small-scale hydro installations (up to 10 MW) located in Austria. Fulfilment of the 8% obligation must be documented by means of specific certificates for small-scale hydro. The Austrian cabinet has in September 2000 agreed on the principles for a national climate change strategy that includes enhanced efforts to promote RES.
Belgium	RES Policy Report for Belgium on AGORES website Beleidsnota Energie 2000-2004 (Flanders)	*Flanders*: 3% RES share of energy production by the end of 2004 and 5% by 2010. RES-E to account for 1% in 2001, 3% in 2004 and 5% in 2010. Decree being passed by Flemish Government to establish a green certificates system with quotas for electricity suppliers (from 2001) together with the establishment of a Renewable Energy Fund. *Wallonia*: 3% RES share of energy consumption in 2000 and 5% in 2010. Preparations for decree to support RES-E, including implementation of a green certificates system with quotas imposed on electricity suppliers (from 2001).
Denmark	"Energy 21" Action Plan (1996) Electricity Supply Act (1999) Political agreement on reform of electricity sector (1999)	Aim of 12-14% RES contribution to primary energy consumption by 2005 and long-term goal of 35% RES share of total primary energy consumption by 2030. Separate target of 20% RES-E share of electricity consumption by 2003. Introduction of annual RES-E quotas imposed on consumers and preparation of green certificates system to be operational by 2003.
Finland	Action Plan for renewable Energy Sources (1999)	Increase of RES contribution to energy demand with 50% (3Mtoe) by 2010 and a doubling by 2025. Increase of RES-E with 8.35 TWh between 1995-2010 leading to a 31% share of electricity consumption by 2010.
France	Le programme national de lutte contre le changement climatique (2000). Plan bois-énergie et développpement local	No overall RES target, but various sectoral strategies and targets: EOLE 2005 programme: 250-500 MW wind capacity by 2005. Proposal for 3000 MW wind capacity by 2010 as part of climate change strategy. In addition, development of wood energy, solar, geothermal and a special programme for the DOM/TOM and Corsica.

Germany	Erneuerbare Energien Gesetz (2000)	At least a doubling of the RES share of total energy consumption by 2010. A substantial increase in contribution of RES-E in order to achieve the doubling of all RES. A sectoral target for photovoltaic of 300 MW additional installed capacity under the "100.000 solar roofs programme" (1999-2004).
Greece	Action Plan "Energy 2001" RES Policy Report for Greece on AGORES website	Increase of RES share in national energy balance from 5.4% in 1996 to 8.2 – 8.5% in 2010, mainly via wind and biomass. Electricity utilities 10-year Development Plan (1994-2003): 306 MW installed capacity of large hydro, 17 MW small hydro and 37 MW wind parks in operation by 2003.
Ireland	Green Paper on sustainable energy (1999).	500 MWe target for installed electricity capacity for the period 2000-2005 (increase in RES-E production from 6% in 1998 to 12.4% in 2005 – a 3,75% RES share in total primary energy requirement). The Alternative Energy Requirement (AER), a competitive central bidding system, is the principal support mechanism for RES-E.
Italy	Italian White Paper for the valorisation of Renewable Energy Sources (1999). Law Decree of 11 November 1999 concerning RES-E	RES production forecast suggesting an increase from 11,7 Mtoe in 1997 to 20,3 Mtoe by 2008 – 2012. Installed capacity for RES-E forecasted to increase from 17104 MWe (1997) to 24700 (2008-2012). From 2002 an obligation on large producers or importers of electricity generated by fossil fuels to generate or purchase a quota of 2% RES-E (by new RES-E plants). A system of green certificates is planned in conjunction with the obligation.
Luxembourg	Stratégie nationale de réduction des émissions de gaz à effet de serre (2000)	10% of total electricity consumption should be covered by RES-E in 2010.
Netherlands	Renewable Energy – Advancing Power": Action Programme for 1997 – 2000 (1997) 1999 Energy Report	5% RES share of total energy demand in 2010 and 10% by 2020. 1000 MW wind capacity on onshore locations by 2000, but no separate policy target for RES-E. The government has made an agreement with utilities stipulating that energy distributors must sell 1700 GWh RES-E by end of 2000. A green label system in operation since 1998 as a forerunner to green certificates. A voluntary system of tradable green certificates for renewable electricity, gas and heat is in preparation and scheduled to become operational in 2001.
Portugal	"Programa Energia" RES Policy Report for Portugal on AGORES website	No overall RES targets, but some specific technology targets established under financial support schemes (e.g. 180 MW RES-E by the end of 1999 within the ENERGIA Programme). Some elements of ENERGIA will continue in new support programme.
Spain	Plan de Fomento de las Energías Renovables/Programa de Energías Renovables (1999)	Comprehensive plan for development of RES setting as overall target that 12% of energy demand should be covered by RES in 2010. Specific RES-E target aiming at 29,4% RES-E share of total electricity generation by 2010.

Sweden	Bill on a Sustainable Energy Supply (1997) Regeringens proposition 1999/2000: 134 "Ekonomiske förutsättninger för elproduktion från förnybara energikällor" (2000).	Additional 1.5 TWh electricity from RES by end of 2002 from 3 sources: - CHP based on bio-fuels: 0.75 TWh - Wind power: 0.5 TWh - Small scale hydropower: 0.25 TWh Government proposal for a green certificates trading system combined with quotas for RES-E to come into force 1 January 2003.
UK	New and Renewable Energy – Prospects for the 21st Century – Conclusions in Response to the Public Consultation, DTI.	Government proposal for 5% RES-E by 2003 and 10% by 2010 to be achieved by means of a Renewables Obligation imposed upon licensed electricity suppliers. Development of a green certificates trading system as a means to fulfil the Renewable Obligation.

(Source: Eurostat)

Appendix 4: Types of Energy Subsidies in the EU

Government intervention	Examples
- Government Intervention	- grants to producers - Grants to consumers - Low-interest or professional loans to producers
- Preferential tax treatment	- rebates or exemption on royalties, duties, producer levies and tariffs - Accelerated depreciation allowance on energy supply equipments
- Trade restrictions	- Quota, technical restrictions and trade embargoes
- Energy-related services provided by government at less than full cost	- direct investment in energy infrastructure - Public research and development
- Regulations of the energy sector	- Demand guarantee and mandate deployment rates - Price control - Market access restriction - Preferential planning consent and control over access to resources
- Failure to impose external costs	- environmental externality costs - Energy security risks and price volatility costs