Mallow Sugar Factory

Ethanol Production Evaluation Study

CORK COUNTY COUNCIL

Cooley-Clearpower Research

4th September 2006

Preface

Cork County Council commissioned this study with the objective of providing a factual evaluation of the technical and financial viability of ethanol production from beet and wheat at the former Mallow sugar factory.

To achieve this objective, the following specific areas have been addressed in the study: Irish and international policy context; ethanol market dynamics; the process and economics of ethanol production; the viability of the Mallow site for ethanol production; and macro-economic and environment effects of ethanol production.

A public consultation process was launched through an invitation for submissions, which was advertised in the national press. Cooley-Clearpower and Cork County Council would like to thank the groups and individuals that made submissions as well as the many organisations that provided information and support. A full list can be found in the appendix. Cooley-Clearpower would like to thank the Cork County Council committee for their help, support and contributions to the report.

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Cork County Council

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Executive Summary

Introduction

The decision to close Ireland's last remaining sugar factory at Mallow was made in March 2006 as an outcome of reform to the EU sugar regime. It ended an 80 year history of sugar production, affecting some 3,700 sugar beet growers and over 300 employees.

As the doors close on sugar production, the question arises as to whether the Mallow plant could be used for ethanol production, in order to sustain the plant facility and a demand for sugar beet or wheat feedstock. This study aims to answer this question by assessing the market demand for ethanol in Ireland, the available supply of beet and wheat feedstock, the economic and technical viability of ethanol production at Mallow as well as other macro-economic and environmental considerations.

The market demand for ethanol in Ireland

The primary market for ethanol in Ireland is determined by the amount of petrol substitution that can be achieved. A key driver for petrol substitution is the EU biofuels directive (2003/30/EC), which advocates that member states replace 5.75% of petrol and diesel transportation fuels by 2010 on an energy basis. This would result in a market of 220m litres of ethanol by 2010 if the targets are met.

However, the effective market demand will be determined by the quantity of ethanol that can be delivered at a cost that is competitive with petrol. Currently, no source of ethanol, produced locally or imported, may be delivered for less than the price of petrol before excise duty and VAT. Therefore, the real demand for ethanol in Ireland will be defined to a large extent by the volumes of ethanol that are granted excise relief by the government. The government has established the Biofuels Mineral Oil Tax Relief Scheme – II and set supported volumes at 11m litres in 2006, 40m litres in 2007 and 85m litres in each year of 2008, 2009 and 2010. This represents about 2.2% substitution of petrol.

The supply of beet and wheat feedstock for ethanol production

At prices that provide a reasonable margin for beet and wheat growers, an estimated 40,000 hectares are likely to be available for beet production for ethanol at Mallow and 12,000 hectares are likely to be available for wheat production for ethanol at Mallow. This would yield some 2m tonnes of beet and some 102,000 tonnes of wheat and provide sufficient feedstock for an ethanol production capacity of 180m litres from beet and 36m litres from wheat. The availability of these volumes is strongly affected by the prices that can be offered to farmers by a competitive ethanol producer.

	Area (kha)	Crop yield (t/ha)	Feedstock (kt)	Ethanol (l)
Beet	40,000	50	2,000	180m
Wheat	12,000	8.5	102	36m

Technical assessment of ethanol production at Mallow

Production of ethanol from beet and wheat is technically feasible at the Mallow site with the appropriate plant and equipment modifications and additions.

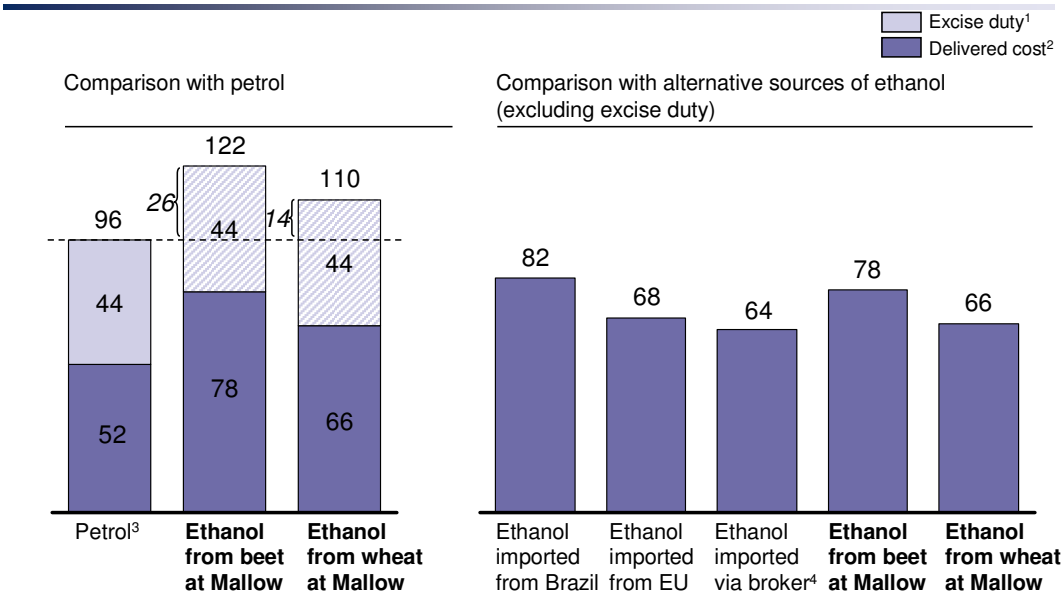
- Additional processes and equipment required for ethanol production from sugar beet alone include: fermentation, distillation, dehydration, storage, instrumentation, quality control and loading. (€45-50m capital expenditure)
- Additional processes and equipment required for ethanol production from wheat (supplementary to above) include: milling, liquefaction and saccharification. (€10-15m capital expenditure)

The annual maximum production capacity of ethanol at the Mallow plant would be 135m litres from beet and 35m litres from wheat resulting in a full capacity of 170m litres/ year. This would be twice the current Irish target of 85m litres by 2010 and 75% of the EU directive target of some 220m litres by 2010.

Economic assessment of ethanol production at Mallow

Ethanol produced from beet or wheat at Mallow requires economic support in order to compete with either petrol or the cheapest source of imported ethanol. The level of economic support required would be 26 cents for every litre of ethanol produced from beet and 14 cents for every litre produced from wheat at current prices (price sensitivities are included in chapter 6). This would amount to some €40m/year at current prices to run the plant at full production capacity.

Relative fuel costs (excluding VAT)
cents/ litre



1. Does not include contribution to national oil reserve (~.5ct/ l); 2. Includes production or import cost, capital recovery, distribution, overheads, blending, retail margin; 3. Pump price Aug 2006; 4. from multiple sources at lowest available cost, mainly from Least Developed Counties, for which no import duty applies
Source: Ecofys, SEI, IFA, Teagasc, CBOT

Support of 26 cents/ litre and 14 cents/ litre for ethanol produced from beet and wheat respectively is less than the full excise relief of 44 cents/ litre of ethanol awarded under the current schemes in Ireland and is also less than current ethanol rebates in all European countries where rebates exist. This support would enable reasonable prices of €40/ tonne of beet and €145/ tonne of wheat to be paid to growers for feedstock. In the absence of excise relief or another source of economic support, the maximum prices that could be offered for feedstock to produce ethanol at Mallow that competes with the cheapest alternative source of ethanol would be €27/ tonne of beet and €141/ tonne of wheat. This beet price is below cost to farmers and therefore unviable. Although this wheat price may currently be attractive to farmers, wheat prices are expected to rise in the next 12 months and €141/ tonne may be less attractive to farmers in 2007.

An investor examining the opportunity of buying and operating the Mallow site for ethanol production would need to consider capital investments in the region of €55-65m for plant and equipment modifications in addition to some €25-30m to purchase the site (this purchase price can only be fully determined from commercial negotiation with Greencore). By comparison, capital investment for a Greenfield site would cost in the region of €100-110m plus land purchase in the region of €1-2m for agricultural zoned land or up to €15-20m for industrial zoned land (renting of land might also be possible). The lead time to first production at Mallow would be 12-18 months from the time of investment. The lead time for construction at a Greenfield site would be similar, although additional time might be required to secure planning permission and other permits.

EU sugar reform regulations indicate that the current restructuring compensation to be shared between Greencore Group and growers would be reduced by €36.4m if partial dismantling of the current plant were to occur instead of full dismantling.

Macro-economic and environmental considerations

An ethanol production facility at Mallow would employ some 50 people at times of peak production. This is less than 25% of the number employed during the 2005 sugar campaign.

At full capacity, the plant would require feedstock from some 50,000 hectares and supply farmers with income at a reasonable margin. Sugar beet grown for the production of ethanol would provide an ideal rotation crop for cereals such as winter wheat and spring barley as it helps to maintain good quality soil and weed control for tillage farming. Sugar beet also yields more ethanol per hectare than other available feedstock in Ireland (e.g., 4,500 litres from 1 ha of beet compared with 3,000 litres from 1 ha of wheat).

Ethanol is one of several alternative fuel sources that can help overcome significant dependence on foreign energy supply and contribute to increased self sufficiency in energy supply and an improved balance of trade and balance of payments in energy.

Ethanol burns more cleanly than petrol and results in fewer emissions. A ‘well to wheel’ reduction of green house gases of up to two thirds can be achieved from the substitution of ethanol for petrol as a transport fuel.

1. International and Irish Policy Background

Reform of the EU sugar regime

The common market organisation (CMO) in the EU sugar industry was set up in 1968 to support income to European producers as well as EU market self supply. It featured production quotas, guaranteed prices and arrangements for trade and self-financing. This regulation came to an end on June 30th 2006, following a ruling by the World Trade Organisation that found guaranteed sugar prices and export subsidies to be illegal.

Changes to the EU sugar regime were agreed by agriculture ministers in November 2005 in Brussels under Council Regulation (EC) 318/2006. As a result, support for the industry was reduced to an extent that made beet growing and sugar production in Ireland unviable. Beet prices would fall by over 50% and income to farmers would drop 75%, taking direct payments into account.

Changes to Irish sugar beet price resulting from EU sugar reform (€/tonne)

	2005/2006	**2006/2007**	**2007/2008**	**2008/2009**	**2009/2010**	**2010/2011**
Minimum beet price	45.09	32.86	29.78	27.83	26.29	26.29
Regional premium	1.90	-	-	-	-	-
Greencore payment	5.49	3.99	-	-	-	-
Production levy	-	-	(0.93)	(0.93)	(0.93)	(0.93)
Total beet price	52.48	36.85	28.85	26.90	25.36	25.36

Source: EU sugar regulation, IFA

Ireland's sole sugar processor, Greencore Sugar, announced its intention to renounce the full sugar quota in March 2006. The subsequent closure of the Mallow sugar factory after an 80 year history, affecting over 300 workers and some 3,700 beet farmers, ended a chapter of sugar production in Ireland. At the high point of the sugar industry, 28,000 farmers across 22 counties had been involved in beet growing to supply four factories at Tuam, Thurles, Carlow and Mallow.

Arising from the changes in the E.U. sugar regime, compensation for producers and beet growers was set at amounts of €145.5m for restructuring, €43.6m for diversification and €123m for growers. The restructuring compensation is described in detail in EU regulation (EC) 320/ 2006. In particular, it outlines that 100% of the restructuring compensation will be made available if full dismantling of production facilities occurs while 75% of compensation will be made available if the option of partial dismantling of facilities is taken (i.e., a reduction of €36.4m if some facilities are retained). A subsequent EU regulation, (EC) 968/ 2006, explains that 'a higher amount of

restructuring aid is granted to full dismantling, because of the higher costs involved,' and the regulation further details the definitions of full and partial dismantling:

> ***Article 4, (EC) 968/ 2006: Dismantling of production facilities***
>
> *"In the case of full dismantling… the requirement to dismantle the production facilities shall concern all facilities that are necessary to produce sugar… for example, facilities to store, analyse, wash and cut sugar beet; all facilities that are necessary to extract and process or concentrate sugar from sugar beet… the part of the facilities… which are directly related to the production of sugar… even if it could be used in relation to the production of other products… all other facilities such as packaging facilities…*
>
> *In the case of partial dismantling… the requirement to dismantle the production facilities shall concern the facilities outlined in paragraph 1 (above) that are not intended to be used for other production or other use of the factory site in accordance with the restructuring plan."*

EU and Irish policy incentives for biofuel production

The EU biofuels directive (2003/30/EC) sets targets for all member states to replace 2% of gasoline and diesel transportation fuels by 2005 and 5.75% by 2010 on an energy basis. Despite the lack of any penalties for missing these targets, most member states, including Ireland, have introduced support mechanisms to encourage increased biofuel use.

In Ireland, a pilot scheme for excise relief on 16m litres of biofuels for transport was tendered in 2005, with 8 successful applicants. Provision was made in the December 2005 budget for a significant extension of the excise relief scheme for up to163m litres of biofuels until 2010. This Biofuels Mineral Oil tax relief Scheme – II was launched in July 2006 and the closing date for applications in August 28th 2006. Furthermore, advice and information on biofuel production and support on capital investment projects is provided by the national energy agency, Sustainable Energy Ireland.

Volumes of biofuels for transport to be awarded excise relief (litres)

	Biodiesel or other biofuel in diesel	Bioethanol blended with petrol	Pure plant oil	Biofuel in captive fleets	Total
2006	44m	11m	0	9m	64m
2007	57m	40m	3m	12m	112m
2008	60m	85m	6m	12m	163m
2009	60m	85m	6m	12m	163m
2010	60m	85m	6m	12m	163m

Source: Department of Communications, Marine and Natural Resources

Rebates are also offered on the production of ethanol for fuel by governments in many European countries including Austria, Czech Republic, France, Germany, Hungary, Italy, Poland, Spain, Sweden and the U.K.

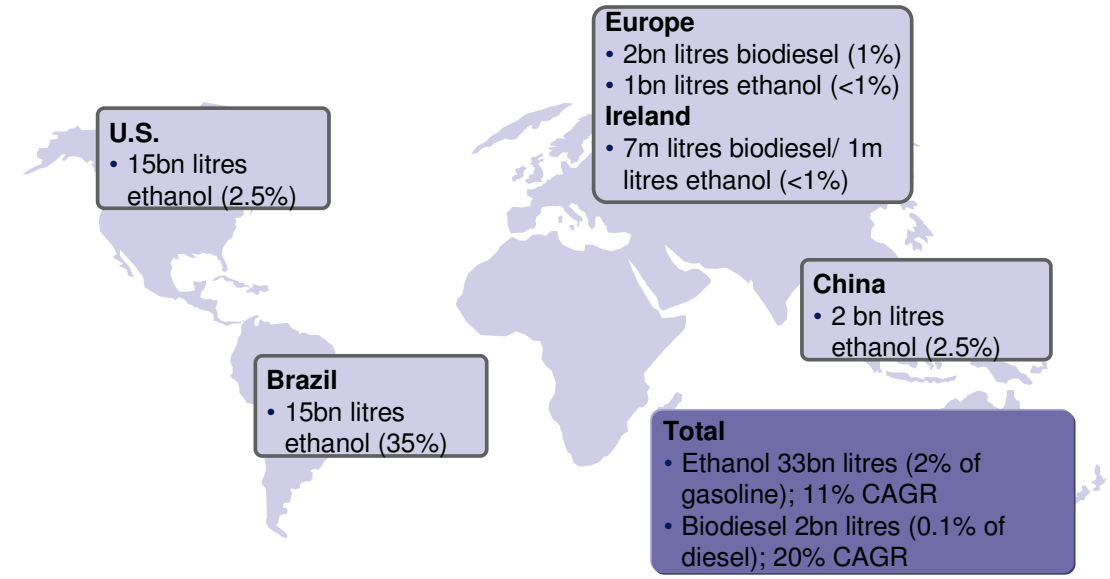
The support and incentives provided by the government aim to make the production of biofuels such as ethanol and biodiesel more economically attractive in the short term. They also contribute to the fulfilment of environmental commitments, increased indigenous enterprise and greater national self-sufficiency in transport fuel provision.

2. Introduction to Biofuels and Ethanol Production

Liquid biofuels are becoming an increasing alternative to hydrocarbon fossil fuels, driven by advances in biofuel technology, current high oil prices, government regulatory support and environmental concern. Biofuel consumption around the world is projected to grow as much as 14% annually by the International Energy Agency (IEA). Major oil and gas companies are investing hundreds of millions of dollars in biofuel development to match the advances of localised industry and research in developing this sustainable energy source.

Ethanol and biodiesel are currently the two main liquid biofuels to consider. Both of these fuels have started to penetrate the transportation sector in all major regions of the world. The production of ethanol has grown at a compound annual growth rate (CAGR) of 11% over the last five years, with a primary market in the U.S., while biodiesel production has grown at 20% over five years, with a primary market in Europe, according to the IEA. Cork County Council has requested that this study focus on the ethanol production opportunity at Mallow.

Biofuel consumption (penetration of fuel market)



Source: Renewable fuels association; European bioethanol fuel association

Ethanol

Ethanol (CH_3CH_2OH) may be produced from sugar crops such as sugar beet in Ireland and Europe or sugar cane in Brazil and it may also be produced from cereal crops such as

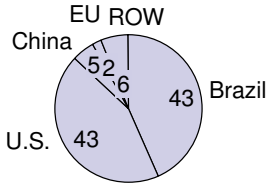
wheat in Ireland, Europe and the U.S. Ethanol can be used as a petrol substitute. It can be added in concentrations of up to 5% without any modification to a vehicle engine. With engine modification, it can fully replace petrol. Ethanol's energy content is about 68% that of petrol although an ethanol blend burns more cleanly and efficiently with higher oxygenate content and results in fewer emissions.

The current key markets for ethanol are the U.S. and Brazil where use is growing at over 11% annually. Growth is driven by increased focus on national self-sufficiency, high oil prices and state bans on MTBE (methyl tertiary-butyl ether) which is a rival substitute for increasing oxygenation but which contributes greater pollutants than ethanol. These factors are creating a rush to ethanol production and the Energy Information Association predicts an oversupply of ethanol to the U.S. market in the near term.

Ethanol global market overview

Global consumption

Percent



Size
- Global usage 33,000 million litres
- Accounts for 1.7% of total petrol

Growth
- 11% CAGR (2004-2012); largest growth in Japan, U.S., China, India and Brazil

Key geographies
- Brazil and U.S.

Challenges
- Requires government subsidies and mandates
- Limited sales points in many regions
- High biorefinery capital investments
- Requires vehicle modification for higher blend ethanol fuels (circa €1,500 for cars in Ireland)

Key trends
- New lower temperature ethanol production starch process being introduced has lower plant investment requirement with 5-10% yield improvement and ~10% energy savings
- Stricter regulations towards reducing greenhouse emissions
- Processes involving alternative feedstock sources are being explored and developed

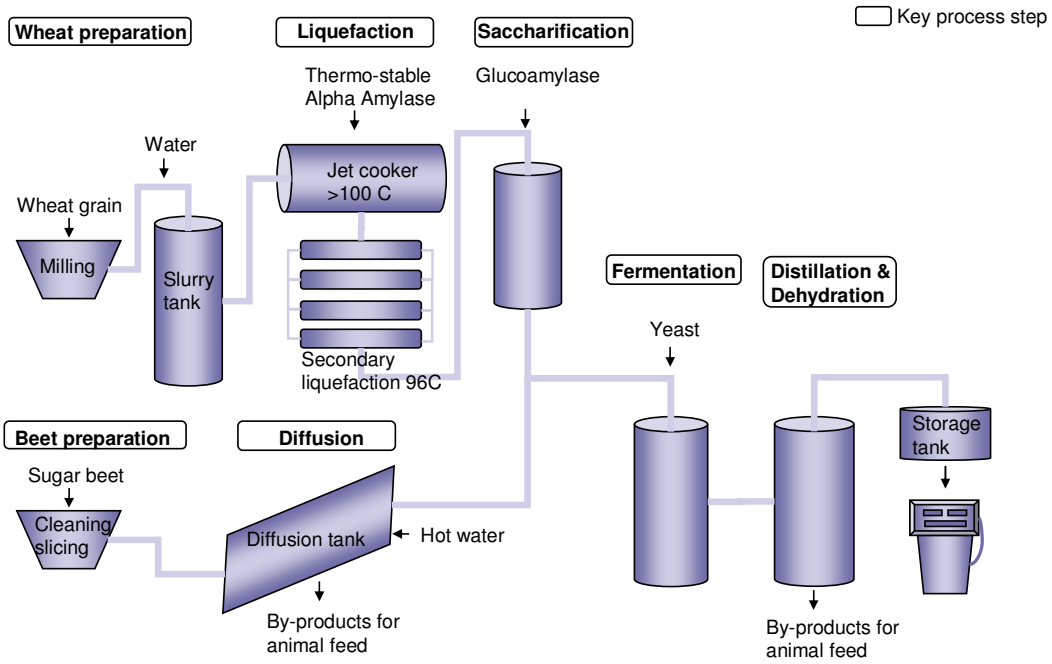
Requirements for success
- High oil price environment
- Ability to obtain and maintain government subsidies
- Technological improvements to process biomass more cheaply
- Maintain cost competitiveness relative to other renewable energy alternatives

Source: International Energy Agency; World Coal Institute

Ethanol production

The production process for ethanol from sugar beet is simpler than from wheat as the sugars are readily available for fermentation. The sugar beet is harvested and brought to the production facility where it is weighed, sampled for sugar content and unloaded. Tare (i.e., earth and stones) is removed and the beet is washed clean. The beet is sliced and diffusion takes place by washing it in hot water to create a sugar juice. Fermentation occurs with the addition of yeast and the ethanol is recovered through distillation and dehydration. In the case of ethanol produced from wheat, the wheat grain undergoes additional milling, liquefaction and saccharification with enzymes to make sugar available in fermentable form. By-products of the production process include high protein animal feed that may be sold to farmers, as well as CO_2.

Ethanol production process



Note: Diagram is illustrative – wheat and sugar beet feedstock cannot both be fermented at the same time
Source: Genencor International

Ethanol value chain

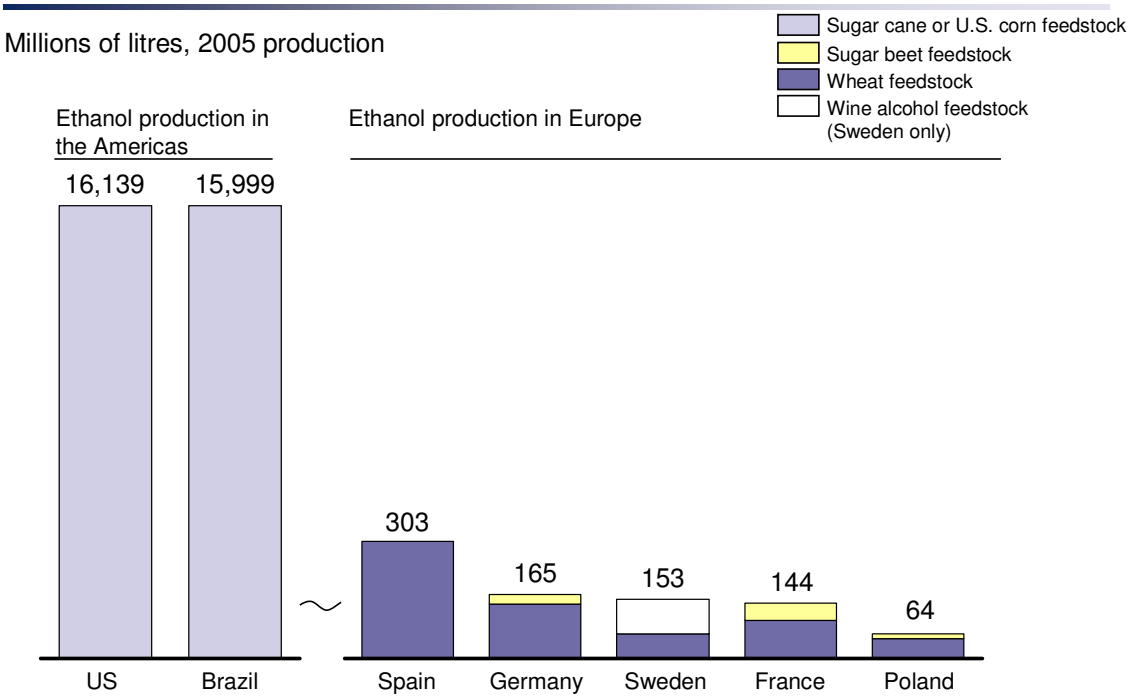
Ethanol	Feedstocks	Pre-treatment and ethanol production	Fuels blending
Key activities	• Grow and harvest crops or collect biowastes	• Dry milling for *wheat* (wet milling is becoming obsolete)… – Grind crop in hammer mills – Liquefy crop by mixing and cooking with water & enzymes – Convert starch to sugar using enzymes • …Slicing, diffusion and purification for *sugar beet* • Ferment sugar with yeast • Separate ethanol from non-fermentable solids using multi-column distillation and water (typically) using molecular sieves • Sell beet and wheat by-product to animal producers	• Blend ethanol with a special petrol blend for various ethanol content fuels (E10, E15, E85, E95, E100)
Key players	• Farmers	• Farmer co-ops • Maxol and Conoco Philips through partnerships (i.e., Carberry in Cork) on a small scale in Ireland	• Conoco Philips • Maxol • Other integrated oil companies

Source: International Energy Agency; Renewable Fuels Association

International production of ethanol from beet and wheat

The feedstock used for ethanol production by the world's major producers in Brazil and U.S. is sugar cane and corn. There are relatively few examples of large beet or wheat ethanol facilities and most of these are found in Europe. France was the first European country to produce ethanol on a large scale in the 1990s with Germany and Spain following in subsequent years. In 2005, some 10,000 hectares was devoted to beet growing for ethanol in France, contributing some 50m litres to an overall production of over 144m litres, with the balance being produced from wheat. Spain is one of the fastest growing European producers of ethanol and has experienced an annual production growth of some 15% in recent years. Most Spanish production is from cereal grains and is undertaken in two large facilities in the southeast at Cartagena (100m litres capacity) and in the northwest at Teixeiro-Curtis (130m litres capacity).

Ethanol production in selected countries



Note: Americas and Europe are on different relative scales for viewing purposes
Source: Renewable fuels association (Americas); European bioethanol fuel association (Europe)

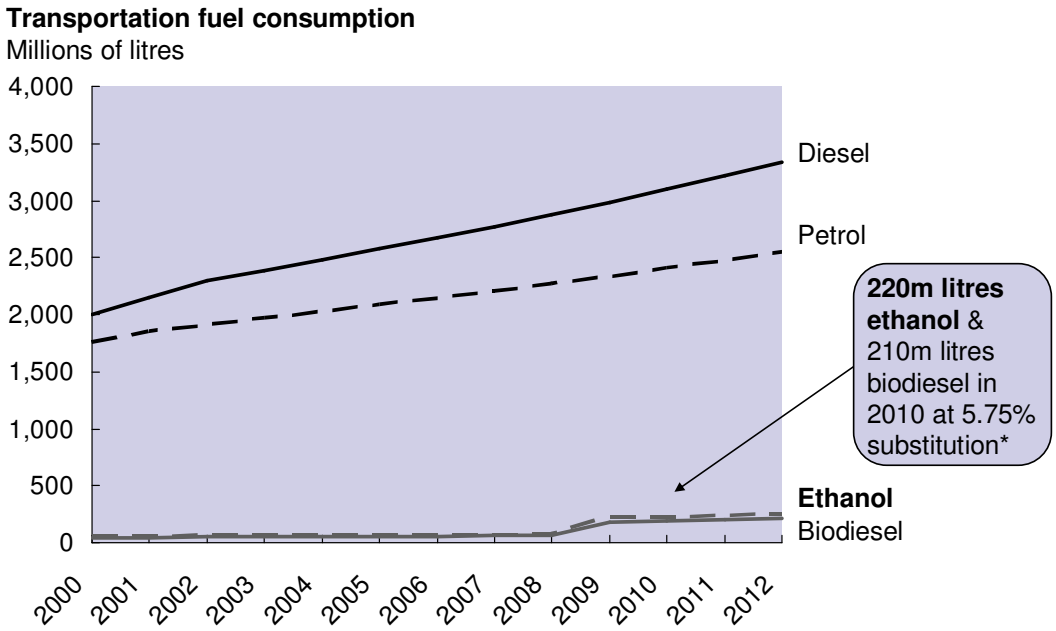
3. The Market Demand for Ethanol in Ireland

The primary market for biofuels in Ireland is determined by the amount of hydrocarbon fuel substitution that can be achieved. At current prices, no single biofuel can be produced or imported cheaper than petrol or diesel. However, the confluence of increasing regulation, environmental concerns, high oil prices, emerging government incentives and improved technology has resulted in biofuels gaining a small but growing market share.

A key driver for hydrocarbon fuel substitution is the EU biofuels directive (2003/30/EC), which advocates that member states replace 2% of gasoline and diesel transportation fuels by 2005 and 5.75% by 2010 on an energy basis.

The following graph showing projected fuel use in Irish transportation highlights the market opportunity for biofuels if EU targets are reached.

Market size of transportation fuel in Ireland if EU directive targets are met: fossil fuels and biofuels



* EU biofuels directive target for gasoline and diesel transport fuels. Ethanol has a lower relative energy content than biodiesel and, therefore, more ethanol is needed on a volumetric basis to replace the same amount of fossil fuel
Source: International Energy Agency (IEA), Sustainable Energy Ireland (SEI)

At 2% substitution, the target market for biofuels would be some 70m litres of ethanol and 65m litres of biodiesel. This assumes a direct substitution of ethanol for petrol and biodiesel for diesel and also takes into account the higher energy value of hydrocarbon fuels. At 5.75% substitution, the target market for biofuels in 2010 would be some 220m litres of ethanol and 210m litres of biodiesel.

However, these figures relate to the targets set by the EU biofuels directive and without enforcement, they act as a guide only. True market demand will be determined by the quantity of biofuels that can be delivered at a cost that is competitive with alternative sources of transport fuel. At current prices ($70-75 bbl oil), petrol is delivered to the pump in Ireland at a cost of 52 cents per litre before excise and VAT is added (i.e., circa €1.18 per litre unleaded petrol at the pump). Currently, no source of ethanol (from local production or importation) may be delivered at less than 64 cents per litre before excise and VAT.

The real market demand for ethanol in Ireland will therefore be more likely determined by the volumes of ethanol that are granted excise relief in the government tender. The current mineral oil tax relief scheme will grant relief only to selected applicants who submitted proposals by August 28th 2006. The removal of excise duty for ethanol will enable producers or importers to deliver ethanol at a price that is competitive with petrol. These volumes have been set at 11m litres in 2006, 40m litres in 2007 and 85m litres in 2008, 2009 and 2010. If the relief scheme was extended to ensure EU directive targets were met, then the market size would increase to some 220 million litres of ethanol per year.

4. The supply of sugar beet and wheat feedstock for ethanol production

The available supply of beet and wheat feedstock for ethanol production at a facility in Mallow is governed by several factors including a) availability of suitable land that is within reasonable distance of the Mallow site; b) yield of sugar beet and wheat per unit area; and c) rotation cycles. Ultimately, the difference between the growing costs and the price offered by an ethanol producer, that must produce ethanol at a competitive rate, will affect the ability and willingness of growers to supply feedstock.

Current sugar beet production

In recent sugar beet campaigns, up to 1.6m tonnes of sugar beet were grown on over 32,000 hectares for the purposes of producing 199,000 tonnes of sugar. Increasing yields and sugar production efficiency have led to a reduction in sugar beet requirements. The Mallow sugar factory processed some 1.2m tonnes of beet during the 2005 campaign. The beet price during the last campaign was €52.48 per tonne and at this price, beet was supplied from as far as Roscommon. With the removal of the sugar quota, the amount of beet grown may theoretically rise if an alternative demand exists.

Current wheat production

In recent years, up to 800,000 tonnes of wheat has been produced on 95,000 hectares according to figures from Teagasc and the Central Statistics Office. This is over 40% of total cereals production on almost half of the land devoted to cereals (2005 Barley: 1,025 ktonnes on 164.5 kha; 2005 Oats: 111 ktonne on 16.5 kha). Most of the produced wheat has been used for domestic consumption with 18-20% of wheat or wheat products being exported. However, Ireland's trade balance for wheat and wheat products has been consistently negative with an average of over 500,000 tonnes of wheat and products being imported each year since 1999.

Availability of beet and wheat supply for ethanol production

It is estimated that 4 Mha of agricultural land in Ireland is currently used for grass and grazing (91% of all land devoted to agriculture). The amount of this land that could be converted to additional production of beet and wheat for ethanol production, taking account of rotation cycles, is estimated by Teagasc to be 63,000 hectares and 15,000 hectares respectively, published in the Liquid Biofuels Strategy Study for Ireland by SEI. This would result in a total of 95,000 hectares available for beet for ethanol production, taking land formerly used for beet for sugar production into account (i.e., 32,000 hectares outlined above), and 15,000 hectares available for wheat for ethanol production, assuming that current wheat production for consumption is not displaced.

However, the realistic available land for ethanol feedstock will be lower than these total figures when account is taken of suitability of farm size (small holdings may not have the

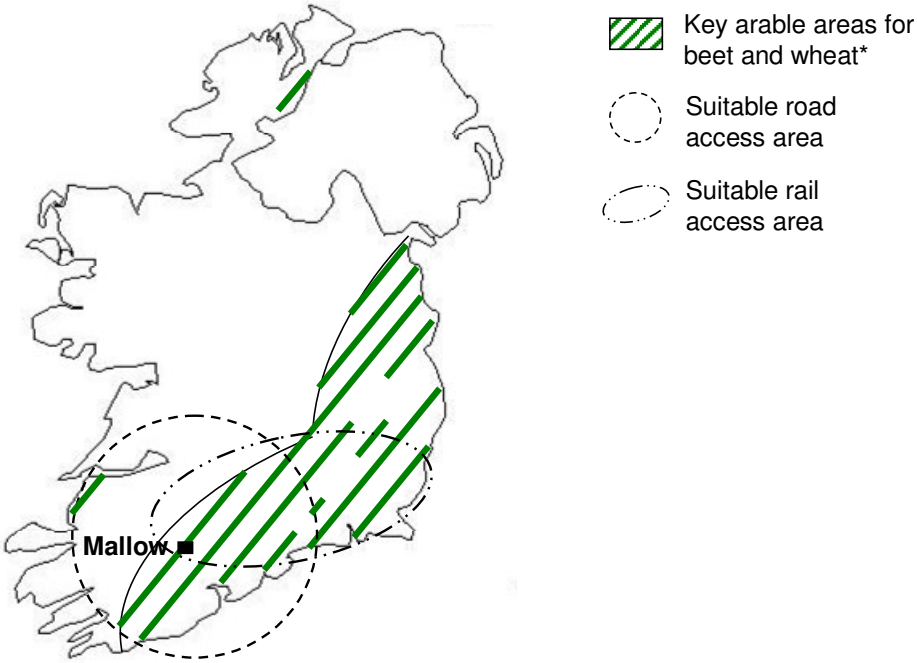
resources), proximity to Mallow (transportation costs for beet are significantly more expensive than wheat) and the price offered.

Submissions from farmer groups indicate that a minimum acceptable price for beet is in the region of €40 per tonne. On this price basis, along with land estimates from Teagasc and quotes from haulage companies for road transport within an 80 kilometre radius and rail from Wexford, it is assumed that 40,000 hectares are available for beet production.

At prices lower than €40 per tonne, the availability of beet will fall off dramatically. Beet production cost has been estimated by Teagasc and the IFA to be €29 per tonne. When farm overheads of €387 per hectare (detailed below) are added the cost rises to some €35 per tonne. It is assumed that if a price of €30 per tonne were offered by an ethanol producer, the supply of beet would be negligible, even from farms in the immediate vicinity achieving high yields.

While a total of 15,000 hectares of additional land are available for wheat dedicated to ethanol across Ireland, a realistic land area of 12,000 hectares has been estimated to be available for wheat production at minimum acceptable prices. This comprises land within a distance of Mallow that does not incur prohibitive transport costs, takes account of farms that have sufficient resources and allows for a price of €140 per tonne. Current prices in Ireland are €135 - €140 per tonne although a fall in world wheat supply and rise in prices in 2006 is forecast by wheat economists due to dry summers in the E.U. and U.S. and droughts in the southern hemisphere. The actual prices for beet and wheat that can be offered by a competitive ethanol producer will be detailed in the economic chapter

Suitable arable land areas and transportation access for Mallow



* These agricultural areas are also used for dairying, sheep and dry stock
Source: Teagasc, Sustainable Energy Ireland (SEI)

Crop growth costs

Estimates for variable and fixed production costs for sugar beet and wheat are detailed below. Seeding, fertilising and herbicides represent significant material costs and sowing and harvesting require use of costly machinery.

A carbon premium of €45/ hectare is currently available to farmers for growing biofuel crops and this will offset these costs slightly.

Variable and overhead costs for beet and wheat growers

2005 Variable costs (excluding VAT)
€/ hectare

Cost element	Beet	W wheat	S wheat
Seed	106	57	68
Fertilisers	305	223	167
Herbicides	155	50	36
Fungicides	28	155	100
Insecticides	52	34	18
Growth reg.	0	12	4
Total materials	**646**	**532**	**392**
Plough, till, sow	175	120	120
Spray	56	70	56
Fertiliser spreading	28	42	42
Harvesting	250	105	105
Total machinery	**509**	**337**	**323**
Miscellaneous	**232**	**62**	**45**
Total variable costs	**1,388**	**930**	**760**

2003 Overhead costs
€

Overhead	
Land rental	5,528
Car/ elec/ phone	2,067
Hired Labour	4,042
Interest charges	1,707
Machinery operating	6,207
Buildings maintenance	621
Land maintenance	633
Other	2,817
Total	**23,622**
Adjusted per hectare (average 61 ha)	**387**
Less carbon premium (€45/ ha)	**342**

Source: Teagasc

Transportation costs

Costs for beet transportation agreed for the 2005/06 season are shown below. Beet is particularly expensive to transport. Four times as much beet must be transported by weight compared to wheat grain for the same output of sugar content. Beet from the field that is not cleaned in advance of delivery will contain a large additional tare weight (i.e., earth, stones and waste). In recent campaigns, it is estimated that some 50% of beet growers cleaned the beet before delivery and some 20% of beet growers delivered beet to Mallow by their own means of transportation. Wheat grain may be transported at similar rates per tonne.

Transportation costs for beet feedstock

2005/06 haulage costs (including VAT – 21% for haulage, 13.5% for services)
€/ tonne

Distance (miles)	Haulage only	Loading and haulage	Cleaning, loading and haulage
0-10	1.61	4.87	6.46
11-15	1.69	4.95	6.54
16-20	2.69	5.95	7.54
21-25	3.28	6.54	8.13
26-30	4.31	7.57	9.16
31-35	5.01	8.27	9.86
36-40	5.96	9.22	10.81
41-45	6.52	9.78	11.37
46-50	6.84	10.10	11.69
51-55	6.96	10.22	11.81
56-60	7.53	10.79	12.38
61-65	7.77	11.03	12.62
66-70	8.12	11.38	12.97
71-75	8.52	11.78	13.37

Source: Beet hauliers association; selected quotes from local haulage companies

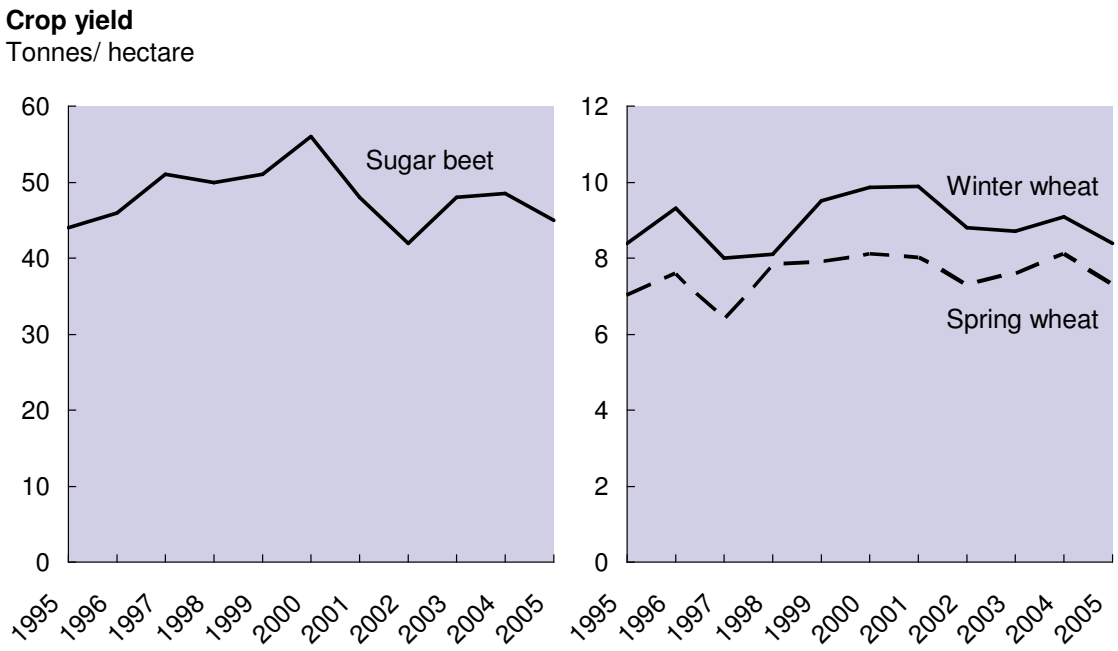
Crop yields

Yields of sugar beet and wheat are shown below for the period 1995 – 2005. At an average yield of 50 tonnes of sugar beet per hectare, 2m tonnes of beet can be produced from 40,000 hectares. At an average yield of 8.5 tonnes of wheat per hectare, 102,000 tonnes of wheat can be produced from 12,000 hectares.

Due to climatic conditions, sugar beet yields in Ireland are lower than those achieved in France and Germany where average summer temperatures are higher and yields of up to 61 tonnes per hectare have been achieved. Some Irish growers with high levels of efficiency will certainly be able to achieve beet yields of up to 55 tonnes per hectare. A lower yield average has been assumed to take account of the delivery of beet from a range of growers needed to support a plant producing ethanol at full capacity (i.e., some 1.5m tonnes). Average yields reported in submissions by both the IFA and local farmers is 20 tonnes per acre (49.4 tonnes per hectare)

Wheat yields in Ireland have been among the highest in Europe due to soil and climatic conditions. Irish wheat yields have been up to 1 tonne per hectare higher than yields in France and up to 1.5 tonnes per hectare higher than yields in Germany, primarily due to sandier soils and periodic droughts in those countries.

Yields of sugar beet and wheat



Source: Teagasc, CSO, Sustainable Energy Ireland (SEI)

It has been suggested that 'fodder beet' can achieve higher yields in excess of 65 tonnes per hectare and should be considered as a feedstock for ethanol production. However, further research on fodder beet is required before it may be used as a viable feedstock. While several studies (including studies conducted by the U.S. Department of Energy) show that fodder beet has less sugar content than sugar beet, field tests underway in New Zealand dispute this finding. Fodder beet brings additional complication to processing as the constituency of its sugars requires different fermentation compared to regular sugar beet. At this time, fodder beet remains an unproven feedstock for ethanol production.

It should also be noted that beet provides a strong rotation partner for cereals. Beet, which itself has a rotation of 1 in 3, can result in increased yields for winter wheat (up to 1 tonne per acre yield advantage recorded) and spring barley (up to ½ tonne per acre yield advantage recorded). It also helps to avoid weed and fungal problems associated with continuous cereal growing. A rotation of beet/ winter wheat/ spring barley has proven effective for many farmers while wheat can also be grown for 2 years after one year of beet, if second year wheat is treated to avoid fungal growth.

Ethanol conversion rates

International practice at ethanol production plants demonstrates a yield of 90 litres of ethanol per tonne of sugar beet and 356 litres of ethanol per tonne of wheat. On this basis, 2m tonnes of beet would result in 180m litres of ethanol and 102,000 tonnes of wheat

would result in 36m litres of ethanol. In energy terms, these volumes equate to 4.25 PJ and 0.85 PJ respectively (1 PJ = 1 Peta Joule = 1 x 10^{15} Joule).

These volumes would represent 50% of the 2010 EU directive target for all transport fossil fuel substitution.

Available feedstock sources of beet and wheat at reasonable prices, relative to requirements of a large ethanol plant and EU directive targets

		Area (k hectares)			Feedstock (k tonnes)		
		Available*	Required for 100m litre plant	Required for total 2010 targets**	Available	Required for 100m litre plant	Required for total 2010 targets**
Ethanol sources	Wheat	12	33	73	100	280	620
	Sugar beet	40	22	49	1,895	1,110	2,440

There is sufficient sugar beet alone available for a large plant but insufficient wheat alone

* Assumes current crops are not displaced and replaced by imports
** 220m litres of ethanol (as well as a further 210m litres of diesel) need to be replaced to meet 5.75% target account taken for higher biodiesel energy content
Source: Teagasc, IFA, SEI

Conclusion

At prices that provide a reasonable margin for beet and wheat growers, an estimated 40,000 hectares are available for beet production and 12,000 hectares are available for wheat production. This would yield 2m tonnes of beet and 102,000 tonnes of wheat and provide sufficient feedstock for ethanol production capacity of 180m litres from beet and 36m litres from wheat. The availability of these volumes is strongly affected by the price that can be offered by a competitive ethanol producer.

	Area (kha)	**Crop yield (t/ha)**	**Feedstock (kt)**	**Potential ethanol (million litres)**
Sugar beet	40,000	50	2,000	180 *(4.25 PJ)*
Wheat	12,000	8.5	102	36 *(0.85 PJ)*

5. Technical assessment of the ethanol production opportunity at Mallow

Production of ethanol from beet and wheat is technically feasible at the Mallow site with the appropriate plant and equipment modifications and additions. Most ethanol production plants in Europe have been built as extensions to existing sugar plants. The former sugar factory at Mallow is in a strong state of technical health. Significant capital investment has occurred in recent years with some €25m invested in 2005 alone. Equipment has been maintained to high quality standards and much equipment has been procured in recent years (e.g., an external conveyor system and a Siemens generator).

The illustrations below show how the production processes vary for sugar and ethanol and the consequent modifications required are highlighted.

- Additional processes and equipment required for ethanol production from sugar beet only: fermentation, distillation, dehydration, storage, instrumentation, quality control and loading (€45-50m capital expenditure)
- Additional processes and equipment required for ethanol production from wheat (supplementary to above): milling, liquefaction and saccharification with enzymes (€10-15m capital expenditure)

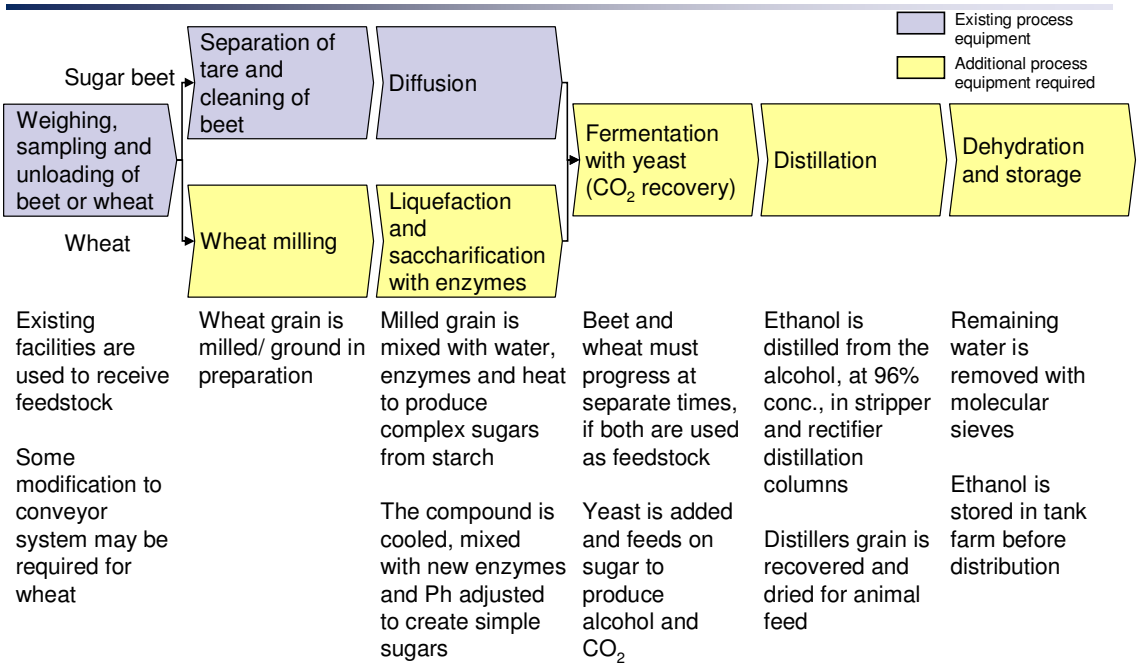
Current sugar production process at Mallow
(10,000 tonne beet/ day capacity)

Weighing, sampling and unloading of beet	Diffusion	Purification/ Saturation	Evaporation/ Crystallisation	Centrifuging	Packing
Beet arrives in trucks (up to 500/ day) or at train depot Beet is weighed and sampled for tare and sugar Beet is unloaded 'dry' or 'wet' (5 tonnes water per 1 tonne beet) Tare is separated and beet is cleaned	Beet is sliced to <1cm and loaded into diffusion vessel Beet is conveyed against counter current of hot water yield 14% sugar juice Slices are pressed and dried for animal feed	Lime and carbon dioxide are added to the juice to bond with non sugar compounds	Non sugar compounds are evaporated to yield a syrup of 60% sugar concentration Evaporation temperature is lowered in vacuum pans to create crystals in the syrup	Syrup is spun off in a centrifuge to leave the sugar crystals Crystals are cooled and stored Molasses are recovered for animal feed	Sugar crystals are checked for quality and packed for distribution

Other significant plant and equipment includes:
- 12 MW combined heat and power generation (two generators: 7 MW + 6.5 MW) fuelled by 30,000 tonnes of coal per year
- Control rooms
- Lime kiln
- Extensive external and internal conveyor belt system
- Waste management system

Source: Mallow site visit, interviews with sugar production engineers and managers, Greencore/ Irish sugar literature

Requirements for ethanol production process at Mallow



Source: Mallow site visit, interviews with plant design engineers, ethanol production plant case studies

Ethanol production capacity at Mallow

The current Mallow plant can process up to 10,000 tonnes of beet each day. Sugar is normally produced with a 12 hour overall throughput time. In ethanol production, a new relative bottleneck is introduced at fermentation and distillation (36 hour cycle time). Beet cannot be stored for more than 1-2 days before infection sets in but if provision is made to store the sugar juice after diffusion then beet handling capacity can be maintained. An extended beet campaign would enable Mallow to accept beet over 150 days (1.5m tonnes). At a conversion rate of 90 litres per tonne, this would result in an annual maximum capacity from beet of 135m litres.

The available supply of wheat is relatively lower than that of beet and new plant equipment would manage to process 102,000 tonnes of delivered wheat grain. At a conversion rate of 356 litres per tonne, this would result in an annual maximum capacity from wheat of 36m litres.

While the combined maximum annual capacity of the plant at Mallow is 170m litres, actual production will be limited to volumes with economic support/ excise relief awarded.

Assessment of Mallow site relative to alternative Greenfield site

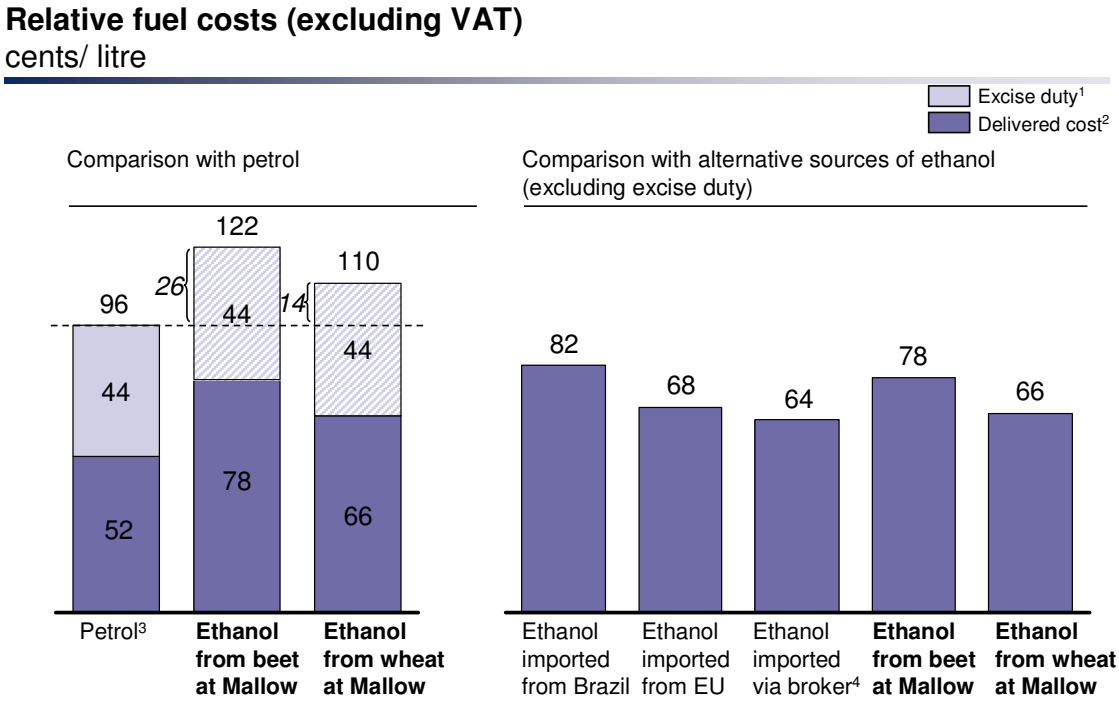
- **Advantages of Mallow site relative to Greenfield site:**
    - Existing key plant and equipment including: Feedstock unloading; tare separation and cleaning; beet diffusion, purification and saturation; control rooms; worker facilities; power generation; waste management
        - Capital investment savings compared to a new Greenfield site would be in the region of €45m (i.e., €100-110m estimated for a new Greenfield site)
    - Transport infrastructure (road and rail to the plant)
    - Highly skilled local workforce
    - Fresh water supply
    - Industrial planning permission for the current site exists
- **Disadvantages of Mallow site relative to Greenfield site:**
    - The Mallow plant is not in a location that minimises the transportation cost of all feedstock that would be required to support production at full capacity.
    - Distance from a port for potential import of feedstock or export of ethanol
    - The purchase price of the Mallow site (i.e., in the region of €25-30m) would be more than the purchase price of a Greenfield site which would be in the region of €1-2m for agricultural zoned land or up to €15-20m for industrial zoned land (renting of land might also be possible).
    - The retention of existing equipment at the Mallow site (i.e., partial dismantling of the site only) would result in a 25% reduction (i.e., €36.4m) of EU restructuring compensation, based on indications in current EU regulations
- **Considerations for both Mallow and Greenfield site:**
    - Application required to Environmental Protection Agency (An application from Mallow would be required as a result of the change in operations although this may be a more straightforward than for a Greenfield site)
    - Environmental and social impact assessment required for emissions, effluents and changes in the local community

6. Economic assessment of the ethanol production opportunity at Mallow

Ethanol produced from beet or wheat at Mallow requires economic support in order to compete with either petrol or the cheapest source of imported ethanol. The level of economic support required would be 26 cents for every litre of ethanol produced from beet and 14 cents for every litre produced from wheat given current prices. This would amount to €40m at current prices each year to run the plant at full production capacity. The highest cost elements for ethanol production at Mallow are beet and wheat feedstock and plant operation.

The cost of ethanol from Mallow delivered to the pump is compared with petrol and other sources of ethanol below. Ethanol produced from beet at Mallow would be more expensive than alternative sources of ethanol. Ethanol produced from wheat at Mallow could be produced at close to competitive prices although available wheat feedstock is low and would be insufficient to fill production capacity at Mallow.

Comparison of the cost of ethanol from different sources with petrol



1. Does not include contribution to national oil reserve (~.5ct/ l); 2. Includes production or import cost, capital recovery, distribution, overheads, blending, retail margin; 3. Pump price Aug 2006; 4. from multiple sources at lowest available cost, mainly from Least Developed Counties, for which no import duty applies
Source: Ecofys, SEI, IFA, Teagasc, CBOT

Costs for ethanol production from beet and wheat at Mallow are based on an analysis of cost components that include: feedstock production costs; variable and fixed farm costs; transport of feedstock to Mallow; operating costs for a best practice international ethanol plant; capital recovery for equipment modification at Mallow; return on the sale of by-

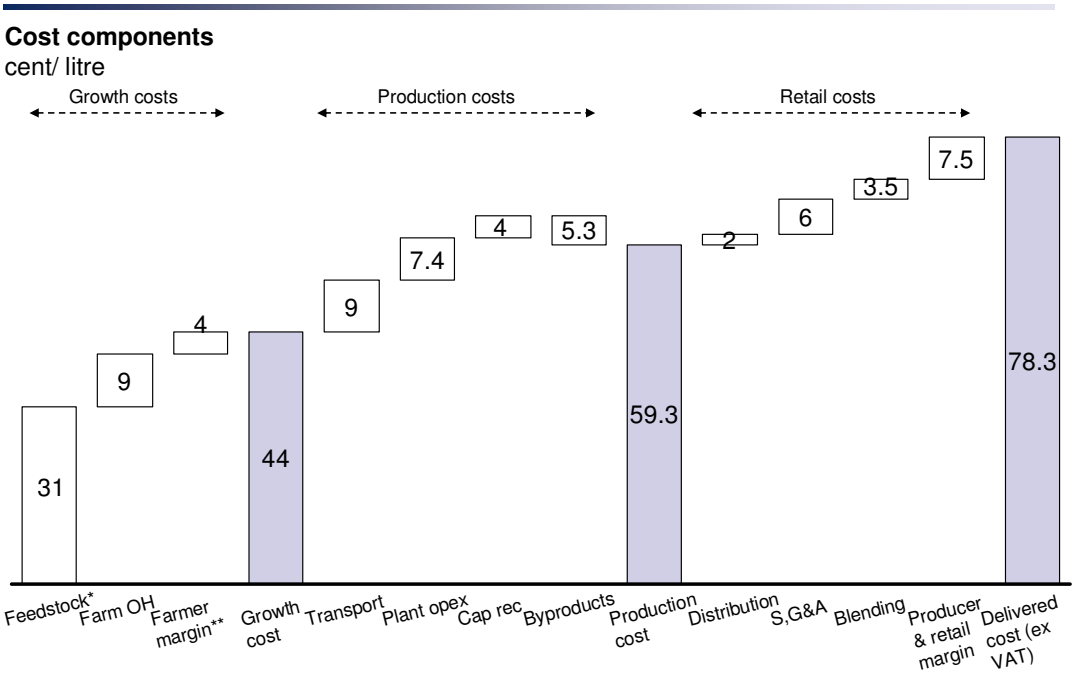
products; distribution; blending costs; retail administration costs and reasonable margins for growers, producer and retailers. These costs are based on best information from Ecofys, Teagasc, Sustainable Energy Ireland, submissions from farmer groups and Cork co-ops and have been cross-referenced with international case studies. The costs calculated reconcile with figures reported by SEI in the 2004 Liquid Biofuels Strategy Study for Ireland (i.e., 74c/l ethanol from beet and 58 c/l ethanol from wheat) when increases in production and feedstock costs and inflation are taken into account. The cost also reconciles with a 2006 Teagasc estimate of 74.7c/ ethanol from beet bought at €40/t, as the Teagasc figure is net of producer and retail margins.

The cost of petrol delivery is based on current pump price in Ireland net of VAT and €0.00476 per litre contribution to the national oil reserves agency. Applying a range of oil prices as a sensitivity test is considered later.

Cost comparisons are shown on a volumetric basis (litres) rather than an energy basis (GJ), despite the lower energy content of ethanol relative to petrol (68%). Studies have shown that fuel energy output is not compromised in the most common low concentration blends of 5-10%, due to ethanol's higher octane content and hydrogen-to-carbon ratio. Higher concentration blends would indeed result in energy output reduction, thus making ethanol even more expensive when compared on a volumetric basis than shown above.

Ethanol from Brazil can be produced at costs as low as €0.25 per litre. However, when margin, transport and import duty are added, the cost rises significantly. Ethanol that can sourced by brokers from alternative sources including 'least developed countries' which do not incur import duty represents the cheapest potential source of imported ethanol.

Ethanol produced from beet at Mallow

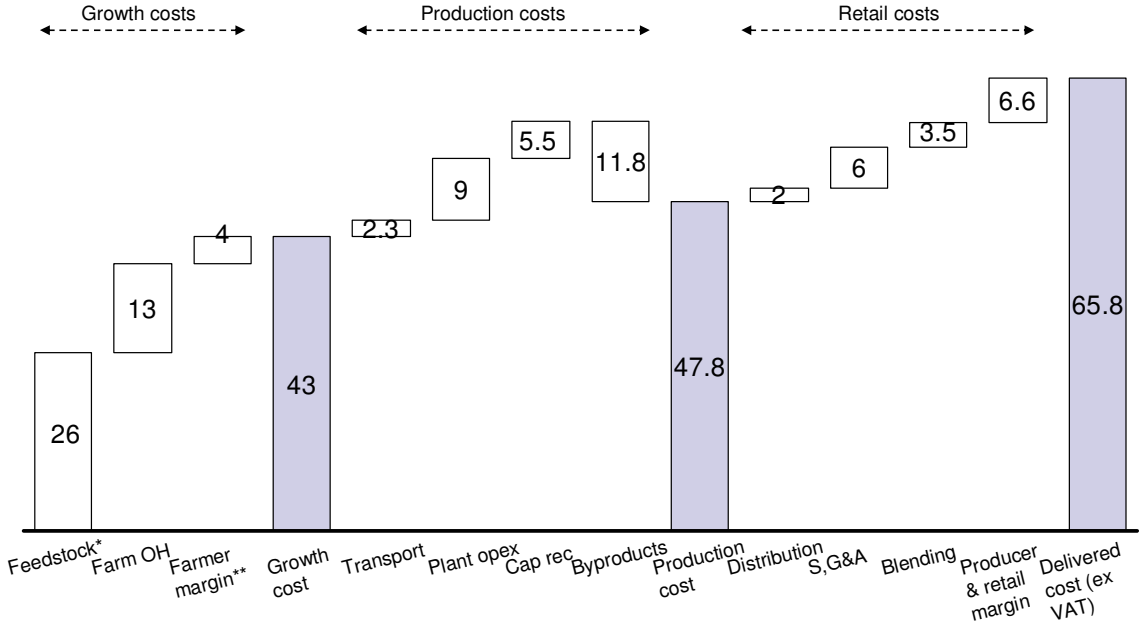


* Includes variable farm costs, net of carbon premium, ** Farmer margin assumes gate price for beet is 40 euro/tonne
Source: Ecofys, IFA, Teagasc, SEI

Ethanol produced from wheat at Mallow

Cost components

cent/ litre



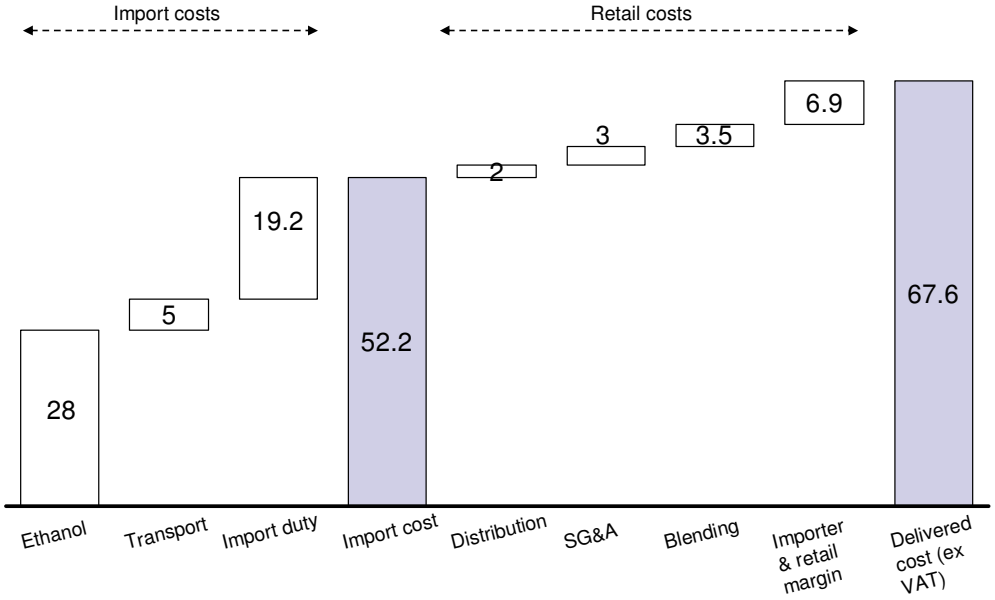
* Includes variable farm costs, net of carbon premium, ** Farmer margin assumes price for wheat is circa 145 euro/tonne

Source: Ecofys, IFA, Teagasc, SEI

Ethanol imported from Brazil

Cost components

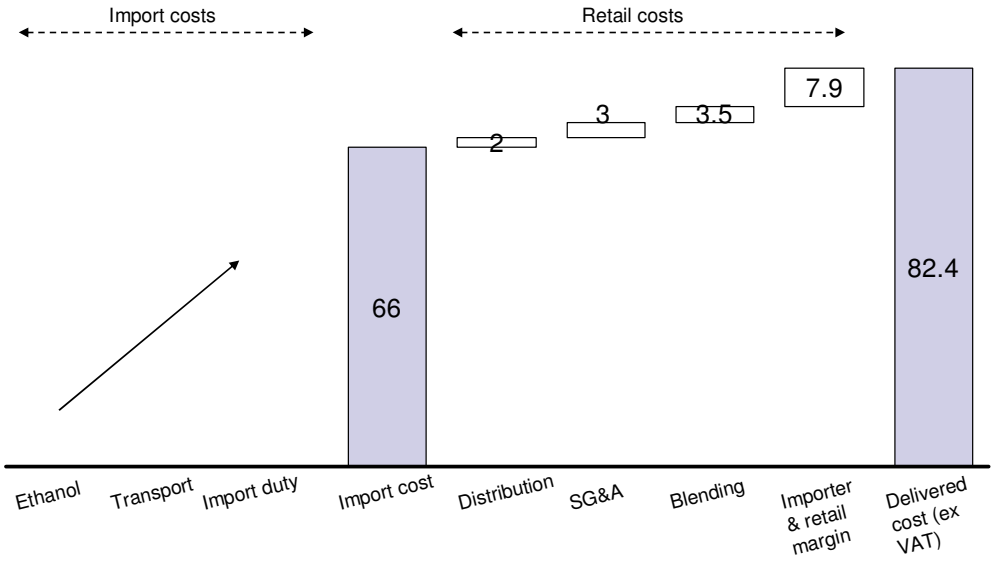
cent/ litre



Source: Ecofys, IFA, Teagasc, SEI

Ethanol imported from the EU (ex Rotterdam)

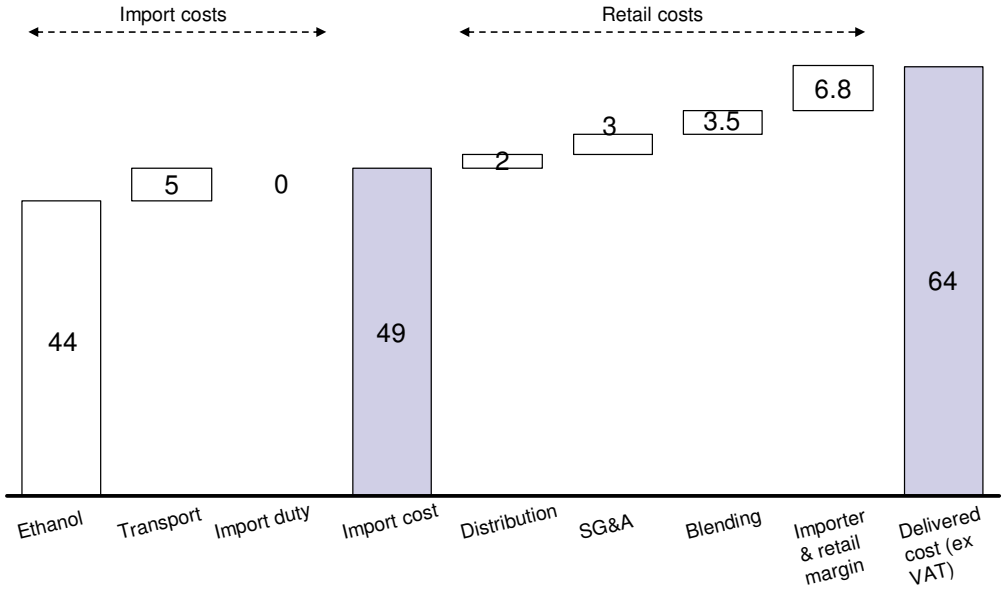
Cost components
cent/ litre



Source: Ecofys, IFA, Teagasc, SEI

Ethanol imported via a broker (e.g., from alternatives sources including Least Developed Countries)

Cost components
cent/ litre



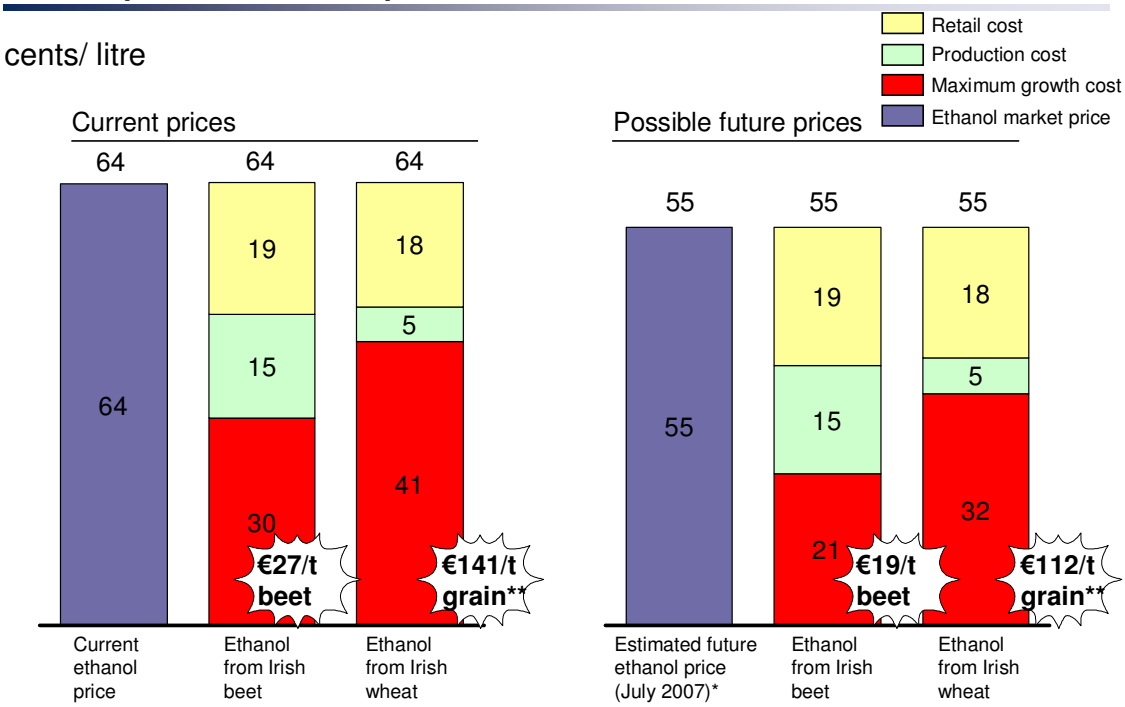
Source: Ecofys, IFA, Teagasc, SEI

Reducing prices for feedstock to enable competitive ethanol production at Mallow

Without economic support, the price paid for feedstock would need to be reduced in order to be able to produce ethanol that is economically competitive.

If 'Mallow ethanol' were to compete with current market ethanol prices, farmers would receive €27/ tonne of beet or €141/tonne of wheat grain. This beet price is below cost to the farmer and therefore unviable. The wheat price may be attractive but limited suitable land would yield insufficient wheat to supply Mallow at full capacity. Furthermore, wheat prices are forecast to rise over the next 12 months due to world shortage of supply and €141/ tonne may no longer be attractive in 2007. International ethanol brokers and exchanges such as the Chicago Board of Trade predict a short term fall in ethanol prices by July 2007 due to increased ethanol production capacity. At these 2007 ethanol prices, a competitive ethanol producer at Mallow could only afford to pay €19/ tonne of beet and €112/ tonne of wheat. There are indications that longer term ethanol prices may increase with rising with demand, despite this short term fall.

Maximum growth costs for Mallow ethanol to compete against market *ethanol* prices, with fixed production and retail costs



* Chicago board of trade futures; ** price paid to a grain merchant
Source: Ecofys, SEI, IFA, Teagasc, CBOT

Note: 18-19 c/l retail costs include distribution (2c/l); blending (3.5c/l); retail fixed and variable costs (6c/l) and margins for both producer and retailer (6.5-7.5c/l). Lower production costs for ethanol from wheat reflect a higher return from by-products.

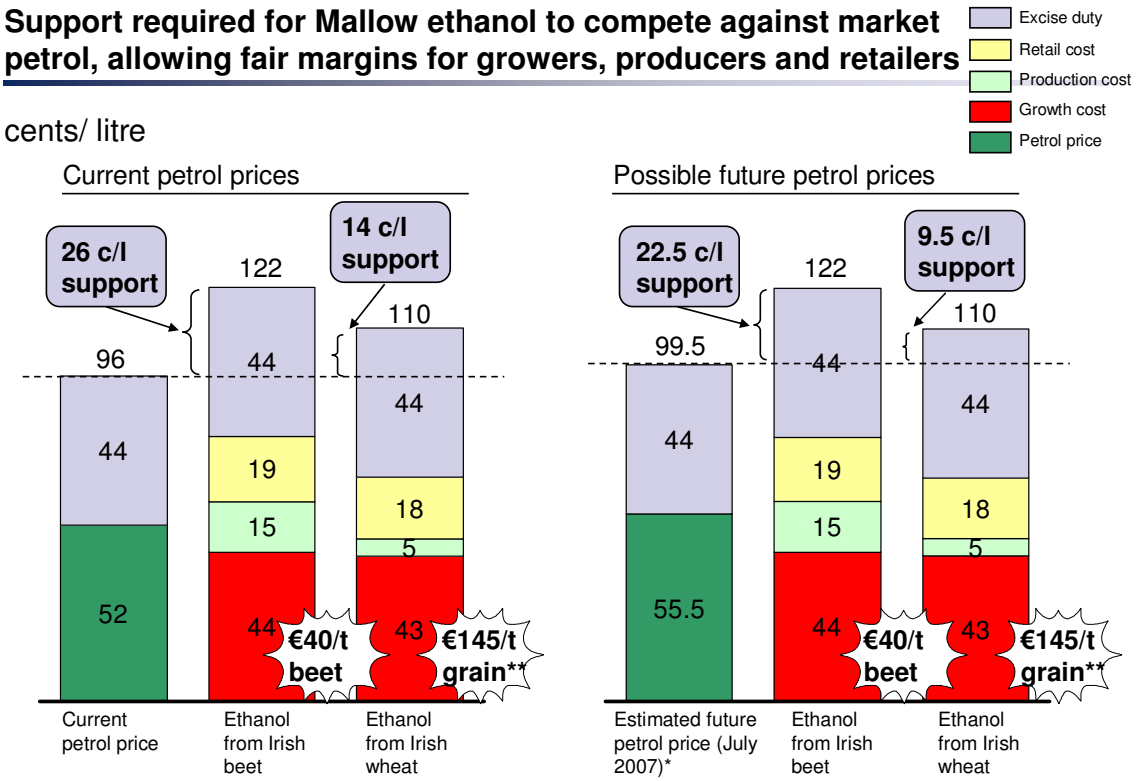
Economic support required to enable competitive ethanol production at Mallow

The comparison of Mallow ethanol with alternative sources of ethanol is only appropriate if support or incentives such as excise relief are introduced that make ethanol more economically competitive than petrol.

If Mallow ethanol were to compete with current market petrol prices and provide reasonable margins to farmers, producer and retailers, economic support of 26 cents would need to be awarded for every litre of ethanol produced from beet and 14 cents for every litre of ethanol produced from wheat. These amounts are less than full excise duty of 44 c/ l. This support would amount to an annual subsidy of up to €40m, potentially in the form of excise relief, for operation at full capacity of 170m litres per year.

The government has established a support scheme for biofuels through the 'Biofuels Mineral Oil Tax Scheme – II'. This will grant excise relief on up to 85m litres of ethanol until 2010. However, this volume is likely to be shared by several successful applicants from among those who submitted applications by August 28th 2006. Ethanol produced at Mallow could only become competitive if a further scheme for excise relief were introduced.

Support required for Mallow ethanol to compete against market petrol, allowing fair margins for growers, producers and retailers



* Nymex oil futures ($80 bbl oil July 2007); ** price paid to a grain merchant
Source: Ecofys, SEI, IFA, Teagasc, Nymex

The competitiveness of produced ethanol as a transport fuel substitute depends on the price of petrol at the pump, which in turn depends on the price at which international crude-oil is traded. The price of oil that is required for Mallow ethanol from beet and

wheat to be competitive without support and allowing reasonable margins is shown below. The price of a barrel of international crude oil would have to rise to $95 for Mallow ethanol from wheat to be competitive and to $115 for Mallow ethanol from beet to be competitive. The figures also reflect the changing levels of economic support that would be required for changing oil prices.

Oil price required for competitive Mallow ethanol from beet and wheat (full excise duty applied)

Oil price ($/ bbl)	Margin for Mallow ethanol from beet (cents/ litre)	Margin for Mallow ethanol from wheat (cents/ litre)
$65	-33	-21
$70	-29	-17
$75	-26	-14
$80	-23	-11
$85	-19	-7
$90	-16	-4
$95	-12	0
$100	-9	3
$105	-5	7
$110	-2	10
$115	2	14
$120	5	17

Source: Ecofys, SEI, IFA, Teagasc, Nymex

Investment considerations for ethanol production at Mallow

An investor examining the opportunity for ethanol production at Mallow should take the following economic considerations into account:

- Purchase of the Mallow site: Quoted independent valuation of €25-30m, which can only be fully determined through commercial negotiation with Greencore. Assume Greencore undertakes environmental remediation.
- Capital investment for required equipment modifications (estimates from engineering and plant design companies):
  - Modifications for ethanol production from beet alone (equipment for fermentation, distillation, dehydration, storage, instrumentation, quality assurance, loading): €45-50m
  - Additional modifications for ethanol production from wheat (equipment for milling, liquefaction and saccharification with enzymes): €10-15m
  - 12 – 18 month plant upgrade lead time

- Support required to produce ethanol at competitive rates: €40m each year at current rates

Conclusion

Ethanol produced from beet or wheat at Mallow requires economic support in order to compete with either petrol or the cheapest source of imported ethanol. The level of economic support required would be 26 cents for every litre of ethanol produced from beet and 14 cents for every litre produced from wheat given current prices. This would amount to some €40m at current prices each year to run the plant at full production capacity. Support of 26 cents and 14 cents is less than the full excise relief of 44 cents awarded under the current schemes in Ireland and is also less than current ethanol rebates in all European countries where rebates exist. This support would enable reasonable prices of €40/ tonne of beet and €145/ tonne of wheat to be paid to growers for feedstock.

The maximum prices that could be offered for feedstock to produce ethanol at Mallow that competes with alternative sources of ethanol without subsidies would be €27/ tonne of beet and €141/ tonne of wheat. Although this wheat price may currently be attractive to farmers, there is insufficient available wheat feedstock to supply a Mallow ethanol plant operating at full capacity. Furthermore, wheat prices are expected to rise in the next 12 months and €141/ tonne may be less attractive to farmers in 2007.

An investor examining the opportunity of buying and operating the Mallow site to produce ethanol would need to consider capital investments in the region of €25-30m to purchase the Mallow site and €55-65m for plant and equipment modifications. The lead time to first production would be 12-18 months from the time of purchase.

7. Macro economic and environmental considerations

Employment

The Mallow sugar factory employed over 200 workers at times of peak sugar production and over 320 people found full or part time work at the factory in the course of the year. An ethanol production facility at Mallow would clearly also require full and part time workers but at a smaller scale than previously required for sugar production. The level of automation in a modern ethanol facility reduces manpower requirements. A new ethanol plant at Norrköping in Sweden with a capacity to produce 150m litres per year (€110m investment) will employ a core of only 18 workers. The two largest ethanol production plants in Spain, with capacity >100m litres per year each employ some 65 people. It is estimated that an ethanol production facility in Mallow would employ close to 50 people at peak periods only. Worker roles are outlined as follows:

Key roles at an ethanol production plant at Mallow

Role	Number	Shifts	Total
Feedstock intake	2	3	6
Early sugar preparation	2	3	6
Fermentation and distillation	2	3	6
Quality control	2	3	6
Engineering (mech, elec, instruments)	3	3	9
Power generation (and fuel management)	1	3	3
Storage and loading	1	3	3
Security	2	3	6
Plant manager	1	1	1
Plant administrators	2	1	2
Retail and marketing	3	1	3
Total			**51**

Source: Interviews with plant designers and managers, international literature

In addition to the plant workers, additional employment would be created for feedstock hauliers and ancillary service providers.

Agricultural benefits

The production of ethanol from Irish grown beet or wheat, if it could be achieved on an economic basis, would provide several direct benefits to agriculture and the farming community: 1) Farmers would potentially receive income at reasonable margins, net of the opportunity cost of land use; 2) The by-products from beet and wheat would provide quality, fully traceable animal feed; 3) Sugar beet grown for ethanol production would provide a strong partner crop for rotation with wheat and barley and in doing so, maintain good soil conditions, high yields and quality tillage crops. Sugar beet also yields more ethanol per hectare than other available feedstock in Ireland (e.g., 4,500 litres from 1 ha of beet compared with 3,000 litres from 1 ha of wheat).

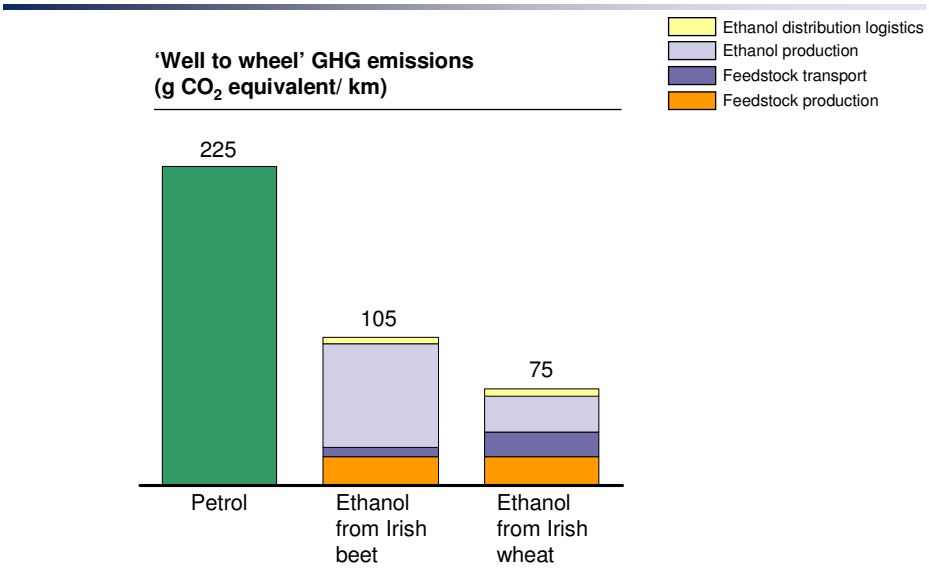
Security of supply

Ireland has a high level of dependence on foreign energy supplies with some 90% of energy needs being met by international sources. Most of this energy supply is in the form of hydrocarbon fuels. The Republic of Ireland is the third highest consumer of oil per capita in the E.U. and the state's reliance on oil for electricity generation in more than twice the E.U. average, according to 'A baseline assessment of Ireland's oil dependence', a report published by Forfás in April 2006. As a result of this dependence, Ireland is in a vulnerable position as oil price continues to rise and the finite pool of world hydrocarbon resources runs out. Biofuel is one of several alternative fuel sources that can help to reduce this dependence and contribute to increased self sufficiency in energy supply and an improved balance of trade and balance of payments in energy.

Emissions reduction

Ethanol acts as an oxygenate when blended with petrol and helps the fuel to burn more cleanly, reducing emissions. Greenhouse gas (GHG) emissions such as carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) are thereby reduced. Some non GHG emissions are also reduced such as sulphur oxides (SOx) and volatile organic compounds, which contribute to respiratory problems. However, studies have shown that carbon monoxide (CO), other nitrogen compounds (NO_X) and particulate matter (PM) emissions actually increase during ethanol feedstock production as a result of increased use of agricultural machinery, such as tractors, and feedstock transport. A Sustainable Energy Ireland study has reviewed the most relevant international literature on GHG emission reductions achieved by ethanol, calculated as a CO_2 equivalent, shown below. On the basis of these figures, 170m litres of ethanol produced from beet and wheat at the Mallow plant would result in a reduction of some 150kg of CO_2 equivalent GHG emissions.

Green house gas emissions for petrol and ethanol



Source: Sustainable Energy Ireland

Appendix – Acknowledgements and References

Members of the Cork County Council committee for the Mallow ethanol evaluation:

- Sharon Corcoran, Director of Service, Infrastructure and Development
- Robert O'Farrell, Senior Engineer, Infrastructure and Development
- Ger Shine, Senior Executive Officer
- Alex Grassick, Cork County Council Energy Agency
- Tom Bruton, Bruton Bioenergy
- Brian O'Gallachoir, UCC
- Jerry McCarthy, Teagasc
- Pat O'Connor, Mallow Town Council
- Valerie Murphy, Blackwater Resource Development Group

Submissions to the evaluation study
The evaluation team are grateful for the information, opinions and perspectives from the following groups in response to an invitation for submissions, advertised in national press:

- Allan J. Navratil
- Bandon Co-op
- Bandon Medical Hall
- Bandon Tillage Discussion Group
- Barryroe Co-op
- Immokilly Young Farmers' Tillage Discussion Group
- Irish Farmers' Association
- Macra na Feirme
- Martin O'Regan
- Southern Tillage Farmers Group

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- Teagasc, Oak Park, Carlow and Cork
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