TECHNO-ECONOMIC EVALUATION

OF THE PRODUCTION OF RAPE-METHYL-ESTER

IRELAND - A CASE STUDY

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I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of M.Sc. is entirely my own work and has not been taken from the work of other save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed : Eimear Kinsella

Date : May 1995

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Interest in using alternative fuels gained momentum in the 1970s as a result of the oil crisis. However, at that time its economics did not appear favourable and this inhibited commercial development. Increased interest and successful commercial use of alternative energy sources has emerged in the 1990s throughout the EU. The stimulus for this renewed interest in alternative fuels is three dimensional, arising from changing policy stances in the fields of agriculture, energy and the environment.

Surplus food production within Europe, a phenomenon of the 1980s, led to the introduction of an input-control policy mechanism known as 'set-aside'. Included in the 'set-aside' regulations is a provision for the cultivation of non-food uses on the land which has been set-aside. These include the production of biofuels, a biomass alternative to oil fuels in the transport sector.

Arising from concern over the depletion of fossil fuel resources the concept of 'sustainability' is being increasingly reflected in international energy policy. Similarly, concern for the quality and future of the environment forms an important part of public policy. The EU is currently committed to stabilising CO_2 emissions at 1990 levels by the year 2000. Transport is a significant source of CO_2 emissions. Urban pollution has also been recognised as a major contributor to acid rain and global warming.

'Biodiesel', the commercial term for rape-methyl-ester and classified as a biofuel, is seen as one part of an overall solution to above mentioned problems. Oilseed-rape can be grown on set-aside land, and if mixed with methanol can produce an automotive fuel for conventional diesel engines without engine modification. Biodiesel is a renewable fuel and often referred to as 'CO_2 neutral', which means that the carbon dioxide emitted during combustion is equivalent to that taken up by cultivating the crop.

The question remains, can this fuel be economically produced? In present circumstances, not without a fiscal advantage in the form of a reduction in mineral oil taxation. This study, following a review of background and issues, aims to show, by comparative analysis applied to the Irish situation, that a reduction in excise duty will result in the short-run. In the longer run, however, the study illustrates that there are potential positive benefits in output, employment and the balance of trade.

ABBREVIATIONS

RME	Rape-Methyl-Ester
CAP	Common Agricultural Policy
EU	European Union
ETSU	Energy Technology Support Unit
CEC	Commission of The European Communities
OECD	Organisation of Economic Co-operation and Development
GATT	General Agreement of Tariffs and Trade
NESC	National Economic and Social Council
DG	Directorate-General
BABFO	British Association for Biofuels and Oils
SAC	Scottish Agricultural College
HEAR	High Erucic Acid Rapeseed
ETSU	Energy Technology Support Unit
ERL	Environmental Research Limited
EPA	Environmental Protection Agency
ETBE	Ethyl-Tertiary-Butyl-Ether
MTBE	Methyl-Tertiary-Butyl-Ether
UFO	Used Frying Oil
TIPP	Tax Interieure sur les Produits Petroliers
ADEME	Agence De L'Environnement et de la Maîtrise de L'Energie
IFP	Institut Français du Pétrole
AGRICE	Agriculture for Chemistry and Energy
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CFC	Chlorofluorocarbons
Nox	Nitrogen Oxide
CH4	Methane

HC	Unburnt Hydrocarbon
SO2	Sulphur
IPCC	Inter-governmental Panel on Climate and Change
TPER	Total Primary Energy Requirement
TOE	Tonnes of Oil Equivalent
OJ	Official Journal
PSE	Producer Subsidy Equivalents
EAGGF	European Guarantee and Guidance Fund
EEC	European Economic Community
EC	European Community
GNP	Gross National Product
ESRC	Economic Social and Research Council
LIFT	Lower Inventory for Tomorrow
ARP	Acreage Reduction Programme
CRP	Conservation Reduction Programme
SRF	Short Rotation Forestry
PAH	Polycyclic Aromatic Hydrocarbon

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INTRODUCTION AND LITERATURE SURVEY

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1.0 INTRODUCTION

Considerable interest exists in the 1990s in developing alternative (i.e. non-food) markets for agricultural produce. This interest has arisen as a result of the economic consequences of maintaining surplus food production which characterised European agriculture during the 1980s and early 1990s. Consequently, the agricultural sector has provided the primary impetus for developing alternative end-uses for biological produce. 'Biodiesel', the generic term most commonly used in reference to RME (Rape-Methyl-Ester) has attracted considerable interest among European agriculturists and legislators in this context.

RME is a fuel, produced from rapeseed, with similar properties to diesel. Its production in Europe has been facilitated by the introduction of 'set-aside' measures as part of the CAP (Common Agricultural policy) Reforms of 1992. The primary objectives of this policy mechanism are to reduce cereal production, while providing farmers with an alternative market for their produce. The agricultural policy mechanisms facilitating the development of this alternative fuel industry have been supported by measures from the energy and research policy divisions of the EU. However, no framework for fiscal harmonisation (in the form of a reduction in excise duty) of this fuel can be agreed upon, consequently it is not economically viable at present. However, most European countries have taken steps to reduce excise duty on biodiesel, the current EU production of which amounts to 0.68mt.

The broad objective of this study is to undertake a techno-economic evaluation of the potential for Biodiesel produced in Ireland. The assessment is carried out within the framework of the EU and other wider international trends and considerations in the energy and environment arena. The specific aims of this thesis are to establish RME's technical application in diesel engines, assess its use in European countries at present, examine the limitations to future production under current policy measures and international agreements and to evaluate its potential production capability within Ireland on a micro- and macro- economic basis.

Chapter II assesses the potential for RME as an alternative fuel for diesel engines on a technical basis. It outlines the development of the use of vegetable oils as an alternative to diesel and illustrates RME's fuel properties in comparison to diesel. This chapter describes the technology used in the production and processing of rapeseed into a technically competitive fuel with fossil diesel. It also highlights a brief survey of the energy balance studies that have been carried out in Europe.

Chapter III outlines the measures taken by the EU to implement a 'biofuel'[1] industry and the necessary programmes implemented to achieve production in Europe. The fiscal treatment of RME in Europe is outlined on a legislative level initially and subsequently on a national level. Limitations to this industry as imposed by the GATT accord are analysed in the light of present production and planned future production. The chapter then reviews current production in Europe and America on a country by country basis. This allows for an analysis of each countries production strategies and attitude towards biofuels.

Chapter IV is primarily concerned with the establishment of an environmental balance for RME. This involves an examination of the potential environmental advantage resulting from the combustion of Biodiesel compared with fossil diesel. The current concerns of the international community and the EU are established, together with the actions being taken to address them. This chapter also to gives an overview of the future of the fossil fuel market By doing this, the future market potential of biofuels as an energy source can be established.

An analysis of the CAP reforms and the rationale behind these are detailed in Chapter V. The motivation for this form of analysis is primarily to comprehend the phenomenon of surplus food production in the EU, and

[1] 'biofuel' is the term most often used in reference to liquid fuels produced from biomass. In general, it relates to fuels such as RME and Bioethanol.

specifically the mechanisms that cloaked European agriculture from market signals. The CAP reforms are analysed specifically in terms of the supply control mechanism known as 'set-aside'. This section then examines the potential acreage available in Ireland for the production of rapeseed for 'non-food' use.

As RME is commercially an uneconomic proposition without a fiscal incentive, one of the aims of this thesis was to establish, on a macro-economic basis the net gains/losses if a reduction in excise duty were introduced in Ireland. In this context Chapter VI investigates the macro-economic effects of an RME industry in Ireland in terms of employment created, added value (distributed over the different sectors of the economy), import substitution and fiscal effects. This section is subdivided into four sections corresponding to each of these elements. The results of this section are based on a comparison of two schemes, an RME scheme and a reference scheme, computing the net effect in terms of one ton of oil produced.

Chapter VII contains the conclusions to the study and the recommendations that arise as a result of these conclusions. Finally the areas of further research are highlighted.

1.1.0 LITERATURE SURVEY

This section of the thesis is concerned with giving a brief summary of the literature consulted throughout the preparation of the study. Due to the nature of the subject and the over lapping of literature sources, an overview of major reports, studies and conferences is also given.

1.1.1 Technical application of RME as a fuel

Harwood[2] established that pure vegetable oil could not be combusted successfully in diesel engines and modification of either the vegetable oil to an ester or blending the pure oil with diesel was required. He asserted that esterification showed more promise than blends of diesel and pure vegetable oil. Ohlson's[3] paper on processing of rapeseed details the various processing steps for rapeseed into oil and meal. This paper concentrates on new developments in the processing industry such as the inclusion of an extruder step in oil extraction. This study then gives a detailed account of the various steps involved in oil extraction from the oil seed. Elsbett[4] pioneered an engine that could operate successfully on pure vegetable oils. Fuls and Hugo[5] and Bacon, Brear, Moncrieff and Walker[6] produced relatively recent papers on the transformation of triglycerides into methyl or ethyl-esters. These technical papers outlined the results of tests using RME in diesel engines. Mittlebach Wörgetter Pernkopf and Junek[7] examined the potential raw material supply in

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[2] Harwood, H.J 1984. "Oleochemicals as a Fuel : Mechanical and Economic Feasibility", Journal of American Oil Scientist's Society, Vol. 61, February 1984.
[3] Ohlson, R.1992 "Modern processing of rapeseed", Journal of American Oil Scientists Society, Vol.69, No. 3 March 1992
[4] Elsebett K., Elsebett L., Elsebett G.1986 "The duothermic combustion for direct injection diesel engines" SAE Technical Papers Series 860310,1986
[5] Fuls, J. and Hugo F.J.C.1981 "On-farm preparation of sunflower oils esters for fuel". Third International Conference on Energy Use Management. Berlin (West) October 26-30 Pergamon Press, Oxford,1981.
[6] Bacon, D.M., Brear, F., Moncrieff I.D., and Walker K.L., 1981 " The use of vegetable oils in straight and modified form as diesel engine fuels" Third International Conference on Energy Use Management. Berlin (West) October 26-30 Pergamon Press Oxford, 1981.
[7] Mittlebach M., Worgetter, M. Pernkopf, Junek H., 1993 "Diesel fuel derived from vegetable oils : preparation and use of rape oil methyl esters " Energy in Agriculture, 1993.

Austria, as well as economic aspects and carried out experiments into the feasibility of RME as a fuel. This paper describes the preparation of RME and the properties of RME for use as a fuel.

The technical assessment section of the thesis is also concerned with establishing an energy balance for RME. Culshaw and Butler[8] (see s.1.2.6) established that RME has a positive energy balance. These results were corroborated by the energy balance surveys carried out by Kőrbitz and Walker[9] and in both CEC studies on the future for biomass[10] and the study on biofuels[11].

1.1.2 RME and Europe

The CEC (Altener)[12] study is primarily concerned with the essential elements of Community policy for renewable energy sources. Specifically this study quantifies objectives for renewable energies, it also assesses the potential of renewable resources in the Community. It covers, hydro-power, wind power, biomass (ethanol, methanol, esters and vegetable oils, etc.), solar power, heliothermal (high temperature active solar power) and geothermal energy. This report also outlines the long term prospects for renewables as doubling their share of the Community's primary energy requirements to 8 per cent by the year 2005. The CEC published a further report in 1992 on biomass and its future in the EU. This study was produced by an Interservices Working Group which began work in 1991 with the objective of examining a number of synergies between developing biomass energy supply and industry for the future. This

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[8] Culshaw F., Butler C.1992" A review of the potential of biodiesel as a transport fuel" Energy Technology Support Unit, Harwell, Oxfordshire, September 1992.
[9] Kőrbitz, W., Walker K.C. 1994" Rationale and economics of a British Biodiesel Industry " British Association for Biofuels and Oils, The Home Grown Cereals Authority, April 1994.
[10] CEC 1992 " Biomass a New Future" Brussels, June 1992.
[11] CEC 1994 "Biofuels - application of biologically derived products as fuels or additives in combustion engines" CEC 1994, DG XII, Science, Research an Development
[12] CEC 1992 "Specific actions for greater penetration for renewable energy sources - Altener", Brussels, 29th June 1992.

research is carried out in the context of the Reform of the CAP, its link with the emerging environmental imperatives and the perspectives of biomass as an alternative renewable fuel supply in the long run. Essentially, this study details the 'economic fundamentals' of producing biomass under the following headings, ethanol from wheat, ethanol from sugar beet, Colza/diester, Colza for diesel engines, short rotation forestry for domestic heating, and short rotation forestry for electricity. The study also deals with the environmental benefits of using biomass, and the energy balance associated with biomass energies.

1.1.3 The Environment and the Future for RME

A CEC[13] report outlines European perspectives in terms of future energy supplies and details various scenarios for the future supply and price of fossil oil. This study has used the 20 year period from 1990 to 2010 as a basis for its analysis. The study outlines four possible scenarios in the coming years and examines the likely effects of these on the market for fossil fuels. Walsh[14] establishes the various pollutants emitted into the atmosphere resulting from the combustion of fossil energy. Their effect on humans and the overall environmental balance is outlined. He establishes that any gains achieved so far in pollution control are reduced by the emissions resulting from the growth in the number of vehicles. He asserts that improving transport and vehicle fuel efficiency coupled with developing non-fossil energy sources specific to transportation requirements could have significant energy and environmental consequences. The report published by the CEC on Biofuels[15] (see s.1.2.6), in relation to the environment, states that a general reduction in CO_2 and other greenhouse gases can be expected as a result of the combustion of biofuels, both for the spark ignition (petrol) and diesel engines. This report also established that the local environmental

[13] CEC 1990 "Energy for a new Century - The European perspective" CEC 1990
[14] Walsh W.P. 1993,"Motor Vehicle Trends and their implications for global warming", Transport Policy and Global Warming, ECMT, 1993
[15] CEC 1994 "Biofuels - application of biologically derived products as fuels or additives in combustion engines" CEC 1994,DG XII, Science, Research and Development.

advantage to be gained from using biofuels may be off-set by the increased use of fertilisers and pesticides if intensive production is to be undertaken. The report states that the economics of fossil fuels versus biofuels should take into account demands from the EC environmental and agricultural policies.

The Department of the Environment[16] report details Ireland's commitment to the CO2 abatement policy to reduce emission to 1990 level by the year 2000. It suggests strategies to accomplish this through measures in the transport and energy sector, and in relation to waste treatment and afforestation and highlights areas of further research.

The OECD[17] report on the environment and taxation highlights the increase in the use of fiscal instruments to abate pollution. It comments on the experience in OECD countries and sets out a set of simple rules and criteria in an attempt to ease the implementation of environmental taxation. It accepts as fact the future introduction of taxes to abate environmental pollution.

Wörgetter[18]established a comprehensive environmental balance in relation to emissions from the combustion of RME in comparison with diesel. Some of these results were in contrast to the findings reported in the 1994 CEC study on biofuels[19]. Körbitz[20] also carried out a survey of emission results in relation to the combustion of RME and their likely effect on the environmental balance.

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[16] Department of the Environment 1993 "Ireland Climate Change - CO2 Abatement Strategy", Department of the Environment 1993.

[17] OECD 1993 "Taxation and the Environment Complementary Policies", OECD 1993.

[18] Wörgetter, J.1991,"Erprobung von Biodiesel, Biodraftstoffe für Dieselmotoren" Symposium Nr. 13982/68.236.,1991

[19] CEC 1994"Biofuels - application of biologically derived products as fuels or additives in combustion engines" CEC 1994,DG XII, Science, Research and Development.

[20] Körbitz W.1993," Technical, Energy and Environmental Properties of BioDiesel", Körbitz Consulting, Vienna, Austria.(Unpublished) 1993

1.1.4 The CAP and Set-Aside

The CEC[21] paper analyses the imbalances that exist in the Community in relation to supply and demand for certain agricultural produce. It acknowledges that the situation arose out of open-ended guarantees isolating the European agricultural sector from market signals. This report advocates the diversification of agricultural crops to provide for new uses. Beard[22] carried out a report to analyse the nature of the cereals policy pre CAP reform. He highlights the amount of surplus food production and the reasoning behind its physical manifestation. This report outlines the nature of the policy mechanisms used in the CAP and examines the consequences of changing them in financial terms. Areas of tension between social and economic priorities are indicated in relation to the successful future operation of the CAP. The NESC[23] report analyses the impact of the CAP reform on Irish agriculture. Sheehy looks at the factors affecting Irish agriculture in the years before the reform of the CAP at sectoral and farm level. He considers the prospective economic environment that will condition the reforms and provides an analysis of the reforms in terms of Irish agriculture. Further on in his paper he examines external changes to the agricultural environment in terms of GATT and Eastern Europe.

The CEC[24] paper analyses the overall agricultural situation in the Community leading up to the reforms, and establishes that the CAP is confronted with a serious crisis. The study then elaborates a number of objectives for the future of Community agriculture.

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[21] CEC 1985 “A future for Community Agriculture” COM 1985, Brussels, CEC 1985

[22] Beard, N.F.” Against the grain? The EC Cereals Policy”, Centre for Agricultural Strategy, Knight Frank Rutley,

[23] NESC 1992 “The impact of reform of the Common Agricultural Policy”, National Economic and Social Research Council 1992.

[24] CEC 1991 “Development and Future of the CAP - Reflections Paper” CEC 1991

1.1.5 Macro-economics and RME

Fere Consultants[25], carried out a study in conjunction with IFP (Institut Français du Pétrole) on the macro-economic effect of RME. The study was originally completed in 1989, and updated in 1991. It computed the economic effects resulting from an RME industry on 'set-aside' land compared to leaving the land fallow. This was evaluated in using figures from the Robbe RME production facility, in Compiégne, on a 10,000t and 20,000t basis. The net benefits were calculated in terms of distributed added value, saved imports, jobs created and tax revenues and social welfare contributions.

1.1.6 Overview of major reports, studies and conferences

A study carried out by Culshaw and Butler[26] investigates the potential of RME as a transport fuel for the UK situation. Essentially, it assess the economics of production, conversion and combustion of RME in UK terms. Environmental issues are assessed and required areas of research highlighted. This study established that the cost of post-refinery diesel would have to increase by a factor of 2.4 before RME (without subsidy) could become commercially competitive with fossil diesel. This report also recognised that the value of the by-products can greatly effect the economics of the end product, and suggested more research into this area. and asserted that there would need to be a "compelling environmental and socio-economic benefit from conversion of oilseed rape to biodiesel to warrant a subsidy". The study then asserts, that given the fact that there is a substantial environmental and socio-economic benefit, the optimum potential market for RME should be inland waterways and urban transport, where it could be of most benefit.

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[25] FERE Consultants 1992 " Economic and Fiscal Effects of the Rapeseed Methylic Esters Incorporation into diesel", Fere Consultants, Réseau European D'Expertise et De Conseil, Paris 1992.

[26] Culshaw F., Butler C.1992" A review of the potential of biodiesel as a transport fuel" Energy Technology Support Unit, Harwell, Oxfordshire, September 1992.

The most comprehensive study that has been published to date was carried out in 1994, by the EC Directorate-General XII (Science, Research and Development).[27] This study provides a meaningful overview of current technologies, market situations and current EU legislation in relation to biofuels production and use. The first section of the study encompasses the technical application of existing biofuels. These include; plant oils, methyl-esters, ethanol, methanol and gaseous biofuels (biogas and producer gas).

The study then looks at the potential benefits of developing a biofuel industry on the agricultural sector and the environment. This study devotes a section to comparing the environmental effects of fossil fuels and biofuels, throughout all stages of production. Economic aspects and issues relating to a reduction in excise duty for biofuels are also analysed.

A study was conducted in 1992 by R.H. Levy[28], known as the 'Levy Report'. The aims of this report were to establish the possibilities of developing a biofuels industry in France. This report studied both bioethanol and biodiesel, and found that support should be given to RME (as it is technically successful, few negative consequences at macro-economic level, requires less subsidies compared to ethanol). This study advocates that the production of RME should be authorised but without limits other than those required by national policies. It also advises that a programme of research and development should be launched.

The Scottish Agricultural College in association with the Austrian Consultant Werner Körbitz, produced a report in 1994 for the British Association for Biofuels and Oils (BABFO)[29]. This report is a highly focused assessment of the potential for an RME industry specifically for

[27] CEC 1994"Biofuels - application of biologically derived products as fuels or additives in combustion engines" CEC 1994,DG XII, Science, Research and Development.

[28] Levy, R.1992 " Biofuels - report to the Prime Minister of France" February 1992.

[29] Körbitz, W., Walker K.C. 1994" Rationale and economics of a British Biodiesel Industry " British Association for Biofuels and Oils, The Home Grown Cereals Authority, April 1994.

the UK. It suggests that the potential size of a British biodiesel industry would be in the region of 100,000t for 1994/5. The report indicates that a biofuel industry of this size would create a minimum of 500 jobs to a maximum of 2,000 jobs. This study advocates a reduction in excise duty to facilitate the development of this industry and suggests that the lost revenue would be more than offset by the environmental value of the reduced emission of greenhouse gases. The study also states that in the long term, a British biodiesel industry would not be dependent on set-aside payments.

The first European Forum on motor biofuels was held in France in May 1994. This conference concentrated specifically on the development of a biofuels industry for Europe. It considered the future of biofuel production in terms of the CAP and GATT. It examined present and planned future production throughout Europe in this context. Environmental and energy balances were outlined. In effect the conference dealt with all dimensions of the potential future for a European biofuels industry. As this industry is relatively young (not in terms of technology, but in relation to market aspects, fiscal treatment, international trade and environmental effects) the outstanding feature of this forum were that there were, in general, contradictions over the major issues at the heart of the forum.

From a technical view point the bone of contention, raised in general by oil company representatives, in relation to RME production were in relation to the long term effects of using RME in diesel engines. In an environmental context, contradictions were also apparent, however, the overriding view is that environmental advantages are to be gained from combusting biofuels compared to fossil fuels. From a fiscal view point, the issue over the level of taxation was perceived to be excessive while others maintained that it is less than the reduction in excise to promote lead free petrol. Advocates also suggest that this subsidy has indirect benefits relating to the creation and maintenance of agricultural and industrial activity and that indirectly the Revenue would not suffer.

CHAPTER II

DESCRIPTION AND DEVELOPMENT OF RME AS A FUEL AND PROCESS TECHNOLOGY

TABLE OF CONTENTS

2.0 INTRODUCTION

The concept of using vegetable oils in conventional diesel engines is not new. Since the turn of the century research has been carried out to establish its technical feasibility. RME (rape-methyl-ester) an automotive fuel, produced from oilseed rape, with similar properties to diesel, is now being produced with technical success.

The aim of this chapter is to outline the chemical transformation of rapeseed oil to RME; a fuel that is commercially used in most European countries and North America (See chapter III). The technical success of RME as a motor biofuel can be illustrated by the development of various standards throughout Europe. This chapter will also demonstrate the confidence of engine manufacturers in its use as a feasible fuel for diesel engines.

The renewed interest in the latter half of this century, in utilising vegetable oils as automotive fuels was primarily as a result of the oil crisis of the 1970s. However, at that time its production economics did not appear favourable, and commercial development did not occur until the 1990s. The oil crisis emphasised the dependence of the industrialised world on a potentially unstable source of fuels (See chapter IV, s.4.1.0). The need for diversification of energy sources became apparent. One possible solution was the development of renewable, sustainable energy resources from agricultural produce.

The emergence of surplus food production in the EU has prompted the introduction of 'set-aside' land as a policy control mechanism. In 1994, 5.86 million ha. (hectares) of arable land have been withdrawn from production in the EU.[30] Under the present set-aside regulations, two options arise for farmers;

- to leave surplus set-aside land fallow or
- to dedicate this land to the production of raw materials for energy or industrial uses.(See Chapter V, s.5.5.1)

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30 Muldowney,J." CAP Reform and Set-aside Issues", Proceedings from the Conference held in Galway, November 1994 - Renewable Energy and Economic Development.

The second option appears more favourable from the viewpoint of both the farmers and industrialists as it maintains output. The cultivation of 'non-food uses' on set-aside land also has the potential of being a key factor in rural development.

There are two routes available at present which utilise agricultural crops for the production of liquid motor biofuels:

- **ethanol** production from agricultural raw materials, where cereals/ sugar beet/ potatoes are used to produce a fuel for the spark ignition engine (the petrol engine).
- **RME** production, where vegetable oils are used in the production of a fuel for diesel engines.

This chapter is concerned with the technical feasibility of rapeseed oil, modified to produce rape-methyl-ester for direct use in conventional diesel engines without modification. (For a brief overview of Bioethanol production, see Appendix A).

2.1.0 THE USE AND DEVELOPMENT OF VEGETABLE OILS AS FUELS

Rudolf Diesel, the inventor of the compression ignition engine, recognised at the turn of the century that vegetable based fuels would work in his engines. He demonstrated his patented invention, the compression ignition engine, fuelled with peanut oil,[31] at the Paris Exposition in 1900. He also wrote in 1912, "The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in the course of time as important as petroleum and the coal tar products of the present time"[32]

Until the 1940s the diesel engine was developed for both diesel and vegetable oil fuels. However, with the abundance of fossil fuels from the 1940s onwards the interest in vegetable oils faded away. The existence

[31] The main vegetable oils include; soybean, cottonseed, sunflower, rapeseed, groundnut, Copra, Palm kernel, Palm, Sesame, Corn, Olive, Linseed Castor.

[32] CEC 1994, "Biofuels : application of biologically derived products as fuels or additives in combustion engines", CEC DG XII, Science, Research and Development.

of three significant factors in today's economic climate make R. Diesel's predictions more plausible in the 1990s than in 1912. These include;

1) in the medium to long term, oil price rises are inevitable due to the finite nature of resources and for a variety of other reasons. These include further increases in extraction and exploration costs since new oil reserves need to be found and exploited, (See chapter VI, s.4.5.1)
2) the EU's interest in diversifying agricultural production to include energy crops and the existence of a proposal for a directive (Scrivener Directive), to reduce excise duty on motor biofuels (See Chapter III, s.3.1.1),
3) environmental concerns, which could in the near future translate into financial burdens.

This study is not concerned with analysing the principles of the modern diesel engine. However, a brief description of the two types of compression ignition engines (diesel engines) on the market to day is useful. These include:

- **direct-injection engine** : fuel is injected directly into the combustion chamber;
- **indirect-injection engine** : fuel is injected and combustion begins in the pre-chamber. Briefly, the purpose of a divided chamber is to speed up the combustion process in order to increase output by increased speed.

2.2.0 VEGETABLE OILS AS A FUEL SOURCE : TECHNICAL FEASIBILITY

There are three fundamental routes available for using vegetable oils as fuels[33]. These include;

1) the use of 100 per cent pure vegetable oil in existing diesel engines,
2) modification or development of an engine that can burn unprocessed rape-seed oil,
3) production of a fuel that can be burned in any diesel engine.

2.2.1 Pure vegetable oils

The technical feasibility of using pure vegetable oil as a diesel fuel in an unmodified engine, is well established. Known problems, arising from the use of using pure vegetable oils in diesel engines are summarised in Table 2.2.

The main problem observed, when using pure vegetable oils in direct injection diesel engines are coke depositions, at the injector nozzles and at the combustion chambers, pistons, valves etc. This can be directly attributed to the increased viscosity and carbon content found in vegetable oils. Pure vegetable oils are approximately 10 times as viscous as diesel. This can be seen in Table 2.1 below.

Table 2.1 : Specific fuel properties : Rapeseed Oil, Sunflower Oil and Diesel Compared

Fuel property	diesel	rape oil	Sunflower oil
specific gravity (kg/dm^3)	0.835	0.916	0.924
viscosity (cSt)			
at 20°C	5.1	77.8	65.8
at 50°C	2.6	25.7	34.9
Carbon residue %	0.15	0.25	0.42
Sulphur %	0.29	0.0001	0.01

Source : CEC, 1994" Biofuels - Application of biologically derived fuels or additives in combustion engines", Science Research and Development, 1994

[33] This study is not concerned with the technical feasibility of blends of pure vegetable oil with diesel, extensive studies have been carried out on the subject but the technical feasibility as yet is not satisfactory, see McDonnell, K.P. "Rapeseed Oil as a Potential Alternative Fuel for Diesel Engines", M.Sc.Eng.,UCD,1992.

Depending on the type of vegetable oil and condition of the engine, power loss and engine deterioration result.

Table 2.2 : Problems and probable causes associated with using pure vegetable oils in diesel engines

Problem	**Probable Cause**
Short-term	
1. Cold weather starting.	High viscosity, low cetane number and low flash point of vegetable oils.
2. Plugging and gumming of filters, lines, and injectors.	Natural gums (phosphatides) in vegetable oil. Other ash.
3. Engine knocking.	Very low cetane of some oils. Improper injection timing.
Long-term	
4. Coking of injector nozzles	High viscosity of vegetable oil, incomplete combustion of fuel. Poor combustion at part load with vegetable oils.
5. Carbon deposits on piston and head of engine.	Same as above (no. 4).
6. Excessive engine wear.	Same as no. 4. Possibly free fatty acids in vegetable oil. Dilution of engine lubricating oil due to blow-by of vegetable oil.
7. Failure of engine lubricating oil due to polymerisation.	Collection of polyunsaturated vegetable oil blow-by in crankcase to the point where polymerisation occurs.

Source : Harwood, HJ.1984 "Oleochemicals as a Fuel : Mechanical and Economic Feasibility", Journal of American Oil Scientist's Society, Vol. 61. Feb. 1984.

The table above summarises the short and long-term problems and causes in using vegetable oil as a fuel in existing diesel engines. All of the above mentioned problems associated with the use of pure vegetable oils in diesel engines lead to the conclusion that vegetable oils can only be used when the oil is transformed, in modern conventional diesel engines.

There are two methods available to overcome the problems listed above, these are

- modification of the engine
  and
- modification of the oil.

2.2.2 Modification of engine for pure vegetable oil combustion

Vegetable oil use in diesel engines is possible, when degummed, and only in indirect injection (Deutz engine) and swirl chamber (Elsebett engine) systems. Mixtures of diesel and plant oils are possible in all engine types. However, long term use will eventually lead to deposits in the engine.

One solution to overcome the coking of the injector nozzles, carbon deposits etc. is to modify the engine. One existing engine that can use pure vegetable oil successfully was pioneered by Elsbett[34]. This engine is a 1.4 litre turbo-charged swirl chamber engine suitable for cars or light transport. Production is only on a small scale at present.

A franchise is currently held by an Irish company, to produce Elsbett engine driven vehicles and it is currently attempting to start production of this engine.[35] The present price range for the engine only is circa. IR£6,000[36] which is about three times that of an existing diesel engine. This divergence in cost is largely explained by the economies of scale of production. While it is technically possible to develop engines to be fuelled with 100 per cent vegetable oils, market penetration for such engines is proving extremely difficult given current costs.

[34] Elsebett K, Elsebett L, Elsebett G.,Behrens,1986, “The duothermic combustion for direct injection diesel engines”. SAE, Technical Paper Series 860310,1986

[35] Elsebett Environmental Engines 1991, Prospectus. Elsebett Environmental Engines (Ireland) Ltd., Ballyroan, Co. Laois.

[36] Rice, B "Rape-oil and tallow as diesel extenders or replacements for automotive use" Teagasc, Oak Park Research Centre, Unpublished.

"Deutz"[37] has developed an engine using indirect injection systems, operating on the principle of turbulence. This engine system was found to be more tolerant of a variation in fuel properties.

2.2.3 RME : Modified Vegetable Oil

The alternative to engine modification is oil modification which can be achieved through a transesterification process. However, before this process can take place, vegetable oil has to be produced from the oilseeds.

2.2.3.1 Production of rapeseed oil

Rape-methyl-ester is the term given to the esterified version of rapeseed oil (which is also referred to as Colza oil). Before this process can take place the raw oil has to be 'crushed' from oilseeds. Other vegetable oils are also suitable for producing biodiesel, however, oilseed rape (*Brassica Napus L.*) is the most important of the Brassica plants grown for oil. Due to its ability to germinate and grow at low temperatures, rapeseed is one of the few edible oil seed crops that can be cultivated in northerly latitudes. Its production is thus well suited to Europe.

Up to 1980, despite Ireland's entry into the then EEC, there was virtually no oilseed rape grown in the country. Traditionally, oilseed rape was viewed as an arable break crop (i.e. it is a soil improver) with a number of advantages to the cereal grower as it provides a good entry for winter cereals. Most oilseed rape varieties grown in Ireland and the EU are known as '00' or 'double low'. This variety has the characteristic that oil produced from it is low in glucosinolates and erucic acid[38]. There is a small market for high erucic acid rapeseed (HEAR) for the production of oil for industrial use.

Prior to the CAP reform, winter varieties of rape were more popular, mainly because they were higher yielding than the spring variety. Aid[39] is

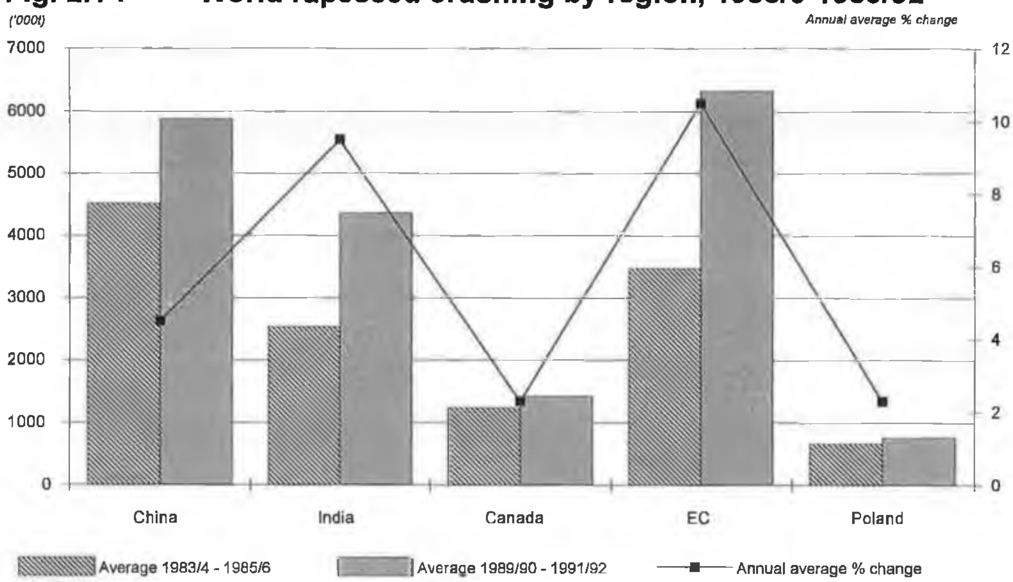
[37] CEC, 1994," Biofuels - application of biologically derived products as fuels or additives in combustion engines" EC, DGXII, p.3
[38] Thereby satisfying the current legislation on edible oil standards, as both are considered to be anti-nutritional to humans and animals.
[39] Freeriks, R, 1993 "EC crushing industry's decade of growth", INFORM, Vol.4, No.10, Oct. 1993

now tied to area rather than production, and gross margins for farmers who grow the lower yielding spring oil seed rape are higher. Although the spring crop is lower yielding, it is also cheaper to cultivate as it requires fewer inputs.

The regulations governing the cultivation of oilseed rape for 'non-food use' on 'set-aside' land state that in order to be eligible for the compensatory payments, a contract between the producer and the first processor must be submitted.[40] The oilseeds are then sold to the crushers at world market prices, 'crushing' takes place and raw vegetable oil is produced and a high protein animal meal is produced as a by-product.

The figure below illustrates average 'crushings' by the world's major producers. The EU has maintained a stable 13 per cent of global crush. The then EC underwent by far the most radical increase in crushing over the period, increasing on average 10.5 per cent per annum.

Fig. 2.1 : World rapeseed crushing by region, 1983/6-1989/92



Source : Howard, B., "Oils and Oilseeds to 1996 : The new patterns of supply and demand", The Economist Intelligence Unit, Special Report No. M703. 1996

[40] Department of Agriculture, Food and Forestry, 1993"EC Arable Area Payments -1993/4" Department of Agriculture, Food and Forestry, Sept. 1993

There are two different methods available for crushing the seeds to obtain raw vegetable oil. In larger oil processing plants these are usually used in combination. These are;

- **screw press expellers** : This relates to the mechanical method of pressing the oil from the seed, after the seeds have been cleaned to take out low-density impurities. The first thermic process is known as 'pre-conditioning'[41], and heats the rapeseed to about 65°C. The seeds are then flaked to rupture the oil cells, to enhance coalescence of oil droplets by increasing fluidity, and to inactivate enzymes. The flakes are then cooked at 95°C to stop adverse enzymatic reactions, agglomerate protein, decrease the plant oil viscosity, and control appropriate moisture level. The flaked and cooked seed is then subjected to continuously working screw-press expeller and the oil and cake are separated,
- **solvent extraction** : Flaked cooled seed can also be directly solvent extracted. The oil is removed from the seed almost 100 per cent by the action of a solvent (hexane). Solvent extraction is much more energy intensive than screw - pressing.

The rape-cake which results has to be dried down to a moisture content of about 4 per cent and cooled. For a complete commercial product specification, a product profile comparison with soy meals is set out in Appendix B. The pressed oil still has to undergo a mechanical cleaning process. The cleaned oil is then taken through a degumming process in which lecithin gums and phosphatides are removed.

2.2.3.2. Transesterfication

The conversion of an organic acid ester into another ester of that same acid is defined as 'transesterification', the other compound may be an acid, alcohol or another ester[42]. The transesterification reaction has been studied comprehensively. In the 1940s more than a dozen US patents were granted to Dupont, Colgate, and others dealing with the conversion

[41] Ohlson, R., "Modern Processing of Rapeseed", Journal of American Oil Scientists Society, Vol. 69, No. 3, March 1992.
[42] McGraw-Hill Encyclopaedia of Science and Technology, Vol.18, 6th Ed. McGraw-Hill Book Company.

of vegetable oils to esters i.e. transesterification. More recent successful research has been carried out in South Africa [43] and elsewhere [44].

Rapeseed oil consists of triglycerides, with three long hydro-carbon chains bound together by a modified glycerine molecule. The process of transforming rape seed oil to RME is a relatively simple process, it operates by reacting the pure filtered oil with methanol (110kg methanol to 1 t oil) in the presence of a catalyst (generally sodium or potassium hydroxide) at about 50°C producing an ester and glycerine as a by-product.[45] See Fig.2.2 for a diagrammatic representation of the process.

The transesterification process is then followed by a separation of the heavier glycerine (density 1.26) from the lighter RME (density 0.88). Both products are then cleaned to remove the excess methanol which is recycled back into the process and the raw glycerine can be used directly for spray-on feed meal or for utilising the caloric value by burning or can be refined to a 80/99.5 per cent pure pharmaceutical grade glycerine in several process steps, if this is the commercially justifiable option.

The end result is that a fuel with similar properties to diesel is produced with proven successful technical feasibility. Table 2.3 outlines the fuel properties of RME and Diesel.

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[43] Fuls, J. and Hugo, F.J.C. 1981. "On-farm preparation of sunflower oils esters for fuel." Third International Conference On Energy Use Management. Berlin (West). October 26-30 Pergamon Press, Oxford, 1981

[44] Bacon, D.M., F. Brear, I.D. Moncrieff and K.L. Walker. 1981. "The use of vegetable oils in straight and modified form as diesel engine fuels". Third International Conference On Energy Use Management. Berlin (West) October 26-30. Pergamon Press Oxford,1981

[45] Mittlebach M., Wörgetter M., Pernkopf J. and Junek H. 1983 : "Diesel fuel derived from vegetable oils : preparation and use of rape oil methyl ester ", Energy in Agriculture, 1983

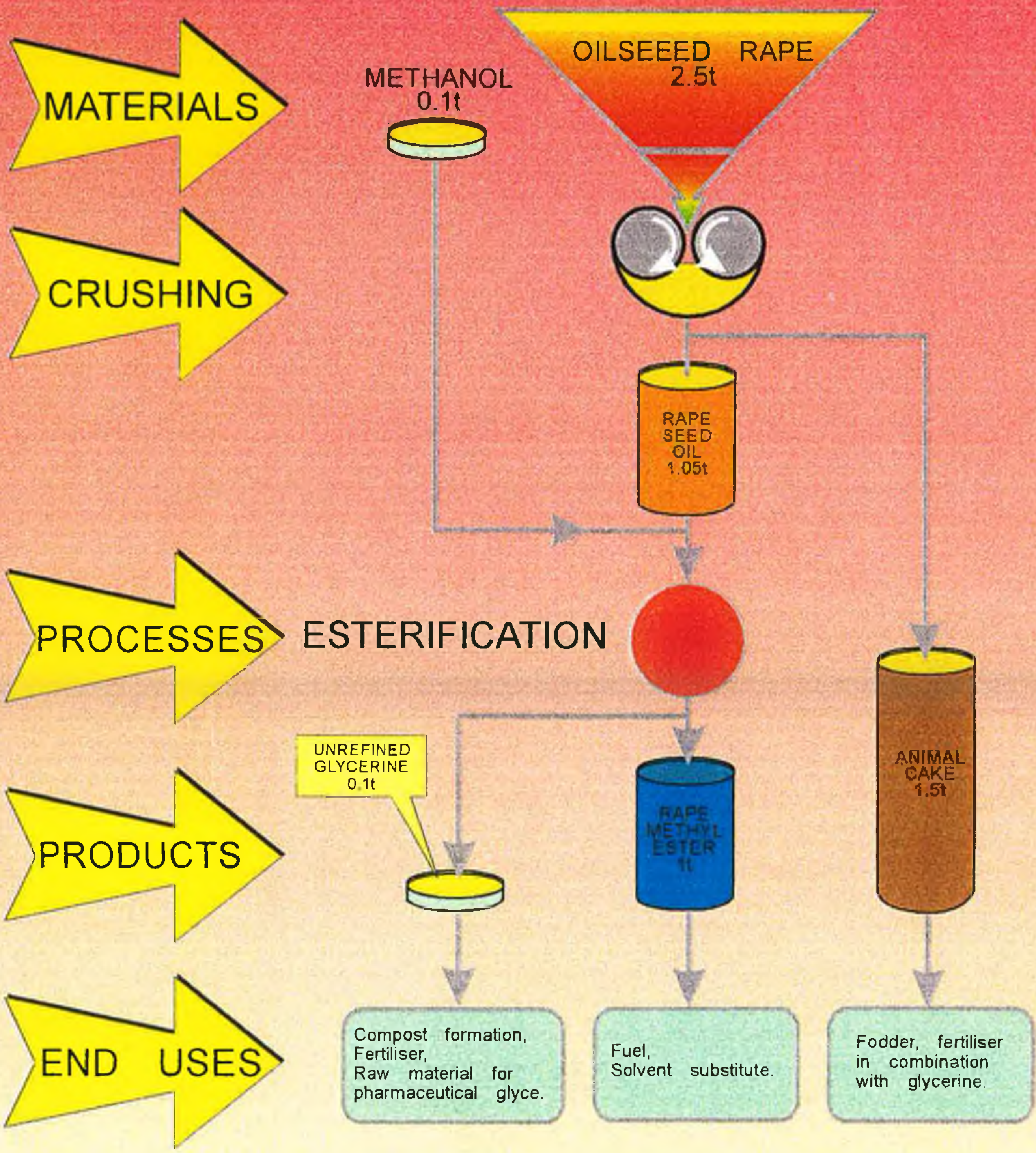

Fig. 2.2 RME PRODUCTION PROCESS

Table : 2.3 Physical Chemical Properties of Rape-Methyl-Ester and Diesel

Property	Unit	Rapeseed-ME	Diesel
Specific Gravity	kg/dm3	0.882	0.835
Caloric Value	MJ/kg	37.2	42.9
	MJ/dm3	32.9	35.6
Viscosity	cSt		
at 20°C		7.5	5.1
at 50°C		3.8	2.6
Cetane number		52 - 59.7	>45
CFPP (Summer)	°C	-8	5
Number of double-bonds		1.33	-
Iodine number		114	-
C/H/O/S - content	%		
C		77.20	88.60
H		12.00	13.40
O		10.80	0.00
S		0.002	0.29

Source : Körbitz Consulting June 1993, Agricultural Engineering Research, BLT Wieselburg (1991), modified.

The production and commercial use of esterified oil is already established in many European countries. (See chapter III,s.3.2.2)

Product specifications have been developed to win the confidence of engine producers and end-users, in Austria (Önorm Standard), and a proposal for a European standard has been established, see Appendix C for a brief survey of up to date standards and specifications and engine manufacturer' clearances.

2.3.0 ENERGY BALANCE : RME

Energy balance analysis determines[46] whether the sum of the energy required to produce the energy (including all inputs; ploughing, harvesting, transportation, plus the indirect energy used to produce nitrates, pesticides and the seeds themselves) is greater than the energy output from the fuel, and the by-products. To assist the process of rational energy policy formulation it is necessary to establish the energy balance for a comprehensive technical analysis of a fuel. For RME to be a viable alternative fuel, it is essential that the energy balance is positive.

"Biomass- A New Future"[47] detailed the results of two energy balance studies. The first study was completed by ERL (Environmental Research Ltd.) in 1990, and it asserted that the energy balance of the well known biomass alternatives (bioethanol, RME etc.) tended to be positive, provided the direct and indirect values of the by-products are evaluated. The second extensive body of research was submitted to France's International Biomass Committee in 1991. This study concluded that even ignoring the by-products, the energy balance results were always positive.

In a study reported in 1989[48] Dunne and Kileen compared different feedstocks for energy production in Ireland. Estimates were made of the energy inputs consumed and produced, both in the form of the main crop and the by-product. Out of the 15 different feedstocks examined, oilseed rape (end product RME) was found to be the one of the least efficient with an overall energy ratio of 5.4. Whereas spring barley (end product ethanol) was found to be the most energy efficient with an overall energy ratio of 13.1.

A notable UK study carried out by ETSU (Energy Technology Support Unit),[49] evaluated an energy balance for RME under UK conditions. The results include the following;

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[46],CEC "Biofuels: An application of biologically derives products as fuels or additives in combustion engines," 1994, and others.

[47] CEC" Biomass A New Future", Brussels, June,1992

[48] Dunne, W. Kileen L., 1989 "Impact of renewable derived Fuels on Energy and Agricultural Sectors" CEC 1989.

[49] Culshaw, F.A. 1992"The Potential of 'Biodiesel' from oilseed rape - a UK perspective", Renewable Energy Sources Department, ETSU, Harwell 1992.

Table 2.4 : **RME Energy Balance Results : ETSU Study**

Product	Winter oilseed rape	Spring oilseed rape
RME	1.35	1.35
RME plus animal meal	2.55	2.55
RME plus animal meal plus glycerine	2.62	2.61

The data used for the agricultural inputs were provided by the MAFF (Minister of Agricultural Food and Fisheries), and Italian data was used for processing inputs[50]. The results of this study are consistent with those of the French study mentioned earlier, establishing that RME production has a positive energy balance, 1.35, even without by-products. The ETSU study also shows, that with the by-products included (animal meal and glycerine) the energy balance is even more favourable.

The extensive CEC study, carried out by the Agro-Industrial Research Division of DG XII[51] confirmed that the overall energy balance for vegetable oils and their methyl esters is positive ranging from 2.1 - 3.1. This coincides with the findings in the ETSU study ".. energy balances for Austria, Italy, France and Switzerland range from ....2 - 3 with by-products taken into account".

A report produced by BABFO (British Association for Biofuels and Oils)[52] cites results from a Scottish study[53] which compares results from a French Study.

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[50] D. Koch, Novamont, Milan, Italy.
[51] CEC 1994 " Biofuels : application of biologically derives products as fuels or additives in combustion engines " 1994.
[52] Körbitz, W., Walker, K.C. " Rationale and Economics of a British Biodiesel Industry", BABFO, The Home Grown Cereals Authority, April 1994.
[53] Batchelor, S.E., Booth E.J., Walker K.C." Energy analysis of RME production from winter oilseed rape" Scottish Agricultural College, 1994.

Table 2.5: RME Energy Balance Results : BABFO Study

	Scottish Agricultural College MJ/h		Soufflet MJ/h	
Inputs				
Crop production	19578		15464	
RME production	15067		15429	
Total		34645		30893
Outputs				
RME	50019			
Meal	35809		35908	
Glycerine	2470		2278	
Total		88298		89910
Input / Output		**2.5**		**2.9**

The above data is based on winter oilseed rape.

There are a number of conclusions to be drawn from the above mentioned studies. Firstly, no studies reveal a negative energy balance when the by-products are included, results will vary depending on soil types, husbandry practice, yield location and figures can only be averages over a large acreage. These studies also show that, the energy balance of RME production will improve as further reductions in nitrogen use (as it is the single largest energy input) arise. European studies have shown more positive results than the UK equivalents, as less nitrogen is used in crop production.

2.4.0 CONCLUSION

The degree of interest in using vegetable oils and their methyl ester derivatives as fuels was constrained by the relatively abundant supply of fossil fuels up until the latter half of the century. The more recent successful commercialisation of biomass alternatives to fossil fuels is as a result of a combination of three factors; the unstable and finite nature of fossil fuels, the environmental concerns of fossil fuel use and the introduction of a policy mechanism in the European CAP (Common Agricultural Policy) to diversify crop production to include 'non-food use'.

RME is a technically feasible alternative to diesel in unmodified conventional diesel engines. Numerous energy balance studies have been carried out to estimate its viability in energy utilisation terms. All studies conclude that the energy balance is positive when by-product credits are included. Confidence in this product is evidenced by the existence of various standards for fuel specifications and by the preparation of an EU standard. Confidence from the commercial sector is corroborated by the approvals of engine manufacturers.

CHAPTER III

RME PRODUCTION IN EUROPE AND AMERICA : POLICY ANALYSIS AND COMMERCIAL PRODUCTION

TABLE OF CONTENTS

3.0 INTRODUCTION

Support for RME production is currently gaining momentum throughout the EU. Several RME plants have been established and put into operation, or are presently at project phase, in most European countries. However limitations to production do exist under the GATT agreement, and future production could be limited. In general, support throughout the EU is given for programmes of biofuel use in public transport in urban areas (i.e. high risk pollution areas), participation in site finding and construction of production units. At present, there is no uniform fiscal legislation in operation in Europe concerning the tax treatment of biofuels, a decision of this nature requires all 15 Member States to be in total agreement.

Until the 1970s, the US federal tax system favoured oil and gas. In the years which followed, this preferential treatment changed. In 1978, the Energy Tax Act paved the way for biofuels to enter the American energy arena. Tenacious support is now evident in the US assisted by the EPA (Environmental Protection Agency), by regulating emission levels (Clean Air Act and Clean City Programmes) and the Department of Energy (National renewable Energy Laboratory).

3.1.0 EU POLICY FRAMEWORK FOR BIOFUELS

The first European Community programme for the development of renewable energy industries dates as far back as the first oil crisis in the early 1970s. Interest in continuing to pursue these policies is heightened by the increasing awareness of global warming, which has manifested itself in a Community policy for stabilising CO_2 levels.

Although the Community has expressed energy policy objectives previously[54] renewable energy objectives were never quantified. Since the inception of the ALTENER Programme[55], the Council has adopted the following specific objectives for the year 2005;

[54] CEC, Council Resolutions for 1985, 1990 and 1995.

[55] The Altener programme, approved by the Council in September 1993, for the duration of 5 years, is to promote renewable energies by means of instruments other than technological promotion.

- an increase in renewable energy contribution from 4 per cent in 1991 to 8 per cent in 2005.
- triple electricity generating projects using renewable energies.
- obtain a 5 per cent share for biofuels in the motor vehicle fuel market. This corresponds with 11mtoe[56] of all biofuel types. It has been estimated that 7 million ha. (hectares) is required to achieve this.[57]

These objectives may appear ambitious in the light of prevailing economic constraints, i.e. low oil prices. However, the Community has taken several measures to help biofuels find their niche in the European energy arena;

- introduction of non-food crop production on set-aside land in the Reform of the CAP, (See chapter V),
- fiscal policy measures, (See section 3.1.1 below),
- Agro-Industrial Research Programme : AIR, (See Appendix D),
- research and development carried out as part of APAS, (See Appendix D)
- pilot schemes and market entry undertaken with the assistance of THERMIE and ALTENER projects, (See Appendix D),
- development of technical specifications for biofuels (See chapter II, Appendix C),

3.1.1 Fiscal Measures Proposed By The Commission

A notable study was completed for the Community, entitled "Biomass - A New Future"[58] in 1992. One of the ideas that emerged from this study was a privileged taxation scheme for biomass energies compared to other energy sources. Specifically, detaxation to 0 - 10 per cent of mineral oil taxation for RME was proposed. This ideology was developed into a proposal for a Directive, on the reduction of excise duty on biofuels, unveiled in February 1992.

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[56] Million Tonnes of Oil Equivalent.

[57] CEC, 1992, "Specific Actions for greater penetration for renewable energy sources - Altener". Brussels, 29 June 1992.

[58] CEC 1992, " Biomass - A New Future", Brussels, June 1992

The proposal has a wide scope and covers all motor fuels from agricultural sources, applying to bioethanol, ETBE, methanol produced from agricultural products, used directly or as MTBE, vegetable oils and their esters. The main features of this proposal are;

i) the Member States fix the excise duty on biofuels between 0 and 10 per cent of that applicable to fossil fuels that can be replaced by biofuels; [59]

ii) this tax advantage is applicable for 10 years and then decreases progressively by 10 per cent every five years;

iii) it is intended to evaluate the main results of these measures in 1997, then at 2 year intervals, to enable adaptations to be made if necessary.

Mrs. Christiane Scrivener, EU Commissioner for Taxation, was one of the initiators of this proposal. Consequently, it became known as the "**Scrivener Directive**". Mrs. Scrivener stated[60] "..that the proposed tax advantage for biofuels would consequently create the conditions favouring investment and thus 'kick-start' a sector which is intrinsically viable in the long term." Speaking again at the 1st European Forum on Motor Biofuels in 1992, Mrs. Scrivener stated that aid would not be for an indefinite period of time, thereby giving biofuels an unfair advantage over the competition.

The introduction of this proposal for a Directive is intended to ensure commercialisation of biofuel production, by compensating for the following factors[61];

- **The increased cost of production**
  At present, most studies indicate that it costs three times as much to produce RME as to import diesel, (See chapter VI s.6.6.1).

[59] Biofuels are currently governed by Council Directive 92/81 on the harmonisation of the structures of excise duties on mineral oils. Article 8(2) of this directive empowers Member States to apply reduced rates of taxation on fuels used in the context of pilot plants.

[60] Conference Proceedings " The Future of BioFuels in Europe "Club de Bruxelles, Brussels 1992.

[61] Bill, S. Directorate of Fiscal Policy, EC, 1994" The Commission Proposal for a reduced rate of excise duty on biofuels", Proceedings from the first European Conference on Motor Biofuels, Tours, May 1994.

However, prospects for medium to long term production are more positive.

- Various **economic risks** associated with alternative fuels from agricultural sources, which are;:
  - oil prices,
  - the exchange rate of the dollar,
  - climatic conditions,
  - changes in the value of the by-products which greatly affects economic success,
  - price developments of UFO[62] and other plant oils.

- **Commercial and Industrial risks** to the investor, compensating for the introduction of a new process, the distribution, promotion and launching of a new product.

- The aim of this measure is also to **encourage investment** in this sector.

In May 1992, the Economic and Social Committee gave a favourable opinion on the proposal. The European Parliament also approved, provided a number of amendments were adopted. The Commission is now preparing the amended proposal.

The idea of a privileged taxation situation for a fuel is not a new development. Other examples for special tax treatments for energy include;

- electricity from biomass,
- unleaded petrol,
- low sulphur diesel.[63]

There is some resistance to this proposal. Doubts exist as to whether the biofuel industry can survive commercially, in the long run, without the existence of this fiscal incentive. In response to this, protagonists of biofuel production state that the future of the mineral oil industry cannot

[62] Used Frying Oil.
[63] Rocchietta C., Novamont, Italy, 1994" Impact of different European Fiscal Systems on the Competitiveness of BioDiesel", Proceedings from the first European Forum on Motor Biofuels, Tours, 1994.

be sustained in the medium to long term. The predictions of future oil price increase arise due to its finite nature, resulting environmental hazards and the strategic economic hazards of military actions[64].

A broader issue arises when considering this question. By encouraging diversification of the farmers crop base, instead of continuing to sustain food surpluses, macro-economic, environmental and energy sustainability benefits result (See chapter VI). The intention of this proposal as Mme. Scrivener points out, is to support its initial production through a fiscal privilege, acting as a 'kick-start' to the biofuel industry.

3.2.0 EU DEVELOPMENT AND LIMITATIONS TO RME PRODUCTION

3.2.1 Limitations to RME Production In the EU

In the 1994 season, 5.86m ha. of arable land in the EU have been taken out of production under the set-aside scheme. 0.685m ha. of this land has been approved for the production of rape and sunflower production for non-food use (for biofuel production). The Blair House Agreement of the GATT requires that oilseed production on set-aside land be limited to the equivalent of 1mt of soybean oilcake. (See chapter V s.5.3.1) Based on current yields achieved in the Community, it is estimated that this is equivalent to 0.8m ha. of rapeseed or 1.6m ha. of sunflower seed. Assuming this trend of increased RME production continues (See Table 3.7), coupled with a possible EU Directive for a reduction in excise duty, it is very possible that restrictions to production will occur in the very near future unless the Blair House Agreement is re-negotiated.

A brief survey of RME production, fiscal status and marketing strategies in Europe follows, as at March 1994. See Fig. 3.1.

[64] Energetics," The National Security Costs of Petroleum" Over the last decade, a number of analysts have attempted to determine these costs. The Centre for Defense Information estimated that of the $2 trillion spent on defense from 1982 to 1988, approx. $194 billion was devoted to defending the Persian Gulf. This works out at approximately $49 billion per year.

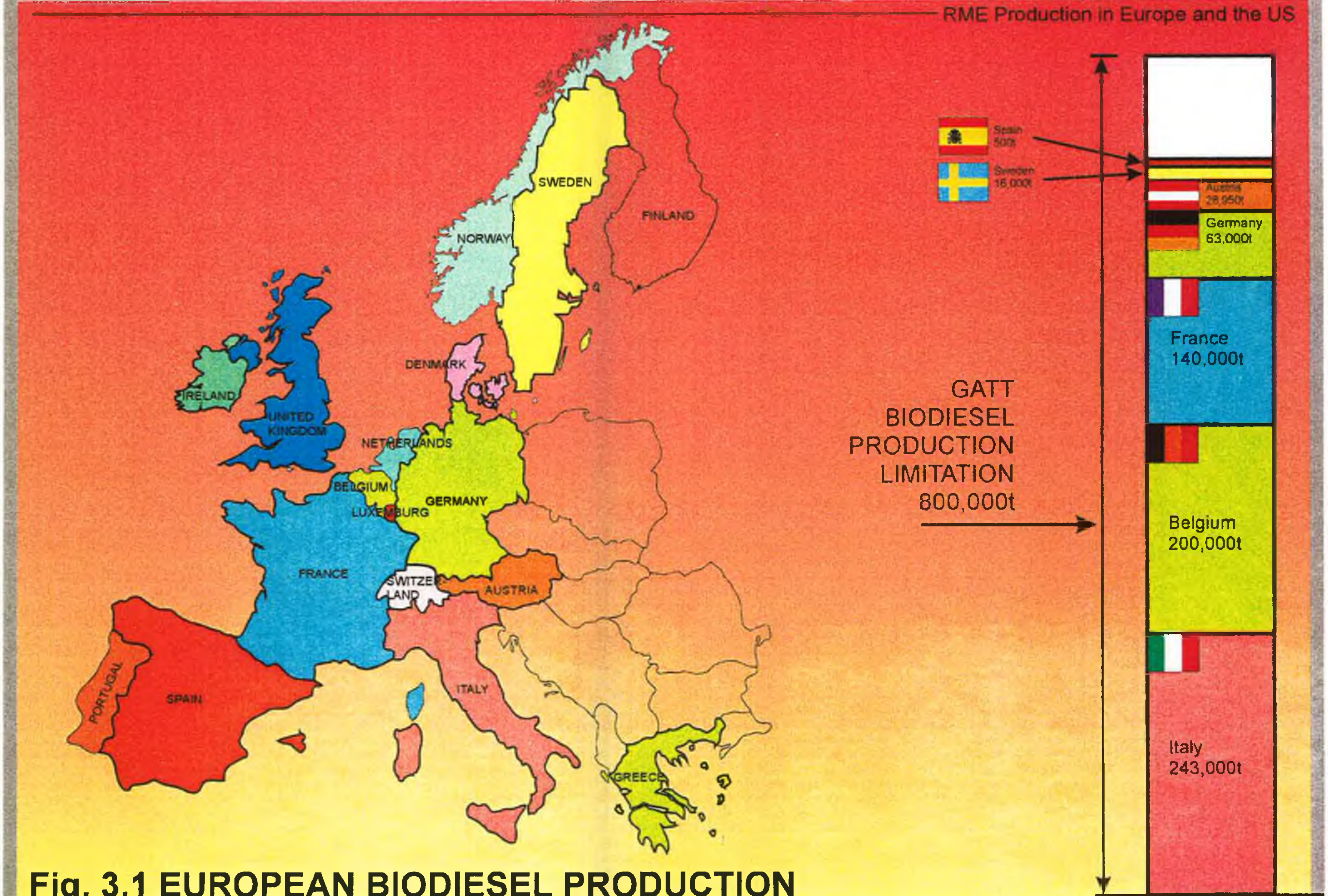


Fig. 3.1 EUROPEAN BIODIESEL PRODUCTION

3.2.2 Austria

Studies into the use of vegetable oils and animal fats as fuels, began in Austria as far back as 1973 as a result of the increase in oil prices. After a 400 hour trial test of 50 per cent blend of rape seed oil with diesel, it was decided that some adaptations had to be made to the vegetable oil to achieve mechanical feasibility.[65] Studies into esterification also began. The first positive trials were reported in 1982 at the engine test station at Wieselbürg. In 1985, the first pilot plant was installed in the Agricultural High School, in Silberberg. This was followed by a second plant with different technology in Wieselbürg in 1987. It was decided that before full scale production occurred in Austria, two important conditions had to be fulfilled, engine producer co-operation and the development of an Austrian fuel standard for RME.

i) Fleet tests were carried out by the Wieselbürg Institute from 1987 to 1989 to obtain the support and co-operation of engine producers and manufacturers. This was viewed as an important element for commercial success. The tests were completed in 1990, resulting in a large number of engine approvals from major companies. See Appendix C, Chapter II.

ii) The development of a fuel standard in co-operation with the universities, tractor producers, agricultural engineers and mineral oil companies. See Appendix C, Chapter II.

[65] AFRC Engineering,1990 "Plant oils as fuels - a preliminary evaluation lecture at the OKL Colloquium, 1988", October 1990

Table 3.1 RME Production in Austria

Production	Capacities
small scale plants	
Güssing	1,300t
Murek	1,350t
Starrein	1,300t
industrial scale plants	
Aschach	10,000t
Bruck	15,000t
Planned - 1995	
Pischelsdorf	30,000t
Total	**58,950t p.a.**

Source : Wörgetter M., Schrottmaier J., Prankl, H. Rathbauer, J. Federal Institute of Agricultural Engineering, A-3250 Wieselburg, 1994 "Country Report, Market introduction of BioDiesel in Austria", 8th European Conference on Biomass, Oct.1994, Vienna.

Austria taxes biodiesel at circa. 5 per cent of existing mineral oil taxation. Austrian BioDiesel is at present marketed towards areas of high risk to the environment (soil, water, air). Market niches have been established as follows[66];

Table 3.2 Austrian RME Marketing Strategy

Market Niches	Strategy
• Slow moving mining construction machines	Reduced soot inhalation risk
• Stationary irrigation pumps in agriculture.	Reduce ground water contamination risk.
• Pleasure boats in areas of touristic importance	Reduce water pollution risk.
• Ski-lift machines	Reduce risk to priority drinking water areas, and alpine environment.
• Forest machines	Chain saw lubrication oils must have a minimum biodegradability of > 90 per cent, legally enforced.

[66] Werner Körbitz Consulting, Graben 14/2, Pf/pob 97, A- 1014 Wien, Austria.

Due to the solvent application properties of RME, observed on the body paint of cars, research into the non-fuel applications of RME began in 1990. To-date only two alternative uses of RME have been identified, they include;

- replacement of toxic solvents, in liquid emulsifying formulations, by an emulsifiable RME formulation,
- replacement of toxic chlorinated hydrocarbons as cleaning agents in the printing industry by an emulsifiable RME formulation.[67]

In the past Austria has been the European leader in RME technology development and production. Innovative alternative uses of RME help to secure RME as a quality product. However, RME production in Austria has not always been economic.

Austrian researchers carried out extensive experiments and testing, and ground breaking work was carried on in a number of areas in the country i.e. Wieselbürg, Silberberg. As a result, small production facilities resulted. More often then not, these were uneconomic, due to the lack of economies of scale of production. However, an industrial scale production facility of 30 000t is now planned at Pischelsdorf, which will process mainly UFO.

3.2.3 France

A major study, commissioned by the Prime Minister, into the technical and economic aspects of biofuels, known as the ' Levy Report', (so-called as it was carried out by the former chairman of Renault Raymond H. Levy), was carried out in February 1993. This report favours the implementation of an RME industry as opposed to a bioethanol industry in France "in answer to an agricultural rather than an energy problem"[68]. The agricultural (set-aside) problem, meant that France had to set-aside 1.5 million ha. The study asserted that RME technology had virtually no

[67] Körbitz, W. 1994, "Development of esters in Austria and in the Czech Republic", Proceedings from the First European Forum on motor Biofuels, Tours, May 1994.

[68] Levy, R.H.1992,"Biofuels - report to the Prime Minister of France", February 1992.

technical drawbacks; it has macro-economic benefits, and it requires less subsidies than ethanol production[69].

Regulatory measures have been taken in France to allow RME to be added to diesel oil for domestic and automotive use. These steps were only taken after extensive studies and experiments carried out by the IFP (Institut Français du Pétrole - French Oil Institute) in which engine manufacturers, (Renault, Peugot and Renault Véhicules Industriels), oil companies (Elf and Total), and the Minister of Agriculture and Industry and the ADEME (Agence De L'Enviornnement et de la Maîtrise de L'Energie) and the French Oil Bearing Seeds Industry all participated.

Following the results of the various experiments and the recommendations of the Levy report the French Government adopted the following measures;

- Long term market share of 5 per cent ester added to diesel for distribution in service stations starting from March 1993.
- A 4th of March 1994 decision by the Hydrocarbons Directorate (DHYCA) also adding 5 per cent of ester to domestic fuel.
- Captive fleets can use up to 33 per cent ester mixtures with diesel.

Article 32 of the 1992 Finance Act exempts rapeseed oil and sunflower oil esters from TIPP (Tax Interieure su les Produits Petroliers) when they are made in approved pilot plants and are used in experimental programs. Article 30 in the 1993 Finance Act makes three major modifications to Article 32.

i) It restricts, from 1st January 1994 the benefits of this exemption to biofuels obtained from agricultural raw materials obtained from set-aside land.
ii) It enables esters mixed with domestic fuels to be fully exempt from mineral oil taxation.
iii) It limits the exemption to 230f/hl for esters.

Production in France is as follows;[70]

[69] A litre of RME would cost the Budget little more than the exemption from excise duty currently imposed on diesel fuel (1.74F/l) to approach the import value of (0.85F/l). It would cost the entire tax take on petrol whose MTBE is replaced by ETBE, some 2.90F/l in order to approach the price of petrol before tax, at about 1.0F/l.

Table 3.3 RME Production in France

Plant/ Company	Approvals given on 31.12.92	Approvals for which the principle has been acquired	Totals
Compiegne/ **Robbe**	20 000t		20,000t
Peronne/ **Castrol**	10 000t		10 000t
Boussens/ **Henkle**	70 000t		70 000t
Verdun/ **Novaol**	40,000t		40 000t
Rouen/ **Comexol**		120 000t	120 000t
Nogent-sur-Seine **Soufflet**		100 000t	100 000t
Total			360 000t

France is a strong advocate of Biofuel production. France is also unique in that 'diester'(RME mixed with diesel) production was supported by the oil companies, ELF and Total. Since the introduction of set-aside regulations France has utilised the non-food use to maintain output. In 1994, 140,000 ha. were used to produce biofuels, this is expected to increase in 1994/95 season to 250,000ha. The limitation on licences for production currently stands at 400,000t

Research bodies work in co-operation with one another promoting RME production. Mr. Levy stressed the importance of further research into the importance of biocombustables and biofuels as " there is room for immense progress".

[70] According to a document submitted to the Consultative Committee for the Production of Substitution Fuels in its March 10 1994 meeting. Vermeersch G." Installation of Ester Production Units in Europe", Proceedings from the 1st European Forum on Motor Biofuels, Tours, 1994.

The research that is being carried on in France at present is concentrated on the competitiveness of biofuel production, and assessing economic and technical alternative uses of agricultural products. The French Government has created a research body to study this more closely, AGRICE (Agriculture for Chemistry and Energy). It is intended that this body work with partners of common interest. These partners include INRA (National Agronomic Research Institute), IFP, Oilseeds groups (ONIDOL, SOFIPROTEOL) and ADEME. In short, the French Authorities consider the biofuels industry as an opportunity for the future.

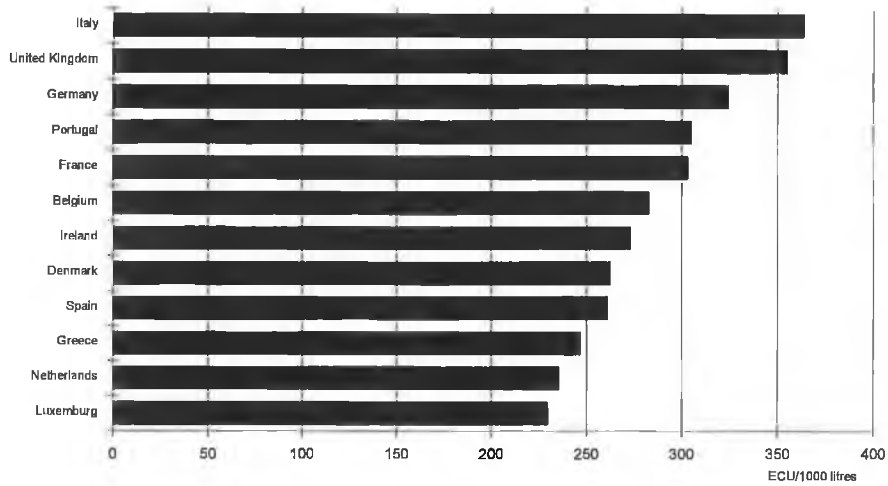
3.2.4 Italy

Novaol, an affiliate of the multi-national agro-industrial company Ferruzzi, started to produce in Italy and promote RME in Europe under the trade name "DieselBi" in 1992.

Italy has undergone considerable development in the production and use of RME. Italy has a comparatively high level of excise duty on diesel oil, both for automotive and domestic use as a heating oil, for which a lower quality is sufficient. See Fig. 3.2 on the following page.

Despite this, RME has been exempt from excise duty since 1992. There have however, been five changes to that legislation since its inception. On the 31st of December 1993, the tax system for biofuel production was altered. Prior to this change, the taxation on biofuels was identical to the German system i.e. 100 per cent excise duty exemption for biofuels. This order now requires a reduction of 80 per cent of mineral oil taxation, on products which originate from seeds derived from non-food set-aside.

Fig. 3.2 Excise Duty Rates for EC-12, 01.01.94



Source : CEC Statistics, 1994

There is also a limitation on the amount of RME that can qualify for this tax exemption. This was reduced from 250,000t to 125,000t, in 1993. From the 1st of January 1994, RME production in Italy was as follows;

Table 3.4 RME Production in Italy

Location	Producing companies	Planned Projects	Quantity p.a.
Livorno	Novaol		117 000t
Milan	Far IGS Defilu		60 000t 19 000t 20 000t
Cittá di Castello	Estereco		27 000t
Napoli	Palma	118 000t	
Bari	Oleifici Italiani	100 000t	
Brescia	Comlube	70 000t	
Ancona	Fox Petroli	40 000t	
Total		**328 000t**	**243 000t**

3.2.5 Germany

Germany is a European leader in carrying out extensive, accurate emission studies. They have also carried out comprehensive studies on global environmental balance including aspects of N_2O (laughing gas) as one of the green house gases. One interesting conclusion to these complex studies asserts that "For each kg of fossil Diesel, which is replaced by BioDiesel, we need 0.92 - 0.79 kg less mineral oil and we emit 2.9 - 3.2 kg less CO_2 including all types of greenhouse gases"[71]
See Chapter IV, s. 4.7.1)

This provides us with an understanding of the German attitude towards RME production and use. RME is not subject to excise duty when used in its pure form (i.e. not mixed with diesel). When mixed with oil products, regardless of quantity, they bear the full tax burden as mineral oil products. The rationale for this form of taxation ensures that RME will only be used in zones subject to environmental constraints.
As of mid 1994, production in Germany included;

Table 3.5 RME Production in Germany

Location	Producing Company	Planned Projects	Production
Leer			3 000t
Düsseldorf	Henkel		60 000t*
Kiel	Ha-Ge	10 000t	
Leer		60 000t	
Saxony	Anhalt	60 000t	
Saxony		2 000t	
Thuringia		2 000t	
		134 000t	**63 000t**

*mainly used for non-fuel purposes.

RME is used 100 percent in agriculture, public transport, taxi fleets and/or in touristically important areas (e.g. North Sea Islands).

[71] Scharmer, K; 1993 "Umweltaspekte bei Herstellung und Verwendung von RME " RME Hearing on April 21, 1993, presided by the Minister of Agriculture, Vienna, Austria

3.2.6 The Czech Republic

In 1990, the first bench tests were completed by the tractor company Zetor. This was followed by extensive and successful field tests, consequently Zetor have given engine approval.

Several attempts have been made in the Czech Republic to produce their own RME technology and failures to produce the necessary high product quality have resulted. A Commission for a fuel specification was established and a decision on the Czech name for BioDiesel has been arrived at, "BioNafta".

RME in the Czech Republic is subject to 100 per cent exemption on excise duty and vat has been reduced from 23 per cent to 5 per cent, to encourage production.

Only one production facility has been planned, with an annual capacity of 30,000t. It is to be situated at Olomouc, where the Milo oil mill is. Full scale production began in September 1994.

3.2.7 Ireland

Interest and enthusiasm for BioDiesel production is growing in Ireland. Technical and economic feasibility studies have been carried out. Teagasc, the educational and research arm of the Department of Agriculture are presently involved in an EU funded[72] experimental project, the ALTENER Project. This project was undertaken with the following objectives in mind;

- allow potential users the experience of using Irish RME in their vehicles, from a technical and environmental view point,
- provide Teagasc with an opportunity to monitor, on a pilot plant scale, production costs and examine ways of reducing them,
- help to create public awareness of RME as a renewable fuel with potential rural employment and environmental benefits.

All participating vehicles are operating on 100 per cent BioDiesel (for a list of participants see Appendix E). The ten vehicles involved changed to

[72] **Altener** is a community action programme for the 1993 - 1997 period, designed to encourage greater penetration for renewable energy sources.

BioDiesel in May 1994, most of the data remains to be collected. The preliminary results can be summarised as follows;[73]

- alternate use of diesel and RME was completed over 100,000km, without replacement of injector nozzles.
- little difference in power output between diesel and RME
- the level of carbon monoxide in the exhaust gas was higher with diesel than with RME, but there was little difference with the injector nozzles were changed.
- smoke levels were significantly lower with RME than with diesel
- hardly any practical difficulties have arisen to date. Two cases of slight damage to the paint work at the filling point have been observed.
- no engine breakdowns, or starting difficulties have been reported.
- a survey of 200 passengers using the BioDiesel bus in Cork showed a very positive attitude among the public to the concept of indigenous, renewable fuel.

No changes have been made, in Ireland, to the excise duty system to make biofuels a commercially competitive alternative to mineral oil diesel.

3.2.8 United Kingdom

The United Kingdom has been debating the RME question for some time and as yet arguments against a UK RME industry can be summarised as follows;[74]

- the reduction in excise duty to the Treasury
- conflicting environmental evidence of the advantages of RME use
- distortion of the UK glycerol market
- alleged poor energy balance from RME production.

Many extensive studies have been carried out, most notably from ETSU (Energy Technology Support Unit), and the SAC (Scottish Agricultural College together with Körbitz Consulting, Vienna, Austria).

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[73] Rice, B, 1994 "An Irish Altener Project", Proceedings from the Renewable Energy and Economic Development Conference, Galway, November 1994. The Irish Energy Centre.

[74] Körbitz, W., Walker, K.C. 1994 "Rationale and Economics of a UK BioDiesel Industry" ,British Association for Biofuels and Oils. January 1994.

The British Association for Biofuels and Oils (BABFO) was formed in November 1992. Engine tests have been carried out with the Reading Bus company in conjunction with Novamont. The first UK project successfully produced small quantities of BioDiesel in East Durham.

The situation in the rest of Europe appears to be as follows as at January 1994;

3.2.9 Belgium

1 industrial scale plant located in Pantochim, with an annual production capacity of 200,000t at Feluy Oleofina.

3.3.0 Denmark

1 industrial scale plant of 30 000t in Otterup due for completion in 1995.

3.3.1 Sweden

2 medium sized plants, one in Gothenburg producing 10,000t (SOAB) and one in Skane producing 6,000t (Ecobränsle). There is also one project under construction at the moment, in Örebro. The marketing strategy in Sweden for RME is a mixture of 40 per cent RME and 60 per cent N-paraffin, called "Scafi 101" used for soot reduction in areas of higher risk to workers inhalation safety.

3.3.2 Slovak Republic

There are 4 small scale plants producing 500 - 1,000t each, but producing RME of questionable quality.

3.3.3 Hungary

18,000t project in Györ.

3.3.4 Spain

Spain has been reluctant to enter into the biofuel market even though it is one of the largest oilseed producers in the EU with over 1 million ha. of land devoted to the cultivation of sunflower seeds. However, the situation has changed and the first pilot plant has been established in Bilboa in the Basque province. Important developments in Spain include, the new Spanish Ley No. 42/1994 of December 1994 which legislates tax exemption for biofuels of agricultural origin as long as they are produced in facilities which can be classified as innovative projects.

Production in Spain at as at March 1995 is as follows;

Table 3.6 : RME Production in Spain

Location	Producing Company	Planned Projects	Production
Bilboa	Biovac		500t
Barcelona	Novaol, Caila y Pares, Catalan Government	50 000t	
		50 000t	**500t**

Most European countries are currently interested in RME production, primarily in order to maintain agricultural production. Italy and Belgium are the major producers at present, but it is expected that production in France, Denmark and Spain will increase in the short term Future interest and production will be motivated by environmental concerns and sustainability.

Table 3.7 Summary of actual and planned production

Country	planned projects (t)	production (t)
Austria	30,000	28,950
France	276,000	140,000
Italy	328,000	243,000
Germany	134,000	63,000
Belgium	-	200,000
Denmark	30,000	-
Sweden	-	16,000
Spain	50,000	500
	848,000t	**691,450t**

3.4.0 THE US

The US has relied on fiscal policy to boost the biofuels industry. Traditionally, the US biofuels industry centres on ethanol production. However RME production has now been introduced. However, it is produced with soy oil instead of rapeseed oil. The National BioDiesel Board (NBB) was established and is presently active with a 4 phase commercialisation strategy. This is also supported by the American Biofuels Association (ABA)[75]. Industrial capacity presently amounts to 50 000t facility using soya oil as its raw material. There is one semi - commercial plant planned in Nebraska with an annual capacity of 10 000t.

The principal fiscal policy incentives for alcohol fuels include;

- 1978 Energy Tax Act, which provided for a tax exemption for alcohols of $0.54 per gallon. It also introduced blender tax credits for alcohol fuels.
- 1990 Omnibus Budget Reconciliation Act, which provided for a tax credit for small producers of ethanol.
- 1992 Energy Policy Act, which made provision for an income tax deduction for cars that used 'clean burning' fuels.[76]

Regulations have also been introduced in the US to encourage the use of motor biofuels. These regulations have been introduced primarily as a result of environmental concerns. They include;

- 1988 Alternative Motor Fuels Act,
- 1990 Clean Air Amendments Act, providing incentives for oxygenated fuels, reformulated gasoline. The Californian Clean Air Programme, was introduced, along with clean fuelled fleets.
- 1992 Energy Policy Act, which provides support for renewable energies, and requirements for fleets to use alternative fuels in their vehicles.

The marketing strategy in America in 1994, was highlighted by a round the world expedition of the "Sunrider", fuelled by BioDiesel. The public

[75] Assisted by the Fat and Protein Research Fund (FPRF).

[76] Bull R.S. 1994 "Implications of US Policies on biomass energies" 8th European Conference on Biomass For Energy, Environment, Agriculture and Industry. 3-5 October 1994, Vienna,Austria.

Transport system has been targeted, encouraged by the "Clean City Programmes" and the "Clean Air Act" Amendments[77] detailed above.

3.5.0 CONCLUSION

Support exists at EU level for RME production (and biomass energies in general), evidenced by the vigorous research and development programmes (See Appendix D for a list of these). The 'Scivener' proposal for a Directive has yet to be approved by all Member States, as it proposes to employ a fiscal adjustment to aid the introduction of a European RME industry. Many European countries (France, Austria, Italy, Germany and Spain) have already decided to implement their own reduction in excise duty to aid the development of an RME industry. RME production in 1994 has already utilised 685,000 ha. of set-aside land. Predictions for future production state that the limitations imposed by the GATT accord will shortly be reached.

The US has been a supporter of indigenous renewable energies since the 1970s. This is evidenced by the introduction of fiscal measures as early as 1978, to encourage the development of an alcohol fuel programme. More recently, the production of biofuels has been encouraged by the Energy Policy Act of 1992, and the Clean Air Amendment Act of 1990.

It is evident from the overview of biofuels industry in various EU countries and the US, that an RME industry will not occur without an initial 'kick-start', generally in the form of an initial privileged taxation system. The onus lies on the Governments concerned, to decide whether the overall benefits from encouraging an RME industry outweigh the reduction from the privileged taxation system.

[77] Körbitz Consulting, January 1994.

CHAPTER IV

ENERGY AND ENVIRONMENT

TABLE OF CONTENTS

4.0 Introduction

The current concern over the environment is primarily attributed to the levels of CO_2 emitted into the atmosphere, manifesting itself in a warming of the earth's surface. The greatest source of CO_2 production comes from the energy sector and transport has been identified as a significant contributor within that sector.

This chapter attempts to evaluate the environmental issues that face the global community today and assess the actions being taken to address them. The present and likely future fiscal remedies that exist for reducing CO_2 emissions are outlined, and the projected future supplies and prices of fossil fuels are assessed. Therefore, the environment and the economics of supply and prices of fossil fuels are considered in a transport context, allowing a discussion on the environmental impacts of RME as an alternative to diesel. It must be stressed that this study is not advocating substitution of RME for fossil diesel, rather it is analysing whether a case exists for RME as an environmental alternative to fossil diesel.

The overall environmental balance of RME is evaluated throughout the different phases of production, illustrating the diversity of results among the various studies that exist today.

4.1.0 The New Energy Crisis

In the 1970s and 1980s the term 'Energy Crisis' was used to describe the concern, expressed by the industrialised economies with; the rising costs of energy, security of supply, and the finite nature of fossil fuel resources. The energy crisis of the 1990s, experienced at on a global level, is associated with and results from the use of fossil fuel energy and the danger it poses to the environmental balance. Transport is a significant user of energy, and in the new energy crisis context the emphasis has shifted from 'whether there will be enough fuel in the world to feed cars to whether the global environment can cope with what comes out of the back end of cars'[78]. This crisis is fundamentally different from previous crises and requires far reaching remedies.

4.1.1 The Greenhouse Theory

'Climate change' has been identified by meteorological studies into recent weather patterns. Evidence from these studies indicate that the earth's temperature may be rising at a gradual level. This phenomenon has been termed 'The Greenhouse Effect'. Briefly, the basis of this lies in the fact that the earth's heat balance is maintained through a series of complex interactions within the atmosphere. According to this theory, incoming solar ultra-violet radiation is absorbed by the earth and is re-emitted as infrared radiation. Some of this radiation is trapped by water vapour and greenhouse gases and emitted back to the earth and the balance goes to outer space. As the amount of greenhouse gases produced increases, so does the amount of infrared radiation that is absorbed back into the atmosphere[79]. This could cause a substantial warming of the earth and have far reaching effects. In general, there is a relative consensus among the climate modelers about the possible range of global surface temperature increase in response to increasing greenhouse gas concentration, there is less agreement about the possible regional changes that could result.[80] However, certain regional responses have been shown in a number of studies that have investigated the response to increasing greenhouse gases.

Temperature increases would probably occur during the winter in high latitudes of the Northern Hemisphere. It is estimated that changes could be 2 - 2.5 times greater and faster than the globally averaged annual values. It has been suggested that the outcome could be enhanced winter precipitation in the high latitudes, intensified rainfall in the

[78] Adams, J.G.1990 "Car ownership forecasting - Pull the ladder up, or climb back down?," Traffic Engineering and Control, UK March 1990.

[79] Ho, S.P.,Renner, T.A. 1982"Global Warming Impact of Gasoline vs. Alternative Transportation Fuels", Amoco Oil Company. International Conference, Fargo, North Dakota, USA 1982.

[80] ENFO"Global Warming", briefing sheets.

presently rainy low latitudes and perhaps a decrease in summer rainfall in the mid-latitudes.

A rise in sea level could be accelerated as a result of global warming.[81] This rise in sea level would come about as a consequence of the thermal expansion of sea-water and the melting of land ice. The future rate of increase of sea-level could be greater than 15 mm per decade. Resultant effects of sea-level rise include; erosion of beaches and coastal margins; wetland loss; increased frequency of severity of flooding; damage to port facilities and water management systems.

It is estimated that at the mid latitude, climate change would be expected to have a significant impact on forests. Extinction of species, reproductive failure and large-scale forest die back is expected to result due to the rapid rise in temperature and the increasing frequency of severe drought .

Global warming would also cause intra-regional shifts in agricultural productivity. For all but the most rapid climate change, however, adaptation based on agricultural research should permit maintenance of total global food supplies.

Carbon Dioxide (CO_2), Chlorofluorocarbons (CFCs) Nitrous Oxide (NOx) and methane (CH4), have been identified as the main agents of the greenhouse effect. Over the last century human activities have increased atmospheric concentration of naturally occurring greenhouse gases. CO_2 accounts for half the annual increase in global warming.[82] The atmospheric concentrations of CO_2 is now growing at 0.5 per cent per annum. It has been estimated[83] that 85 percent of man made CO_2 emissions arise from fossil fuel combustion. Under the current trend

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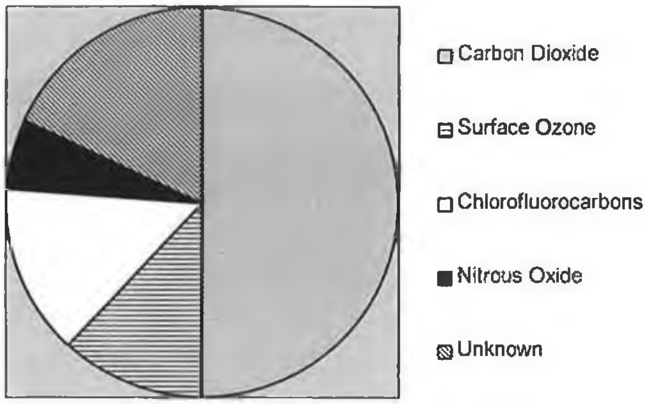
[81] Robin, G. de Q., 1986 " Changing the sea level." The Greenhouse Effect, Climatic Change and Ecosystems, Wiley and Sons Chichester, England.
[82] Walsh, M.P."Motor vehicle Trends and their implications for global warming",Transport Policy and Global Warming, ECMT 1993.
[83] ibid.

these higher concentrations are expected to lead to an average increase in global temperature of circa. 0.3 per cent per decade.

Fig. 4.1 Contributors of Greenhouse Gases to Global Warming

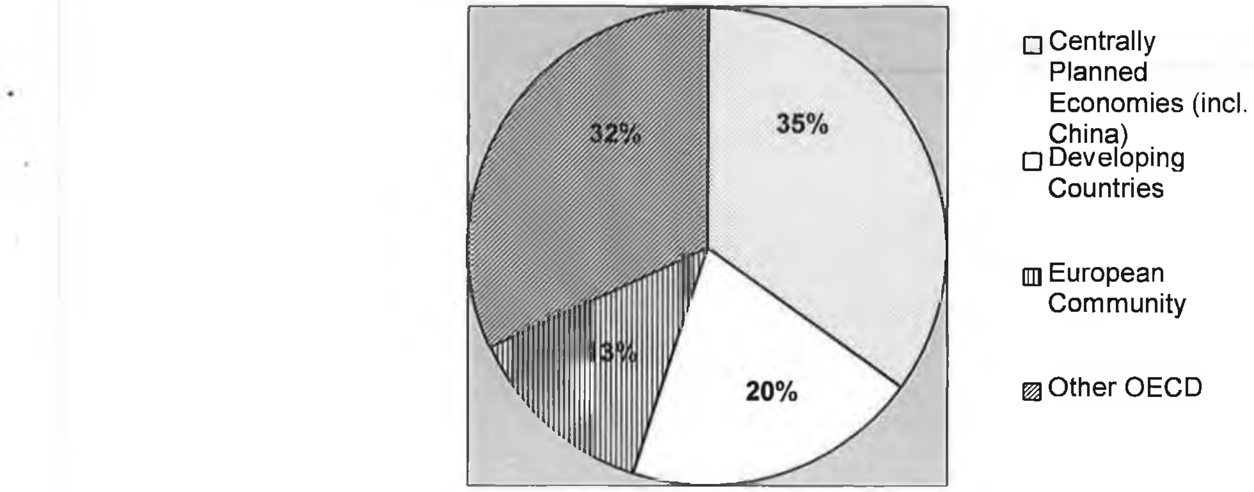


Source : Association for the Conservation of Energy, 1989.

The figure above illustrates that CO_2 is responsible for about half of the warming effect attributed to the increased atmospheric concentrations of greenhouse gases. The figure below illustrates CO_2 emissions from fossil fuel combustion in 1987. OECD countries make the largest contribution at 45 per cent of the total but this figure has been falling in the past.

The energy crisis of the 1990s is associated with the rising concern over the environment. Excess CO_2 emissions have largely resulted in the 'green house' effect. This could manifest itself in climate change which could have devastating effects on our natural resources. International response to this energy crisis is concerned with maintaining the earth's natural balance for future generations.

Fig. 4.2 Global CO_2 Emissions by Region



Source : ENFO Information Fact Sheet

4.1.2 Forecasts

The EC Commission published a study[84] in 1990, on the future emission of the main pollutants caused by traffic in different scenarios. The 20 year period from 1990 - 2010 has been used as a basis for forecasting. The basic principles of the four scenarios examined in this study, and expectant environmental level of pollutants are contained in Appendix F.

The study indicates that under the 'Conventional Wisdom Scenario' car traffic in the EC is expected to grow by 80 per cent over the period. As the efficiency of fuel consumption is expected to increase, it is anticipated that fuel consumption will grow by 45 per cent over the same period. In the light of this fact, a number of important issues must be discussed which concern the environment, the future market for fossil fuels and the potential market for biofuels.

Recent UN projections indicate that the population will increase from 5 billion people in 1990 to 10 billion in 2050. Consequential energy projections indicate that demand will increase from around 9 billion toe in

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84 CEC 1990, "Energy for a New Century - The European Perspective", CEC 1990.

1990 to 20 billion toe under the high energy efficiency scenario. These developments will have a drastic impact on the environment at large if we continue to use fossil energy with the same vigour as is the past.

4.2.0 Transport and the Environment

In the context of the New Energy Crisis, energy combustion has been identified as the key contributor to the increase in greenhouse gases. Transport is a significant user of energy. In this context, and in an overall framework of assessment a profile of air pollutants emissions from fossil fuel operated vehicles will follow at a local and global level.

Pollution, resulting from fossil fuel operated vehicles, occurs as a result of the combustion of the fuel. Pollutants which occur at a local level are detailed in section 4.2.1 below.

4.2.1 Local Environmental Impacts

4.2.1.1. Carbon Monoxide (CO)

CO is a colourless and almost odourless gas which is produced amongst other things by the incomplete combustion of carbon- based fuels and poses a serious risk to human health. Exposure to CO can result in serious health problems, as it interferes with the absorption of oxygen by red blood cells. CO in urban atmospheres has also been linked to loss of worker productivity. Although ambient CO levels have been reduced across Europe, Japan and the US, the problem is far from abated. Global carbon concentrations in the lower atmosphere are increasing by between 0.8 per cent and 1.4 per cent per annum.[85]

CO also contributes to global warming through its contribution to surface ozone or photochemical smut. Carbon emitted as CO is oxidized to CO_2 over a relatively short period.[86]

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[85] Walsh, M.P. 1993 "Motor vehicle Trends and their implications for global warming",Transport Policy and Global Warming, ECMT 1993.

[86] "Energy Transport & the Environment" TRANSnet, innovation in transport 1990.

4.2.1.2. Unburnt Hydrocarbons (HCs)

HCs are chemical compounds made up of hydrogen and carbon and are the basic compounds in fossil fuels. They result from incomplete combustion of carbon based fuels. The resultant effect of unburnt HCs are twofold;

- photochemical oxidant formation which leads to eye irritation, plant damage and smog, and by contributing to the formation of photochemical oxidants, HCs also indirectly contribute to acidification of rainfall and global warming via surface ozone creation,
- secondly, there are some HCs emitted from car exhausts during vehicle operation which on their own are toxic to human health. Benzene is an example of this and it is a known carcinogen causing leukemia. [87]

4.2.1.3. Nitrogen Oxides (NOx)

Nitrogen Oxide is the collective term for a group of nitrogen - based pollutants, including nitric oxide, nitrous oxide and nitrogen dioxide (NO_2) .This group of pollutants has detrimental effects on human health and on the environment. Specifically, they affect the respiratory systems and prolonged exposure can eventually lead to emphysema. When NO_2 is emitted in combination with SO_2 the result is a very active pollutant and these two constituents are the main constituents of acid deposition on the earth's surface in the form of rain, snow, hail, mists and low cloud (acid rain). The main concerns of acid deposition is in the context of long term environmental effects on natural resources i.e. lakes, soils, forests, crops and buildings.

[87] CEC 1994, "Application of biologically derived products as fuels or additives in combustion engines", DG XII, Science Research and Development, CEC 1994

4.2.1.4. Sulphur Dioxide (SO_2)

SO_2 results from combustion of fuels which contain sulphur. Much of the SO_2 in the earth's atmosphere is derived from natural sources but in highly developed and heavily populated areas the majority comes from the burning of fossil fuels, in particular, coal and oil. Diesel contains a higher proportion of sulphur than petrol.

4.2.1.5. Particulates

Particulates are fine solid or liquid particles found in the air or in emissions such as dust, smoke or smog. Particulates of different kinds are known to exacerbate various respiratory ailments. Transport is the major source of airborne particulates.

4.2.1.6. Lead

Lead is a metallic element which can be retained in the body in the form of its compounds. Lead poisoning can result when levels retained in the blood are high, but also more sub-clinical effects in IQ and behaviour, particularly in children, can also result.

The OECD[88] reports that, as for the first three main pollutants, the contribution of the motor vehicle to the overall emission level are;

- Carbon Monoxide (CO) 66%
- Unburnt Hydrocarbons (HCs) 39%
- Nitrogen Oxides 47%

[88] OECD 1989 "Transport and the Environment", OECD Publications 1989.

4.2.2 Global Environmental Impacts

The second category of negative environmental effects stemming from the combustion of fossil fuels gives rise to impacts on a global scale, resulting in the greenhouse effect[89]. The increased production of greenhouse gases resulting from transportation are identified as being the following; CO_2, Methane, unburnt HCs and NOx.

The relevant environmental impact indicator for global warming is 'grams of carbon dioxide equivalent per vehicle - km'[90] The table below illustrates the different emissions from different vehicle types.

Table 4. 1 Road Transport : Emission Indicators

	Emission of Pollutants (g/vehicle km)					
Type of Vehicle	CO	NO_x	HC	CO_2	SO_2	particulate
Private car						
Petrol :urban	45	1.2	6.4	315	-	-
Non-urban	12.5	1.6	1.3	160	-	-
Diesel: urban	1.7	0.8	0.5	331	0.08	0.4
non-urban	0.7	1.7	1.0	201	0.06	0.23
Bus						
urban	18.0	15.5	12.0	1158	1.7	n.a.
non-urban	3.8	15.0	2.7	1123	1.5	n.a.
Heavy goods vehicle						
urban	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
non-urban	8.0	17.5	2.8	1158	1.59	n.a.

Source : CEC 1994,"Biofuels - Application of Biologically derived products as fuels or additives in combustion engines", DG XII, Science Research and Development, 1994.

[89] It has also been identified that the depletion of the stratospheric ozone is as a result of CFCs, for which there are alternatives in the medium term. Further discussion on this topic does not come into the ambit of this study.

[90] CEC 1994,"Biofuels - application of biologically derived products as fuels or additives in combustion of engines.", DG XII, Science Research and Development CEC 1994

It is evident from the above table that all modes of vehicles listed above contribute greatly to the increase in CO_2 levels and thus to the greenhouse effect. It may also be relevant to illustrate average emission levels per litre of fuel burnt. Thereby estimating the output per litre used of each of the identified greenhouse gases.

Table 4.2 Average Emission Levels Identified Per Litre of Fuel Combusted

Greenhouse Gases	Petrol engine (grams)	Diesel engine (grams)
CO	360	7
NO2	15	20
HCs	30	40
Particulates	1	14

Source : CEC 1994,"Biofuels - Application of Biologically derived products as fuels or additives in combustion engines", DG XII, Science Research and Development, 1994.

The above table illustrates that the diesel engine produces 98 per cent less CO, 33 per cent more NO_2, 33 per cent more HCs and 14 times more particulates than the petrol engine

In the 'Conventional Wisdom Scenario' (See Appendix F), CO_2 production is likely to increase by 12.8 per cent over the 20 year period unless environmental policies intervene. Under the second scenario, 'driving into tensions' (high economic growth where market mechanisms drive the system), CO_2 emissions are forecast to increase by 34.8 per cent. The last two scenarios assume environmental standards are taken into account. Firstly under the 'sustaining high economic growth' scenario, (where high economic growth is sustained in conjunction with strict environmental standards and increased energy efficiency) CO_2 level are set to reduce by 28.6 per cent. The final scenario, 'high prices' assumes moderate economic growth with stricter environmental standards, and estimates that CO_2 emission levels will be reduced by 46.9 per cent. Therefore, it is clear that environmental policies are required to reduce pollution levels in the future, but the environmental result will depend on how these policies are implemented.

4.3.0 ENVIRONMENTAL POLICY

The first concrete step taken by the international community to address the effect of human activity on the atmosphere was the establishment of the Inter-governmental Panel on Climate Change (IPCC) by the United Nations. This group was given the task of analysing the scientific basis for climate change, to assess its potential impacts and to explore appropriate policy responses. After this initial recognition of the need to stabilise CO_2 emissions at a Ministerial Conference in Holland in 1989, an agreement was made in 1990 among many industrialised countries, including Ireland, that emissions would be reduced to 1990 levels by the year 2000. The IPCC also concluded that the total level of all greenhouse gases was rising at a very rapid pace.[91]

4.3.1 EU Response

The EU envisages long-term multi-sectoral (Energy, Transport and the Agriculture) measures which ensures that the solution for one problem, does not exacerbate another.[92] In pursuing these measures the EU has identified its belief, that the greatest global challenge for the future lies in the compatibility of;

- ensuring **economic growth**,
- efficient and **secure energy supplies**
- and a **clean environment.**

Long term planning is seen as the key to practical results. In the short-term the Commission proposes: improvement in energy efficiency, development of strategic technology programmes and moving towards less carbon-intensive energy structures including renewable energies. All of the above have been subject of communications from the Commission to the Council of Ministers since November 1989.[93] The Commission has proposed to apply a mixed carbon/ energy tax across

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[91] IPCC, 1992 "Scientific Assessment of Climate Change" IPCC 1992. Supplement United Nations Environment Programme/ World Meterological Organisation, Geneva, 1992.

[92] CEC 1992" Towards Sustainability, An EC Programme of Policy Action in relation to the Environment and Sustainable Development" March 1992

[93] CEC1990 "Environment and Energy" Com (89) 369, Feb 1990.

the Community, but the proposal remains blocked a present by the 'conditionally clause' under which no such tax can be applied unless the Community's main trading partners, essentially the US and Japan, adopt similar measures. However, several European countries have already opened the way by introducing carbon taxes (see section 4.4).

EU implemented initiatives to achieve these goals include (see chapter III):

1. SAVE : potential for energy savings and more efficient use of fuels.
2. ALTENER:[94] This programme sets ambitious standards for the development of renewables. Specific targets include;
    - increase of renewables from 4 per cent in 1991 to 8 per cent of TPER in 2005,
    - treble production of energy electricity from renewable sources
    - increase market share of biofuels to 5 per cent of TPER for motor vehicles (it has been suggested that this will requires 11 mtoe of biofuels by 2005 and 7 m ha. of farm land).
3. The Commission also has a proposal for a reduction in excise duties on biofuels, entitled the 'Scrivener Directive' (see chapter III).
4. THERMIE,(See chapter III, s.3.1.0)

4.3.2 The Irish Response

The Dublin Summit Declaration of June 1990 called for a more systematic approach to environmental management. Ireland is fully behind Community action. Initiatives under SAVE and ALTENER programmes will encourage the limitation of CO_2 emissions. Research is already underway into the potential of hydroelectricity, wind, wave, solar, and energy crops as viable sources of renewable energy.

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[94] CEC 1992, " ALTENER - Specific actions for greater penetrations for renewable energy sources". COM (92) 180 final, June 1992.

4.4.0 Environmental Policy Instruments

There is a widely recognised need for public intervention to restrict environmental pollution because of the 'externalities' involved in pollution[95]. Without government intervention, firms and individuals have no reason to take this into account. Government intervention can manifest itself in two ways by implementing either market mechanisms or by imposing regulations, thereby changing decisions which cause pollution, such as the level of production, consumer activities or choice of technology. Pollution abatement measures will then be made on the basis of 'private cost' to the individual or firm.

The difficulty which arises in forming an environmental policy, lies in the balance between the cost of pollution and the costs of restricting it. In economic terms, pollution should be controlled up to the point where the marginal cost of further abatement measures outweighs the gains from reduced emissions. In practical terms this means that whilst it would be desirable to eliminate some forms of pollution entirely, the costs of eliminating it would be greater than the benefits gained from its elimination. Therefore an environmental policy has to be able to accommodate the different interests outlined above.

Over the last decade or so, economic instruments (see Appendix G)- such as taxes, charges, tradable emission rights have grown in importance. Between 1987 and the beginning of 1993, the number of economic instruments has increased by 25 - 50 per cent according to country.[96]

Besides VAT and excise duties, motor fuels are also subject to a number of special taxes in different countries. These include environmental damage tax, fuel storage, taxes to fund national R&D projects. However

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95 Externalities are the cost that the polluter, either individual or firm, imposes on society.

96 OECD 1994 "Integrating Environment and Economics : The Role of Economic Instruments, "OECD Publications, 1994.

in general, excise duty still comprises 95 per cent of the taxes levied on motor fuels.

Some countries are now beginning to implement co-ordinated fiscal and environmental policies directed at reducing motor vehicle emissions.

1. In Finland, in 1990, the State budget introduced a package of environmental measures, including an increase in the tax rate on vehicle fuels, and an explanation for the tax in environmental objectives. Tax differentiation in favour of lead free petrol has been in place since 1986. Finland also operates a tax system on cars which is differentiated as to whether they have catalytic converters or not.

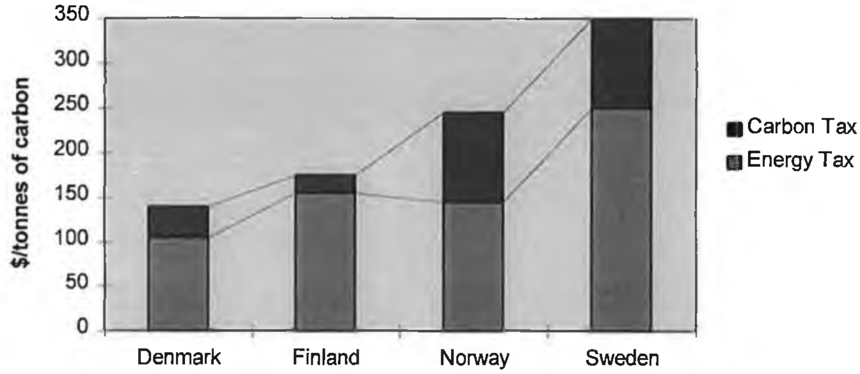
2. In Greece, a law was introduced in March 1990, which provides a car tax differential which promotes the use of vehicles that meet US 1984 emission standards.

3. A differential system of taxes operates in the Netherlands for new cars. There has also been a discussion of proposals to 'variablise' car costs, in other words, to increase car fuel taxes while at the same time reduce annual road tax on cars.

4. In Norway a tax advantage is given to cars fitted with exhaust catalysts. There has also been a tax advantage for lead free petrol since 1987.

Carbon taxes have been implemented in Denmark, Finland, Norway Sweden and the Netherlands.

Fig. 4.3 Average Taxes On Energy And Carbon In Four European Countries



Source : "Integrating Environment and Economics : The Role of Economic Instruments, " OECD Publications, 1994.

Many countries have done much to encourage the wider use of lead-free fuels by using a differentiated tax system.

The green house effect is of major concern among legislators and agreement has been reached on abating CO_2 levels. In Europe, although no formal tax exists on pollution from motor vehicles, it seems that it is likely to be introduced in the near future. Meanwhile some EU countries have decided to implement their own forms of environmental taxation. This leads to the conclusion that the price for fossil fuels again will be increased. The discussion now turns to the future of the fossil fuel market.

4.5.0 FUEL MARKETS : AN OVERVIEW

The increase in world oil prices as a result of the 'energy crises' of 1973 and 1979 led to the implementation of new energy policies in most industrialised countries. Increased emphasis was put on improving energy efficiency, and diminishing energy consumption, while domestic supplies have been prioritised and diversified.

The 'European Energy Charter', elaborated in the Hague in 1991 stipulates that goals to be achieved include " to improve security of energy supply and to maximise the efficiency of production, conversion, transport, distribution and use of energy to minimise environmental problems on an acceptable economic basis".[97]

From the above statement, it would appear that certain goals lie ahead for the EU as regards the energy sector. Priorities appear to be, securing energy supply and reducing dependency on foreign sources. Apart from the UK, no other EU member countries has substantial oil reserves. Most of the world's oil reserves are concentrated in the Middle East, an area noted for its political instability.

The EU is one of the most important areas in the world in terms of energy consumption. It has been established that roughly 50 per cent of this comes in the form of oil. Within the industrial sector and the transport sector consume 29 per cent and 30 per cent, respectively.[98]

In 1990, total energy supply per capita was 2.80 TOE for Ireland compared to 3.70 for the Community as a whole. However, TPER (Total Primary Energy Requirement) for 1990 was 9.8 mtoe (Million Tonnes of Oil Equivalent). It is evident from the table below, that all energy consumed in the transport sector comes from oil, and that oil imports in 1990 represented 44 per cent of TPER.

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[97] CEC 1994, "The European Energy Charter Treaty" Official Journal L380, vol.37, Dec.1994

[98] CEC 1994, " Biofuels - Application of biologically derived products as fuels or additives in combustion engines", DG XII, Science Research and Development CEC 1994.

Table 4. 3 Ireland -Total Primary Energy Requirement, by Fuel and Sector, 1990

Fuel	Coal	Peat	Oil	Gas	Hydro	Total
	Million Tonnes of Oil Equivalent					
Sector						
Electricity	1.307	0.667	0.348	0.848	0.059	3.229
Industrial	0.337	0.033	0.997	0.803		2.170
Commercial	0.005	0.040	0.544	0.082		0.671
Residential	0.490	0.683	0.333	0.126		1.632
Transport			2.016			2.016
Own use/ Losses			0.050	0.049		0.99
Total	**2.139**	**1.423**	**4.288**	**1.908**	**0.059**	**9.817**

Source : "Ireland Climate Change - CO2 Abatement Strategy" Department of the Environment, 1993.

Biofuel market potential, on a European and national scale, might be measured in terms of the above, as an alternative energy source. However it is important to note that RME production potential is only possible as an additional supply to oil, thereby alleviating dependency on foreign resources. It is clear that significant amounts of crude oil cannot be substituted by biofuels for many years to come. Dependency on fossil fuels is likely into the beginning of the next century. The question also remains, should they be replaced?

It would appear that an integrated cross-sectoral approach to renewable energy should be implemented, thereby reducing the risk of one source being unsustainable in the future or relying on valuable agricultural land for an energy source instead of as a food source. The Community estimate that at present renewables contribute 43 MTOE per annum or 4 per cent of the Community's energy requirement.

If all set-aside land were to be used for a variety of renewables, it has been estimated[99] that only 15 - 30 MTOE could be produced (depending on the energy systems used).

4.5.1 Fossil Fuels : Market Predictions

The future potential of market viability of biofuels will greatly depend on the fluctuations of;

- future supplies,
- future prices

4.5.1.1 Future Supplies

As a general principle, the greater the world's consumption of oil, the more there seems to be in the ground.[100] Historically, this seemingly paradoxical statement has been proved correct. In 1982, the world reserves stood at 677 billion barrels and the reserves to production ratio was 33 years. A decade later in 1992, after a cumulative production of 240 billion barrels the reserves were reported as being 1,007 barrels, with a R/P ration of 43 years.

The conclusion therefore remains that in the short to medium term new discoveries will replace oil at a faster rate than it is being used. Still large areas of the world remain unexplored. In the long-term, however, this resource is a finite one.

4.5.1.2 Future Prices

Long-term predictions of oil price changes remain a difficult task due to the volatility which has characterised the market in the past. Long -run projections in general seem to suggest unavoidable increased in oil prices which would, in turn, make biofuels more economically feasible as an alternative to autodiesel.

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99 CEC 1994, " Biofuels - Application of biologically derived products as fuels or additives in combustion engines" ,EC DGXII Science Research and Development , 1994.

100 Waterlow, J,1994 "The Evolution of the cost of fossil fuels," Proceedings from the 1st. European Forum on Motor Biofuels, "Biofuels in Europe" May 1994.

Two notable studies have been carried out on the likely future predictions of oil price levels. The CEC study " Energy in Europe' details four likely scenarios (See appendix F).

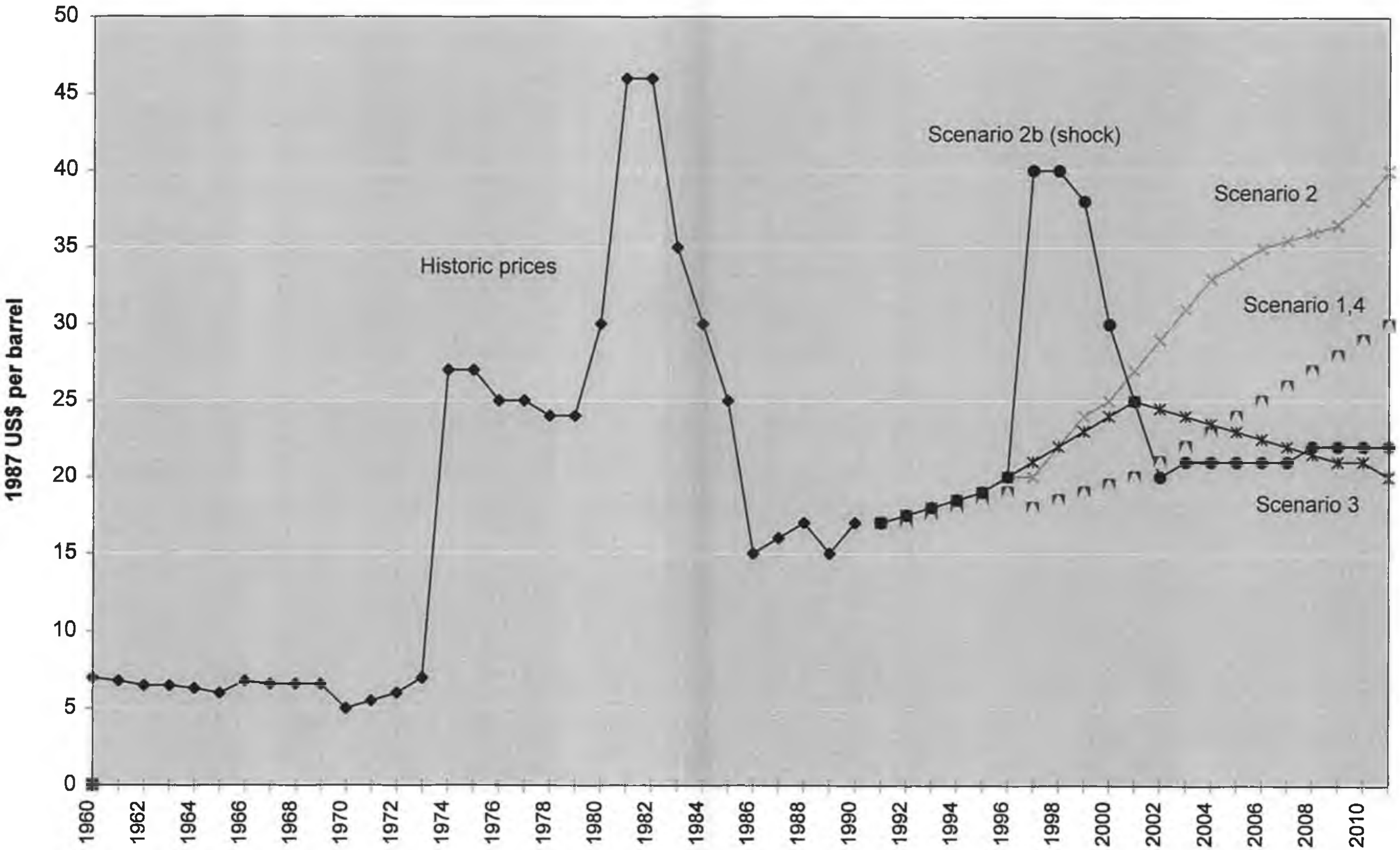
Fig. 4.4 on the following page illustrates the projected predictions under the four different scenarios. Three broad price levels emerge by the year 2010[101]

Scenario 1 :	$25 - 30
Scenario 2 :	$40
Scenario 3 :	$20

A separate shock scenario was developed in this study as a variant on Scenario 2 where prices increased to $40 per barrel in the late 1990s. It is suggested in this study that EC production is expected to decline. It also states that there is a real possibility of strong growth in oil demand in the short term, followed by a downturn should policies be introduced which reduce transport demand or emissions of CO_2.

[101] All prices are expressed in US1987$ per barrel

Fig. 4.4 : Future Oil Prices : 4 Scenarios



The second study again compiled by the CEC in 1989[102], states that some elements seem certain about the future rise in oil price. This rise in price of crude petroleum is inevitable in the short term because of;

- increasingly high production cost of crude petroleum from new deposits,
- progressive concentration of cheap resources in the Persian Gulf,
- high cost of alternative solutions.

This study asserts that this rise could occur in one of two ways;

- average prices stagnate until early 21st. century, (with little effort to limit consumption) followed by a sharp increase after this period
- and a more regular price rise, enabling the implementation of alternative solutions and energy saving measures.

The results of this study were elaborated by the French Ministry of Industry. Under the first scenario, the assumption is that sustained economic growth at 3 - 3.3 per cent, the crude petroleum market no longer operates under any cartel except the Middle East, and production costs remain stable.

Under the second scenario, the assumptions remain the same as scenario 1, but it adopts high import prices and stable economic growth of around 1.2 to 1.5 per cent. A combination of these factors results in a more stringent energy saving strategy. In this scenario, the cartel controls the market, but less stringently.

The results are proposed as follows;

Table 4.4 **Oil price predictions, French Ministry of Industry 1989**

Crude petroleum ($/bbl)	1990	1995	2000	2010
Scenario 1	15	15	20	25
Scenario 2	25	30	35	50

102 CEC 1989, Becker,J.J., CEMAGREF,"A prospective estimation of EEC agriculture from the point of view of energy production".EUR 12067 EN

4.6.0 ENVIRONMENTAL BALANCE OF RME

In assessing environmental effects of an end product, in this case a fuel, it is important not just to assess it in its end use, but also to evaluate its effect on the environment during its production and transformation. It is generally accepted however, that the most significant effects do occur during the final phase - the combustion of the fuel in the engine.

Before becoming RME the rapeseed has to be grown, crushed and transesterified, and finally combusted as a fuel. Therefore each separate stage will be dealt with separately.

4.6.1 Agricultural Impact

The most significant impact on agricultural land occurs when a new crop is cultivated on previously fallow land, resulting in increased pressure on soil resources. This pressure creates environmental problems in terms of soil depletion, effluents, pesticides and fertiliser. The more intensive the required yield, the greater the pressure on the land results. However the cultivation of rapeseed for RME is only economically viable in Europe if it is intended in the form of the set-aside programme.

- **Impacts on soil and water**

  If we are to assume that land otherwise used for continued food production is used to grow energy crops, then it seems there is effectively no change in environmental conditions of the soil. However, as energy crops such as rapeseed, have a relatively high nitrogen demand, due to the high protein content of its seed, some change may be seen in overuse of nitrogen fertiliser.[103] This could have adverse effects on the environmental balance of the final product.

[103] Jakl, T. Minister for Environment, Austria, 1994" Environmental practices concerning the production of rapeseed esters and their use in ecologically sensitive areas", Proceedings from the 1st. European Forum on Motor Biofuels, "Biofuels in Europe" May 1994

Advocates of the biofuel industry however state that soils in the EU are already contaminated with heavy metals pollutants and unfit for food cultivation[104]. However, this position is not compatible with the concept of sustainable development. When implementing new industries all aspects of environmental impact should be assessed. However, Dr. Jakl outlines two possible solutions to reducing the negative environmental impact of using nitrogen fertiliser.

1. Crop rotation: by including leguminous plants in the crop rotation system, the nitrogen is captured in the soil thereby reducing the use of nitrogen fertiliser. This makes the soil nitrogen enriched for the next crop, in this case rapeseed.
2. Photogenetic solutions: nitrogen in rapeseed is secondary to its function as a fuel, and ecologically it would be more desirable to reduce nitrogen while at the same time increasing the lipid content. Experiments have successfully been carried out on other plants, which show that it is possible to change the metabolism of assimilates using photogenetic methods. A reduction in the protein content, coupled with an increase in the lipid content would reduce the plants demand for nitrogen.

- **Impacts on soil erosion**

  An underlying assumption of this study is that energy crops will only be grown on land that has been previously cultivated. Therefore no soil erosion would occur as this is only the case when land is cultivated that was previously fallow. The use of minimum or no tillage cultivation not only would reduce soil erosion as compared to traditional cultivation but would also conserve soil as compared to no cultivation i.e. fallow set-aside.

[104] CEC 1994,"Biofuels, applications of biologically derived products as fuels or additives in combustion engines", CEC 1994 DG XII, Science Research and Development.

4.6.2 Production : Extraction and Transesterification

As illustrated in chapter II, to produce RME from rapeseed, two processes are required;

- **oil extraction**

  This process is an established industry whose environmental effects are well known.

- **transesterification**

  This process is a standard chemical process. The greatest environmental concern arises during the handling of methanol. This is a highly poisonous chemical and extremely volatile and its use requires the strictest standards.

4.6.3 Emissions : RME and Fossil Fuels Compared

Extensive tests have been carried out in Europe concerning the emission profile of RME compared to diesel. As yet, no conclusive evidence has resulted and any results that have emerged are challangeable. This can mainly be attributed to the following factors:

- diversity of tests
- laboratory conditions
- quality of RME used in tests, as no standard has been established.

A digest of recent studies and conference findings reveal that:

1. A conference held in Dublin[105], in 1993 established that there was a 'negligible' reduction in the level of CO, non methane organic compounds, Benzene and Butadiene when combusting RME. The results concerning NOx were 'questionable' and the level of CO_2 emitted was slightly improved.

[105] "Alternative Fuels for Transport Fleets" Conference proceedings, Forbairt, Dublin 1994

2. SOFIPROTEOL analysed exhaust gases from a tractor running on neat diester[106] and compared it to the emissions from pure diesel. Differentiating between esters grown on previously idle land and where energy crops have replaced food crops. The results are quantified in Table 4.5 below.

Table 4.5 **SOFIPROTEOL Emission Results**

Atmospheric Emissions (mg/l)	Combustion			
	Diesel	**RME[a]**	**RME[b]**	**%***
Particluates	1761	754	754	-57.18
CO	25884	7675	7675	-70.4
HC	5248	4020	4020	-23.4
NOx	14870	14929	14929	0.4
Aldehydes	1281	1445	1445	12.8
Organic Compounds	438	505	438	-

[a] rape grown on fallow land
[b] "energy" rape instead of "food" rape.
* % change between RME[b] and diesel
Source : p.119 "Biofuels - application of biologically derived products as fuels or additives in combustion engines" CEC, 1994.

3. M. Wörgetter, Austria, has carried out the most comprehensive tests to date. No exact details of the tests were reported, but the results show a substantial variation when compared to some of the French studies. These results are shown in the table below.

[106] Diester is a mix of RME with Diesel, when neat diester is used it refers to RME.

Table 4.6 Wörgetter : Results Emission Tests from Diesel and RME compared (g/h)

	Diesel	RME	%
CO	55	62	13.4
HC	39	21	-46.1
NO	116	123	5.9
NO2	20	24	22.6
NOx	197	212	7.9
Formaldehyde	458	456	-0.5
Acetaldehyde	445	284	-36.1
Propionaldehyde	76	52	-31.1
Acroleine	26	72	182.6

Source : M.Wörgetter,"Erprobung von Biodiesel, Biodraftstoffe für Dieselmotoren",Symposium Nr. 13982/68. 236. 1991

Worgetter also found that there was a substantial reduction in Polycyclic aromatic hydrocarbons (PAHs) when using RME instead of diesel. The percentage reduction ranges between 48 and 98 per cent (see Appendix H for details).

4. The Energy Technology Support Unit in the UK have carried out extensive studies into the feasibility of RME for the UK market. A study completed in 1992[107] details the environmental impacts. Emissions are generally reported to be much lower than those from conventional diesel on combustion, although reports on nitrogen oxides in particular are contradictory, see table 4.6.

[107] Culshaw, F.,Butler, C. 1992"A Review of the Potential of Biodiesel as a Transport Fuel" Energy Technology Support Unit, Harwell, Oxfordshire, Sept. 1992.

Table : 4.7 : ETSU: Emission Survey

SO2	CO	HC	PAH	NOx	Part.	Smoke
0 - 90 % lower	10 - 65 % lower	12 - 50 % lower	60 % lower	10 % lower to slightly higher	Lower	50 - 57 % lower

5. Körbitz Consulting, (Austria) has produced an overview of various emission tests and has reached the following conclusions.

Table 4 8: Körbitz : Emissions of RME and Diesel Compared

Emission	Results
SOx	Reduction to 0%
HC	Reductions of 30 - 46% (variable results)
CO	Results vary by test point, generally an increase of 5-10%, when using an oxy-cat, emissions reduced by 68% compared to fossil Diesel without oxy-cat.
NOx	Most tests show only a minor change in the range of +/- 5%.
PAH	In the complex analytical investigation of over 20 compounds of PAH-group, in which some compounds are considered to be either carcinogenic or mutagenic, there was clear evidence for substantial reduction in general.
Aldehydes, Aromatic compounds	Reduction of 13% For the group of Aromatics a reduction of 30% was observed; within this group the emission of Benzol increased by 32%
N_2O (laughing Gas)	Beside the emissions resulting from combustion within the engine a report of the UBA [108]included additionally the aspect of emission of N_2O, as one of the greenhouse gases, caused by biological activity in the soil when growing plants, which has to be considered, when completing a full cycle balance of emission in comparison to fossil Diesel.

Source : "Technical, Energy and Environmental Properties of BioDiesel", Werner Körbitz - Vienna, Austria.

[108]Umwelt-Bundes-Amt/Berlin/Germany.

4.7 ADDITIONAL ENVIRONMENTAL BENEFITS

There are two other areas of environmental gain from the use of RME as a fuel:

- RME results in a reduction in greenhouse gases.
- RME has nil acute oral and dermal toxicity and is rapidly biodegradable.

4.7.1 Greenhouse gases

There is an accepted commitment on a European and National level to reduce CO_2 emissions, for which motor vehicles are one of the greatest sources. A recent study[109] was made on the ecological impact of the production chain and use of RME as a fuel in comparison with fossil diesel. The results of this study show that there is a large benefit from using RME which reduces CO_2 emissions by a factor of 4.4 when compared to diesel. The study converted all greenhouse gas emissions from RME into CO_2 equivalents. This illustrates the overall benefits of biodiesel production in terms of benefit to the environment. The study involved not only gaseous emissions from the combustion of RME, but included CO_2 and other gaseous emission for each step, agricultural production, fuel transformation and combustion. The conclusion was that each kg. of RME produced and used, avoids the emission of greenhouse gases equivalent to 2.88kg. of CO_2.

In Ireland, the greatest source of CO_2 emission comes from the transport sector (19 per cent with road diesel responsible for 75 per cent of these emissions)[110] Road transport is therefore responsible for 1.24 million tonnes of carbon emission per annum. By penetrating the diesel market with 30,000t (See chapter VI) of RME, a reduction of 86,400t (7 percent of CO_2 emission from road transport) would result.

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109 Muschalek, I,Scharmer K, "The global Econolgical Balance for Engine Fuel Production from Vegetable Oils", 7th European Conference on Biomass for Energy and Environment, Agriculture and Industry, Florence, 1992.

110 Department of the Environment, "Ireland Climate Change - CO2 Abatement Strategy", Department of the Environment, 1993

4.7.2 Biodegradeability

98 per cent of RME degrades biologically in 21 days[111], whereas in the same time approximately 50 per of fossil diesel degrades, after which degradation is much slower. Risks of pollution of ground water would be greatly reduced if RME was introduced instead of fossil diesel.

111 Körbitz, W.,Walker K.C., 1994 "Rationale and Economics of a UK Biodiesel Industry" British Association for Biofuels and Oils. 1994

4.8.0 CONCLUSIONS

Fossil fuel combustion, specifically using automotive fuels, has been identified as a major contributor of pollutant emissions resulting in global warming. This warming of the earth's surface could lead to a variety of environmental disasters over the coming years. The international community has recognised this and aims to reduce CO_2 levels to 1990 levels. The question remains how is this to be done? The EU has implemented a number of programmes in an effort to introduce renewable energy into the market. Biofuels are targeted to replace fossil fuels to reach 5 per of TPER cent by 2005.

It is estimated that fuel consumption in the EU will grow by 45 per cent by the year 2010 assuming we continue to use energy at the same rate as we have done in the past. If this is to be the case then the environmental aims of the international community cannot be achieved unless a change from fossil fuels to some alternative takes place.

This study is concerned with the potential for RME as an alternative fuel to diesel. In the assessment of its environmental profile, RME would appear to be a more environmentally friendly fuel. However, the findings of a number of studies which have been referred to in this report are conflicting, and further extensive research is required. It must also be remembered that the use of RME would still contribute to pollution, but total elimination of pollution, while technically possible, is not desirable as it would be too costly. One fact remains constant throughout, that there is a substantial reduction in CO_2 emissions to be gained as a result of the combustion of RME when compared to diesel.

In the light of the future finite supplies of fossil energy, the likely future increase in price, and imminent increased taxation, a potential market exists.

CHAPTER V

CAP REFORM AND SET-ASIDE IMPLICATIONS

TABLE OF CONTENTS

5.0 INTRODUCTION

The Common Agricultural Policy (CAP) in terms of volume of expenditure and historical significance is arguably the most important EU[111] policy. During the 1980s the CAP has taken an estimated 2/3 of the EU budget expenditure and even if this share is declining it is likely to remain by far the biggest item in the EU budget during the 1990s[112].

The rapid growth in public concern over the operation of the CAP up to the 1992 Reforms, was primarily as a result of two factors :

- within the last decade it had become increasingly evident that the farming industry is capable of producing more than sufficient foodstuffs, resulting in surpluses, the disposal of which is becoming increasingly costly
- and growing international tension fuelled by increasingly high Producer Subsidy Equivalents (PSEs)[113] used in Europe, sustaining the tradition of protectionism.

This aim of this chapter is to chart the evolution of the CAP from its beginnings, to the most recent, and most far-reaching of policy measures since its inception, the reforms package agreed in 1992. Its purpose is to illustrate, primarily from an arable producers view-point, how price support and guarantee spending led to the physical manifestations of its subsequent failure : agricultural surpluses.

An analysis of the CAP reforms decided in 1992, and introduced in the 1993/4 crop year follows. The emphasis of this chapter is primarily on the introduction of the policy mechanism known as 'set-aside', a common device used in most industrialised countries to combat the existence of surplus production.

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111 Legally, the EEC (European Economic Community) changed to the EC (European Community) on the 1st of November 1993. It had been known as the EEC since 1979. The media has established the use of EU (European Union), but there is no legal basis for this.

112 CEC, 1993 "European Economy Reports and Studies No.5" CEC 1993

113 **PSEs** are a widely used, primarily by the OECD, measure to gauge the value of transfers from domestic consumers and taxpayers to the agricultural producers. It allows comparisons to be made between different countries and therefore different agricultural support policies.

Having established the basis of the operation of the CAP and its reform mechanisms to combat soaring expenditure and to prevent continued growth of surpluses, this chapter then focuses on the alternative uses of set-aside land. Traditionally, the role of the European farm has been to provide agricultural produce - in this the operation of the CAP has succeeded, while simultaneously falling victim to its own success. With the introduction of 'set-aside' the emphasis on providing food remains strong, but the opportunity to diversify the farmer's crop base has arisen, thereby enhancing agricultural resource utilisation.

Assuming a continuation of set-aside policy and a continuation of technological progress the prospects for the major factors of production - land, labour, capital - are limited if the opportunity to diversify is not embraced. There is growing concern that farmers should take up this opportunity, thereby maintaining agricultural output and its spin off industries, and opening a new door for agricultural produce - the automotive fuel industry.

As far back as 1985, the EC Green Paper[114] advocated a number of measures which was to include the non-food utilisation of EC agricultural produce. With the policy structure now in place, as a result of the 1992 reforms, 'set-aside' land can and is being used in Europe to grow raw materials for industrial use, including the biofuel industry.

These pressures prompt the conclusion that political decisions, leading to financial incentives for the development of the agricultural business are responsible for the past trends in farming. Farmers, like business men, have a responsibility to themselves to earn a living and aspire to a better living standard in response to market signals. And as these market signals are distorted by policy intervention, then more farmers will cultivate more wheat, use more fertiliser etc. Therefore, the onus is on the market signals and how they are interpreted at policy level to generate more acceptable developments in the industry.

[114] CEC 1985,"A Future for Community Agriculture", COM85, Brussels, Dec.1985

5.1.0 THE COMMON AGRICULTURAL POLICY (CAP) AND THE NEED FOR REFORM

In order to assess whether reform of the CAP and the introduction of 'set-aside' was necessary, it is helpful to look at the development of agriculture since the introduction of CAP. By doing this, a greater understanding of policy mechanisms in place can be achieved.

In the late 1950s, after the Second World War when economies were virtually ruined and agriculture had fallen back to its level of the 1920s[115], Europe's 17.5 million farmers had only 65 million ha. from which to feed a population of 150 million.[116] In contrast, the US had over 400 million ha. to feed 200 million inhabitants and the then Soviet Union over 600 million for just under 250 million inhabitants. The average farm size in the US was almost 20 times that in Europe, each American farmer could feed 50 inhabitants, whereas the European farmer could only feed 10. Europe then produced 85 percent of its food requirement.

The period which followed was characterised by intensive growth in agricultural products as Europe had to import agricultural goods to satisfy its growing needs, while the US, for example, became the largest exporter of wheat (1955 - 1960 US exported 12.2mt of wheat compared with Canada 8mt, Australia 2.5mt). The ensuing effect was that an increase in agricultural production was essential, not only for the success of European agriculture, but for the Community as a whole.

The CAP emanates from Article 39, of the Agricultural section of the Treaty of Rome, which set up the European Economic Community with the express intention of effectively establishing a 'Common Market'. The principles of the common market were applied to agricultural produce, but a CAP was also established and the objectives of this were primarily to:

- increase agricultural productivity,
- ensure a fair standard of living for the agricultural Community,
- stabilise markets,
- ensure food supplies,

[115] 1959 European wheat production regressed to its 1939 level, World Wheat Statistics, International Wheat Council, various issues

[116] CEC 1989 ,"A CAP for the 1990s" ,CEC 5th ed. July, 1989

- ensure supplies were available to consumers at reasonable prices.

In July 1958, the Stresa Conference laid down the first guide lines for the future CAP, and stressed that "*agriculture must be regarded as an integral part of the economy and as an essential factor in social life*"[117]. The most significant outcome of this was the call for an approximation of agricultural prices.

Since production costs were in general higher in the Community than in other main producing countries, prices had in many cases to be above world market level, if Community production was to be guaranteed. The aim of the Community was specifically to; achieve self-sufficiency, price stability and to protect farmers' incomes while on a global level to obtain a proper balance in its trade with the rest of the world. On this basis the Council of Ministers in 1960 adopted the principles for a 'Green Europe'. This was to be the beginning of the policy on markets and prices. Then began the gradual process of planning and implementing market organisations for the various products.

There are two fundamental bases for the operation of the Common Agricultural Policy : the policy on prices and markets regulated and determined the economic framework for agriculture while the structural policy provided selective support for the adaptation of farm structures.

Single market and Community preference have wrapped European trade in a protective cocoon of high prices and guarantee markets cushioned by border protection, afforded by the European Agriculture Guarantee and Guidance Fund (EAGGF) guarantee expenditure, with virtually no exposure to the basic principles of market trade.

[117] CEC 1985, "Twenty years of European agriculture", Green Europe, no.217, p17

5.1.1 The cereal policy : a prototype

The cereal policy was introduced in 1962 and from the outset was regarded as the model for the other market organisations, as the cereal sector constitutes a very important position within farming policy. This originates from the fact that cereals are a major competitor for premium quality land and an input to many farm enterprises i.e. animal feed market and compound feed production. In essence cereals, unlike all other agricultural products, are a key component of both agricultural output and input.[118] As a result, cereal policy decisions can have resounding effects throughout the farming Community.

The principal driving force behind the choice of a cereals policy (and a CAP) was the need to maintain farm incomes. It was envisaged that there were two ways to do this; direct financial aid or price support. The latter was chosen for a number of reasons.[119]. Primarily, price support was less expensive, in view of the number of small farmers and the resultant diversity of their economic situations, combined with the fact that it was already in practice in most Member States. Maintaining farm prices, as long as the Community was import dependent, succeeded.

Price support policies create a wedge between the world market prices of commodities and the internal domestic prices. In essence assistance is conveyed from consumers to producers. This income is provided indirectly through domestic and associated border measures, resulting in an increase in the price of the units produced.[120] The Community's cereals policy was effectively an uncontrolled commodity specific policy, delivering assistance on the basis of raising the producer price for each unit of output. This resulted in a correlation between the level of assistance and output.

Common prices and market organisations are the policy mechanisms used to guide production and, in theory, stabilise markets. Market organisations fall under four main categories;

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118 Dunne,W. "Cereal Proposals Could Destabilise CAP", Farm and Food, 1992

119 "Against the Grain? The EC cereals policy", N.F. Beard, Centre for Agricultural Strategy, Knight Frank and Rutley

120 OECD 1990, "Reforming Agricultural Policies : Quantitative Restrictions on Production, Direct Income Support.", OECD, Paris 1990.

- External protection and intervention : 70% of agricultural production including cereals, butter, skimmed milk powder, beef.
- External protection without intervention : 25% of agricultural production including eggs, poultry, and quality wines.
- Aid to complement prices :under the GATT the Community has agreed to keep its import levies at a constant level, the market organisation must do without any external protection.
- Flat rate aid :relates to a small percentage of Community production which are highly specialised in nature.

Source : CEC 1989,"A common agricultural policy for the 1990s"

The market for cereals is supported by the system classified under the first category and can be summarised as follows;

Table 5.1 : Summary of the cereal market support system

Internal measures

Support buying at an intervention price carried out by intervention agencies throughout the EC. This system should prevent market prices falling much below the intervention price. Grain which is acquired may be stored (mountains)or, with the aid of export subsidies, sold abroad.

Trade Measures

- *Import restrictions*
  A variable import levy or tax is imposed on grain imports from non-EC sources at the ports of entry into the EC. The levy is calculated so that grain cannot enter the Community at less than the threshold price. This is designed to ensure that imported grain landed at Rotterdam cannot undercut the target price.

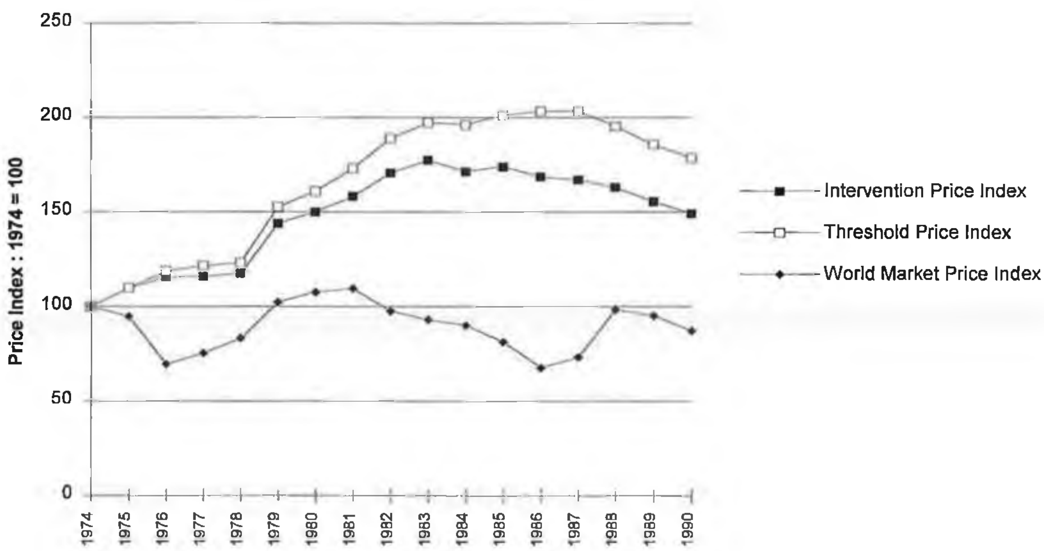
- *Export Subsidies*
  Subsidies on exports of cereals produced in the EC to enable traders to export profitability to the generally lower-prices world market.

Source : "Against the grain? The EC cereals policy", N.F.Beard, Centre for Agricultural Strategy, Knight Frank & Rutley.

The authors of the original cereals regime clearly did not envisage such rapid growth in agricultural production as occurred in member states. The CAP was not designed with adequate flexibility to address this dilemma. Continuous anxieties pertaining to the level of farm incomes maintained intervention prices above world market prices, with little or no exposure to underlying world market signals.

The mechanism to guide the cereals policy is based on a system of official reference prices providing a framework for regulation of trade in non-EC countries. The *threshold price* is used as the ceiling and governs the import arrangements, since it represents a minimum entry price, the *intervention price* is used as the floor, thereby defining a price band within which Community prices were contained, and the *target price* is designed only as an indicator for the market price.

Fig. 5.1 World Market, Intervention, and Threshold Prices Index for Cereals, 1974 - 1990



Source : International Wheat Council, Review of the World Wheat Situation, 1973/4 - 1984/5and L. Dunne, Teagasc, Sandymount.

The indices for EC support prices for cereals (intervention and threshold price indices) as illustrated above have usually exceeded world market prices by a substantial margin. The difference between the world market price index and the threshold price index reached peaks in 1976/7 and again in 1986/7. The proximity of the world market price index to the intervention price index as opposed to the threshold price index can be explained by the fact that the EU is a net exporter of cereals.

5.2.0 THE INEVITABILITY OF REFORM.

Ever since the 'Mansholt Plan' of 1968 the need for reform of the CAP has been discussed, but as Professor S. Sheehy[121] points out 'The reform of the CAP is inherently an on-going process'. The reasons for this may appear simplistic, but are vital to a flexible working CAP. The reform will, and should be an ongoing process as the economic, technological and environmental parameters of agriculture are constantly changing and inextricably interdependent. The success of the policy is therefore dependent on its ability to react to problems as they arise.

After more than a quarter of a century of CAP, the success or failure of the policy is a mixed one. The fact that the CAP was not controversial when it was first created is as a result of the fact that the ratio of agricultural production and consumption between the original six member states was originally small and because they had originally similar agricultural policies.[122] Increased production **has** secured food supplies and consumer choice **has** expanded to a wide range of goods at favourable prices. Therefore, the CAP did succeed in its original goals, however, these achievements have been attained at a high cost to the Community, both at individual (through inflated consumer prices) and budgetary level (expanding expenditure on the maintenance/disposal of surpluses).

The CAP was formulated in the 1960s, when European farming and its context were fundamentally different. The pronounced 'growing pains' of the CAP were further accentuated by the subsequent enlargement of the Community, which altered the situation on the agricultural markets, simultaneously aggravating the structural disparities within Community agriculture. Mounting farm surpluses and soaring agricultural expenditure coupled with declining farm incomes and increasing strains on world market for agricultural products exerted immense pressure for reform of the CAP.

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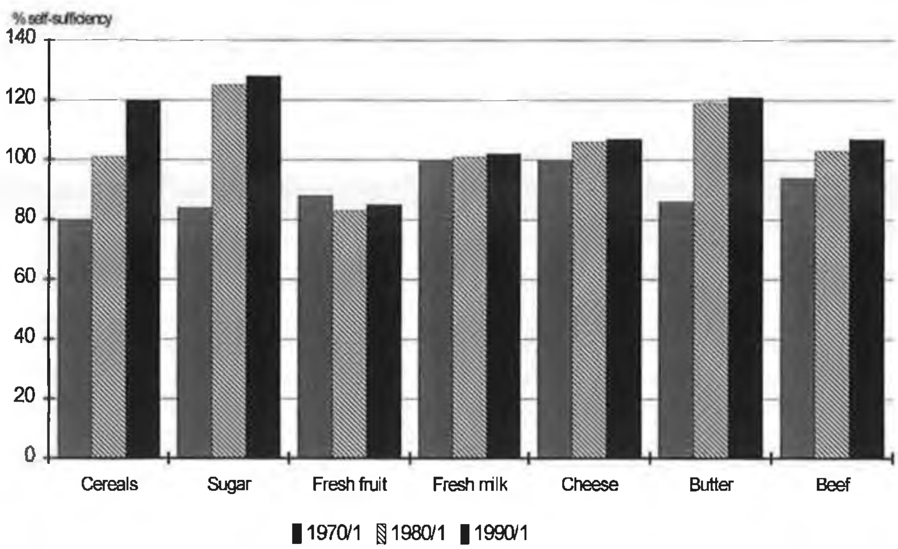
[121] Sheehy S.J. "The Impact of Reform of the CAP", NESC, April 1993
[122] CEC 1993, "The European Economy, Reports and Studies", No. 5 CEC 1993

5.2.1 The main problem : Farm Surpluses

The CAP and its policies on prices were established with a view to increasing agricultural productivity, as much of the Community food requirements were imported. Subsequently, the mechanisms within CAP were devised to meet this situation by supporting internal prices, which by their nature are tied to production while cushioned by external border protection.

The external protection and the relatively high guarantee farm prices did have that result. Within a few years, the use of modern methods of livestock and crop production had greatly increased yields in that area. The Community's degree of self-sufficiency rose substantially as production increased at a rate increasingly beyond the market's absorption capacity.

Fig. 5.2 : Degree of self-sufficiency in main agricultural products, 1970/1,1980/1,1990/1



Source : CEC, Agricultural Situation in the Community, 1972, Vol.II,1981,1992.

Economic crises and increased unemployment outside agriculture coupled with static population growth meant the growth of domestic demand continued to slow down and per capita consumption of foodstuffs had reached its ceiling in many member states. Between 1973 and 1988, the volume of agricultural production increased by 2 per cent per annum, whereas internal consumption grew by only 0.5 per cent per annum.[123]

Consequently, supply began to outstrip demand in heavily protected sectors (cereals, beef) giving rise to surpluses for which the Community had no purchasers. The world market was amply supplied with these products and effective demand in Third World countries could only absorb a comparatively small part of the surpluses, and only if the Community subsidised its exports through export refunds.

In the absence of outlets on the world market, producers had no alternative but to offer increasing proportions of their production to the intervention agencies, which were obliged to buy up these quantities at fixed intervention prices. As surpluses mounted, intervention was increasingly misused as the 'normal disposal route'. A guaranteed outlet at a guaranteed price, without any restriction made the intervention agencies an attractive alternative for many producers and processing industries. The consequences were inevitable.

Public stocks rose very quickly to high levels : in 1991 following their significant reduction in 1988 and 1989, cereals stocks rose from 12.8 million t at the end of 1990 to 16 million t at the end of 1991. Stocks of butter and skimmed milk powder, which had virtually disappeared during 1990, reached peaks of 400,000t and 500,000t respectively. The CAP had indeed achieved its objective of increasing farm production, while simultaneously becoming the victim of its own success.

5.2.2The paradox of mounting agricultural expenditure and plummeting farm income.

It has become increasingly clear that the basic principles of sound economic policy making were infringed, with ample examples to be found not only at farm level, but also at budgetary level. As far back as 1985 when the Commission adopted a Communication on the perspectives of the CAP ("Green Paper") it pointed out that "...*current trends in many sectors of agriculture are leading inevitably to a growth in surpluses*

[123] CEC 1991, “Development and Future of the CAP - Reflections Paper", 100 Final, Feb.1991.

which are becoming increasingly difficult and costly to dispose of ...the situation arose mainly as a result of the open ended guarantees which have gradually isolated farmers form market forces".[124]

The growth of farm surpluses became a heavy burden on the Community budget, storage and disposal measures took an even larger slice and brought the Community to the verge of insolvency. It would appear that the disciplining of out of control spending was only introduced when the EC finances were strained. Community enlargement and soaring expenditure are the two principal changes since the inception of the CAP, and major contributors to its virtual collapse.

Included in the original six Member States of the EEC were major exporting countries i.e. France and the Netherlands. Expanding into a protected Community was therefore a vital incentive for membership. As major exporters, additional receipts were received as a result of higher prices. Thereby giving already rich exporters good reason for dismantling their trade barriers.

In 1973, three additional countries joined the EEC. Ireland and Denmark joined for access to the high priced agricultural markets. The UK however, was a net importer of agricultural products and consequently was not accustomed to the high agricultural price levels prevailing in the European market. Traditionally the UK imported food not of Community origin. This resulted in increased food prices for UK consumers as a consequence of entry to the EEC. At the same time payments by the Community for agricultural export restitutions and intervention purchases went to those member countries which were net exporters, resulting in a policy which was perceived as being unacceptable and inequitable.[125]

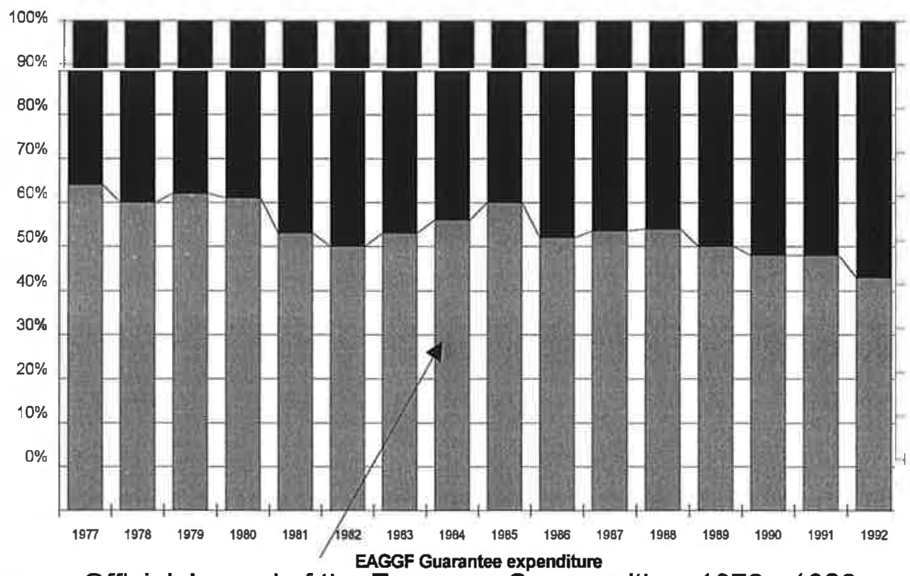
The second important change responsible for budget pressure on CAP reform was as a result of continuous increases in agricultural productivity. Two thirds of the Community budget have been steadily poured into agricultural market support, to the detriment of other Community policies, which had to be pruned to a minimum due to the

[124] CEC 1985 "A Future for Community Agriculture", Com 85, Brussels, 18th Dec.1985

[125] Marsh, J. "Can Budgetary Pressures Bring CAP Reform?", European Institute of Public Administration, Working Papers, ed. J.Pelkmens.

tight budgetary situation. From 1975 to 1988 EAGGF (European Agriculture Guarantee and Guidance Fund) increased sixfold, and constituted 64% of total budget expenditure. In 1990, it represented 58% of all expenditure, or circa. 0.6% of Community GNP.

Fig. 5.3 : EAGGF Guarantee expenditure as a percentage of total budget expenditure, 1977 - 1992

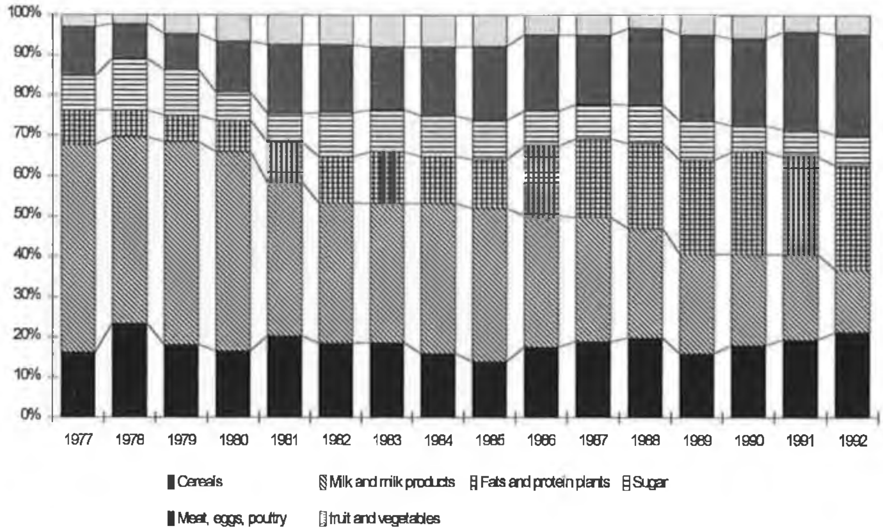


Source : Official Journal of the European Communities, 1978 - 1993

Despite the increasing volume of resources devoted to it the CAP still failed to improve or even stabilise farm incomes consistently. The apparent contradiction is explained by the failure of market support spending. In 1987 almost one half of the EAGGF expenditure was taken up by schemes solely concerned with storage and disposal of surpluses. In addition, large subsides were granted, for instance, to reduce the price of milk products to a level at which they could be sold on the Community markets. 49 per cent of all expenditure went towards the storage of unsaleable surpluses. This situation improved in later years with an upturn in world trade and a short term scarcity of supplies was created by the 1988 North American drought

Expenditure on cereals market support constitutes the second largest budget outlay by commodity after milk, as can be seen from the breakdown of EAGGF Guarantee spending from 1977 to 1992, and amounting to 18 per cent in the 1992 budget.

Fig. 5.4 : Cereals and other agricultural commodities as a percentage of EAGGF Guarantee expenditure, 1977 - 1992



Sundry items include : Agri - Monetary measures (compensatory amounts and different exchange rates), other markets, and clearance of previous years accounts.
Source : Official Journal of the European Communities, 1977 - 1993

As well as the weighty criticisms of the cost of maintaining CAP and the resultant instability and inefficiency of the world market, the CAP has also failed in one of its primary objectives : raising the relative incomes of the agricultural sector.[126]

The critical economic variables for the farmer are the demand for and supply of agricultural goods. As a result of protectionist policies previously implemented by the CAP supply grossly outstripped demand forcing a downward pressure on prices paid to the farmer and on incomes. The popular debate argues that the CAP is not interested in the small farmer, and does little to support incomes and arrest decline in remote rural areas. The bulk of the benefits went to large efficient farmers who paradoxically produced most of the surpluses. This is because larger farmers have the ability to offset declining unit margins by increasing productivity, the example is given that, 6 per cent of cereals farms account for 50 percent of surface area in cereals and for 60 percent of production; 15 percent of dairy farms produce 50 percent of

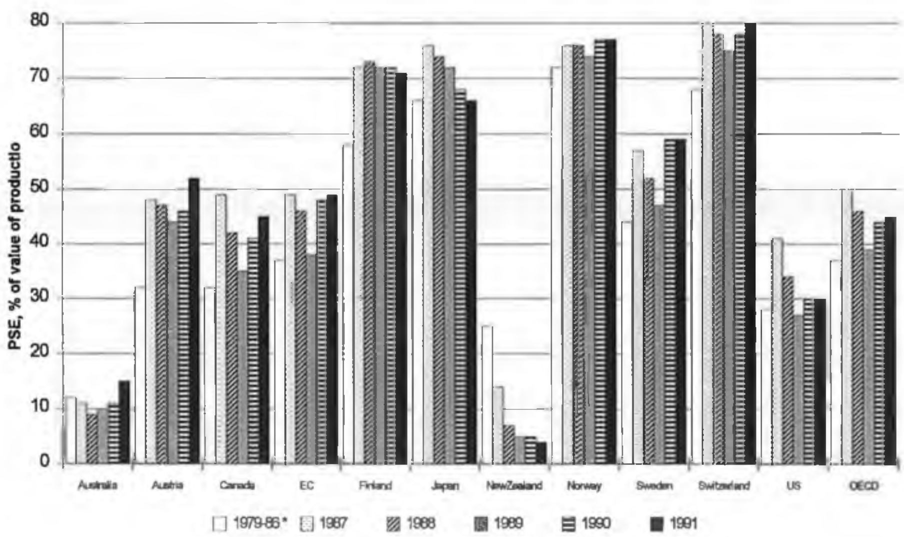
[126] Bowers J. 1990,"The Consequences of declining support for agriculture", Agriculture and Rural Land use : into the 1990s, ESRC, 1990.

beef cattle. The resultant effect being that 80 per cent of support is devoted to 20 per cent of farms.[127]

5.2.3Growing international trade tensions

Farm surpluses are not only a heavy burden on the efficient operation of the CAP and Community budget; with the advancement of time, they have developed into an encumbrance on Community international trade relations. Agriculture has long been the subject of trade disputes due to its long established tradition of protectionism with producers in almost every country receiving support. Producer Subsidy Equivalents (PSEs) are a measure of the value of transfers from domestic consumers and tax-payers to agricultural producers.[128] The figure below illustrates the level of PSEs or assistance afforded to each country, from 1979 to 1991.

Fig. 5.5 : **PSE as a % of value of production for OECD countries**



Source : OECD Statistics on member countries ed. 1990,1991,1993,"The resistance to agricultural reform, G. Viatte and C. Cahill, OECD Observer, 171, August/Sept. 1991.

In 1991 the OECD average PSE as a percentage of production was 45 per cent while the EC average amounted to 49 per cent. The

[127] CEC 1991, "The development and future of the CAP - reflections paper", Feb.1991

[128] Viatte, G., Langer, F. 1990,"Agricultural Reform : A hesitant start", OECD Observer, 165, August/Sept. 1990

corresponding US PSE as a percentage of production amounted to 30 per cent. During the 1976 - 1986 period the OECD average and the EC average amounted to 37 per cent while the US equalled 28 per cent.

As long as stocks and storage costs were not completely out of control, the Community relied on increasing its exports to non-member countries. However even on world markets, there could only be a limited demand for such an ever increasing abundance of agricultural produce. Although many east European countries have substantial import requirements, their foreign-exchange resources are grossly insufficient for them to import farm products on a large scale.

By the mid-1980s world markets for farm commodities had become completely destabilised, due mainly to soaring production in most industrialised countries. Under the pressure of increased surpluses, there was a sharpening of competition for markets; world market prices dropped and reached an all time low in 1987. This resulted in increased tension between major farm commodity exporters.

5.3.0 GATT AND OILSEEDS

The discussion now turns to a different dimension of policy issues and includes a synopsis of the historical trading environment for oilseeds, oils and meals. The importance of this is reflected in three ways; Community enlargement to include major oilseed producing countries which further strained international relations, the involvement of oilseeds in the final agreement of GATT at Blair House and the resultant limitations on oilseed production in the EU.

Distortion of the international trading environment results largely from the operation of national trade policies, usually driven by domestic political and economic imperatives. Among industrialised countries oilseeds and oil meals enter duty free whereas a progressive duty is levied on vegetable oils (the rate rising with the degree of processing in order to protect domestic crushing and processing industries); such duties are bound by GATT provisions.

The operation of CAP was a major source of distortion in the world oilseed market. Traditionally the EEC has been an importer of meals and oilseeds. However it had become a significant exporter of temperate vegetable oils - rapeseed oil and soybean oil. In 1986, the EC threatened to restrict the import of duty free animal feeds in an attempt to curb the non-cereal feed ingredients which were displacing domestic grain. Under the threat of US retaliatory action on wines and cheeses, the EC agreed to guarantee a minimum purchase of non- EC animal feedstuffs. The EC oilseeds policy has its roots directly in the US embargo of soybeans in the early 1970s. The threat of this embargo reminded politicians just how dependant they were on imported supplies of animal protein from the US. As a result EC policy was directed at securing domestic production of protein meal rather than to producing vegetable oil. The policy implemented a programme of generous price supports. The intervention system set the intervention price for oilseeds, at which the authorities undertook to buy all EC grown oilseeds.[129]

To enable high priced domestically produced oilseed to compete with imported seed, a subsidy was paid to compensate crushers for using the higher priced locally grown seed, providing them with a financial incentive to prefer locally produced to imported oilseeds.

The rate of subsidy was high, generally representing half of the producer price of rapeseed. Furthermore, the meal content of rapeseed is fairly low; so a policy designed to boost EC production of a protein meal resulted in surplus production of rapeseed oil.

Spain and Portugal joined the EC in 1986, which further strained trade relations between the Community and the US. Prior to joining the EC, the Spanish domestic olive oil market was heavily subsidised by the government. Spain also imports large quantities of soybean for processing for soybean meal to sustain its livestock industries. Because of the olive oil situation this resulted in surplus soybean oil.

The Uruguay Round of the GATT between the US an EU was originally launched in 1986. The main objectives of this round were to remove

[129] Howard B.," Oils and Oilseeds to 1996 : The new patterns of supply and demand" Special Report No. M703, The Economist Intelligence Unit, 1993.

tariffs, taxes and other subsidies on agricultural products, thereby entering into a freer trading environment. At the commencement of the talks, the US and the EU adopted opposing positions in relation to agriculture. The US wanted total elimination of subsidies and the EU wanted rectification of trade distortions allowing internal trade support measures to be dealt with at a later stage.

By October 1989, after a breakdown in 1988 in Montreal, details of each sides bargaining stance emerged. The Blair House accord of the Uruguay Round of talks, appealed to the EU as some important measures were included. The most important of these deals with internal support measures. Compensatory payments, a crucial component of the CAP reform are not included in compiling the Aggregated Measure of Support (AMS). The importance of this can be illustrated by a brief summary of the Blair House agreement.[130]

Table 5.2 Summary of the Main Features of the Blair House Accord.

Internal support	Import access	Export competition
• 20% reduction in AMS 1994 - 2000 vs. 1986-88	• 36%reduction in tariff equivalents 1994 - 2000 vs. 1986-88.	• reduction in subsidised exports 1994 - 2000 vs. 1986-88.
	• increase in minimum import opportunities from 3% to 5% of domestic consumption.	

Source : Boyle, G."Bleary-eyed and Blair- Housed : some reflections on the GATT",Dublin Economic Workshop, Annual Policy Conference, Kenmare, October 1993.

[130] Boyle.G, "Bleary-eyed and Blair Housed", Dublin Economic Workshop, Annual Policy Conference, Kenmare, October 1993

5.3.1 Blair House Accord and the Consequences for a European Biofuel Industry

A common organisation for oilseeds was established first in 1966 (under the Treaty of Rome Council Regulation 136 of 1966), aiming mainly to encourage self-sufficiency, especially in meals, by encouraging domestic production. Subsequent enlargement of EC membership and production and use of oilseeds have meant that a number of changes have been made to the support arrangements over the intervening years. 1993 saw the introduction of the three main oilseeds into the Arable Area Payments Scheme.[131]

The source of various breakdowns (1990 and 1992) and an impending trade war, was non-resolution of the then outstanding dispute over the oilseeds. The Uruguay Round was completed and full agreement was reached in December 1993. The Blair House Agreement, defines limits in oilseed acreage for the EU[132] to 5.128 million ha. (average of the years 1989 - 1991).

One element of this agreement has the potential to limit the use of set-aside land for non-food use. Clause 7 of the EC - US Memorandum of Understanding imposes a limit of one million tonnes of by-product from rape, sunflower and soya grown on set-aside land and expressed in the form of soya bean meal equivalents. On the basis of current yields, this limitation would equate to approximately 800,000ha. of rapeseed (or 1.6 million ha. of sunflower). The Commission estimates that the area in the EU used for non-food crops was 685,000 ha. in 1994 this limitation could pose problems in the near future.

[131] Oilseeds are now considered arable crops and eligible under the arable area payments scheme. Compensatory payments will be paid to producers of cereals, oilseeds and protein crops to recompense producers for a reduction in prices. CAP Information Series,"Tillage Crops : EC Arable Area Payments

[132] EU 1993/355 L147 18th June 1993

5.4.0 The Reform of the CAP and the Potential for a Biofuel Industry

In May 1992, after several months of negotiations, the EC ministers for Agriculture reached a political agreement on the reform of the CAP, heralded by the then, Commissioner for Agriculture Ray Mac Sharry. The reforms addressed the issues of agricultural surpluses and attempted to achieve a more rational pattern of production. These reforms were to be phased in over the marketing years 93/94 and be fully implemented by 1995/96. This study is concerned with the cereals regime, therefore for arable producers (cereals, oilseeds and protein plants) the various elements in the reform package will have limiting effects on production.

The principal tenets of the reform of the cereals regime, which is the most far reaching in the entire reform package, include a mixture of two basic policy instruments: supply control and price reduction.

Specifically this included,

- 29 per cent price reductions
- withdrawal of the co-responsibility levies in 1992/93
- abolition of stabiliser mechanisms
- decoupled (not attached to production) compensatory payments
- set-aside requirements.

In 1987, roused by the concerns about trade tensions and the economic cost of agricultural assistance and protectionism, the OECD Council of Ministers undertook to implement a reform of agricultural policies. It stated "*The long-term objective is to allow market signals to influence by way of progressive and concerted reduction of agricultural support, as well as by all other appropriate means, the orientation of agricultural production; this will bring about a better allocation of resources which will benefit the consumers and economy in general.*"[133] The ministers agreed " *on the supply side, to implement measures which, by reducing guarantee prices and other types of production incentives, by imposing quantitative production restrictions or by other means will prevent any increase in supply*"

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[133] OECD, Press Release : Council of the OECD at Ministerial Level, PRESS/A(87) 27, Paris, 13th May, 1987.

Although the 1992 reforms have introduced some major changes to the CAP, the opportunity was not taken to reshape some of its basic mechanisms and principles, such as common prices. Although a price reduction has been introduced the double pricing system stays in place. It has been suggested that the system introduced tackles the symptom - over production rather than dealing with the cause - high prices and protection levels.[134]

5.4.1 Price Reduction

Expenditure on cereals has varied from year to year, due directly to world price fluctuations, generally accounting for between 10 - 20 per cent of total EAGGF spending. In 1992 cereals as a percentage of EAGGF spending amounted to 18 per cent which constitutes the highest category of expenditure in 1992[135] see **Fig. 5.4.**

The prices fixed by the Council for all cereals are to be reduced as follows over the three year period 1993/4 to 1995/6 :

Table :5.3 Cereal Prices 1993/4 - 1995/6

Year	Target Price ECU/t	Intervention Price ECU/t	Threshold Price ECU/t
1993/4	130	117	175
1994/5	120	108	165
1995/6	110	100	155

Source : CAP working notes 1994, Cereals, EC v1/1159/94 - EN.

The proposed phased reduction to 100 ECU target price is integral to the 1992 reforms. This is a proposed indication of "expected world market prices, on a stabilised world market." Henceforth, the function of the target price is now to provide a basis for compensation payments to arable producers. This will directly affect the incomes of cereal producers. The basic principles of the common organisation will remain the same; that is, the double pricing system remains in place but the price band fluctuations will be reduced.

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[134] OECD 1990, "Reforming Agricultural Policies : Quantitative Restrictions on Production, Direct Income Support", Paris 1990

[135] Official Journal of the EC, 1978 - 1993

By implementing a scheme of price reductions the Reforms will allow partial exposure to market signals and in the long - run ease the journey towards trade liberalisation within agricultural markets. Consumers also benefit from lower prices. The 1992 Reforms introduced a system of price reduction coupled with direct income payments to farmers, in the form of compensatory payments.

5.4.2 Direct Income Support

Direct income support is a mechanism used by the Commission, which relates to budget-financed income transfers made directly to individual farmers. The main advantages of direct income support as an agricultural support mechanism is that it can be targeted at specific farmers whose situations are deemed to warrant such payments[136]. For example in the 1992 Reforms, compensatory payments are paid to arable farmers to recompense farmers for the 29 percent reduction in cereal prices. The focus of direct income support is in sharp contrast to price support policies as it is detached from the commodity and its production.

Compensatory payments are not the first measure of direct income supports to be introduced into the Community. Since 1975 direct income support has been given to farmers in less favoured areas to compensate for the higher costs involved in farming in difficult areas. The Community has also implemented measures to encourage elderly farmers to retire by means of annuity payments. The differences between these measures and the current compensatory measures are primarily that they are tied directly to production, as claims can only be made if land is 'set-aside' and it would appear that the Community are implementing a change from price support system to direct income support as a major policy mechanism.

5.4.3 Supply Control : Set-aside

The introduction of measures that attempt to control supply has been one of the most frequently used policy instruments to combat the

[136] Legg, W." Direct Payments for Farmers?", OECD Observer, No. 185 December 1993/ January 1994.

persistence of surpluses in OECD countries[137]. The theory behind the set-aside principle lies in the assertion that farmers are offered incentives not to use land unlike the quota system which penalised farmers for over production. The main policy objective of the set-aside principle currently implemented in the EU, is to reduce cereal over production. Other objectives include environmental and ecological improvements, diversification of agricultural crop base, and advancing the process of structural change in agriculture i.e. changing the distribution and size of farm structures.

5.4.3.1 Set-aside schemes in practice

The USA has been taking land out of production since the 1930s. However, set-aside schemes in the USA in the 1930s were more related to soil conservation than reducing surplus production. The 1933 Agricultural Adjustment Act evolved from the problems of soil erosion which led to the more comprehensive 1936 Soil Conservation and Domestic Allotment Act which paid farmers to shift land from soil depleting crops which were in surplus into soil conserving legumes and grasses. During the 1950s the Soil Bank Act had the dual effect of creating an acreage reserve and a conservation reserve. The acreage reserve as its name suggests, was introduced to curb production of certain agricultural products i.e. maize, peanuts etc. The uptake of the scheme was low, and it was discontinued the following year.

The Conservation reserve, again as its name suggests was concerned with putting agricultural land to conservation uses. In short it entailed long term retirement of land. This scheme was eminently more successful than the acreage reserve. However, the type of land that went out of production was mainly of poor quality. Considerable opposition was encountered due to the considerable rural depopulation which followed. The Cropland Conservation Programme was introduced to succeed the Conservation Reserve Programme. In this instance farmers were enticed to switch permanently from crops to grazing and grass. Considerable opposition again resulted from livestock farmers who complained that arable farmers were being subsidised to keep livestock. In response, under the provisions of the 1965 Food and Agriculture Act

137 C.Cahill, G.Viatte "A fallow year for agricultural reform", OECD Observer, 1991

land was shifted from arable farming to conservation and recreation activities. Neither cropping nor grazing were allowed. The scheme suffered eventually from financial difficulties, and the legislative emphasis shifted from farm retirement to farmer retirement.

The Food Security Act, of 1985 introduced an arable diversification scheme, with both supply reduction and conservation objectives. Again there were two programmes introduced. The Acreage Reduction Programme (ARP) and second the Conservation Reserve Programme (CRP). The ARP pays farmers deficiency payments if they agree to take a specific percentage of their land out of production. A compensation based on the estimated net return is also paid. Again the CRP is targeted towards long term retirement of the land using 10 year contracts.

The Canadian LIFT programme (Lower Inventory For Tomorrow) was an emergency programme, introduced in 1970, to reduce agricultural supplies. This programme aimed to take 22 million acres of prairie out of production by offering farmers payments for putting land into summer fallow. The encouragement given to diversion into forage production corresponds to the aim of developing the fed-livestock sector while controlling wheat production.[138]

Japan has also tried to divert land out of rice production, but rather than see it idled, the authorities tried to encourage the growth of perennial crops such as fruit trees, as Japan is less than self sufficient in most other food stuffs.

[138] All the examples of 'set-aside' schemes have been extracted from OECD 1973,"Supply Control in Agriculture", OECD Paris 1973.

5.5.0 THE COMMUNITY'S SET-ASIDE PROGRAMME

In 1988, the Council of Ministers agreed to commit itself to a set-aside scheme which was binding on all member countries except Portugal which was given until 1994 to initiate their arrangements.

The reforms changed the basis of support from a commodity basis to a land areas basis, with the expectation that commodity prices would fall to a world market price[139]. Three policy objectives have been identified for the implementation of a set-aside scheme;

(i) Set-aside may be a means of meeting environmental/ecological objectives.
(ii) Set-aside may be designed to assist the process of structural change in agriculture.
(iii) In a situation where surpluses are a problem, set-aside may be used to reduce production.

Originally the set-aside rate was fixed at 15 per cent for rotational set-aside i.e. the land should be rotated around the farm over a period of six years. From the 1994 harvest year the new arrangements came into place and producers could set-aside between 15 per cent to a maximum of 50 per cent (Ireland set its maximum at 30 per cent). A further measure was introduced that provided for a voluntary non-rotational (fixed) set-aside at a minimum rate of 20 per cent. For the 1995 harvest the Council of Agricultural Ministers has agreed to reduce the rates to 12 per cent and 17 per cent for rotational and fixed set-aside respectively.

5.5.1 Set-aside conditions and permitted uses

Set-aside land may be used for the provision of materials not primarily intended for human or animal consumption. Accepted crops and end-uses are contained in Appendix I.

There is a wide range of annual and perennial crops permitted under the regulations, but the one of most interest to Irish producers are oilseed rape (for the production of RME) and sugar beet (for the production of Bioethanol) and short rotation forestry.

[139] British Association for Biofuels and Oils, "Rationale and Economics of a BioDiesel Industry", The Home Grown Cereals Authority, April 1994.

The regulations surrounding the cultivation, production and processing are strict. One of the most important of these regulations being that the value of the non-food end products (in the case of oilseed rape production the value of the fuel) must be greater than the value of all the by products (glycerine and animal feed) destined for human or animal consumption.[140]

Most of the cereal production undertaken in Ireland (circa. 80-90 per cent)[141] incorporates a farming system that includes both crops and livestock . Unlike European farmers, production is not geographically segregated. Under the management rules of set-aside[142] it is possible for producers to use set-aside land to produce forage or grazing out side of the set-aside period and yet remain within the rules, i.e. still receive the set-aside payment.

The areas on which compensation was claimed and the areas set-aside in the Member States (with the exception of Portugal) during 1993 and 1994 are:

Table 5.4 : Set-aside areas in the EU, 1993 - 1994

,	land under crop ('000) ha.	Area set-aside ('000) ha.
1993	44,393	4,543
1994	46,509	5,868

Source: Muldowney, J. "CAP Reform and set-aside issues", Proceedings of conference - Renewable energy and economic development, 1994, Galway, Ireland

Agricultural food production must remain a priority for EU farmers, and legislators. Attention must be given to maintain the optimum balance between surplus and required food production.

The Commission estimate that the areas in the EU used for the production of non-food crops was approximately 265,000 ha. in 1993

140 "Tillage Crops - EC Arable Area Payments - Implications for cereal producers", CAP Information Series, Teagasc, Department of Agricultural and Food, 1994.

141 W. Dunne, Teagasc estimates that 80 - 90 per cent of land under arable farming also incorporates livestock.

142 Commission Regulation (EEC) No. 2594/93, Article 3 (4).

while in 1994 it amounted to 685,000 ha. [143] This amounts to 160 per cent increase in the amount of land that was used to develop crops for non-food use in the EC.

5.5.2 Set-aside in Ireland and the potential for a biodiesel indusrty

In 1993, set-aside payments were made by the Department of Agriculture for circa. 27,000 ha. in the Republic of Ireland. In the same year 1,200 ha. were set-aside in Northern Ireland. In 1994 the figure rose to 36,000 ha. a 35 per cent increase due primarily to two reasons;

- increase in set-aside payments and
- increase in set-aside land.

5.5.2.1 Increase in set-aside payments

There are two schemes relating to the payment of area aid : the General Scheme and the Simplified Scheme. The general scheme is open to all arable producers irrespective of area sown, but requires a proportion of land to be set-aside (15 percent in 1994, 12 per cent in 1995). The Simplified Scheme is confined to those producers claiming compensation on a maximum of 15.13 ha. of cultivated land.

There is an increasing economic incentive for producers to enter the General Scheme as grain prices decline in line with the CAP reform and set-aside payments increase. The incentive to use the Simplified Scheme ceases to exist leading to a probable increase in the area under the General Scheme resulting in an increase in the set-aside area. [144] A cereal producer in 1994 will receive £338 per ha. to set-aside land but will only receive area aid £207.78 per ha. if he/she grows a crop. Therefore a gross margin of at least the difference between the two payments is required before the producer would consider growing the crop.

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[143] Muldowney, J."CAP Reform and Set-aside Issues", Proceedings from the Conference " Renewable energy and Economic Development", Galway, 1994.

[144] The implications of CAP reform for Irish Feed Grain Market " W.Dunne, J.O'Connell, Rural Economy Research Centre, Teagasc

5.5.2.2 Increase in set-aside acreage.

Initially a 15 per cent set-aside requirement was implemented for larger tillage farmers (greater than 15.13 ha.). Non-rotational set-aside was introduced in 1994, with a requirement of 20% for 1994. More recently the EU Council agreed an option to allow producers to voluntarily set-aside up to 50% (level to be decided by each Member Government) of their cereal growing area.[145] In 1994, the Voluntary Scheme puts a ceiling on set-aside for the Republic of Ireland to 30% of the arable area. It will be economically logical for producers to transfer land from production into set-aside as long as the difference between receipts from set-aside and areas aid payments exceed the market based gross margin i.e. as long as the net aid payment exceeds the market based gross margins.

5.5.3 Potential for an RME industry in Ireland

In 1993, 27,000 ha. of land were set-aside in Ireland. In 1994, 36,000ha. were set-aside. In theory all of this land would have been available for the production of rapeseed for non-food use. The figure for 1995 is likely to be slightly less due to the reduction in rotational set-aside to 12 per cent. In practise some of this land is put into fixed set-aside and therefore most likely will not be used for the production of non-food use. With this in mind, it is likely that the area available for 1995 for the production of rapeseed for non-food use amount to between 20,000 to 25,000 ha. (this figure does not take account of farmers who choose to graze their livestock on 'set-aside' as it is unquantifiable at present).

Little or no use has been made so far in Ireland of set-aside land for the production of crops for non-food use. A small project involving 500ha. of oilseeds was undertaken in Leinster in 1994. In addition, Teagasc have undertaken a project involving the use of biodiesel as an alternative to diesel initiated in May 1994, (see Chapter III, section 3.2.7).

145 "Arable Area Payments Scheme : Forms of Set-aside", Department of Agriculture for Northern Ireland, 1994.

5.6.0 Conclusion

The CAP was introduced when the agricultural situation in Europe required a policy mechanism that would create a situation of agricultural self-sufficiency. Its primary aims were : ensuring adequate food supplies at reasonable cost to the consumer and ensuring a fair standard of living for farmers. Overall, the CAP was successful in providing adequate food supplies, however, it failed in its ability to react to market signals. The operation of the cereals policy (and the CAP) was characterised by a price support mechanism which, at the time of its inception was perceived to be the most efficient and equitable to deal with the problems at hand. As long as the Community was import dependent, it succeeded to a certain degree. Its success was characterised by an increase in agricultural productivity, its partial failure was physically evident in surplus production, excessive budget spending to maintain the former and falling agricultural incomes.

The CAP was reformed in 1992. As part of the reform package, 'set-aside' regulations were introduced to combat surplus cereal production. To this end, it has been successful in reducing the levels of cereals produced. By introducing this policy mechanism the Community has also given European farmers the choice of diversifying their agricultural crop base to include crops for 'non-food' use. Permitted uses include the production of rapeseed to be used in the production of alternative fuels.

Due to the management regulations for 'set-aside' land, a potential RME industry may be prohibited, as the structure of farming in Ireland is mainly mixed (i.e. livestock and crops). Under these regulations a farmer may at certain times of the year graze his livestock on 'set-aside' land and still remain eligible for payments. This appears to be a contradiction, in terms of the theory behind 'set-aside' (i.e. to reduce surplus production).

The final conclusion that arises from this chapter concerns the limitations to an EU biofuel industry. Under the Blair House accord, EU 'non-food' rapeseed production is limited to 0.8mt. In 1994, 0.68mt. of RME was produced, and it is likely that production in 1995 will be greater. Consequently further negotiations will have to take place to determine the EU limit for RME production.

CHAPTER VI

RME : A MACRO-ECONOMIC EVALUATION

TABLE OF CONTENTS

6.0 INTRODUCTION

The aims of this chapter are;

(i) to illustrate, using 1993/4 data, the implications of leaving agricultural land idle as opposed to cultivating energy crops (rapeseed), within the 'set-aside' regulations, in terms of employment, added value, import substitution and fiscal effects.

(ii) to demonstrate in financial terms, how a reduction in excise duty on biofuels to 10 per cent of the mineral oil rate, would mean an increase in net macro-economic gain.

Most research in Ireland into the production of fuels from the agricultural sector has concentrated on the production of biomass from short rotation forestry (SRF). The production of fuels from conventional crops with emphasis on ethanol and methanol is now a priority.[146] The advantages of having such a renewable energy resource derived from agricultural production include the following:

- maintenance and creation of employment,
- use of a renewable energy source,
- improvement in the balance of payments,
- reduction in environmental cost of energy consumption, by reducing certain pollutants,
- helping to maintain rural communities.

[146] Dunne, W. Kileen L.,1989" Impact of renewable derives fuels on energy and agricultural sectors", CEC 1989

6.1.0 BACKGROUND, METHOD AND ASSUMPTIONS

6.1.1 Background

The French company, FERE Consultants, carried out a macro-economic study in May 1989, updated in January 1992, for the French economy by defining a comparative framework which incorporates a RME production facility and one which does not. Specifically, they computed the net economic effects of a diester[147] production facility, of 20,000t and 100,000t, in terms of its effect on distributed added value, imports, job creation, tax revenues and social contributions.

In response to the set-aside restrictions, France has commenced the production of biofuels. It was estimated that in 1992, 18 per cent of all French industrial capacity was lying idle, and as M. Levy[148] stated in his summary report to the Prime Minister of France on the subject of biofuels;

"Farmers are not accustomed, as are industrialists, to leaving a certain amount of their capacity unused, and the figure of 15 per cent which this 1.5m ha. represents is therefore a considerable sentimental and emotional shock for the farming community."

There are few policy options for the development of energy from agricultural production which do not involve introducing financial incentives of one kind or another. A critical factor in determining the future of biofuel production is the extent of budgetary support necessary. From the action taken by the French Government, with the inclusion in the Finance Act of 1992, which states that biofuels are exempt from the tax usually imposed on imported oil products when used in public transport, it is clear that there is a definite political will to see biofuels succeed. Such a fiscal policy mechanism is the incentive needed to secure the introduction and future success of biofuel production in Ireland.

The transformation costs used in this study are taken from the accounts of the French production facility of ROBBE near Compiegne. This

[147] 'diester' is a mix of RME and diesel - Sofiproteol created it and hold the exclusive license for the know-how and the patent.
[148] M. Raymond H. Levy, former Chairman, Renault.

production unit has been in operation since December 1992, and has a capacity of 20,000t per annum.

6.1.2 Method

The method used throughout this report to calculate the net macro-economic effect of having a RME production facility in operation, is based on a comparison of two schemes, an RME scheme and a Reference scheme.

The "**RME Scheme**" relates to the whole rapeseed production channel where rapeseed is grown on set-aside land, then crushed on the national territory producing rapeseed oil and meal. The raw oil is then processed with methanol in a 'transesterification' process, producing rape-methyl-ester, glycerine and fatty acids. The entire process is carried out within the state. The assumption has been made that the land used for rapeseed growing would otherwise lie fallow.

The "**Reference Scheme**" appertains to the situation that currently exists in Ireland, diesel is the only fuel used in diesel engines. All diesel used in Ireland is derived from imports, either in its ready to use state or in the form of crude oil refined at Whitegate, Co. Cork. Animal feed is also imported. About 34,000ha. of land would lie idle on a continuous basis under the set-aside scheme.

Using this method of comparative analysis, the economic, employment and fiscal effects of one ton of ester production are evaluated compared to the national equivalent of diesel oil obtained with imported raw materials.

The chapter is divided into four sections as follows:

(i) Employment created
(ii) Distributed added value
(iii) Import substitution
(iv) Fiscal Effects

6.1.3 Assumptions

General (1) Consumers pay the same price for RME as conventional diesel. Assume that RME is exempt from 90 per cent excise duty (see Appendix J, for breakdown of retail price of diesel).

(2) In economic terms, additional produced added value from a resource that would otherwise lie idle, creates the conditions for an increase in direct employment, and for the farm sector, rapeseed cropping on set-aside land maintains jobs that would otherwise disappear.

(3) Throughout the following discussion, it has been assumed that the optimum plant size capacity for a RME plant in Ireland would be 30,000t. This assumption has been made as a result of the set-aside area 34,000 ha. (11 per cent of arable land) which could produce 30,000t of raw oil for the RME industry.

(3) In the Reference scheme, it is assumed that RME produced on the national territory will not impinge on the macro-economic dimension of the oil refinery industry.

Densities (1)

Ester density	=	0.883 kg/lt
Diesel oil density	=	0.84 kg/lt

Production (1) Reference scheme

All diesel consumed in Ireland is, for the purpose of this report imported.

(2) RME scheme

(a) Crushing Phase

1t of rapeseed → 0.4t rapeseed oil + 0.59t meal

According to the accounts at Robbe, crushing costs can be divided as follows:

• added value	32%
• imports	12%
• inputs from other sectors	56%

(c) Transesterification phase.

The chemical reaction in this phase is

1.05t rapeseed oil + 0.11t of methanol→ 1t of rape-methyl-ester + 0.1t glycerine

6.2.0 EMPLOYMENT CREATED

In the current economic climate of persistently high unemployment it would seem appropriate to begin by examining the *potential net employment effect* of having a RME production facility in operation in Ireland.

This section of the chapter is concerned with quantifying the net number of employees, and their value to the national economy, created under the RME scheme. It not possible to determine precisely where rapeseed (the raw material for the RME industry) would be grown, consequently, a national rather than a regional study has been undertaken.

It is generally accepted that the agricultural labour force has been subject to a continuous decline, one which can be expected to continue. As far back as the 1960s, irrespective of economic stagnation or expansion[149] - employment in agriculture has diminished. In each of the decades of the 1960s and 1970s farm labour declined by about 30 per cent. and in the 1980s the pace of decline was almost 20 per cent. During the period from 1987 to 1992, employment in agriculture declined on average by 2,800 per annum.[150]

A recent National Economic and Social Council (NESC) report has asserted that "..*the agricultural employment base is now lower, so that a decline at the same historical rate will have less impact on total employment performance in the years ahead.*"[151] This is an accepted fact, but the significance of a declining agricultural labour force should not be ignored. Given that the regions outside the Dublin area are predominantly rural, the task of maintaining a satisfactory rural living standard is synonymous with the critical national problem of generating employment locally for those coming onto the labour market.

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149 NESC Report No.92. Position paper, "Rural Development : Trends and Issues", P.Cummins, Teagasc.

150 Labour Force Statistics, 1971, 1981, 1992. Central Bank Report 1971,1981,1992

151 NESC Report No. 96 " A strategy for Competitiveness, Growth and Employment" p.280

Table 6.1 Agricultural Labour Force as a percentage of the Labour Force, 1988 - 1993

	Number of person employed in agriculture	Total number of persons at work	Agricultural labour force as a % of no. of people employed
1988	166,000	1,091,000	15.2%
1989	163,000	1,091,000	14.9%
1990	167,000	1,126,000	14.8%
1991	154,000	1,125,000	13.6%
1992	153,000	1,139,000	13.4%
1993	144,000	1,146,000	12.5%

Table 6.1 illustrates the agricultural labour force, as a declining percentage of the total number of persons at work, from 15.2 per cent to 12.5 per cent over the years 1988-1993. In contrast, the total number of persons at work during the same period has been increasing on average by 1% per annum, while the number of people employed in the agricultural sector has been decreasing on average, by 2.2 per cent per annum.

The ceilings put on mainstream agricultural produce and the evident decline in agricultural employment indicates the importance of diversifying the agricultural sector. An alternative to the CAP reform policy, 'set-aside,' is imperative in order to maintain rural employment, agricultural production and utilise the most important natural resource - land, thereby avoiding the visual blight on the landscape, of this 'input control mechanism'.

Under the proposed RME scheme, farmers would grow rapeseed (an energy crop), on 'set-aside' land producing a dual effect, while diversifying the farmer's crop base, maximum output from the land is sustained. The net employment effect is calculated by subtracting the potential jobs created from the RME scheme, away from the jobs required for the Reference scheme.

Table 6.2 on the following page, illustrates, by sector, the net employment created. Refer to Appendix K, for calculations.

Table 6.2 Potential Employment Gain Classified by Sector

Sectors of Production	30 000t
Rapeseed production per cent employed in the agricultural sector	324 92.57 per cent
Crushing process	13
Transesterification process	13
TOTAL	**350**

This analysis is based on a comparison of two schemes, described on in section 6.1.2, one where RME is produced by growing rapeseed on set-aside land and the other where all oil and animal cake are imported and set-aside land is left fallow. It has been estimated that no jobs losses would occur if the RME scheme is implemented. Farmers who grow rapeseed will grow it as opposed to setting land aside, not instead of growing cereals. The oil industry will lose employment marginally in the distribution sector, if a reduction of imports of say 30,000t occurs. This reduction would be negligible, and would be cancelled out by the distribution jobs created under the RME scheme. Consequently, the net employment effect is equal to the number of jobs created under the RME scheme.

It is concluded from Table 6.2 above, that approximately ninety to ninety five per cent. of the employment created would be in the agricultural sector. This would not only benefit the national economy in fiscal terms (i.e. saved social welfare payments, income tax collected), but also aid rural development, while beginning to reverse the trend of a diminishing agricultural labour force.

Therefore, Table 6.2 illustrates the potential gain in employment if a production facility were in operation. It also depicts the potential loss in employment due directly to the 'set-aside' regulations. As 'set-aside' for 1993 means leaving 34,000ha[152]. fallow, 324 jobs will be lost in the agricultural sector.

152 An unpublished report compiled by J. Crowley, Oak Park Research Centre, Teagasc, Co. Carlow.

In 1993 the then IDA's end of year statement reported that the average cost per job to the economy amounted to £12,850. Table 6.3 and 6.3a illustrates alternative costs of creating the number of potential jobs created under the RME scheme to the state.

Table 6.3 Job creation costs (Manufacturing)

Levels of production	30 000t
No. of jobs	350
cost per job £12,850	£4,497,500

A measure of the value to the economy of the jobs created is £4.5m, which relates to the cost to the State of creating 350 manufacturing jobs. However, as stated above, 90 - 95 per cent of the jobs created would be in the agricultural sector, and as such a more appropriate measure of their value to the economy may be the average farm income and the average industrial wage, as illustrated in Table 6.3a below.

Table 6.3a Job creation costs (Agricultural/Industrial)

Levels of production	30 000t
No. of jobs	350
324 jobs at £10,928 per job (average farm income)	£3,540,672
26 jobs at £12,371 per job (average industrial wage)	£321,646
TOTAL	**£3,862,318**

Source: "National Farm Survey", R. Power an M. Roach, Rural Economy, Teagasc, Research Services, Sandymount Ave. Dublin4. CSO. Labour Force Survey.

This section of the report has shown that under the proposed RME scheme 350 jobs would be created thereby replacing the 324 jobs that will, be lost under the 'set-aside' regulations. Although in 'total agricultural employment' terms the number of jobs that would be created is relatively small, the area of set-aside is due to increase, consequently the number of people that will lose their jobs will increase, unless an alternative such as the RME scheme is found.

By encouraging farmers to diversify their crop base, employment, farm incomes, gross agricultural output, will at least be maintained.

6.3.0 DISTRIBUTED ADDED VALUE

Added value is used in National Accounting terms as a method for calculating GDP. which is a measure of the level of domestic production in a given year. This section of the report will calculate the level of net added value gain distributed over the different sectors of the economy if a RME plant were in operation.

It is a generally accepted principle that if land is taken out of production, output will decrease, all things being equal. The question is, by how much? A recent report by *Fitzpatrick Associates* to the Industrial Policy Review Group[153], outlined the specific effects of the set-aside policy for cereals as effectively reducing production in that sector by 10 per cent; an alternative must be found in order to maintain domestic production.

Table 6.4 **Agricultural production and GDP., 1988 - 1993**

	GDP. (constant prices) £m	Gross Agricultural Output (constant prices) £m	Gross Agricultural Output as a % of GDP
1988	18,485	2,739	14.82%
1989	21,334	2,995	14.0%
1990	23,581	2,952	12.5%
1991	25,485	2,955	11.6%
1992	27,781	3,218	11.6%
1993	33,355	3,498	10.5%

Source : Central Bank Reports, 1988 - 1993, National Farm Survey 1992, Personal contact with Teagasc, the Agricultural and Food Development Authority, Research Services, Sandymount.

Agriculture, as a share of the total domestic economy (measured by GDP.), has diminished, from 14.82 per cent to 11.6 per cent, between 1988 and 1993 as is evident from Table 6.4. However, GDP. has increased at an annual average rate of 3.5 per cent per annum during the years 1988-1993, while agricultural output as a percentage of GDP. has been diminishing on average by 1per cent per annum. These trends signify the importance of finding an alternative use for the 'set-aside' land.

153 "Study on external macro-economic issues", Fitzpatricks Associates, October 1991.

This section of the chapter illustrates how output can be maintained over two sectors of the economy (e.g. agriculture and industry) by computing the net amount of added value if the proposed RME scheme is implemented. The figures are evaluated in terms of 1t of oil produced and subsequently illustrated in full production terms.

For 1t of RME (or diesel oil equivalent) total added value and imports are computed for the RME scheme and the Reference scheme. Added value for the purpose of this report is defined as;

A - B + C = Added Value

Where	**A**	=	output (sales) and
	B	=	inputs of goods and materials and
	C	=	subsidies (EU)
			For the added value calculations see appendix L

6.3.1 RME scheme

Under the scheme rapeseed would be grown on set-aside land, then crushed and transesterifed on the national territory. Table 6.5 represents a breakdown of the added value distributed over three sectors of the economy. It is evident from Table 6.5 that the greatest proportion of added value will accrue to the agricultural sector, which will help maintain agriculture's share in the economy.

Table 6.5 Potential Added Value Gain : RME scheme

For 1t of RME produced	30 000t
Rapeseed production per ton (See appendix L)	£303
Crushing	£33
Transesterification	£17
Total	**£353**

6.3.2 Reference scheme

This scheme relates to a situation where the set-aside land, used for rapeseed production will be left fallow. Allowing the land to lie idle,

6.3.3 The Multiplier Effect

There is however, a secondary economic impact which can be calculated by applying the multiplier principle to the added value created by the RME production facilities. Added value created by the RME scheme can be seen as an injection of cash into the circular flow of money in the economy, the overall effect on the economy exceeds the size of the initial amount generated. This is due to what is called the multiplier effect.

Empirical research[154] on the size of the multiplier in Ireland suggests the following;

(i) the marginal propensity to save is 0.2

(ii) the marginal propensity to tax is 0.3

(iii) the marginal propensity to import is 0.4

Therefore, the multiplier in an Irish context is

$$Multiplier = \frac{1}{(0.2 + 0.3 + 0.4)} = 1.11$$

Due to an increase in added value to the economy from the RME scheme, we can state that its actual worth to the economy would be equal to £2,963,700.

Before the 'set-aside' measures were introduced, agricultural output as a share of GDP. was declining at a rapid rate. From 1988 to 1993, Gross Agricultural Output as a share of GDP had declined by 4.32 per cent to 10.5 per cent of GDP. Therefore, even without the 'set-aside' policy in operation it has been evident for a long time, that the agricultural sector is in need of re-organisation. This section of the report has shown how in added value terms the net gain of an RME scheme would increase total agricultural production by 0.12 per cent (£2.67m). By using the multiplier for Ireland, this £2.67m is actually worth £2.963m. Also, the RME scheme pertains to a fuel producing industry, with the raw materials provided from the agricultural sector.

[154] "The Macro-Economy of Ireland", A.J.Leddin, B.M.Walsh, pps.42-46

6.4.0 IMPORT SUBSTITUTION

If RME is produced on the national territory, processed from the seed cultivated by Irish farmers, import substitution will take the form of the end product, RME and the animal cake which is used as a feed for livestock.

Import substitution has to be evaluated in terms of the import price. This is however, an inopportune time to be discussing alternative fuels as the cost of imported diesel has decreased (-18.5 per cent over the three year period from 1990-1993) and the cost of rapeseed has increased (+17 per cent during 1993), due primarily to the scarcity of the seed, as a result of the flooding in the Mississippi basin. However, the situation could well be reversed in the future as it was during the 1991 Gulf Crisis where oil prices were climbing and rapeseed prices were at their uninflated level of approximately £100 to £120/t.

6.4.1 Diesel Oil

As oil prices have decreased by 18.5 per cent since 1990, analysis over the three year period is important.

Table 6.9 Import substitution of oil for different price levels, 1990 - 1992

Year	Import price £/ t	30,000t
1990	130[155]	£4,099,680
1991	126	£3,973,536
1992	106	£3,342,816

The figures used in the report will only relate to the 1992 level of diesel oil prices. However, it is evident from Table 6.9 that if this study had been carried out in 1990 the results would have been more favourable in terms of implementing the RME scheme. However this change in the price of the competitor illustrates how volatile, in economic terms, the production of the RME could be as it is in competition with oil prices and dependent on agricultural prices.

155 Dermot O' Sullivan, Development Engineer with Irish Refining Plc,Whitegate, Co. Cork.

6.4.2 Animal Cake

Animal cake is a by-product of the crushing phase; 1t of RME produces 1.5t of animal cake. Oilseed meals (cake) are mainly used as protein supplements in animal feeds. Global demand for red meat, and the derived demand for oil meal has grown over the past number of years. Rapeseed meal, is a high value oil cake. In 1992 Ireland imported 128,000t of rape cake with an import value of IR£12m.. Therefore if a RME production facility were in operation, the Balance of Trade could be reduced by the following;

Table 6.10 Import substitution of animal cake for at full production level, 1992 prices.

Production facility	30 000t
Meal produced	46,800t
IR £95/t[156]	£4,446,000

Western Europe is the principal market for meals, totalling nearly 40m tons[157], in 1991. The CAP makes cereals much more expensive relative to protein meals than they are in the US, because of the EU price support policy. Consequently, the EU market has grown especially rapidly reflecting the operation of the CAP for cereals as well as the intensive livestock farming. However, the demand is likely to fall in the future as a result of the CAP reforms, which will lower the price paid for grain by feed users. Some estimates have suggested that global consumption of meals of all types (soya, sunflower, cottonseed and rapeseed) could drop by up to 5m tons (-12.5 per cent).

A policy of import substitution attempts, where possible, to replace imports with domestic production. If a country endeavours to be self sufficient in high value commodities such as diesel oil substitutes, namely RME and high value animal cake, in national accounting terms the Balance of Trade will be improved as a result of the reduction in imports of £7.79m (animal cake £4.446m and diesel oil £3.342m).

156 Personal contact with Teagasc, Oak Park Research Centre, Co. Carlow, CSO. Trade Statistics.
157 "Oils and Oilseeds to 1996 - The New Patterns of Supply and Demand" The Economist Intelligence Unit, Special Report No. M703

As seen in Appendix L, a wide range of inputs are used at farm level to produce rapeseed. Some of these are imported and therefore compared to the set-aside alternative, growing rapeseed increases the cost of imports. Even for those inputs produced in Ireland, like nitrogen, the opportunity cost is likely to be the revenue foregone by not exporting. These increased imports and the potential exports foregone, while not included in the scope of this study would have an impact on the Balance of Trade.

6.5.0 FISCAL EFFECTS

The purpose of this section is to quantify, in fiscal terms, the net effect of having a RME production facility in operation in Ireland. By calculating the income tax earned from the net employment effect, coupled with the saved social welfare contributions and subtracting the net excise duty effect, (where RME is sold at a 10 per cent rate of mineral oil taxation), the net fiscal effect has been ascertained.

Each of the aforementioned calculations have been separated into three separate sections;

(i) excise duty,
(ii) income tax,
(iii) social welfare contributions.

6.5.1 Excise duty

Excise duty, in national accounting terms, refers to the duty imposed on hydrocarbons, alcoholic drinks, tobacco, motor vehicles and other (betting, table waters, foreign travel, licences etc.). In 1992, net receipts amounted to £1,747.8m[158], an increase of 2.8 per cent over the 1991 total despite a reduction in the excise for petrol of 9p a gallon from 1st May, 1992. Net receipts from hydrocarbons amounted to £620.43 m (35.5 per cent of total).

At current crude oil prices, untaxed post-refinery mineral diesel costs approximately £118/t (10p/lt.[159]). Pump diesel costs circa. £620/t (52p/lt.) due to an excise duty of £265.6/t (22.31p/lt.), VAT, distribution and retail

[158] Annual Report, Revenue Commissioners, 1992.
[159] Dermot O'Sullivan, Development Engineer, Irish Refining Plc., Whitegate, Co. Cork.

margin of £236.4/t (19.8p/lt.). See Appendix J. The cost of producing RME is approximately three times that of importing diesel at £348.8/t (30.7p/lt.). Since VAT, distribution and retail profit must remain constant, a reduction in excise duty to 10 per cent of the mineral oil tax rate would make RME competitive with diesel at £592.6/t (52.10p/lt.).

This section illustrates how the net excise duty receipts are affected by this reduction. Table 6.11a enumerates the losses to the Exchequer as the equivalent amount of diesel oil is reduced.

Table 6.11a Excise duty foregone

Diesel imports	Excise duty £/t	Total Loss
31,536t	£265.6	£8,375,961

Table 6.11b illustrates the revenue that would be received from the equivalent amount of RME being sold, at a rate of 10 per cent of mineral oil taxation.

Table 6.11 b Excise duty @ 10% of mineral oil tax

RME production	Excise duty £/t	Total excise from RME
30,000t	£25.4	£762,000

Therefore the net loss to the Exchequer as portrayed in Table 6.11c, represent the actual amount of excise duty that the Exchequer would loose if RME was produced instead of importing diesel.

Table 6.11c Net Loss of Excise Receipts

Production Facility	Net Loss to Exchequer	Reduction in Excise Receipts (1992)
30,000t	£7,613,961	0.44%

Table 6.11c, while illustrating the actual reduction in excise duty receipts the Exchequer would experience if a RME production facility were in operation, shows also what this reduction represents in percentage terms, of total receipts for 1992. This illustrates the percentage reduction the Revenue Commissioners would have to endure in order to make RME competitive with diesel.

6.5.2 Income tax

This section of the chapter attempts to estimate the amount of income tax that could be receivable, from the net employment effect calculated in section 6.2.
Certain assumptions however, have to be made.

Assumptions

(1) **Table 6.12a** :Marital status of industrial/ agricultural workers[160]

	Single	Married
Agriculture, Forestry, Fishing	43%	57%
Production industries	42%	58%

Table 6.12a makes the assumption that of the total number of people working in the 'agriculture, forestry and fishing' sector 43 per cent are single and 57 per cent are married and in 'production industries', 42 per cent are single and 58 per cent are married.

(2) **Table 6.12b** :Tax wedge[161]

	Single	Married
Employer social security	7.8%	7.8%
Income Tax	23.9%	15.8%
Received by employee	68.3%	76.4

In section 6.2 of this chapter, potential employment figures were evaluated. This in fiscal terms means an increase in the amount of income tax received, as well as saved social welfare payments. However, income tax liability at any income level is determined by the interaction between the tax reliefs, the rate, and in cases where both spouses have earned income, by whether or not these incomes are aggregated. Therefore, the amount of income tax actually received by the Exchequer can be estimated by using the tax wedge model in

160 Unpublished 1991 Labour Force Survey Estimates (1992 not available yet), CSO.

161 "Reform of the Irish Taxation System from a industrial point of view", A report by Arthur Anderson & Co., to the Industrial Policy Review Group.

assumption (2) and applying it to the average industrial wage and the average family farm income (for field croppers).

Employment created by the production of RME can be divided between two sectors of the economy, namely, agriculture and industry. Therefore, the average income tax liabilities can be estimated on the basis of average industrial wage and average farm income. These are as follows;

- Average farm income : £10,928[162]
- Average industrial wage : £12,371[163]

Income Tax Results

Table 6.12c Number of potential employees paying income tax classified by martial status

Sector	Marital Status & Income Tax rate	30,000t
Farm Sector	Married @ 15.8%	185
	Single @ 23.9%	139
Industrial sector	Married @ 15.8%	15
	Single @ 23.9%	11
TOTAL		**350**

Using the information above and applying the relevant average wages (agricultural £10,928, and industrial £12,371), and income tax level, Table 6.12d depicts the actual amounts of potential income tax payable if an RME production facility is in operation and lost if the land is left idle.

162 "National Farm Survey", R. Power and M. Roach, Rural Economy, Teagasc, Research Services, Sandymount Ave. Dublin 4.
163 CSO Labour Force Survey 1992.

Table 6.12d : Amount of potential income tax payable/lost

Sector	Marital Status	30 000t
Farm Sector	Married @ 15.8%	£319,425
	Single @ 23.9%	£363,039
Income tax lost under the set-aside proposals		£682,464
Industrial Sector	Married @15.8%	£29,319
	Single @ 23.9%	£32,523
TOTAL		**£744,360**

Thus, Table 6.12d estimates the actual amount of income tax lost due directly to the set-aside proposals, effectively for the set-aside proposals for 1992/3 this means 34,000ha. which in terms of oil produced relates to £0.7m. At the same time, the table above represents the amount of income tax that would accrue to the government if the RME scheme were in place.

6.5.3 Saved social welfare contributions

The purpose of this section of the chapter is to estimate how much the Government would save on social welfare payments if an RME production facility were established, occasioned by a 90 per cent reduction in excise duty. However, an appraisal of this kind is difficult as little is known about the financial status of the estimated 'unemployed'.

A comprehensive national Household Budget Survey was carried out by the Central Statistics Office in 1987. This study outlines the average size, composition, income of urban and rural households classified by the livelihood status of the head of household. Under the category of 'out of work' in rural areas, the average weekly household income is as follows;

Table 6.13a Analysis of State Benefits for Unemployed[164]

state transfer payments (weekly)	persons out of work IR£1987
child allowance	7.689
widows and orphans pensions,	1.288
unemployment benefits and assistance	66.459
education grants and scholarships	0.320
other state transfers i.e. fuel vouchers, bottled gas allowance etc.	10.932
Total	86.688
This figure relates to 1987, therefore it has to be adjusted for 1993 figures	1.2024
Total per week	IR£104.23
Total per annum	**IR£5,420**

This figure is then used as the average amount of amalgamated payments made to the unemployed.

Table 6.13b Saved Social Welfare Payments at Full Production Level.

Production facility	30 000t
Number of potential employees	350
£5,420 per person	**IR£1,897,000**

Table 6.13b calculates the amount of social welfare that may be saved if rape-methyl-ester were produced in Ireland at different production levels.

This section of the chapter illustrates the net fiscal effects of having a RME production facility, which can be summarised as follows;

[164] Household Budget Survey 1987, CSO.

Table 6.14 Overall Net Fiscal Effect

	30 000t
Excise duty	-£7,613,961
Income Tax	+£744,360
Saved Social Welfare	+£1,897,000
Net Fiscal Effect	**-£4,972,601**

The above table represents the net reduction to fiscal receipts, if the proposed RME scheme was implemented. It is apparent from table 5.4 that the overriding negative in the fiscal receipts is the excise duty loss. However, this is the only loss that will have to be endured in national accounting terms, and by yielding to Mdm. Scrievener's proposal for an EU directive (See chapters III) the overall gains will outweigh the excise duty loss. In the short term, the government may increase net borrowings to amend the reduction in fiscal receipts. However, as discussed in section III (Distributed Added Value) with the rise in output and the consequent rise in GDP, coupled with the effect of the improvement in the Balance of Trade (due to a reduction in imports section 6.4), this deficit will be eliminated.

6.6.0 CONCLUSION

The renewability aspect of an agricultural raw material for the fuel industry is unquantifiable. The environmental benefits associated with using RME as opposed to fossil diesel are unquantifiable. However, this chapter is concerned with illustrating quantifiable, in macro-economic terms, effects of investing in an RME industry for Ireland. In short, employment, added value, import substitution and net fiscal effects have been ascertained.

Short-run costs of RME production suggest that it would cost three times that of the import price of diesel fuel (see appendix J). Therefore, this study advocates a fiscal advantage, in the form of a tax exemption on the final product RME, acting as a kind of 'kick-start' for the RME industry, in line with Mdm. Scrivener's proposal[165]. The aim of this proposal is to establish at Community level, a reduction of at least ninety per cent on the excise duties currently applied in each member state. In Ireland's case, this would mean a reduction of £7.613m. The proposed tax advantage for biofuels would consequently create the optimum economic conditions favouring investment in an RME industry. As it is a proposed macro-economic fiscal advantage, net positive macro-economic effects have been aggregated (see table 6.15).

A reduction in mineral oil taxation for a 30,000t production facility would mean a net loss in excise duty revenue of £7.613m (0.44 per cent of total excise duty receipts for 1992), which, in the short-term may result in an increase in net borrowings to compensate for this loss. As is evident from table 6.15, the net benefits of such an investment by the Irish Government more than outweigh this reduction in revenue. The increase in GDP. due to increased production, coupled with the improvements in the Balance of Trade, as a result of import substitution, will more than compensate for the decrease in revenue to the State.

Table 6.15 illustrates the overall net macro-economic effects of an RME scheme in operation in Ireland.

[165] Mdm. Christiane Scrivener, EU Commissioner for Taxation, a proposal for a directive on biofuels, in February 1992.

Table 6.15 : Overall Net Macro-Economic Effects

	30 000t
Number of jobs created	350
Saved employment creation costs to the economy	£3.862m
Net fiscal effect (negative)	-£4.972m
Net effect on Government Expenditure	**£-1.11m**
Net Added Value Result of the multiplier effect on the Net Added Value	£2.67m £2.964m
Import Substitution •Oil •Animal Cake	£7.79m

CHAPTER VII

CONCLUSIONS, RECOMMENDATIONS AND FURTHER RESEARCH

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7.0 INTRODUCTION

The considerable interest in developing alternative markets for agricultural products has lead to the successful development of an environmentally friendly, renewable, indigenous alternative fuel to fossil diesel in Europe. The preceding study has attempted to evaluate on a techno-economic basis the viability of RME as an alternative to diesel. This chapter will concentrate on the conclusions and the recommendations of the study and finally suggest some further areas of research.

7.1 CONCLUSIONS

7.1.1 RME as a fuel and a process technology

- Results of engine tests, successful commercial use, engine manufacturers' approvals and the development of various standards in Europe illustrate RME's technical success as an alternative fuel to fossil diesel for use in conventional diesel engines. The successful production of 0.68mt. of RME throughout Europe in 1994 demonstrates the successful production technologies that exist.
- All energy balance studies conclude that RME is positive when by-products (glycerine, animal cake and rape straw) are taken into account. The ETSU study estimated that an energy balance of 1.35 was established without the by-products.

7.1.2 RME in a European context

- EU legislators are in favour of developing a biofuel industry evidenced by the rigorous R&D programmes for the development, research and production of biofuels, in operation today. The EU has stated that one of their objectives for the year 2005 is replacement of 5 per cent of fossil fuel by biofuels.
- European production of RME in 1994 amounted to 0.685mt. The limitation to the European RME industry is defined by the Blair House

accord under the GATT. Clause 7 of this agreement limits rapeseed production for non-food use in the EU to 0.8mt. It is likely that some form of conflict will arise if this issue is not resolved first by the EU, and then negotiated with the US.

7.1.3 The new CAP and a potential for a biofuel industry in Ireland

- It is likely that between 20,000 and 25,000ha. of land will be available in Ireland for the production of rapeseed for non-food use.
- The management rules relating to grazing of cattle on 'set-aside' land need to be addressed in an Irish context if a biofuel industry is to be implemented.

7.1.4 RME : An environmental balance and the future for fossil fuels

- Due to the considerable amount and variety of environmental assessments that have been reported in relation to RME, it is difficult to obtain conclusive evidence of specific environmental benefits of RME in comparison to diesel. However, most research results suggest:
    - A general reduction in the level of CO_2 emitted, resulting in a reduction of greenhouse gases and subsequent reduction in global warming.
    - Reduction in particulates, which is known to affect respiratory systems.
    - Reduction in SO_2
    - Slight increase in NOx, which effects respiratory system, prolonged exposure can result in emphysema. NOx also contributes to acid decomposition.
    - Results vary for CO. This pollutant poses serious risks to human health and can result in loss of worker productivity.
    - biodegradability.

- The future price of fossil fuels are likely to increase in the medium to long term as a result of the following factors; the finite nature of this resource, increased costs associated with exploration and extraction, environmental objectives resulting in the imposition of taxation to discourage the use of fossil fuels.

7.1.5 Macro-economic implications of RME production in Ireland.

- This section of the thesis, based on 1994 figures, investigates the macro-economic effects of a RME plant in Ireland, in terms of employment created, added value (distributed over the different sectors of the economy), import substitution and fiscal effects. The optimum plant capacity has been decided upon by analysing the area of land that is to be 'set aside' in Ireland, in 1994 this figure was estimated at circa. 34,000 ha. This area of land can produced enough raw material for a plant capacity of approximately 30,000t per annum. The results of the study are based on a comparison of two schemes, a reference scheme and a comparison scheme, computing the net effect in terms of 1t of oil produced.

- If a 30,000t production facility were in operation in Ireland, it is estimated that 350 jobs would be created, 92 per cent of which would be in the agricultural sector. If 'set-aside is left fallow, 324 jobs would be lost.

- The analysis of employment effects is followed by an examination of the potential gain in net added value that would accumulate if an RME plant were in operation. This is discussed in terms of gross agricultural output and GDP. For a 30,000t production facility, the net added value gain is estimated to be IR£2.67 or 0.12 per cent of gross agricultural output. If the proposed RME scheme is implemented, imports substitution will occur in the form of; RME substituting oil imports and rape animal cake substituting imported animal cake, consequently improving the Balance of Trade. Import substitution that would result from a 30,000t RME plant is estimated at £3.342m in diesel oil and £4.446m in animal cake.

- The overall fiscal effects are evaluated in the final section of the chapter. The fiscal effects of an RME production facility in Ireland are estimated in terms of excise duty foregone, income tax gain, and saved social welfare contributions. The net excise duty loss would amount to £7.614m, if a 30,000t production facility were in operation. The income tax gain is evaluated in terms of typical marital status of industrial and agricultural workers with an average income tax rate applied. For a 30,000t production facility this amounted to £0.744m.

- Finally the social welfare payments are estimated for those workers who may lose their jobs, or remain claiming social welfare, as calculated in the employment section. If an RME scheme of 30,000t production capacity is implemented, saved social welfare payments would amount to £1.897m. The overall net fiscal loss has been estimated to be £4.9m.

- Short - run production costs suggest that RME is three times more expensive to produce than its sole competitor, imported diesel (See appendix). A tax exemption on the final product would therefore be required. In Ireland, a 90 per cent reduction in excise duty on 30,000t of oil would amount to £7.163m (0.44 per cent of excise duty receipts for 1992). A reduction in mineral oil taxation for a 30,000t production facility would mean a net loss in government revenue of £1.11m, which may result in an increase in borrowings over the short term. However, the decrease in revenue of £1.11m will be more than counter balanced by the increase in GDP resulting from additional added value (£2.67m) and decrease in imports (£7.79m).

7.2 Recommendations

- If widespread production of RME is to become a reality, it is very important that an EU standard on RME product specifications is implemented if the industry is to enjoy a long period of success.

- Establishment of an EU safety and handling standard for the use of methanol is also necessary.

- The 'Scrivener Proposal' should become a directive to ensure the continued development of an RME industry.

- The implementation of a carbon tax discouraging polluters to use fossil energy is required. This will also make RME commercially more competitive with fossil diesel.

In an Irish context;

- A comprehensive PR exercise would need to be undertaken to ensure that farmers can choose whether it is in their best interest to grow rapeseed and to make them familiar with the production and processing phases of RME production.
- Suggested market niches for RME include;
    - urban transport,
    - use in areas of environmental beauty,
    - waterway systems
- On a macro-economic and environmental basis, it would appear favourable for the Irish government to grant a 90 per cent fiscal reduction in excise duty. However, when limitations to the total EU production of RME remain at 0.8mt. given the existing and planned capacity in Europe, it is unlikely that production could proceed. It would also be imperative to examine the likely future availability of raw material supply. Under the 1995 'set-aside' regulations 20,000 to

25,000ha. are estimates of potential land available in Ireland under the 1995 regulations. This figure has not taken the into account the number of farmers that would benefit from using 'set-aside' for grazing their livestock.

7.3.0 FURTHER RESEARCH

- Further analysis is required to establish the long-term effects of RME use on diesel engines.

- Additional comprehensive research into the economic feasibility, environmental analysis and energy balance of other biofuels.

- It has been suggested that Increased oil yields could be obtained from genetic research on rapeseed. This type of research would be valuable for optimum utilisation of land resources.

- Further research is required into alternative possible uses of glycerine, a by-product to increase the end value of RME.

- Long - term projections are required to establish the future for 'set-aside' and the possibility of biofuels remaining competitive.

- Further analysis is required on the macro economic implications of the indirect effects of implementing an RME industry as opposed to leaving 'set-aside' land idle, i.e. the effect of increased inputs and farm machinery, as a result implementing an RME scheme, on the balance of trade.

- A comprehensive comparative analysis is required for the evaluation of the environmental effects of RME combustion with fossil diesel.

APPENDICES

APPENDICES

APPENDIX A - Bioethanol : An Overview

Ethanol is a fuel with similar properties to petrol, and can be used in existing spark ignition (petrol) engines. It has a high octane rating, but low calorific value.

Starch is the basic raw material for the production of ethanol. This is obtained from wheat, sugar beet, cereals etc. Bioethanol has its origin in agricultural raw materials, as do all biomass energies. Technically there is no chemical difference between ethanol derived from agricultural produce and fossil origin ethanol. Bioethanol has three end uses in the fuel market ;

1) direct blending with petrol,
2) conversion to Ethyl-Tertiary-Butyl-Ether (ETBE), an oxygenate for petrol,
3) use as a direct replacement for petrol.

Like most biomass energies, bioethanol use produces lower amounts of aromatic substances and is therefore a more environmentally friendly fuel than petrol. Some important points must be made when considering bioethanol production;

- 1 litre of bioethanol requires 2.8kg of cereals, and costs approximately $0.6 per litre. This cost is almost twice the price of petroliferous origin ethanol, at $0.3 per litre.[1]

- The financial support required for bioethanol production is by far the highest by a considerable margin, as illustrated in the table below.[2]

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[1] CEC " Biofuels - Application of biologically derived products as fuels or additives in combustion engines", Agro-Industrial Research Division, DG XII, 1994

[2] ibid.

Land use	Support ECU/ha.
Wheat for non food utilisation	649
Peas/ beans	400
Oilseed rape/ sunflower	771
Wheat for bioethanol	8720- 920

- A number of studies has been completed concerning the energy balance of bioethanol production. [3] The majority of these studies concluded that bioethanol production showed a negative (0.93 - ECOTRAFFIC Study, 0.91 - ERL Study) or slightly positive (1.15 - CCPMS study) energy balance, if the by- products were excluded. The results were more favourable if the by-products were taken into account.

- Successful commercial production of bioethanol in Brazil and North America have triggered similar projects in Europe. Annual production of bioethanol in Brazil was 600 million litres in the 1970s, and is now 12 billion litres, obtained from sugar cane. Both countries have actively backed ethanol production. Brazil entered into a pro-alcohol programme in 1975 and since October 1993, it has been compulsory to have a petrol mix with 22 per cent ethanol derived from agricultural resources.[4]. A federal tax incentive equal to $0.54 per gallon of alcohol in 10 per cent motor fuel blends was introduced in the US in 1978. The grain ethanol industry has grown to over 1 billion gallons annually in 1993.[5]. The US Clean Air Act Amendments of 1990 has resulted in the adoption of an oxygenated fuels program. The principal oxygenates are ethanol and methyl

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[3] ERL, Energy Research Ltd. 1990,ECOTRAFFIC, Stockholm, 1992, CCPMS (Commission Consultative pour la Production des Carburants de Substitution -Consultative Committee for Production of Substitution Fuels) Study France 1991.

[4] Duarte Coelho, A.C. "Biofuels : The Brazilian Experience", Procedings from the first European Forum on motor biofuels, Tours, May 1994.

[5] Costello R, US Department of Energy " Proceedings from the first European Forum on motor biofuels, Tours, May 1994.

tertiary butyl ether (MTBE). In the first year of the program, ethanol production from grain increased by 150 million gallons. The impetus for encouraging biofuel production in these countries comes from energy security and environmental concerns.

Bioethanol production in Europe, so far, has been concentrated in France. In 1991/2 3.4 million hl was produced from sugar beet in 26 plants (sugar factories/ distilleries), which are still not running at full capacity. There is also a pilot plant producing bioethanol from wheat, but so far it has been uneconomic, due mainly to the low value of the by-products, when compared to maize production. Both wheat and sugar beet are classified as non-food crops[6].

The purpose of this study is not to advocate the use of either bioethanol or RME, rather it is to illustrate the importance of fossil fuel replacement with renewable, environmentally friendly alternative energies. Successful production of bioethanol in the US and Brazil has occurred due, mainly to the fiscal incentives employed by the respective governments. Commercial success has also proved possible due to large scale production facilities[7]. Therefore before large scale production can take place, similar incentives are required.

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[6] EC Regulation Nr. 2296/92.

[7] The single biggest bioethanol plant in the US has a capacity of 9.65million hl. per annum.

APPENDIX B - Quality Specifications for Oilseed Rape-Meal

(OSRM)

obtained trough a screw press expeller without hexane extraction

Meal Type	dry matter %	raw protein (g)	raw fat %	raw fibre (g)	starch units	net energy MJ dairy cows	transferable MJ pigs
OSRM	**>91**	**340**	**<10**	**117**	**716**	**7.2**	**12.5**
Soymeal HP		**490**		**30**	**715**	**7.2**	**14.5**
Soymeal 44		**440**		**71**	**106**	**7.1**	**13**

Meal Type	Ca g	p g	K g	Na g	Lysin g	Methionin g	Cyctin g
OSRM	**5.9**	**10.5**	**12.1**	**0.1**	**18**	**6.5**	**6**
Soymeal HP	**2.8**	**6.6**					
Soymeal 44	**2.7**	**6.2**					

APPENDIX C - RME Specifications and Standards

Rapeseed oil-Methyl-Ester (RME) Specifications and Standards				
Property	**Unit**	**Final ÖNORM**	**Mercedes**	**Euro Proposal**
Density at 15 °C	g/cm^3	0.87-0.89	0.875-0.885	0.86-0.90
Viscosity at 20°C	mm2/s	6.5-8.0	6.0-9.0	
Flashpoint	°C	min.100	min.55	min.100
CFPP (Summer)	°C	max.0	max.-5	max.0
CFPP (Winter)	°C	max.-15	max.-15	max.-15
Total sulphur	% wt.	max.0.02	max.0.02	max.0.01
CCR (of 100%)		max.0.05	max.0.05	
(of 100%)				max.0.30
Cetane No.		min. 48	min.50	min.49
Sufatash	%wt	max.0.02		
Neutralisation-no.	mg KOH/g	max 0.08	max.0.5	max.0.5
Methanol content	%wt.	max.0.20	max.0.03	max.0.3
Free glycerine	%wt.	max.0.02	max.0.20	max.0.03
Total glycerine	%wt.	max.0.24	max.1115	max.0.25
Iodine-no.	g I/100g			max.115
Phosphor	mg/kg	max.20		max.10
Free of				
Solid substances		yes	yes	
Separated water		yes	yes	

Source : Körbitz Consulting June 1994

Existing and well defined fuel specifications in connection with bench and field engine testing have resulted in a number of engine clearances of well known producers.

The table below gives a brief illustration of existing clearances.

Engine - Companies - Existing Permissions in Austria	
1. No adaptations necessary	
Fiatagri	All new tractors
Ford	All new tractors
John Deere	All tractors since 1967
Deutz-Fahr	All tractors with 912/913-engine
Linder	All tractors since 1985
Massey-Ferguson	All tractors since 1985
Mercedes-Benz	All tractors
Same	All tractors since 1980
2. Some adaptations necessary	
Case	All new tractors since 1971
Fendt	With RME - package
Renault	With RME - package
Steyr	All new tractors since 1974/ with RME - package
3. Additional experience	
Farymann - Holder - IVECO - Komatsu - Kubota - Mercedes - MWM - Nissan - Ortech - Valmet - Volkswagen - Volvo	

APPENDIX D - EU Measures To Assist Biofuel Development

Primary Measures taken by the Community to assist the development of production, technology, and market introduction

DG VI **: Agricultural Policy**

Production of crops for biofuels on set-aside land; use of intervention products for biofuel production.(See chapter V)

DG VI and XII **: AIR**

Agro-Industrial Research (AIR) Programme.

This is a specific programme for technological research, development and demonstration in agriculture and the agri foods industry. It explicitly covers research and demonstration work on biofuels.

DG XII **: APAS 1994: 4th Framework Programme**

Research, development and demonstration of motor biofuels

DG XII and XVII : **International Co-operation**

Agreement for the co-operation with IEA, co-operation with EEA - EFTA countries.

DG XVII : **THERMIE/ ALTENER**

Market introduction : support to pilot plants, field and fleet tests.

The Commission has also been involved in the demonstration of new energy technologies before its inclusion in the THERMIE programme in 1990.

APPENDIX E - List of Participants in Irish Altener Project

- **The Oak Park Research Centre**
  Acting as project co-ordinator, and responsible for agricultural and energy crops research.

- **Bus Eireann**
  This company uses approximately 5,000t of diesel per annum in its urban bus fleet. Since May 1994, it has been operating a single-decker bus in Cork on RME.

- **Waterford Foods**
  Waterford foods have been involved in completing a feasibility study in conjunction with Teagasc of RME production in Ireland. Waterford has also operated two vehicles on biodiesel-diesel : a 10-tonne rigid and a 25-tonne articulated truck.

- **Emerald Star Line**
  This company operates pleasure crafts on lakes of the river Shannon. A reduction of the toxicity of spillages to marine life would be an important advantage. Emerald Star has operated a new pleasure cruiser on Carrick-on-Shannon on RME for the 1994 tourist season.

- **Glenveagh National Park**
  This is one of the larger parks in the country operated by the Office of Public Works. By using RME the reduction in pollution risks of harmful emissions in woody areas, would be of great benefit. Glenveagh has operated two of its mini-bus fleet on RME for the 1994 season.

APPENDIX F - EC Forecasting Scenarios

Scenario 1 : CONVENTIONAL WISDOM

This scenario assumes an unspectacular economic growth rate, with a gradual development of existing policies. Technology would continue to improve and the effects on end-use and on production could result in improved efficiencies. The distinguishing feature in this scenario is the lack of special concern on energy policy, with market forces driving the system within existing frameworks.

Pollution Forecasts under the "Conventional Wisdom Scenario"

(Mt)	1990	1995	2000	2010
CO_2	672.91	716.76	743.42	759.26
NO_x	6.53	5.67	4.51	4.64
SO_2	0.68	0.73	0.76	0.79

Scenario 2: DRIVING INTO TENSIONS

This scenario assumes a situation of high economic growth without appropriate policy measures, thus market mechanisms will drive the system. This scenario assumes that supply capacities will be under pressure (supply gaps and price shocks) and polluting emissions will attain high levels.

Pollution Forecasts under the " Driving into Tensions Scenario"

(Mt)	1990	1995	2000	2010
CO_2	672.91	797.69	898.28	907.16
NO_x	6.53	6.31	5.50	5.55
SO_2	0.68	0.83	0.94	0.96

Scenario 3 : SUSTAINING HIGH ECONOMIC GROWTH

This scenario asserts that sustained high economic growth is not in conflict with strict environmental standards. In this scenario it is assumed that those two objectives can be achieved within a secure energy future through mastering both energy consumption (more efficiency via technological innovation and improved consumer behaviour, such as through traffic management) and more efficient means of production.

Pollution Forecasts under the "Sustaining High Economic Growth Scenario"

(Mt)	1990	1995	2000	2010
CO2	672.91	797.69	769.32	480.22
NOx	6.53	6.31	4.71	2.97
SO2	0.68	0.83	0.80	0.51

Scenario 4 : HIGH PRICES

This scenario is intended to illustrate the effects of a moderate economic growth combined with stricter environmental standards and goals, and through mastering both energy consumption and efficient means of production.

Pollution Forecasts under the " High Prices Scenario"

(Mt)	1990	1995	2000	2010
CO_2	672.91	695.72	656.07	357.32
NO_x	6.53	5.51	4.02	2.20
SO_2	0.68	0.71	0.68	0.37

APPENDIX G - Economic Instruments For Pollution Control

Economic instruments can be defined as proxies for market signals in the form of change in relative prices. Economic instruments fall into one of four main classes;

- **Marketable permits** are pollution quotas, permits or ceilings (in other words rights to use the environment), marketed by the competent authorities. Permits can be traded, bought and sold, within the bounds of rules laid down by the authorities. This approach applies mainly in the US to control air pollution.

- **Emission charges and taxes** are applied to emissions on air, water and land pollutants and also to noise pollution. France for example levies water pollution charges and taxes on sulphur oxides; Sweden taxes nitrous oxides.

- **Product taxes** are designed to alter the relative prices of polluting produces such as fuels, fertilisers, pesticides, batteries, packaging materials etc.

- **Deposit - refund** systems have long been applied to beverage containers; a deposit, a kind of tax is paid on the packaging or container and reimbursed when the packaging or container is returned to an approved agent to be re-used, recycled or destroyed.

APPENDIX H - Polycyclic Aromatic Hydrocarbons Emissions: Diesel and RME Compared

PAH	Diesel (mg/h)	RME (mg/h)	%
Acenaphthylene	n.a.	58.2	-
Acenaphthene	n.a.	91.2	-
Fluoren	17150	390	-97.7
Phenanthrene	45770	1489	-96.7
Anthracene	689	43.3	-93.7
Fluroanthene	2887	407	-85.9
Pyrene	4186	426	-89.8
Benz(a)anthracene	300	42.6	-85.8
Chrysen+triphenilene	1456	144	-90.1
Benzo(b+j+k)fluoranthene	144	63.3	-56.1
Benzo(a)fluoranthen	29.8	6.5	-78.2
Benzo(e)pyrene	98.6	36.4	-63.1
Benzo(a)pyrene	27.1	7.9	-70.9
Perylene	n.a.	0.54	-
Indenopyren-Dibenzanthracene	39.1	17.1	-56.3
Benzo(ghi)perylene	41.8	21.5	-48.6
Anthanthrene	n.a.	5.9	-

APPENDIX I - Permitted Uses Of Set-Aside Land

1.0 Raw material/crops which may be grown on set-aside land when destined for use in the manufacture of the permissible end products set out in section two of this appendix.

- Short-rotation forest trees having a maximum cultivation period of ten years inclusive.
- Perennial plants e.g. miscanthus sinesis.
- Potatoes
- Peas (Pisum arvense L.) other than those for sowing.
- Seeds of caraway, neither crushed nor ground for the industrial manufacture of essential oils or resinoids.
- Spelt, common wheat and meslin other than for sowing.
- Rye
-
- Barley other than fro seed
- Oats other than seed
- Maize (corn) other than seed
- Buckwheat other than seed
- Millet other than seed
- Triticale other than seed
- Soyabeans other than for sowing
- Shelled ground nuts
- Linseed other than for sowing
- Rape or colza seeds other than for sowing
- Cotton seeds other than for sowing
- Castor oil other than for sowing

- Sesamum seeds other than for sowing
- Mustard seeds other than for sowing
- Safflower seeds other than for sowing
- Other oil seeds and oleaginous fruits other than for sowing
- Plants and parts of plants (including seeds and fruits), of a king primarily used in perfumery, pharmacy or for insecticidal, fungicidial or similar purposes
- Vegetable plaiting, stuffing or padding materials, or those used in brooms or brushes
- Flax, raw or processed but not spun; flax tow and waste (including yarn waste and garnetted stock).

2.0 Acceptable end-uses for non-food corps grown on set-aside land

The following end-uses are permitted, as long as the value of the non-food product is greater than the total value of any food by-products;

- Oils, fats and waxes for uses other than for human or animal consumption
- Denatured ethyl alcohol and other spirits for direct use in motor or for processing for use in motor fuel
- All agricultural products listed in section 1.0 and their derivatives which are burned in power stations for energy.

APPENDIX J - Price Structure Of Diesel and RME Compared

	DIESEL		RME	
	p./lt.	£t	p./lt.	£/t
Ex-refinery price (1993)	9.91	118	30.7	348.8
Distribution costs 12.8% of total	6.67	79.4	6.66	75.6
Excise Duty	**22.31**	**265.6**	**2.23***	**25.40**
Sub-total	**38.89**	**463**	**35.59**	**449.8**
VAT @ 21%	8.17	97	8.31	94.45
Sub-total	**47.06**	**560**	**47.90**	**544.2**
Retail margin	4.17	49.6	3.5	40
VAT @ 21%	0.875	10.4	0.7	8.4
Total	**52.11**	**620**	**52.10**	**592.6**

Source : (i) Werner Körbitz Consulting, Feasibility Study for Ireland, 1993, internal report commissioned by Teagasc, Oak Park Research Centre, Co. Carlow.

(ii) Dermot O'Sullivan, Development Engineer, Irish Refining Plc., Whitegate, Midleton, Co. Cork.

* 10% of mineral oil excise duty.

APPENDIX K - Employment Calculaitons

1) Rapeseed production level:

-1t of RME requires 2.7t of seed[8]

- 1 worker for every hundred ha.,

-1 ha. Yields 2.54t of spring rape[9]

- 1 worker is required for every 250t of seed used

Levels of production	30 000t
Amount of seed required	81,000t
Amount of workers required	324

2) Seed crushing level :

- 1 job for every 6,000t of seed crushed

Levels of production	30 000t
Amount of seed to be crushed	81,000t
Amount of workers required	13

3) Transesterification level:

- From the accounts at Robbe Production Facility

[8] Culshaw" A Review of the Potential of Biodiesel as a Trasnport Fuel", ETSU, 1992, p.11

[9] Jim Crowley, Oak Park Reserch Centre, Teagasc, Carlow

APPENDIX L - Distributed Added Value Calculations

1) Rapeseed Production Level

- 1 ha. = 2.471 acres

- 1 ha. yields 2.5t of spring rapeseed

Note : Farmers are more likely to grow the lower yielding spring rape as it is cheaper to produce, with fewer inputs required. The EU payments are based on acreage rather than tonnage. Consequently, spring yields and costings are used.

- 1t of rapeseed yields 0.4t of rapeseed oil

- 1.05t of rapeseed oil required to produce 1t of RME

- 1t of RME requires 2.7t of rapeseed.

1) RME SCHEME : 1T OF OIL PRODUCED=

Added Value at Farm Production Level		**£**
Market value of rapeseed (output)		392
Less cost of material inputs		
Costs		
Materials/machinery/transport	£	371
Hire of drill, combine and transport	120	
Seed	33	
Fertiliser	135	
Herbicides	17	
Insecticides	33	
Desicant	33	
Plus subsidies		
(set-aside subsidy per ha. £261 £261/2.5t per ha. = £104.4 £104.4 = subsidy per t produced, 1t of RME requires 2.7t of seed therefore 2.7 x £104.4 = subsidy for 1t RME		
	282	
Added Value (per t of RME produced)		**£303**

2) REFERENCE SCHEME : 1T OF OIL PRODUCED

Under this scheme, the land used for the cultivation of rapeseed is left fallow, producing neither output nor market value. However, under the set-aside regulations there are costs involved in maintaining the land.

Market Value (output)	**£**
Less the costs of the inputs	
Spraying 2/3 times per annum	-68
Plus subsidies	
(set-aside subsidy per ha. £261/2.5t per ha. = £104.4 £104.4 = subsidy per t produced, 1t of RME requires 2.7t of seed therefore 2.7 x £104.4 = subsidy in terms of 1t RME	282
Added value (in terms of 1t of oil produced)	**214**

However as stated earlier, farmers may at certain times of the year graze their cattle on set-aside land and as Dunne and O'Connell [10]stated the most reasonable assumption was that these (grazing) benefits would equal or exceed the cost of set-aside land. As no detailed analysis has been carried out the author has assumed that zero output and no market value will result from set-aside land left idle.

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[10] Dunne, W., O'Connell, J.,"The Implications of CAP Reform for the Irish Feed Grain Market" Rural Economy Research Centre, Teagasc, Sandymount. March 1994.

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