The Effectiveness of Policy Instruments in Promoting Bioenergy

University of Manchester

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This report has been prepared by the Tyndall Centre at the University of Manchester, as part of its activities within the "barriers" task of the European Commission Thermalnet project.

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1. Background

Thermalnet is a closely integrated cluster of three networks on thermal processing of biomass for fuels and electricity. This includes combustion, gasification and pyrolysis, with a common focus of providing support for more rapid and more effective implementation of all the technologies in the market place by addressing technical, non-technical and commercialisation issues. This is executed via a matrix of three technologies and eleven tasks. The task on barriers is led by the University of Manchester The Tyndall Centre at the University of Manchester.

Workshops, meetings and reviews undertaken as part of the barriers task identified policy as a key barrier to European bioenergy implementation. On this basis a work plan was developed; the objectives of which include understanding better the role energy policy can play in increasing bioenergy deployment and its limitations, what policy instruments are available for this and what the current obstacles to this are.

The work described in this report makes a key contribution to these objectives. It carries out a comparative evaluation of bioenergy policy (current and historic) in a small number of representative countries in Europe (UK, Germany, Italy and Sweden) analysing

- What types of policy instruments had been used in each country
- How successful these had been at stimulating bioenergy development by looking at the evidence base in each country of how many and what type of projects were actually initiated
- Any unexpected/unwanted impacts of certain policy instruments
- The reasons why certain instruments had not been successful
- The reasons why successful policy instruments had been successful in particular circumstances and to identify any lessons that can be learned from this eg. Under what circumstances/market conditions/state of technology development might a particular instrument be expected to work well and under what circumstances might it fail to achieve its objectives

Specific recommendations are made based on this assessment, which will be disseminated further as part of the task work plan.

2. Executive Summary

Historical evidence relating to the implementation of policy instruments intended to expand bioenergy in four European member states has been gathered. The resulting data has been analysed to establish how instrumental policy interventions have been in the development of the national bioenergy industries. Country specific factors, policy context and other related issues have been evaluated in conjunction with representatives from each country in order to better understand the reasons for policy successes and failures. General findings and recommendations have been extracted from this as follows:

- Continuity of policy instruments is critical in supporting any bioenergy industry.
- Policy instruments should be used to specifically guide investment in the country's preferred form(s) of bioenergy, i.e. electricity, CHP and/ or co-firing.
- Fixed prices are a prime way to kick-start a bioenergy industry. To sustain activity, premiums for bioenergy need to be sufficiently generous to take account of capital and fuel supply costs.
- Investment subsidies can help a bioenergy industry in its initial stages and temporarily reduce costs, but will not generally attract long term investment.
- However, for countries lacking in biomass fuel supply investment subsidies are an important means to encourage and support the growth of biomass.
- Trading certificates generate investment in bioenergy, however the degree of investment will depend on the obligation and if it is weighted to specifically favour bioenergy.
- Taxation has a degree of effectiveness, but generally is best used alongside another stronger mechanism.
- For taxation alone to be effective it needs to be at a high level, increased incrementally and long term.

3. Introduction

The European Union has ratified the Kyoto Protocol and set out ambitious targets concerning climate change. As part of this commitment all major European states have devised a renewable energy programme, since the 1990's, seeing alternative sources of energy as a key way to greatly reduce carbon emission levels. In seeking alternative sources of energy, the potential of bioenergy has been acknowledged and plans to thus unlock this potential have been developed EU-wide. However, commercialising a new form of energy can be challenging since it often involves the creation of a new industry, new power plants and grid connection work. In order to ensure successful creation or development of an industry as complex as bioenergy, governments must offer sufficient incentives to attract developers and sustain a continual interest in this industry.

Governments use policy instruments as a way to guide the market and arouse investment in an emerging industry. In this particular case, policy instruments are used as an attempt to address the negative consequences of industrial activity such as pollution and excessive carbon dioxide emissions. Instruments and mechanisms can be put into place to steer investment towards more environmentally friendly activity, and deter development away from activity that produces pollution and harmful emissions. In order to activate and sustain a bioenergy industry in countries which have little experience with this type of electricity source, a range of instruments are needed to ensure that both government and the private sector invest in this industry. More importantly, the development of this industry needs to be successful and long lasting. Policy instruments must take account of this and thus aim to promote a long term interest among developers and suppliers of electricity.

Often, policy instruments are successful and assist a country in meeting its renewable energy carbon reduction targets. Sometimes, however, the support provided by governments is insufficient and does not advance an industry. In light of the current challenging targets, it is extremely important that governments orchestrate an effective system of policy instruments. For those countries beginning to devise a bioenergy industry, it may be helpful to consider the success or failures of other countries and analyse which policy instruments have proven to be effective. By doing this, they will be able to activate a strong and long lasting bioenergy industry.

This study analyses the effectiveness of policy instruments in their ability to promote bioenergy. In order to do this, four European countries will be selected and their policy instruments examined, with the aim of eventually concluding which instruments seem to be the most effective.

4. Biomass Utilisation Issues

Bioenergy is different to other forms of renewable energy for several reasons, which may affect the applicability and effectiveness of different policy instruments. The key issues that relate specifically to bioenergy are therefore outlined below.

4.1 Resource limitations

The major difference between bioenergy and other renewable sources of energy is that biomass is *not* a free resource. Unlike wind and solar energy which involve exploiting a free and natural resource, bioenergy is derived from the combustion of organic matter. However, this organic matter does not come freely and the Earth does not hold an infinite supply. In contrast to other forms of energy where man only has to retrieve and redistribute a natural resource, biomass is human-induced, and thus we are responsible for its growth and development, and of course its retrieval for exploitation for energy.

Biomass matter that can be used to create bioenergy can be found in a range of sources. Firstly, agricultural or forestry residues can be used to power a bioenergy plant, this would include wood and wood residues, and any agricultural waste. Other waste products can be used as biomass material, such as animal waste and there are energy crops that are grown particularly for the purpose of creating energy, including miscanthus and short rotation coppice.

4.2 The biomass chain

Biomass is unlike other renewable sources of energy because man must ensure the growth of organic material to fuel the power plant. Also the supply of biomass fuel must be continuous so that the power plant may be constantly powered. An important bioenergy policy objective is therefore to ensure an adequately functioning supply chain.

Governments promoting biomass must ensure that enough support is given at plant level, i.e. that extensive capital costs for plant installation are aided, but further, support must be allocated to the fuel supply chain to ensure that the quality and quantity of biomass material meets demand.

4.3 Electricity and heat potential

A further complication to biomass that makes it unique from other sources of renewable energy is the way in which it holds the potential to be used for electricity or heat or a combination of both via combined heat and power (CHP). This must be addressed by governments aiming to exploit the potential of biomass. Policy measures are further complicated since governments must provide effective measures to promote not only electricity but the heat potential offered by biomass.

4.4 Potential for biomass transportation fuels

Policy instruments are extended yet again when one considers that biomass can also provide transport fuels. Thus, as well as supporting the development of a fuel supply and ensuring operating costs are aided, government must also take account of the electricity, heat and also transportation uses fuelled by biomass. Policies must take into account that current transport fuels are established, internationally traded commodities with a substantial supporting infrastructure in place.

5. Policy Instruments

This section will look at why society needs economic policy instruments and what they are trying to achieve. The different types of policy instruments that governments can use to exploit the potential of bioenergy will then be discussed.

5.1 The importance of policy instruments

Governments can employ policy instruments as a way of promoting bioenergy in the electricity, heat or transport sectors. Bioenergy is promoted for its renewable qualities and the fact that it does not cause any increase in atmospheric carbon emissions. Bioenergy is described as carbon neutral because any carbon emissions emitted in the combustion of biomass material have recently been offset by the growth of this material, whereby carbon dioxide was absorbed.

Despite the advantages of bioenergy, industries have previously favoured fossil fuels which have been found to be easier to exploit. However, the combustion of fossil fuels for heat and electricity bring about externalities to the environment. Externalities occur when we have too much or too little of something and production or consumption decisions directly affect a third party, such as polluted air from a chemical factory or congestion from a stadium (Griffiths, 1996, p.456.). Externalities denote an imbalance between private costs and social costs, i.e. the social costs of the damage resulting from the private activity are not offset by equivalent social benefits.

Often when externalities affect society, governments intervene and endeavour to guide firms' behaviour. Policy instruments are thus introduced by governments as a means of ensuring that firms and industry address their social costs, and attempt to reduce the externalities that they bring to society. In the electricity industry policy instruments may encourage firms to switch their supply to renewable electricity, which does not induce carbon dioxide emissions into the atmosphere,, thus creates no externalities to society. Policy instruments can ensure that externalities are eradicated or lowered by two ways; firstly, electricity suppliers eradicate externalities by turning to renewable sources, and secondly, by imposing a penalty on firms that do pollute so that social costs are addressed as the cumulated penalty is often put towards rectifying pollution.

5.2 Types of policy instrument

The aim of national environmental policies is usually to change people's (or corporate institutes') behaviour. Generally this will happen only if

- People/companies are persuaded to change their behaviour of their own accord

- The change is enforced by a law or rules
- People/companies perceive an economic advantage in making the change

The first of these possibilities relies on persuading companies or individuals to act voluntarily for the good of society as a whole. This may, for example, be achieved via information provision and propaganda campaigns. These are important components in achieving social change, but using them alone tends to have limited success where there is a significant economic cost attached to the switch that is being advocated. Therefore for renewable energy implementation at the present time they will generally play a supporting role alongside policy instruments designed to regulate or economically incentivise change. These instruments can either hinder investment in a certain activity, or conversely, stimulate development and investment of another activity. The main instruments that have been put in place by governments EU-wide are discussed below:-

5.2.1 Deregulation

Deregulation entails the opening up of markets that were previously closed and regulated, these are normally markets that were formerly a monopoly e.g. a state-owned company that dominated the market. In deregulating the market, governments allow other developers and suppliers of electricity to enter the market and offer a wider choice of sources of electricity (for example, renewable electricity). The aim of deregulation is to induce competition into the market, which, in turn, will provide scope for investment in renewable electricity and may also reduce the price of electricity for consumers.

5.2.2 Regulation

Environmental regulation is the implementation of law or directives which aim to remove externalities. In order to address externalities and promote a cleaner environment, governments can introduce laws to prevent or reduce the maltreatment of the environment and encourage more sustainable behaviour. In the case of renewable energy, governments may use regulation to ensure that electricity producers are ensuring that a share of electricity is derived from a renewable source of energy, which will in turn reduce externalities to society.

5.2.3 Fixed Prices for Renewable Energy

Governments also have the choice of introducing fixed prices for renewable energy. This ensures that suppliers or developers of electricity are rewarded for their renewable energy and are guaranteed a fixed price for a given number of years. Normally, this fixed price (also known as a feed-in tariff, or a fixed price premium) is higher than the prices paid for conventional fossil fuel electricity. In order to supplement producers and suppliers of

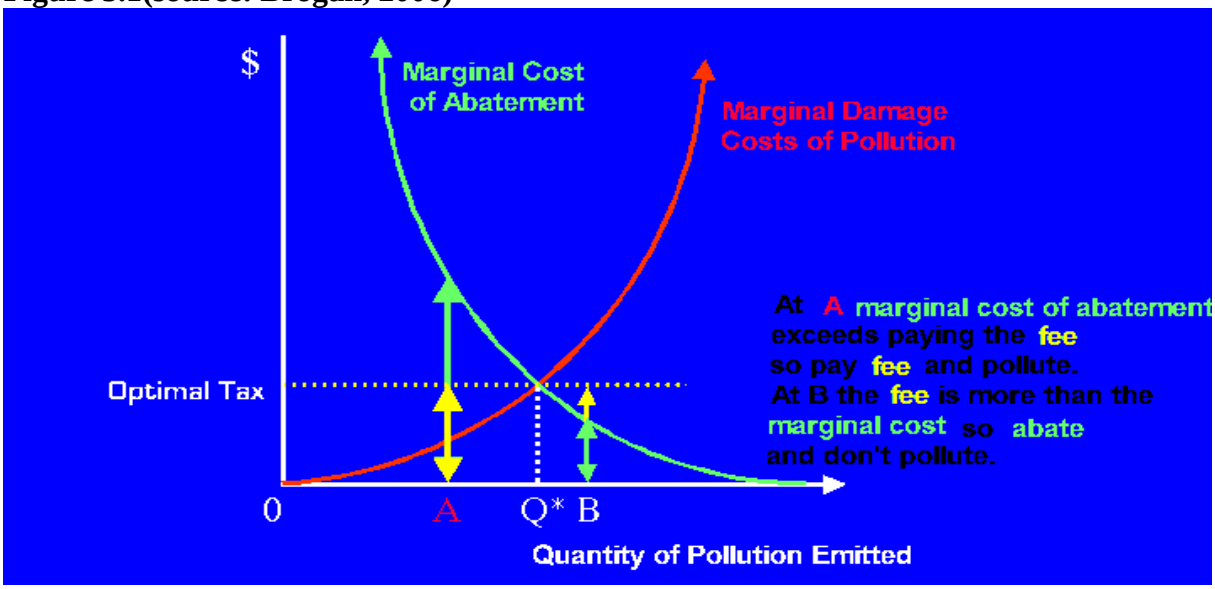
renewable electricity, governments often use the funds amassed from taxation on the generation of fossil fuel electricity.

5.2.4 Taxation of Environmental Damages

Environmental tax generally signifies a regulated sum charged against a polluting activity, such as the use of petrol, or in this case; electricity produced from a fossil fuel source. In an environmental context, taxes are used to remove externalities from the market. Taxation is often employed as a punishment; to discourage a polluting activity, in the hope of encouraging its replacement with a sustainable one.

In practice a carbon tax is used to tax the carbon content of fossil fuels. (Griffiths, 1996, p. 491-3) In the case of renewable energies; tax is used as a way of addressing the social costs of global warming, by taxing energy from fossil fuels (which emits carbon dioxide) firms are inclined to take up renewable projects which will in turn alleviate society from the externality of carbon pollution.
Figure 5.1 below explains how a tax works and how a correct tax level can ensure that damage to society is reduced.

Figure 5.1(source: Brogan, 2006)



The red line shows the cost of pollution, i.e. the social cost, and the green line shows the cost to clean up this pollution, i.e. the cost of abatement. Suppose that a government decides it wishes to reduce carbon dioxide emissions from fossil fuel consumption and induce a change in industry practice by introducing a carbon dioxide tax. If the tax is set at A on the x-axis, it would cost companies more to reduce its carbon dioxide emissions

than it would to pay the tax because the tax level is lower than the cost of abating the pollution they create; so they will pay the tax and continue to pollute. By increasing the level of tax to point B on the graph it costs less to actually reduce the pollution than it does to pay the tax, so the companies would preferentially reduce their pollution levels. Figure 5.1 shows that the **sufficient tax** would be at Q*, because it is here that the marginal cost of abatement equals the cost of paying the tax, thus firms are incentivised to pay for abatement measures which will reduce the impacts on society. An **ideal tax** would equate to the size of the marginal damage to the environment, in other words the tax would equal the social cost.
Taxes can be used to punish polluters, however with renewable electricity they are often used as rewards, so that producers of renewable electricity benefit from tax exemption, which makes them a more attractive option than fossil fuels which face a tax.

5.2.5 Green Certificates

Governments can also use the market in conjunction with an obligation or regulation. This would typically require that energy suppliers supply a given percentage of their electricity from a renewable source and for every unit of electricity they produce they are awarded a green certificate. By law, they must ensure they have a sufficient number of certificates corresponding to the required percentage of renewables. This mechanism takes into account that some suppliers will not be able to finance investment in alternative forms of energy, thus they are able to buy certificates from other companies who have succeeded in doing so. A market of certificates is thus created, and suppliers may trade their certificates to gain a higher price from those who have not succeeded. The detail of these schemes varies across countries e.g. there may be price controls for the certificates or a penalty may be payable for deficits, which may be recovered by central government or recycled back to certificate holders.

5.2.6 Investment Subsidies

Governments can opt to use grants as a means of stimulating uptake of a certain activity. Grants are subsidies that are made available to firms, to compensate them for their costs in developing a renewables project. This financial help towards the initial capital outlay serves as a great cost advantage, as it instantly renders the project more economical for the developer. As previously mentioned, bioenergy is unique in the way that it often requires financial aid to support the growth of biomass material such as energy crops. Thus in the case of bioenergy, grants can be awarded for capital costs and also for fuel supply costs.

5.3 Choice of policy

Governments have a large choice regarding policy instruments that they can implement in order to eliminate externalities; in this case, the use of fossil fuels by switching to bioenergy. Some instruments are very straightforward and simply provide help with capital costs and the growth of biomass fuel, and thus by reducing the costs of bioenergy projects make render them more accessible. Other instruments are more complex, and depend on the creation of a market to bring about the trading of green certificates earned from employing bioenergy, which in turn stimulates growth in the uptake of bioenergy projects as the market for certificates evolve.

It is important to remember, however, that each country must chose a system of policy instruments that best fits its objectives. Each country will differ in their goals and targets, and thus the type of instruments used and rate at which they are implemented will vary according to the urgency of their targets. Furthermore, the status of bioenergy differs in every country. Some countries have a long forestry tradition, so the emphasis will be on supporting new conversion plants rather than fuel production or supply. . For other countries, bioenergy is relatively undeveloped and attention may need to be paid to developing particular resource bases, supply chains or infrastructure, depending on policy objectives. It is essential therefore that policy instruments are chosen and adapted to suit the natural resources, level of experience and specific targets and goals.

While the impact of a particular instrument will be country-specific it is nevertheless useful to examine the effect that policy instruments have had in some European countries to date to establish what general inferences may be drawn that can inform future policy formulation elsewhere.

5.4 Country Factors

This study will therefore analyse bioenergy policy impacts in four European countries, and in particular how successful they have been in accelerating development in bioenergy. The countries are

1.Germany

2. Italy

3.Sweden

4.United Kingdom

These were chosen to reflect a diverse range of industries and states of development. Some have a long history of successful implementation, while others are at a much earlier stage of development and each have different natural resource bases and biomass markets and each has utilised a range of different policy instruments.

6. Germany

6.1 Germany's Electricity Production

The German electricity market relies on a range of energy sources. Coal is responsible for a strong share of electricity production, whilst nuclear power is also very significant, followed by gas. Hydropower is the next most important source of electricity in Germany followed by a mixture of other renewable energies employed. Of the other renewables, biomass and wind power are prominent and are enjoying strong and steady growth.

6.2 Germany's Biomass Penetration

Biomass is used in Germany largely for heat production, but also electricity and transport. Combined Heat and Power (CHP) plants in Germany tend to utilize waste wood, industrial wood and wood residues, while wood which exists as a result of Germany's extensive forestry industry tends to be used for heating. Anaerobic digestion is also commonly used with manure and other biomaterial in the generation of electricity (Kerckow, 2004, p.3).

6.3 Germany's Electricity Market

The liberalisation of Germany's electricity market came about in 1998 after the German Electricity Act was passed. This act broke up the regulated monopoly and introduced competition in generation and trading, widening choice on the retail and wholesale level (Stecker, 2001, p.1). The liberalisation of the electricity market triggered a number of mergers between electricity suppliers, with four newly merged suppliers owning most of the electricity transmission network and about 80% of generation capacity. The remaining 20% was reserved to plants for which electricity was a by-product, such as combined heat and power plants or renewable energy which enjoyed guaranteed preferential access to the grid (OECD, 2006, p.3).Germany's electricity market, unlike many European counterparts, has no independent regulator. The market is self-regulated by a system of laws. In 2001, there were six transmission systems operators and several hundred distribution network (grid) operators.

6.4 Policy Instruments to date

1991	**Fixed Prices**
1992-2002	**Investment Subsidies**
1998	**Amendment to Fixed Prices**
1999	**Eco Tax Reform**
2000	**Fixed Prices revised**
2002	**Fixed Prices regulation extended**
2004	**Fixed Prices regulation revised**

6.4.1 Fixed Prices: 1991

Fixed prices for renewable electricity were introduced under the Electricity Feed-in Law in January 1991 which was also known as the Strom-Einspeisungs-Gesetz (StreG). The law worked as follows; utilities were obliged to buy electricity from renewable energy producers, who were guaranteed a fixed price for the electricity. The tariff was set as a percentage of the average utility electricity rates for consumers. These tariffs were fixed by the regulatory authority, and lasted for a period of one year and were then modified, always based on the average utility revenue per kWh sold. This law obliged utilities to buy electricity from producers using renewable sources and guaranteed a fixed price in combination with a digressive price element. The tariff was set as a percentage of the average utility electricity rates for consumers:

- 90% for wind and solar power
- 80% for biomass, hydropower, sewage and landfill gas installations <0.5 MW
- 65% for hydropower, sewage and landfill gas plants with a capacity between 0.5 MW and 5 MW

Table 6.1 shows the price in euros that was fixed for each type of renewable energy;

Table 6.1
Feed-in tariffs for electricity under the Strom-Einspeisungs-Gesetz

Technology	Price [ct/kWh]
Photovoltaic	Between 8.2 and 8.8
Wind	Between 8.2 and 8.8
Biomass < 0.5 MW	Between 7.05 and 7.85
Biomass between 0.5 MW and 5 MW	Between 5.95 and 6.38
Hydropower < 0.5 MW	Between 7.05 and 7.85
Hydropower between 0.5 and 5 MW	Between 5.95 and 6.38

Source of data: Energy research Centre of the Netherlands , P.O. Box 1, 1755 ZG Petten, The Netherlands

6.4.2 Amendment to Fixed Prices: 1998

In 1998 an amendment to the feed-in-law saw the introduction a 'hardship cap' (Sijm, 2002, p.7) or 'cap' of five per cent on the purchase obligation of the utilities. The cap dictated that if the amount of renewable energy purchased by a utility surpassed 5% of its total energy in one calendar year, then the upstream system operator must reimburse the costs of purchasing additional renewable electricity until it also reached the 5% ceiling in its grid territory. This amendment implied that beyond the 5% mark, the utility was no longer obliged to purchase renewable electricity offered to the grid.

6.4.3 Investment Subsidies: 1992-2002

The Ministry of Economics and Technology are responsible for allocating grants to support investment in renewable energy. A large system of grant allocation was conducted under the Market Incentive Programme from 1992.

A total of 1341 projects with grants amounting to around DM 19 million and an investment volume of around DM 45 million in this area were sponsored from 1995 to 1997.

Then between 1999 and 2002 the Ministry of Economics and Technology awarded further grants to a range of renewable energy installation developments (excluding photovoltaics and wind projects). Initially an annual budget of 100 million euros was allocated over 5 years. This sum represents the estimated additional tax revenue that comes from renewable energy sources. The scheme redistributes the tax from renewable energy to allow individuals, and Small-Medium enterprises to apply for grants and soft loans for a range of renewable energy technology. The level of support ranges from 10-30% of investment costs, and can support biomass boilers and biomass fuelled CHP plants. Available funding increased each year, so that in 2000 102 million euros was

available, in 2001 153 million euros, and in 2002 200 million euros. Grants totaled 203 million euros in 2003.

6.4.4 Eco-Tax Reform: 1999

In 1999 taxes on gasoline, diesel, natural gas and liquid gas were increased. This reform also saw the introduction of a special tax on electricity, introduced at 0.0102 euros per kWh. Electricity from renewable sources does not directly benefit from this tax because all forms of energy are taxed irrespective of the type of fuel utilised. However, revenues raised from taxes on renewable energy are put towards the Market Incentive Programme, described in 6.4.3. There were some exceptions to the taxation, such as those for energy-intensive industries, commuters and low-income households who were given reduced tax levels and compensation.

The first stage of the reform increased the tax on the above fuels by the following rates; tax on gasoline and diesel was increased by 0.0307 euros per litre, and by 0.0205 euros per litre for heating oil, and by 0.00164 per kWh of natural gas, and by 0.01278 per kg of liquid gas. The second stage of the reform was introduced in late 1999. The second stage proposed that the tax rate increase annually by 0.0307 euros per litre, and by 0.0026 kWh for the following four years.

6.4.5 Fixed Prices Revised: 2000

In the year 2000 the fixed pricing system for renewable electricity was revised and as a consequence the Electricity law was replaced by the renewable energy sources act on 1st April under the new Renewable Energy Law (REL) known as the Erneuerbare-Energien-Gesetz. Under this law, the network operators are obliged to purchase renewable electricity paid at fixed prices for 20 years. Their costs are covered by the additional fee which all consumers pay. The tariffs decline over a period of time as Germany wishes to bring the costs of renewable generation in line with that of conventional methods in the medium to long term.

The Renewable Energy Law came into effect on the 1stApril 2000, and targeted a number of renewable energy sources including wind, photovoltaics, geothermal, small hydro, offshore wind power, gas from mines and certain forms of biomass plant such as those up to 20MWe.

With the introduction of this law, it was no longer the utilities that were required to pay the feed-in tariffs, but instead the grid operators. The utilities were still required to take off the electricity produced from renewable energy sources. The grid operator closest to the installation of the renewable energy plant is required to pay the tariffs. The tariffs are only paid to the generators within the territorial scope of the Act, or within Germany's

exclusive economic zone. In order to allow renewable energy producers access to the grid, the grid operators may in fact be required to upgrade their network at their own expense. The premium paid by the grid operators may be compensated partly by the consumers, to whom they could charge a higher price.

The main differences between the REL and its predecessor the Stre G was that the price was no longer based on average consumer prices but on generation costs of various renewable energy sources. Furthermore, the REL Feed-in Tariffs could also apply to biomass plants up to 20MWe, as well as renewable electricity generated by utilities, unless the federal government or the Länder governments owned a quarter of the utility's shares. Also, the tariffs were digressive; they are lower as the installed capacity is larger. Table 6.2 outlines the premiums paid to each type of renewable energy.

Table 6.2
Feed-in tariffs for electricity under the REL

Technology	Price 2001 [ct/kWh]	Price 2002 [ct/kWh]
Photovoltaic	50.62	48.1
Onshore Wind	9.1 for first 5 years, 6.17 for following years	9 for first 5 years, 6.17 for following years
Offshore Wind	Turbines before 2006 9.1 for first 9 years, 6.17 for following years	Turbines before 2006 9 for first 9 years, 6.17 for following years
Biomass < 0.5 MW	10.23	10.10
Biomass between 0.5 MW and 5 MW	9.2	9.1
Biomass > 5 MW	8.69	8.6
Hydropower < 5 MW	7.67	7.67
Gas from Landfills, Mines, Sewage Treatment plants	7.67	

Source of data: Energy research Centre of the Netherlands , P.O. Box 1, 1755 ZG Petten,

The REL brought about the removal of the 5% cap. The burden of the feed-in payments are thus shared equally among all grid companies according to their amount of delivered electricity, so as to eliminate many cost distortions.

6.4.6 Fixed Prices extended: 2002

The fixed pricing mechanism was extended under a law introduced in 2002. The Combined Heat and Power Law regards electricity and heat plants and aims to promote large CHP plants, that were previously affected by decreasing electricity prices brought

about by the liberalisation of the electricity market. This law requires grid operators to purchase electricity from CHP plants and pay a premium price on top of the market price. This law applies only to renewable energy technologies not covered by the Renewable Energy Sources Act (EEG), thus including co-firing of biomass and biomass-fired CHP plants with a capacity above 20 MW. The premiums paid to CHP plants are outlined in Table 6.3.

Table 6.3: Premiums paid to CHP Plants in Germany

Combined Heat and Power Law (KWK Modernisierungsgesetz)

Evolution of Premiums for CHP Plants

(€ cents per kWh)

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
Plants erected before 31 Dec 89	1.53	1.53	1.38	1.38	0.97	-	-	-	-
Plants erected after 31 Dec 1989	1.53	1.53	1.38	1.38	1.23	1.23	0.82	0.56	-
Modernised plants	1.74	1.74	1.74	1.69	1.69	1.64	1.64	1.59	1.59
Plants erected after 1 April 2002	2.56	2.56	2.4	2.4	2.25	2.25	2.10	2.10	1.94
Plants < 50 kW_{el} erected between 1 April 02 and 31 Dec 2005	5.11 for 10 years after commissioning								
Fuel cell plants	5.11 for 10 years after commissioning								

Source of data: International Energy Agency

6.4.7 Fixed Prices revised: 2004

The fixed pricing mechanism was replaced again in July 2004, when the Renewable Energy Sources Act was introduced, replacing the Renewable Energy Sources Act of 2000. This law states that the grid operators are obliged to give grid access to renewable energy plants, and they must also purchase the electricity at premium prices. The tariffs are set for each type of technology based on their generation costs. Bioenergy plants receive a fixed remuneration level over 20 years. Biogas and biomass plants receive a higher tariff if they utilise energy crops rather than residues. Concerning new installations, the premium is reduced annually to ensure that the plant seeks cost reductions and higher efficiency. The tariffs of biomass-fuelled plants regress by 1.5% each year. This new law also states that plant operators are responsible for grid connection costs, but and also must bear the cost of grid enforcement if necessary.

6.5 Biomass Penetration in Germany

Table 6.4: ***Electricity Generation from RES in Germany in GWh***

In GWh	1999	2000	2001	2002	2003	2004	2003//04
Wood, Wood waste	632	804	639	543	2775	3900	40.50%
Municipal Waste	3479	3688	3718	3898	4324	4232	-2.10%
Biogas	949	1683	2077	3247	2968	3264	10.00%
Biomass Total	5060	6175	6434	7688	10067	11396	13.20%

Source of data: Eurostat, 2006 data

Table 6.5: ***Electrical Capacities of RES in MW for Germany (Eurostat, 2006 data)***

in MW	1990	1995	1999	2000	2001	2002	2003	2004	2003//04
Wood, Wood waste	0	79	103	157	190	285	500	810	62.0%
Municipal Waste	550	509	555	585	585	585	585	585	0.0%
Biogas	229	229	321	345	560	580	599	654	9.2%
Biomass Total	779	817	979	1087	1335	1450	1684	2049	21.7%

Source of data: Eurostat, 2006 data except for 2000 wood/wood waste data - from "EUBIONET Biomass Survey in Europe, Country report of Germany, Nuse Lack, 2002"

6.6 Analysis of Policy Instruments and Biomass Penetration

Tables 6.4 and 6.5 outline the development of the biomass industry since 1990. These statistics will be analysed with regards to the implementation of policy instruments to judge the impact of the market incentives.

6.6.1 Impact of Fixed Prices

The initial introduction of fixed prices for renewable energy in 1991 obliged utilities to buy electricity from producers of renewable energy at a premium price. This had some effect on wood and wood waste installations, highlighted by the increase from 0 installations in 1999 to 79MW in 1995 in Table 6.5. By contrast municipal waste and biogas installations did not increase following the year 1991 to 1995 because premiums were not paid to the production of electricity using waste or biogas.

Therefore the fixed premium prices paid for biomass installations under the Electricity Feed-In Law did help bring about activity in biomass from wood and wood wastes. This policy instrument seems to have sustained growth in the industry up until its abolition in the year 2000, but at a slower growth rate during the latter part of the 1990's.

It is important to note however that at the same time other sectors of Germany's renewables industry were growing much faster, for example wind capacity increased from almost nothing in 1990 to 2,875 MW in 1998. (http://www.crest.org/repp_pubs/articles/issuebr14/03German.htm)

This was partly due to the fact that wind power received 90% of the average utility rate for consumers, and biomass producers received only 80%, and 65% for biogas. Also, Germany has successfully implemented large-scale demonstration programmes for wind (the 250 MW wind programme) and photovoltaics (the 100,000 roofs programme), while programmes for biomass have had more modest targets and levels of support.

6.6.2 Impact of Eco-Tax Reform

The eco-tax reform of 1999 increased the tax on electricity and proposed substantial annual increases for the following four years. This did not especially benefit biomass installations as they were also taxed and so will not have contributed to the growth of the industry. However, the proceeds from the tax were used to fund the Market Incentives Programme, the impact of which is discussed in 6.6.3.

6.6.3 Impact of Investment Subsidies

Investment subsidies were available for biomass under the market incentive programme from 1992 and the further funding from 1999-2002, as a result of the eco-tax reform discussed in 6.6.2. Table 6.5 shows initial growth in biomass capacity between 1990 and 1995, but the rate of growth then slows during the period 1995-99 and then increases significantly between 1999 and 2000, with sustained growth beyond that period. Normally we would expect a lag of at least 2 years between the introduction of a specific measure and seeing its effect on bioenergy development, as this correlates with the minimum development period for such facilities. The limited data available makes it practically impossible to determine whether the initial growth between 1990 to 1995 was as a result of investment subsidies, introduced in 1992 or fixed prices in 1991.

However, it is possible that the initial increase from 1999 is spurred by the impact of the enhanced funding for investment subsidies, since these would have most likely been allocated in 1999 to facilities that had completed initial development plans and so may have come "on line" by 2000. However, fixed prices were also revised upwards in 1999 and this, discussed below, is also likely to have contributed to the increases in capacity beyond 2000.

6.6.4 Impact of Revision of Fixed Prices

While the investment subsidies in 6.6.3 may have had some impact on increased biomass capacity the revision of fixed prices in 2000 is also likely to have contributed to the sustained strong growth in wood and wood waste capacity from 2000 onwards. It is clear from the sustained nature of the increases in table 6.5 that the longer term price commitments (20 years) under this law have allowed biomass installations to be planned and then completed in the following years, which is why the generation from biomass increased in later years (see Table 6.4).

The biomass total has indeed increased annually, especially since 2002 as shown in Table 6.5. The increase from 2002 may be linked to the extension of the fixed prices law which encouraged the deployment of CHP plants in Germany and also covered biomass co-firing, which has enjoyed substantial success in Germany.

The replacement of the Electricity Feed Law with the Renewable Energy Law seems to have assisted development of the biomass industry in Germany. The main reasons for this are likely to be the long term security offered by the latter with predictable prices over a period of 20 years and the substantial increase in the actual tarrifs for biomass between the two sets of regulations. These appear to have been successful even though the actual rates payable are digressive. In the latter these are set at a level much more likely to compensate a generator's actual costs. However, it is interesting to note that the rates payable for wind generation shown in table 6.2 decrease very sharply after the first 5 years. This is reasonable because with wind power the bulk of the cost is in the capital cost and payback times tend to be consequently shorter. Bioenergy plants have substantial ongoing fuel costs, so it is reasonable that the premium prices continue at higher levels for a longer time period.

It is notable that the largest increase in biogas installations occurs between 2000 and 2001, just one year after the fixed price system was revised to include biogas. This demonstrates that for this sort of plant (short development and construction lead time, lower technology risk) can be very effectively stimulated by electricity price mechanisms alone.

6.6.5 Impact of Extended Fixed Prices

Extending the premiums to include combined heat and power from biomass and cofiring in 2002 seems to have been very effective in increasing the actual quantities of electricity generated from biomass. This can be seen by the huge increase in the number of GWh generated from wood and wood waste installations between 2002, 2003 and 2004, compared to the much smaller (but still very significant) increase in capacity displayed in table 6.5. This policy measure has thus been very effective in its specific objective of increasing the level of utilization of biomass in existing large plant.

6.6.6 Summary of the Effectiveness of Policy Instruments in Germany

Investment subsidies have helped to initially stimulate the sector, but have been less effective at providing long term support. Using general energy taxes to provide the revenue for the investment subsidies avoids overly burdensome central government costs and, in this case, has been successful in providing an increasing revenue for project support.

Fixed prices can be very effective, but only if set at an appropriate level vis a vis the technology costs.

With fixed price mechanisms considerations such as the long term security of the prices offered needs to be taken into account.

Offering incentives to existing plant to convert to or use more of a renewable fuel can be a much quicker and more effective way of stimulating an industry than supporting new technology development.

For relatively proven, short lead time technologies relatively modest price incentives alone can be effective.

7. Biofuels for Transport in Germany

Since policy for biofuels used in transport differs to the instruments implemented to promote electricity from biofuels, this section will address the instruments that concern biofuels specifically for use in transport.

The German biofuels industry has been hailed a success by many policy critics. Germany's early start in this newly emerging market has no doubt supported its success. In 1995 the first production of biodiesel at a commercial level commenced. Further, as well as producing biodiesel to be used in transport or blended with mineral fuels, German car manufacturers began to adapt their cars especially for biodiesel. This market has also been supported by the prohibition of marketing of leaded petrol in 1996, which consequentially liberated tanks available for pure biodiesel around Germany. Thus within a few months more than 600 public filling stations marketed pure biodiesel. A combination of policy instruments and factors related to Germany's investment market helped bring along the superb growth of biofuels which tool place between 1996-2003 and is illustrated in figure 7.1.

7.1 Policy Instruments for Biofuels for Transport

1999	Tax Exemption
2002	Investment Subsidies
2004	Tax Exemption

7.1.1 Tax Exemption: 1999

In 1999 the German government introduced an eco tax for fossil diesel in addition to the mineral oil tax. Despite the introduction of this tax on fuel, biodiesel received full tax exemption. Fortunately, biofuels escaped the eco-tax which for fossil fuels increased annually from 1999-2003. It is important to note that this was for biofuels used in pure form and not mixed with mineral based fuels.

7.1.2 Investment Subsidies: 2002

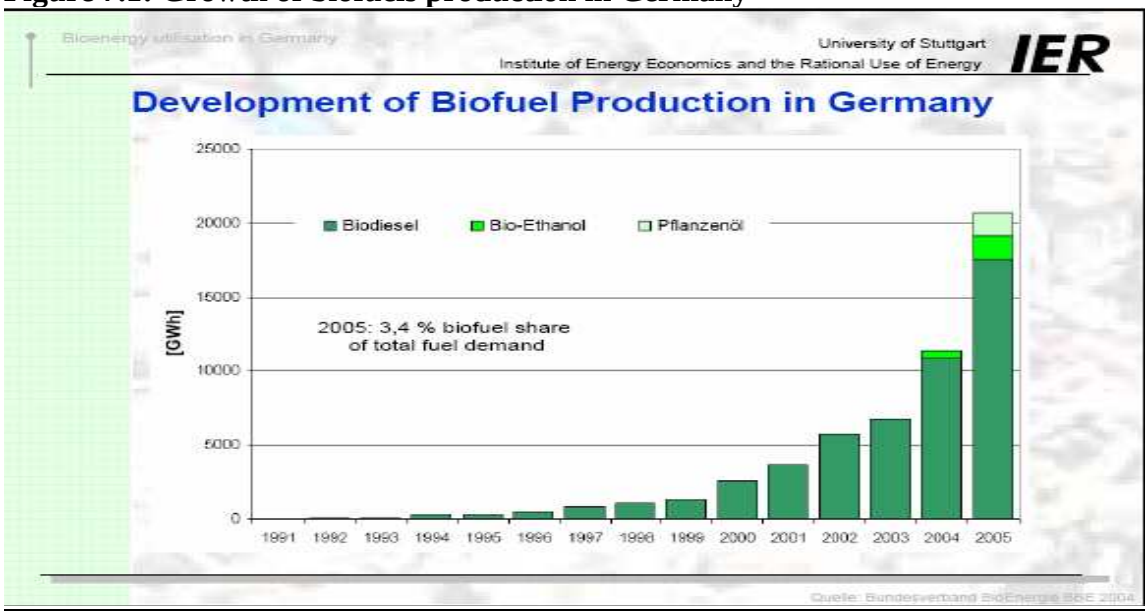
Investment subsidies in the form of capital grants up to 35% for the investment are provided to certain commercial plants in East Germany that qualify for regional selective assistance.

7.1.3 Tax Exemption: 2004

In January 2004 however German tax policy was adapted to further support the biofuels growth, and thus as a result biofuels blended with mineral oils enjoyed full tax exemption until 2009.

7.2 Biofuels Penetration in Germany

Figure 7.1: Growth of biofuels production in Germany



Source of data: University of Stuttgart

Sales of biofuels also show impressive growth over a similar period. In 1999 the sales of biodiesel was 130 kton In 2003 the sales of biodiesel was 800 kton. Sales of pure plant oil reached 5 kton. In 2004 the sales of biodiesel was 1050 kton, 5 kton of pure plant oil and 65 kton of bioethanol in the form of ETBE. Biofuels thus accounted for 1.8% of total transport fuel sales.
The new taxation rules of 2004 triggered a wave of investment in the biodiesel industry, creating an additional 740,000 tonnes of production capacity by the end of 2005.
(Source of data: Thuijl, E and Deurwaarder, E.P. 2006. European Biofuels in Retrospect. ECN. Energy Research Centre of the Netherlands. Petten.)

7.3 Analysis of Policy Instruments on the Promotion of Biofuel

Clearly rendering biofuels exempt from taxation has helped stimulate growth in the biofuels sector, since following the introduction of the tax exemption in 1999 sales of biodiesel have increased greatly. This is evident from Figure 2 which shows a sharp

increase in biofuel production after the year 1999. Thus again, by increasing taxes on fossil fuels and maintaining biofuels exemption seems to ensure a healthy growth of the utilisation of biofuels. It is clear that tax instruments can be used successfully to increase biofuel utilisation.

It is without doubt that Germany has enjoyed success with biofuels, but it must not be forgotten other factors that played a part in its development. Germany was fortunate to have the following conditions which helped develop the market. Firstly, there was much ambition from farmers and breeders to give way to the German 'rapeseed revolution'. This was further assisted by investors looking to produce biodiesel at high quality, who showed enthusiasm from very early on. In essence, the taxation laws that levy tax on petrol and diesel but not on biofuels, was a key driver in promoting the development of biofuels.

Once biodiesel production processes were developed, its commericalisation was aided by Volkswagen and other car manufacturers who gave warranties to end-users. It is important to remember that support instruments aimed at increasing biofuels utilization could be aimed at the biofuels production or at subsidizing biofuel cars. This example from Germany shows how addressing specific utilization/vehicle barriers can reap rewards. However, in general supporting biofuels vehicles will not necessarily increase biofuels utilization as the vehicles can be operated on mineral oil fuels instead.

The political support given by the green party greatly aided biofuels producers and users. Also very important in Germany's biofuel success was the sudden availability of pumps as a result of the prohibition of leaded petrol. Thus between 1996-2003 the biodiesel industry expanded rapidly.

8. Italy

Italy has a growing bioenergy industry, and currently has a range of policy instruments in place; the effectiveness of which are analysed below;

8.1 Italy's Electricity Penetration

Italy has traditionally relied on fossil fuels and hydropower for electricity generation. Gas and petroleum dominate, while the use of coal and hydropower also represent a significant share. The presence of wind power and geothermal installations are increasing, and the use of biomass to generate electricity is indeed increasing at a rapid rate. Italy has phased out any nuclear programmes as from 1980, so nuclear power does not fuel any part of Italy's electricity production.

8.2 Italy's Biomass Penetration

Since municipal waste is sometimes included as a biomass technique, it is important to note that Italy's utilisation of municipal wastes to generate electricity has been growing steadily for several years. However, this is outside the scope of the current study. Electricity from biomass in the form of wood or wood wastes is also experiencing growth, as is the introduction of biogas from landfill discharges, albeit at a slower rate. In Italy, the type of biomass most extensively used is firewood, followed by biomass from plants (energy crops).

8.3 Italy's Electricity Market

A wave of liberalization of markets via privatization occurred in most European countries in the late 1980s and the 1990s. Italy's electricity market took some time to privatize state owned monopolies. In fact, until recently competition in the Italian electricity market has been very slim. Most of the electricity sector was held by two state corporations; ENEL and ENI. In the early 1990s these companies were transformed into joint stock companies, and are thus now privatised. In 1999, following EU integration of member states, the Italian government passed new legislation regarding the de-integration of generation and distribution of electricity. The electricity state monopoly ENEL was then broken up into generation and distribution companies, thus inducing competition into the market between the providers. In addition to ENEL (who account for 80% of total power produced in Italy) there are municipal electricity companies and independent self providers (PNL, 2004, p.2).

In 1999 the Legislative Decree no.79 of March 16, 1999 introduced the GRTN, the National Grid Manager into the Italian electricity market. The GRTN is responsible for

managing energy transmission and distribution. The GRTN also manages any technical rules related to the grid that may affect planning and operating connections. Although GRTN manage the grid, it is ENEL who have proprietary control over it (Cugia di Sant'Orsolam, 2004, p.1).

8.4 Italy's Policy Instruments to date

1991	De-Regulation
1991	Investment Subsidies
1992	Feed-In Tariffs
1999	De-Integration
1999	Carbon Tax
2000	Investment Subsidies
2000	Tax Credits
2001	Green Certificates

The policy measures undertaken by the Italian Government to promote the development of renewable energy sources have evolved since the 1980s. The oil crisis in late 1973 encouraged the Italian Government to turn to alternative sources of energy, to reduce Italy's reliance on oil. The early policy instruments in Italy were thus very much based around Government intervention as a way of mobilising players in the market for renewable energy (Farinelli, p.58). However current policy instruments are more market-oriented to induce investment in renewable energy (Farinelli, p.58). These later instruments reflect the increase in climate preoccupations and Italy's need to meet its Kyoto and EU initiatives (Farinelli, p.58).

8.4.1 De-Regulation: 1991

As part of the de-regulation of the Italian electricity market, laws 9 and 10 were introduced in 1991, building upon law 308 of 1982 which was introduced as part of a National Energy Plan. Law 9 allowed renewable energy plants to increase generation from 3MW to 25MW, and law 10 made it possible to subsidise up to 30% of capital costs for a renewable energy plant generating at below 3MWe.

8.4.2 Investment Subsidies: 1991

Subsidies were introduced in Italy in 1991 as a means to promote development of renewable energy. Grants given to renewable energy projects covered up to 30-40% of costs.

8.4.3 Fixed Prices: 1992

In 1992, following deregulation of the Italian electricity market, the Inter-ministerial Committee for Prices (CIP - responsible for regulating electricity prices) introduced policy CIP 6/92. This introduced fixed prices (or feed-in tariffs) into the Italian electricity market. As a result ENEL (the government's monopolistic electricity utility) had to buy and transmit all electricity produced by renewable energy plants. ENEL set the price paid to all electricity producers by Italian utilities, with higher prices paid to producers of renewable energy. The higher prices acted as a premium and aimed to compensate the higher costs incurred by the development of renewable production. This premium or feed-in tariff was paid for the first 8 years of plant operation and varied depending on a number of criteria, such as project size, technology any other public contributions that the project received. They varied from about 0.1 euros per kWh for small hydro (less than 3MW run-of the river), to about 0.12 euros per kWh for wind and about 0.17euros per kWh for geothermal electricity. After the first 8 years, the producer received the basic component of the energy-selling price, expected to be around 0.07 euros per kWh.

The problem with the feed-in tariffs was that the premiums were linked to the oil price, which was high, so the prices under the CIP-6 became unaffordable, compromising the effectiveness of the instrument and it was eventually withdrawn . Feed-in tariffs were available to projects proposed to ENEL before 30 June 1995, but were suspended in July 1996 and never revived (Farinelli, p. 63).

8.4.4 Carbon Tax: 1999

The Carbon Tax was introduced in Italy in 1999 as a way of encouraging electricity generators to switch to renewable energy sources. The revenues accumulated from the tax contribute to financing energy efficiency and renewable energy projects. The tax was levied on coal, natural gas and oil, with coal facing the highest levy of 5,084 lire (2.63

euros) per tonne, then oil facing a levy of 1286 lire (0.66 euros) for every tonne. The tax was effectively to shift generators from using oil and coal and instead to increase their uptake of natural gas which faced a levy of 0.87 lire (0.045ct) per m^3 (IEA, 2006). The tax was initially supposed to increase annually, however this did not actually occur.

8.4.5 Investment Subsidies: 2000

Investment subsidies have featured periodically among Italy's policies to promote renewable energy. In 2000 subsidies were made available to support investment in capital outlay of biomass plants. The Biomass Fuels National Plan (PROBIO) is a system of capital grants which aim to support investment in agriculture, transport and energy, in developing the use of bioenergy in these sectors.

8.4.6 Tax Credits: 2000

In 2000 energy taxation received an addition to its policy; the issue of tax credits for renewable energy. This policy affects the consumer directly since those connected to a biomass fuelled district-heating grid receive a tax credit of 20.65 euros per kWh of power generated (IEA, 2006). In 2000, the financial law was also extended to establish a reduced excise tax for fuels with a lower environmental impact, such as bio-ethanol and biofuel additives. These fuels enjoyed a reduced tax rate of 289.2 euros per 1000 litres.

8.4.7 Green Certificates: 2001

Tradable permits were introduced into the electricity market in Italy in January 2001. All electricity generators and importers must ensure that they produce 2% of the previous year's non-renewable electricity output from a renewable source of energy. This must come from power plants constructed or re-powered after 1st April 1999. According to the Bersani Decree (79/99), renewable energy sources are listed as being; '*the sun, the wind, the water, geothermal sources, tides, the wave-motion and the transformation of vegetal products as well as organic and inorganic waste into electric energy'*. The obligation is set to increase gradually from 2% in 2002, to 2.35% in 2005, 2.7% in 2006 and 3.05% in 2007.

This obligation applies to those who produced or imported an amount of electricity from non-renewable sources exceeding 100GWh/ year, minus co-generation, power station self-consumption and exports. In order to meet this obligation of 2%, operators must file green certificates (GC) with the Transmission System Operator (GRTN). A renewable energy plant will be eligible for GCs for a period no longer than 8 years.

To fulfill the obligation of 2% the producer can either buy green certificates from others, or build new plants that use renewable energy, or re-power old renewable energy plants. Plants operating from renewable energy sources are entitled to receive GCs relative to the number of kWh for the first eight years of production since their commissioning. GCs are

issued by GRTN who issue them either based on the previous years' production of renewable energy, or based on the foreseeable quantity of energy that is expected to be produced over the coming year.

Although the price of the certificates is set by the market, this policy instrument succeeds in creating an upper boundary to the price. This is because plants that were built as a consequence of the CIP-6 (after April 1999) already receive Government support, so the Certificates that they generate become the property of the Government. It is the Government's Manager of the National Transmission Grid (GRTN) that assumes these certificates and then sells them on to those unable to reach their target. The trading price element of the certificates is controlled because the GRTN establish their price based on the premium paid to generators under CIP-6 and the average price paid to conventional producers. Since the price established by the CIP-6 is high, the price for GRTN'S certificates will also be high, so that the price of GRTN certificates will certainly be higher than the certificates belonging to renewable energy plants built independently of the CIP-6. This therefore acts as a ceiling for the market price of the certificates.

The renewable energy obligation does not distinguish between various renewable energy sources; the choice of source is left to operators based on market principles. This obligation can be fulfilled through the trading of green certificates between electricity producers using renewable energy sources of energy and importers or generators using conventional energy sources. Operators that do not comply with the obligation receive a warning from the Energy Authority Unit and in the most serious of cases, see their participation in the electricity market restricted and are forced to pay financial penalties. Green certificates are issued by the electricity transmission system operator, GRTN. The green electricity certificate system has only been fully operational since its pilot phase ended on 25 March 2003.

8.5 Biomass Penetration in Italy

Table 8.1: ***Electricity Generation from RES in GWh (Eurostat, 2006 data and 2001/02 wood/wood waste figures from ECN Renewable Energy Factsheets http://www.renewable-energy-policy.info/relec/italy/production.html)***

in GWh	1999	2000	2001	2002	2003	2004	2003//04
Wood, Wood waste	586	221	272	400	611	1913	213.10%
Municipal Waste	653	804	1258	1428	1812	2277	25.70%
Biogas	580	566	684	943	1033	1170	13.30%
Biomass Total	1819	1591	2214	2771	3456	5360	55.10%

Table 8.2: Electrical capacities of RES in MW (Eurostat, 2006 data)

in MW	1990	1995	1999	2000	2001	2002	2003	2004	2003//04
Wood, Wood waste	4	68	180	180	180	155	383	503	31.30%
Municipal Waste	46	79	168	219	222	224	446	511	14.60%
Biogas	41	21	141	179	198	224	257	268	4.30%
Biomass Total	91	168	489	578	600	603	1086	1282	18.80%

8.6 Analysis of Policy Instruments and Biomass Penetration

Table 8.1 highlights the share of electricity generation from biomass, from the year 1999 to 2004. Table 8.2 identifies the number of MW of installed biomass in Italy for the year 1990, 1995 and then from 1999-2004.

8.6.1 Absence of Policy Instruments

Prior to 1991 any attempt to encourage renewable electricity in Italy was small-scale. The first significant renewable energy policy came into effect in 1991, with deregulation and investment subsidies followed by fixed prices in 1992. Table 8.2 indicates that in 1990 the installed capacity of bioenergy from wood or wood wastes was very low, but in the decade after 1990 the capacity of bioenergy increased. This implies that the introduction of Italy's renewable energy policy was successful in initiating the industry development, but at a relatively slow rate. Prior to that year the only substantial capacity was in waste and biogas, which was probably due more to environmental/waste policy than renewable energy policy.

Between 1999 and 2001, table 8.2 shows that no more installations of biomass from wood or wood wastes were implemented. This suggests that in the years prior to 1999 there was a lack of effective policy for wood and wood wastes. This is emphasised by a reduction in capacity in 2002, indicating that retired installations were not replaced. The reason for this lack of activity is likely due to the fact that the fixed pricing system of 1992 was dissolved in 1996. The 4 year support period had not been sufficiently long to establish the industry and, in the absence of any other stimulant, development stagnated. This clarifies that the policy instruments previously in place were being effective in assisting the development of renewable electricity. During the same period municipal waste installations increase only slightly, probably due to policies and markets in the waste rather than the renewable energy sector.

It can be concluded from this dip in activity that continuity of support is vital, especially for a country, like Italy, that does not have a long history of using biomass in heat and

electricity plants. Ongoing support and incentives are required for to sustain and develop its biomass industry.

8.6.2 Impact of De-Regulation

De-regulation of the Italian electricity market in 1991 included laws 9 and 10, which increased the maximum permitted renewable energy plant size and allowed renewable energy developers access to a previously monopolistic market. This was the first necessary step in facilitating the expansion of bioenergy capacity that table 8.2 shows followed in subsequent years.

8.6.3 Impact of Fixed Prices

The introduction of fixed prices in Italy in 1992 initiated an increase in biomass installation as shown in Table 8.2 from 91 MWe before its introduction in 1990 to 168 MWe in 1995. Given the lead-time for development of bioenergy plants (typically 3 years minimum) it is possible that this mechanism was just having maximum impact when it was withdrawn in 1996. However, support continued to be available for plants notified to ENEL by 1995 and so the capacity continues to increase to 489 MWe by 1999 on the basis of plants being completed that had been proposed within the time window. It can be concluded that the fixed prices were effective, but their withdrawal because they were uneconomic shows they can also be an expensive measure. The fact that new wood installations cease after 1999, but modest growth in waste and biogas continue indicates that the technology-specific nature of the fixed price mechanism was particularly helpful to the wood industry.

8.6.4 Impact of Carbon tax and tax credits

After the introduction of the carbon tax in 1999 no new wood installations are built for 3 years and there is only modest growth in the biogas and waste sectors. The tax does not appear to be initiating new capacity other than the lowest cost and most proven technologies. In addition the output from the constant capacity of wood/wood waste plants initially falls, illustrating that there does not even appear to be an incentive for existing wood plants to increase generation, despite the fact that the carbon tax was levied on coal, natural gas and oil as a way of encouraging generators to shift to suppliers of renewable electricity and biomass from wood and wood wastes municipal waste and biogas were exempt from the tax. This is most likely because the carbon tax was not high enough to instantly lead to the creation of bioenergy plants.

The tax credits were aimed specifically at district heating plants and, as such, we would expect to see success of this measure reflected in an almost immediate increase in output rather than capacity. This is discernable in 2001 and 2002 from table 8.4, but is more

notable for waste installations than wood ones, showing that the cheaper waste fuel benefited more from this measure.

8.6.5 Impact of investment subsidies

Investment subsidies are introduced for the first time in 1991 and may have assisted the gradual growth in capacity throughout the 1990's. More significantly they are reintroduced in 2000 and focus on the agricultural aspects of the industry as well as the electricity production. Given the typical lead time for bioenergy plants it is very likely that these are contributing to the significant capacity growth between 2002 and 2003.

8.6.6 Impact of Green Certificates

Italy's policy on renewable electricity incorporates the trading of green certificates which was introduced in 2001, which is in fact earlier than their European counterparts. For most countries, given the recent implementation of such a policy it is difficult to judge its effectiveness on the renewable electricity market. Italy's earlier introduction in 2001 means that there is some indication of the effect it has had so far. Allowing two or three years for the construction of a bioenergy plant, the table indicates that the rise in bioenergy capacity in 2003 and 2004 may be as a result of the trading certificates in 2001. In other words, the introduction of trading certificates in 2001 has certainly triggered developments in all kinds of renewable forms of electricity, including biomass. The installed capacity of biomass from wood and wood wastes in 2003 and 2004 is significantly higher than in 2001 and previous years. This indicates that the trading of green certificates in Italy has promise and may be responsible for the increase in bioenergy installations beyond 2001.

It has been felt that the advantages of the green certificates in Italy include the fact that there is a period of postponement for the green certificates of one or two years, in which generators have extra time to present their certificates before sanctions are applied. Also, green certificates are allowed one or two years in advance for plants which are being built. This buffer allows producers to identify when to build renewable energy plants, as they can identify when there are fewer plants and thus infer a higher price for certificates (Farinelli, p.66).

Government also have the freedom to increase the required increment of the obligation of renewable energy electricity output in the event that supply is high and thus the value of the certificates become low. This will ensure that the system is liquid and that renewable energy projects are being developed at the required rate (Farinelli, p.66).

It is interesting to note that, as is usually the case, the green certificates are not technology specific and this is frequently cited as a reason why they are not appropriate

for bioenergy systems, which currently tend to be one of the more expensive forms of renewables. In contrast to what one might expect, therefore, tables 8.4 and 8.5 both show much greater growth in the wood sector than the cheaper biogas and waste sectors. It is likely that this is because of the combination of the green certificates alongside investment subsidies.
It is also notable that the green certificates scheme was run on a pilot basis until 2003 and, after this point, when the scheme is fully operational there is a huge increase in output in table 8.4. This is indicative of successful phased introduction of the scheme.

8.7 Summary of the Effectiveness of Policy Instruments in Italy

- Deregulation paves the way for bioenergy expansion
- Continuity of policy instruments is important and withdrawal is likely to impact negatively on the market, as was the case post 1996.
- Fixed Prices facilitated investment in bioenergy, but in this particular case proved too expensive to maintain and so were ultimately more damaging to the industry, which contracted after their withdrawal
- General taxation measures only work if the level is sufficiently high but those targeted at specific sectors (e.g. biomass district heating) may be more selectively successful
- Trading certificates combined with substantial investment subsidies have been the most effective measures at encouraging the development of new capacity and utilization of existing.

9. Biofuels for Transport in Italy

Italy's biofuels market is currently experiencing growth. This is mainly after EU directives regarding the use of biofuels came into force. Italy is already an importer of rapeseed and sunflower, as well as oil seeds to make biodiesel. However Italy is beginning to establish production of biofuels to be used in transport. This is expected to expand the industry.

9.1 Policy Instruments for Biofuels for Transport in Italy

2000	Tax Relief
2001	Tax Relief Extended
2005	Tax Relief Reduced

9.1.1 Tax Relief 2000

In 2000, Italy introduced a tax relief for biofuels reducing the amount of tax payable on biofuels. The tax relief was available for a production of 125000 tonnes of biodiesel. The tax break is at 403 euros/m3 for biodiesel (His, 2003, p.2).

9.1.2 Tax relief Extended 2001

The quota of biodiesel was increased in 2001, so that for the years 2001, 2002, 2003 and 2004, for each year 300,000 tonnes of biodiesel could enjoy the tax relief.

9.1.3 Tax Relief Reduced 2005

Unfortunately, rather than further increase the quota eligible for tax relief, the quota was in fact reduced. This meant that from 2005 only 200,000 tonnes of biodiesel could benefit from the tax relief. This change in policy will struggle to promote development in biofuels, it may however encourage efficiency within the biofuels sector.

9.2 Biofuels Penetration in Italy

Table 9.1: Biofuels Penetration in Italy 1999-2004

Year	**1999/00**	**2000/01**	**2001/02**	**2002/03**	**2003/04**
Consumption Tons (thous)	70	120	174	270	310

Source of data: SeedQuest

9.3 Analysis of Policy Instruments on the Promotion of Biofuel in Italy

The tax relief introduced in the year 2000 had instant effects on the biofuels industry, with the production and consumption of biodiesel increasingly rapidly after the year 2000 as shown in Table 9.1. When this policy was extended, production and consumption of biodiesel rose further. This suggests that a generous tax break, combined with a high taxation on fossil fuels (as is the case in Italy) will trigger an increase in the development and diffusion of biofuels. It is without doubt that the most recent policy alteration may threaten this growth. In the most positive scenario, a decrease in the quota of those eligible for tax breaks may encourage a more efficient industry. However, with a lower amount of fuel eligible for reduced taxes the biofuels industry, set at a level approximately equal to the current consumption, it is likely that growth will slow down. Consumers may also bear the costs of the lower financial subsidy, by seeing increased prices for biofuels, which may in turn add to this potential decline.

10. Sweden

10.1 Sweden's Electricity Production

Swedish electricity production is dominated by nuclear and hydropower, which combined account for over 80% of Sweden's national electricity generation. Following this, Sweden relies on a strong range of renewable energy to generate electricity. In fact, the conventional fuels; petroleum, coal and gas are responsible for only a minor part of Sweden's electricity production.

10.2 Sweden's Biomass Penetration

Bioenergy is an important player in Sweden's renewables programme, being the leading renewable source of electricity after hydropower. Sweden's biomass industry is particularly strong with regards to Combined Heat and Power and district heating networks. Fuel mainly comprises agricultural residues and forestry byproducts.

10.3 Sweden's Electricity Market

Before the liberalisation of Sweden's electricity market, five state-owned generating companies dominated the market, representing 90% of electricity production. However in 1995 the Swedish government passed legislation inducing competition into the electricity market, within the generation and distribution aspects of electricity, from 1st January 1996 (Swedish Competition Authority, 1996, p.5). The motive was to promote competition to bring about greater choice and lower costs and prices for consumers. As a result, Sweden now has six main parties dominating the electricity production sector. Electricity is generated in plants which are owned either by the state, the municipalities, industries or private companies. The state however owns approximately 48% of electricity production. The liberalisation also saw the formation of Nordpool, a joint Norwegian-Swedish trading exchange which came about with the competition between generators.

Transmission was however, to remain a monopoly. This means that access to the grid is operated by a monopoly company which is separate from the distributors. As a result, consumers' bills are made up of 2 components; the first showing the price of transmission, and the second showing the cost of electricity. The transmission is divided into three levels, those being; high voltage grid and the regional and local networks. The utility Svenska Kraftnat manages the high voltage grid, while the local and regional grids are managed by large power companies' network companies. The grid connection prices

are overviewed by the Electricity Network Authority, who ensures that transmission prices are accurate and efficient.

10.4 Policy Instruments for Electricity from Biomass

1991	Carbon Tax
1991	Energy Tax
1997	Investment Subsidies
2000	Tax Increases
2003	Green Certificates
2004	Tax for Home and Services
2004	Reduced CHP Tax

10.4.1 Carbon Tax: 1991

A carbon tax was introduced in 1991 and is levied on the emitted quantities (kg) of carbon dioxide from all fuels apart from biofuels and peat. Fuels used for electricity production are exempt from the energy and carbon taxes, although they are subject to the NOx and sulphur tax in certain cases. Fuels used for heat production are subject to energy and carbon taxes and sometimes sulphur and NOx. In principle biofuels, solid waste and peat are free of tax for all energy uses, although peat is subject to sulphur tax.

The carbon tax was introduced to complement the existing energy tax and is levied at a rate of 0.36 SEK (0.039 euros) per kg CO_2 or 130 US$ (117.51 euros) per Carbon tonne.

10.4.2 Energy Tax: 1991

Energy taxes have existed for a long time in Sweden, but as part of the eco-tax reforms in the early 1990s the energy tax has been adapted to protect the competitiveness of industry. Energy tax is levied on petrol, fuel oil, diesel oil, paraffin, liquefied petroleum gas, natural gas, coal and petroleum coke. The general rule is that fuels are taxable if they

are used for heating or as motor fuels, but not fuels used for production of electricity. The actual tax rate varies from fuel to fuel, and is independent of the energy content. A separate tax is also payable on the use of electricity which is levied at consumer level. This energy tax has been in place since the 1950s, but has been increased and modified to accommodate certain industries. In all cases however the energy tax has remained high, making the use of fossil fuels economically undesirable.

10.4.3 Investment Subsidies: 1997-2002

Subsidies for renewable energy projects are administered by the Swedish National Energy Administration and formed part of a short term energy programme to stimulate investment in new electricity production capacity from renewable energy sources. Legislation providing investment subsidies for renewable energy projects (Decree 1988 22) was applied from July 1997-2002 and covered small onshore wind projects, small scale hydropower, and CHP using 70% biomass fuel over a five year period. Subsidies of about 330 euros/ kWe were awarded to CHP plants based on biomass, to a maximum of 25% of the total capital cost of the project and, in total SEK 450 million was provided as grants to support electricity generated by biofuel based CHP plants during the period. In 2003, however, the investment subsidies were replaced by a green certificate scheme (see below).

Grants have been available for the building of district heating systems which utilised biomass for at least 5 years and for smaller scale private houses that change their heating from oil fired boilers to pellet fired boilers.

10.4.4 Tax increases: 2001

In 2000 Swedish Government approved the increase of taxation by Skr 3 billion in 2001. This entailed the raising of the carbon tax from 370 SEK (40.19 euros) to 530 SEK (57.57 euros) per tonne. The tax on diesel was increased by 0.117 SEK (0.013 euros) per litre, and taxes on electricity increased by 0.019 SEK (0.002 euros) per kWh. As stated above, biomass is exempt from these taxes.

10.4.5 Green certificates: 2003

Trading of green certificates to mobilise investment in renewable energy was introduced via the Swedish Government Energy Bill of 2002, taking effect from May 2003. Certain users of electricity are subject to an annual obligation, for example, in 2003 they had to ensure that 7.4% of their electricity was from a renewable source. This is demonstrated by producing sufficient green certificates from producers. For each MWh of renewable electricity produced from photovoltaics, wind power, biomass, geothermal energy, wave energy and small-scale hydro, a producer receives one certificate. Waste and large scale

hydropower which could potentially saturate the certificate market and bring down the value of certificates are not eligible, although peat is (Parikka, 2006, p.9).

The obligation increases every year until 2010, when it will be 16.9% of consumption and, while the prices of certificates were regulated for the first two years they have been set by the market beyond that. One major distinction from other countries' certificate trading systems is that some users are not included in the scheme. Initially energy-intensive industries were exempted, as were use of electricity in the following industries: steel-making, other metals processes, paper and pulp, wood board, basic chemical industry, mining, cement and mineral oil refineries.

The obligation is managed by the Swedish Energy Agency, who are informed by the suppliers and the users how much electricity they have supplied or used during the year and how many certificates need to be annulled. In order to maintain liquidity there is a minimum or buyout price at which the government promises to buy certificates from producers. In 2003, this was 0.66 ct per kWh. If the obligation is not met however, there is a penalty of 1.9 ct per kWh (2003 level) or 2.22 ct per KWh in 2004.

10.4.6 Tax for Households and Services: 2004

Since January 2004, households and the service sector have paid a tax of 26.19 euros per MWh on electricity. Users in the manufacturing industry, agriculture, forestry and fishing paid no electricity tax until 1 July 2004, when an electricity tax of 0.54 euros per MWh was introduced.

10.4.7 CHP Tax: 2004

Special rules apply for CHP plants. Since January 1 2004, no energy tax and only 21% of the carbon tax is paid for fuels used for heat production in these plants in order to promote production in existing CHP plants and investments in new plants. However, 3% of the fuel input used for electricity production in CHP plants is regarded as being for internal use and is subject to energy and CO2 taxes. Small scale electricity production based on renewable energy sources are exempt from the tax levied on the households and the services sector.

10.5 Biomass Penetration in Sweden

Table 10.1: Swedish Electricity Generation from RES in GWh (Eurostat, 2006 data)

in GWh	1999	2000	2001	2002	2003	2004	2003//04
Wood, Wood waste	2507	3943	3635	4023	5220	6614	26.70%
Municipal Waste	130	231	225	277	312	1233	291.99%
Biogas	9	32	21	27	36	62	72.20%
Biomass Total	2646	4206	3881	4327	5568	7899	41.90%

Table 10.2: Electrical Capacities of RES in MW (Eurostat, 2006 data)

in MW	1990	1995	1999	2000	2001	2002	2003	2004	2003//04
Wood, Wood waste	1200	1200	1490	1490	1778	1670	1670	1670	0.0%
Municipal Waste	30	76	77	77	171	170	170	264	53.3%
Biogas	0	0	18	18	19	20	20	20	0.0%
Biomass Total	1230	1276	1585	1585	1968	1860	1860	1954	5.0%

10.6 Analysis of Policy Instruments and Biomass Penetration

10.6.1 Impact of Taxation

Table 10.2 shows that, prior to the introduction of energy and carbon taxes in 1991, there was already a high base level of bioenergy capacity in Sweden. This is likely due to the established wood industry and district heating infrastructure providing competitively priced wood resource and efforts during the 1980's by the state owned generating companies to reduce dependence on mineral oil. In 1991 the energy and carbon taxes were introduced, but, from table 10.2, these do not seem to have had any significant impact on bioenergy capacity in the following 4 years. This is probably due to the fact that the energy market was not liberalised until 1996, and the carbon taxes in themselves provided little incentive for the state-owned monopolies to invest in new generating capacity.

By 1999, however, table 10.2 shows a significant increase in bioenergy capacity. This is most likely due to a combination of the energy taxes from 1991 and subsequent liberalisation of the energy market in 1996. So, the tax was effective in assisting the development of bioenergy, but only in the context of a liberalised energy market.

Interestingly the subsequent increase in taxes in 2001 is followed by a significant increase in electricity output from biomass plant but no increase in capacity. It would seem that increasing the taxes was therefore a very effective way of maximising output from existing plant, which will obviously be at much lower cost to the consumer than building new capacity.

Tables 10.1 and 10.2 only cover electricity production from biomass and significant quantities of wood are also used for heating in Sweden. Although the tax is not uniformly levied on industry, fossil fuels used in the heat sector experienced increased costs due to the two taxes in place. Since biomass is exempt from taxation, it was the natural choice and the use of biomass has increased by 44% between 1990 and 1999 (mainly because of an increase in biomass heat applications), as a result of the carbon tax (Johansson, 2001, p.1).

Overall it appears that taxation has been a very effective policy instrument in increasing biomass utilisation in Sweden throughout the 1990's. This has particularly been the case in the heat sector, but, following market liberalisation, significant increases in the electricity sector have also been noted. It should be noted in this respect that the Swedish tax regime is long established and comprises multiple layers of VAT, energy and CO2 taxes, increasing the effectiveness of tax increases. There is also a complex and frequently modified system of allocating rebates to certain industries that has enabled the tax to be augmented as required to encourage biomass use at the expense of fossil fuels, while maintaining competitive industrial advantage.

10.6.2 Impact of Investment Subsidies

Between 1997 and 2003 biomass CHP plants and other renewable technologies benefited from investment subsidies. The impact of this would be expected to manifest itself as an increase in electrical capacity in table 10.2 from 2000 onwards. This is, indeed, evident in 2001 and this is likely to be at least partly due to the impact of investment subsidies, although the previously implemented taxes are likely to also still be contributing to the overall growth. Nevertheless it should be noted that there has been no increase in capacity (other than waste) since 2001, indicating that the withdrawal of investment subsidies in 2002 has halted development of new capacity in the biomass sector. Also, much of the investment subsidy has focused on CHP and district heating plant and so these are the areas that have expanded rather than development of more innovative technologies.

10.6.3 Impact of Trading Certificates

From 2003 onwards there has been little growth in the overall capacity of wood-fired electricity plant, but a huge increase in the output from those plants. It has already been

noted that a similar trend from 2001 is likely to have been caused by tax increases that year and it seems likely that the continued increases through to 2004 have been contributed to by the tax increases, but possibly also by the green trading certificates. It will only be possible to discern if green certificates are having more impact than taxation as more data becomes available for subsequent years.

10.6.4 Impact of General Policy

Given Sweden's forestry background (68% of the land is forested) and its tradition of combusting wood for heat and power it is not surprising that it should have a strong bioenergy contribution in its electricity mix. However, the above analysis has indicated how market liberalisation, introduction of taxation, increase of tax levels and investment subsidies can each be linked to expansion of the bioenergy sector in Sweden. This suggests that, in the absence of these policy instruments the bioenergy sector would not have developed to the same extent and this is borne out by the fact that between 1997 and 2003, there were no major new policy instruments introduced in Sweden and installations of wood or wood waste plants dwindled. Therefore, even in a country like Sweden which has a strong history of combusting biomass for heat and power, policy instruments play an important role in steadily growing the industry.

10.7 Summary of the Effectiveness of Policy Instruments in Sweden

The high levels of available forestry resources and established network of district heating have doubtless been instrumental in Sweden's high level of bioenergy implementation. However, even in this context, policy instruments are required to support and guide sector development.

Investment subsidies have been effective at initiating development of new wood/wood waste capacity.

Taxation has been very effective at supporting the bioenergy, including the heat sector, but needs to be set at a suitably high level and periodically reviewed. The taxes introduced have been more effective at maximising bioenergy output from existing plant than instigating new capacity.

Trading Certificates are expected to have a positive impact on the sector but there has been insufficient experience so far to verify this.

11. Biofuels for Transport in Sweden

Sweden has incorporated the use of biofuels in transport as part of their long term strategy for sustainable development. Already enjoying a growing biofuels market, Sweden has turned to imports of bioethanol and biodiesel from Brazil and South America as a way of mobilising this sector. However, policy has also supported the growth of the indigenous biofuels industry. From 2001 Sweden outlined and commenced a strategy to switch to green taxes, which were subsequently modified to induce investment and development in the biofuels industry.

11.1 Policy Instruments for Biofuels

2002	Tax Relief
2002-2008	Tax Reduction
2004	Tax Exemption

11.1.1 Tax Relief: 2002

In 2002 the strategy for the promotion of alternative fuels came into play. This gave tax relief to pilot projects, which qualified from full exemption of excise duties, including the carbon tax described above.

11.1.2 Tax Reduction: 2002-2008

From 2002-08 it is possible to obtain a tax reduction for the purchase of environmentally friendly company cars.

11.1.3 Tax Exemption: 2004

In 2004, the tax strategy for alternative fuels changed so that from 2004-09 carbon neutral fuels are exempt from both Carbon and Energy Tax. However government may put changes into place at any time to avoid over compensation. For fuels that emit carbon dioxide a tax, a tax of 8.4ct per kg of CO_2 emitted is levied upon them. Biomass based vehicles are exempt from this tax, thus acting as an incentive to purchase cars running on biofuels.

11.2 Biofuels Penetration in Sweden

Between 2002-2003 the use of bioethanol and biodiesel from rapeseed in the transport sector almost doubled and again between 2003 and 2004.

In 2003 the share of biofuels used in the transport sector was 1.3%.

In 2004 0.3 PJ of Biodiesel and 0.5 PJ of Biogas were used in transport, so biofuels had a 2.3% share of the transport sector, exceeding the EU target of 2%. (Thuijl, 2006)

11.3 Analysis of Policy Instruments on the Promotion of Biofuel

Sweden's taxation system suggests an effective mechanism given that Sweden has already reached the EU target of 2% biofuels in transport. As a result of reaching the EU target prematurely, Sweden established an increased target of 3% of transport fuels to be derived from biofuels for 2005.

Sweden's policy concerning biofuels took off in 2002. A series of tax exemptions ensured that the employment of biofuels greatly increased. The subsequent years show that the use of bioethanol and biodiesel have virtually doubled from year to year. By maintaining taxes on vehicles emitting carbon dioxide, and upholding biofuels' exempt from tax, the biofuels market is developing rapidly.

Furthermore, Sweden has made vehicles using biofuels more economical for the consumer, who will pay a lower rate of tax on the purchase of the vehicle. A series of tax exemptions and reductions from 2002 have instantly assisted the expansion of the biofuels market for the transport industry.

12. United Kingdom

12.1 United Kingdom's Electricity Production

The main contributor to the UK's electricity market is electricity generated from the combustion of gas. However, coal and nuclear power also represent a significant amount of the UK's sources of electricity. Beyond these major contributors, the UK has a growing renewable energy market. Hydropower is responsible for a small portion of the UK's electricity, and of late, wind power and biogas and biomass are also increasing in importance.

12.2 United Kingdom's Biomass Penetration

The United Kingdom does not have a particularly large wood or forestry industry base, although there are residues and by-products that could be used for bioenergy production which are currently treated as wastes. There are also significant quantities of agricultural residues potentially available for bioenergy development, but one of the main focuses of bioenergy policy in the UK has been to attempt to develop cultivation of dedicated energy crops for the bioenergy industry.

There have been relatively few bioenergy installations in the UK, and only recently are we beginning to see larger MW-scale capacity coming into effect, fuelled mainly by forestry and agricultural residues, with some firing of energy crops. Currently the biggest biomass demand is for cofiring with coal in existing power stations and much of this material is imported.

12.3 United Kingdom's Electricity Market

In 1990, the UK liberated the electricity market through privatization, bringing about 5 important changes:

- The introduction of a wholesale electricity market
- The introduction of a retail electricity market
- De-integration, i.e. separating generation and distribution
- Regulation through the use of incentive mechanisms
- The sale of nationally-owned assets to private shareholders.

It was envisaged the wholesale electricity market would entail lower and competitive prices for consumers (Thomas, 2001, p.4)

At first the market worked as follows; demand was forecast by the System Operator, utilities bid to meet the forecast demand and the highest successful bidder sets the price for the pool of utilities for that given time. This was known as “the Pool mechanism”, but was uncompetitive and flawed. This market design was thus abandoned in 1997, with the introduction of New Electricity Trading Arrangements ‘NETA’. NETA is the wholesale market, which incorporates the trade between generators and suppliers of electricity. NETA is responsible for ensuring that demand is met by the supply fed into the grid, and also to manage the financial trade between the generators and the suppliers. The National Grid UK is the owner, operator and developer of the electricity transmission network in England and Wales. Ofgem is the regulator of the electricity market, ensuring that there is sufficient competition and that consumers are protected.

12.4 Policy Instruments for Electricity from Biomass

1989	De-Regulation
1998	Investment Subsidies
2001	Carbon Tax
2002	Green Certificates
2002	Capital Grants

12.4.1 De-Regulation : 1989

In 1989 competition was induced into the electricity market and the Non Fossil Fuels Obligation (NFFO) was introduced with the intention of supporting the nuclear and renewable industries. Under the 1989 Electricity Act, regional electricity companies faced obligations requiring them to generate a certain amount of their electricity from a renewable source, with an overall target of 1500 MW installed renewables capacity by 2000.

A fossil fuel levy was paid by utilities for the use of fossil fuel and redistributed among those producing renewable electricity. The premium price for renewables was paid only to contracted suppliers who had been successful in a competitive bidding process within prescribed renewables technology bands. The failure of the NFFO to reach its target of

1500 MW installed of renewables capacity by 2000 led to its replacement by the Renewables Obligation shortly after.

12.4.2 Investment Subsidies: 1998

The New Opportunities Fund under the National Lottery Act was introduced in 1998 to provide financial support for the development of renewable energy projects. The development of biomass was particularly aided by this scheme, whereby a range of biomass applications received grants, as did energy crop development and CHP projects. This scheme provided up to 40% of the total investment costs of new generating plant.

12.4.3 Carbon Tax: 2001

The Climate Change Levy (CCL) was introduced in April 2001 by the Government in order to encourage energy efficiency and reduce carbon dioxide emissions. The mechanism works as follows; energy used by non-household consumers is taxed at a levy of £4.30 (6.39 euros) per megawatt hour, with renewable energy being exempt. The levy is offset by a 0.3% reduction in employers' National Insurance Contributions. The funds raised are used for development projects for renewable energies and the promotion of awareness and understanding of energy efficiency. In principle developers are incentivised to undertake renewable projects because electricity prices in the industrial sector have absorbed the CCL; swelling the electricity price, which effectively acts as a premium for renewables producers. (DTI, 2006)

12.4.4 Green Certificates: 2002

Under the Utilities Act 2000 suppliers have to source an increasing amount of energy from renewables. The Renewables Obligation came into force on 1st April 2002. Each supplier receives an individual Obligation which is a target level of electricity generated from renewables. The system works as follows:

Electricity suppliers have contracts with renewable energy generators, through which they agree to purchase electricity from them at an agreed price per KWh. This contract is known as a Power Purchase Agreement (PPA). The supplier receives a Renewables Obligation Certificate (ROC) for each megawatt hour of renewable energy they supply. This certificate can then be traded with other suppliers who have not been able to meet their Renewables Obligation and who therefore must buy Certificates. Suppliers are thus able to meet their Obligation by:

1. Acquiring ROCs which will represent their total energy generated from a renewable energy source, thus meeting their target or Obligation.

2. Or by paying a buy-out price set by the regulator, OFGEM, currently £33.24 (49.36 euros) per megawatt hour to cover their obligatory total of energy generated by Renewables.
3. Or by a combination of both ROCs and paying a buy-out price.

All of the money from purchases of the buy-out price is put into a buy-out fund, and then recycled to the ROC holder in proportion to the volume of ROCs that they possess. Therefore the ROC has an incremental value in addition to the £33.24 (49.36 euros) per MWh which decreases as the target is approached. So those who have aimed to meet their Obligation by employing electricity generated from a renewable source, and have thus gained ROCs, are then rewarded for their contribution to the national target. This is clearly an encouraging factor, promoting the uptake of renewable projects; since suppliers will be eligible for ROCs which will in turn be rewarded by a cash sum. (DTI, 2006).

It is important to note that ROCs can currently be earned from co-firing, however the required proportions of energy crops to qualify for co-firing ROC's is increasing from year to year. Co-firing will eventually be illegible for ROCs by March 2016. Also, generation from waste is only eligible for ROCs if it is converted through landfill gas or by using advanced technologies such as anaerobic digestion, gasification and pyrolysis.

12.4.5 Investment Subsidies: 2002

A system of investment subsidies was introduced under the Bio Energy Capital Scheme. This scheme was established in 2002 in the aim of promoting development of the use of biomass for energy; in particular, the use of energy crops. 66 million pounds (98 million euros) was available, of this amount 10 million pounds (14.86) was committed to electricity generation and the production of energy crops or wood fuel. A further 20 million pounds (29.71 euros) was to go towards demonstration projects for advanced energy crop technologies, and towards industrial heat produced by energy crops and forestry wood fuel (IEA, 2006). By 2006, the New Opportunities Fund will inject a further 33 million pounds (49 million euros) into the scheme to support biomass projects.

12.5 Biomass Penetration

Table 12.1: ***Electricity Generation from RES in GWh (Eurostat, 2006 data)***

in GWh	1999	2000	2001	2002	2003	2004	2003//04
Wood, Wood waste	460	436	773	1127	1549	1867	20.53%
Municipal Waste	1414	1261	1361	1535	1514	1630	7.66%
Biogas	2113	2555	2870	3047	3619	4383	21.11%
Biomass Total	3987	4252	5004	5709	6682	7880	17.93%

Table 12.2: Electrical Capacities of RES in MW(Eurostat, 2006 data)

in MW	1990	1995	1999	2000	2001	2002	2003	2004	2003//04
Wood, Wood waste	0	0	*84*	133	133	144	163	163	0.0%
Municipal Waste	38	112	227	184	189	203	217	223	2.8%
Biogas	91	199	434	468	503	535	676	790	16.9%
Biomass Total	129	479	745	785	825	882	1056	1176	11.4%

12.6 Analysis of Policy Instruments

Tables 12.1 and 12.2 detail the recent development of biomass, covering the period from 1990 to 2004.

12.6.1 Impact of the NFFO Obligation

The NFFO obligation was successful in kickstarting the industry, growing it from no wood installations to 133 MWe by 2001. Its success was down to providing a tailored (sufficiently high) price to encourage developers, with a guaranteed offtake price for a fixed period. The "competitive tendering" approach adopted facilitated development of lower cost bioenergy projects, such as landfill gas and animal wastes. However, a large proportion of the contacted projects were never built, as contracts were awarded upon reaching a relatively low success hurdle.

12.6.2 Impact of Green Certificates

A first look at the development of electricity production from biomass would suggest that the Renewables Obligation is an effective means of promoting investment in bioenergy given that since its introduction in 2002, the total biomass accountable for electricity production greatly increased as Table 12.2 shows. However this opinion is not felt by all stakeholders who feel that the renewables obligation is unjust in the way it allocates a common price for all types of electricity, when bioenergy is notoriously more onerous than wind power for example. Furthermore, the instable nature of the renewables obligation and the way in which it has undergone changes since its introduction may indeed render it less effective since investors may feel a lack of confidence due to its continual modifications. The seemingly initial success of the Renewables Obligation as regards biomass may be due to the eligibility of co-firing, which is set to change and thus the RO may be less effective for biomass installations.

Despite this, the effects of the Renewables Obligation are beginning to become apparent. At present, looking at 2004 one could conclude that bioenergy from wood and wood wastes, municipal waste and biogas (all of which are currently eligible for ROCs) has increased since the introduction of the Renewables Obligation. The statistics in Table 11 show that the generation of electricity from bioenergy has increased considerably in 2004, and capacities have also increased especially biogas installations. This may be down to the eligibility of certain biogas installations to receive ROCs. The eligibility of co-firing will also have brought about bioenergy installations. The rise in bioenergy installations thanks to co-firing may be noticeable from before the 2 year lead time, as the facilities are quicker to consruct. This certainly holds for installation capacities which have increased slightly in 2003, possibly due to addition of biomass fuel in standard combustion plants. It is thus important to note that the growth of bioenergy installations caused by the implementation of co-firing plants will be threatened once eligibility rule changes come into effect in 2009. This issue thus questions the Renewables Obligation; recent promise may be challenged once co-firing is illegible for ROCs, and installations from bioenergy may cease to increase. This suggests that policy is more effective if it is long term, as short term or erratic policies threaten the confidence in an instrument and distort the scope of effectiveness.

12.6.3 Impact of Lack of Bioenergy Obligation

Although Table 12.2 shows that biomass installations increased slightly in 2004, it must be noted that this increase is only slight and as it currently stands the Renewables Obligation seems to be more successful in promoting wind power installations rather than bioenergy.

The lack of banded obligation in the United Kingdom may explain the weak development of bioenergy. Although the Renewables Obligation obliges electricity suppliers to supply

a given percentage of their electricity from renewable sources, it does not specify from which source. This is why some forms of renewable electricity are growing more rapidly than others; because the Renewables Obligation allocates one price for all types of renewable electricity, thus the less established bioenergy industry is not enticing as much development as other forms of energy. It has been found that policy instruments that oblige the take up of bioenergy have indeed helped contribute to the growth of this industry. Fixed prices used elsewhere in Europe ensure that electricity from bioenergy installations will have a long term buyer. In the United Kingdom, the lack of obligation means that bioenergy installations cannot get planning permission nor finance because suppliers are not required to take their electricity. A lack of obligation means that bioenergy is forgone for other more convenient types of renewable electricity, and this may explain why bioenergy in the UK is developing at a slower rate than its European counterparts.

12.6.4 Impact of Investment Subsidies

Investment subsidies in general have been criticized as a means of promoting the diffusion of renewable energy because they are rarely sufficient, and although they help bring down costs they are unable to sustain long term economic support for a project. Investment subsidies are thought to distort bioenergy installations because they do not encourage a learning curve of efficiency as other policy instruments may do (such as a declining ROC value, or digressive fixed prices). Particularly in the case of bioenergy however, investment subsidies are found to be inadequate. The uniqueness of bioenergy explained in section 3 describes how a country like the United Kingdom who does not have a large forestry industry or tradition of combusting biomass, required incentives to cultivate its own biomass fuel. Given that the capacity of wood and wood waste has not increased greatly, and bioenergy developers are seeking imported biomass as a way of fuelling bioenergy plants, it would be fair to say that the investment subsidies available for the growth of biomass are inadequate. For a country that does not have a strong natural tendency towards the use of bioenergy, it is paramount that support for the growth of biomass fuel is sufficient and reliable. Otherwise, it is impossible to establish a home market that provides for bioenergy plants.

Looking at the capacity from wood and wood waste installations, there is not much activity. Although there is a very gradual growth, there is rarely a period of substantial growth. The slight jump from 1999 to 2000 may be thanks to the series of investment subsidies that were introduced from 1998 onwards (see Table 12). Investment subsidies would have helped cover capital costs and possibly help purchase fuel supply.

Although installations of wood and wood waste bioenergy plants have not increased to a great degree, generation from this type of biomass has greatly increased since the year 2000. This is because UK bioenergy plants are turning to imported fuel to operate their

plants. This instantly suggests that there is insufficient incentives in the UK to encourage the growth or harvest of biomass material.

12.6.5 Impact of Carbon Tax

The Climate Change Levy has almost certainly stimulated interest in the development of renewable installations, although it is unlikely that it has been effective on its own, as its value to developers is relatively small. It is more likely that the increase in installations shown in table 12.2 in the 2 years following its introduction in 2001 are due to projects contracted under NFFO still coming on line.

The UK's carbon tax has been criticized for its alleged short term nature. It is thought that it was introduced as a short term measure to gain revenue to support renewable electricity. A longer term carbon tax, which is regularly increased may divert more investment towards bioenergy.

12.7 Summary of the Effectiveness of Policy Instruments in the UK

Strong obligation which requires suppliers to supply a specified but reasonable percentage from bioenergy should be effective for countries that do not have an established bioenergy industry.

Investment Subsidies are effective in bringing short term costs down, but do not encourage the correct learning curve of efficiency that is required in a new industry like bioenergy.

For a country with limited biomass fuel supply, investment subsidies are required to establish and maintain the growth of biomass. The subsidy must be of a generous amount, and must be long term.

For taxation to be effective, it needs to be long term.

Trading Certificates do stimulate activity in bioenergy, however the obligation may need to be weighted to promote bioenergy specifically.

Trading certificates are effective for promoting co-firing of biomass since it is a more accessible way to use biomass.

13. Biofuels for Transport in the UK

The UK's implementation of environmental policy concerning biofuels was introduced marginally later in comparison to its European counterparts. Indeed, biofuels was recognised in the UK's 2003 White Paper on 'Our Energy Future' as being an important contributor to the future energy plan. Policy instruments to promote the use of biofuels in the transport sector have thus come about just before and indeed after the 2003 Energy White Paper.

More precisely, the UK is particularly interested in exploiting bioethanol and biodiesel production from *biomass* rather than from food crops, due to the larger carbon savings and rural employment benefits involved.

13.1 Policy Instruments for Biofuels for Transport

2002	Tax Exemption
2002	Tax Break
2005	Tax Exemption

13.1.1 Tax Exemption: 2002

In 1995, the Hydrocarbon Oil Duties Act 1979 was extended to include mineral fuel substitutes such as biofuels in order to prevent tax losses from the state. The inclusion of biofuels in this act in 1995 provided no incentive for biofuels. However, due to the pressure of small entrepreneurs and the EU Biofuels Directive, partial tax exemptions were finally given to biodiesel and then later to bioethanol. This occurred in July 2002 in which a duty exemption of 20p per litre (approximately 0.30 euros/l) was given for biodiesel. This was a fairly low tax exemption thus only the cheapest biodiesel was brought to the market, such as those from waste vegetable oils. However, when this reduced tax is taken into account with the reduction of the amount of Value Added Tax, the reduction of taxation enjoyed is almost 0.35 euros per litre.

13.1.2 Tax Break: 2002

A new legislation was passed in 2002 to abate value added tax paid for biofuels. In order to promote the diffusion of the use of biofuel, UK Government has helped bring down the costs associated with biofuel, making it more attractive to investors and consumers alike. The tax payable on biofuels has been brought down from 17.5% to 5%.

13.1.3 Tax Exemption: 2005

A duty tax exemption for bioethanol came in force on January 2005. In this case it was mostly importers of biofuels from Brazil that enjoyed the benefits. This duty exemption was to apply from 2005 to 2008.

13.2 Biofuels Penetration in the United Kingdom

From July in 2002, 2.7 million litres of biodiesel were sold.

In 2003, 19.5 million litres were sold which was approximately 0.04% of road transport fuels.

In 2004, 21 million litres, and from January to May 2005 approximately 10 million litres were sold.

Source of data: Thuijl, E and Deurwaarder, E.P. 2006. European Biofuels in Retrospect. ECN. Energy Research Centre of the Netherlands. Petten.

13.3 Impact of Policy Measures

Instantly it is clear that the reduction of the value added tax paid on biofuels has helped boost this industry. It is difficult to tell if the most recent policy concerning duty tax exemption will further advance this industry, since imports of biofuels will become more economic.

It is also worth noting that the present tax regime means that it is financially worthwhile to export biodiesel manufactured in the UK to other European countries for sale and onward use. This illustrates one potential advantage of a European wide tax position on biofuels. There is already a quota for supply imposed at European level and this could be further strengthened with a European level tax.

14. Appendix

AFB-net Phase IV, Report on EU member states bio-energy policies, support mechanisms and markets, ETSU.

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