Report Abstract.

Charcoal For Barbecue Consumption Within The United Kingdom: A Transport Energy Analysis Of Charcoal Supplied From UK Coppiced Woodlands And From Brazil And South African Importation.

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This abstract provides a shortened account of the study conducted by the author between November 1995 and May 1997.

Executive Summary:

- **Introduction.**

The aim of this report is to introduce to the reader an idea of the environmental impacts associated with our countries demand for barbecue charcoal and to quantitatively analyse the possible merit in terms of transport energy efficiency behind a move away from importing the product to producing it ourselves. Such a move would fit in with the concept of Sustainable Development as described in Agenda 21 of the United Nations Rio Earth Summit, held in 1992.

Every year approximately 100 Million Tonnes of charcoal is produced around the world.
To meet this demand requires roughly 500 - 600 Million Tonnes of wood fuel resource.
This paper demonstrates that currently the UK consumes around 50,000 Tonnes of barbecue charcoal, of this figure only around 5% is produced in the UK. There is however great potential to produce charcoal within the UK to meet our own demands in a sustainable manner from various wood sources.
Options include; wood waste from industry, wood waste from Local Authorities and wood sourced from a regeneration of woodland management - particularly from existing coppiced woodlands.
Much of the UK's stock of coppiced woodlands have been neglected for decades. This has been due to the demise in popularity of traditional coppice products such as thatching materials and fencing products. The resultant overgrowth of coppiced woodlands has led to significant ecological changes. As light has been blocked to the woodland ground layer, the pattern and abundance of certain woodland species of flora and fauna have been affected.

A UK charcoal production initiative in order to meet our own consumption needs would help greatly to regenerate coppice woodland management practices. Such a production system has been operating on a small scale in the UK for two years. Through the national co-ordination of the Bioregional Development Group, local charcoal producers have been brought together to form an effective sales force that has been able to successfully meet the demands of major retail organisations. The problems of centralised purchasing requirements have been greatly overcome whilst the product that reaches the retail stores has still been produced locally.
The resultant charcoal product, rightly labelled as Forest Stewardship Council (FSC) certified and locally produced has proved popular with consumers, the raw material is available in order to expand supplies and there is currently no shortage of potential new woodland charcoal producers.
However, in order to achieve growth in this sustainable local production system, from the current 5% supply of total demand, a greater understanding of the host of environmental issues and the commitment to address them is needed. Such understanding and commitment needs to be translated globally. Many facets of global charcoal production need to be improved in order to reduce timber consumption, protect habitats and reduce airborne pollution - particularly of greenhouse gasses such as CO and CO_2

The primary issue that this project explores is an analysis and comparison in terms of transport energy efficiency for typically imported charcoal - from Brazil and South Africa, and from UK produced charcoal derived from coppiced woodlands.
Much of our imported charcoal is now produced from FSC (Forest Stewardship Council) certified sustainable forest systems. The import scenarios chosen for this study have been purposefully selected from FSC certified systems, although it is still a fact that approximately 70% of our total imported charcoal still comes from uncertified and in many cases unsustainable and environmentally damaging systems of production.
The UK charcoal production system analysed from coppiced woodlands is in its own right sourced from FSC approved woodlands and is thus sustainable.

FSC certification of woodlands and forests in order to demonstrate sustainable timber production methods represents a significant step on a global scale towards saving such environments from consumption for timber products and paper pulp.

The concern expressed in this paper is that the "eco-labelling" of charcoal produced in Brazil, South Africa or any other country and then the subsequent transportation across the world is on the one hand a very positive step in the right direction, but it only represents a form of sustainable isolationism. The timber source is indeed sound but what about pollution mitigation measures, waste residue disposal, socio-economic considerations and transportation impacts?

Developed Nations, in seeking to promote sustainable development, should surely move towards addressing and solving these real issues as well. Chapter 4 of the Rio Earth Summit Agenda 21 encourages developed nations to change their patterns of consumption by promoting green (informed) consumerism. The use of local materials is encouraged in chapter 7. (UNCED, 1992)

It is to therefore state the obvious that the most holistic form of sustainable production for such a product must have considered all aspects of the product life cycle and that the best mode of production would be from sustainable local production, followed by local consumption. This would mean that charcoal production (most particularly for the product sold in the developed world as a leisure product) should be economically accountable for its global impact in terms of its ecological impact, pollution output, equitable labour costs and transportation impacts - both in terms of fossil fuel consumption and pollution output.

Whilst it is recognised that a study involving just one issue of a complete production/supply system can be criticised for ignoring the economic benefits that this world trade may indeed bring to international charcoal producers, their national economies and their employees and families. The only response to that must surely be that fundamentally, and again in line with the concept of global sustainable development, all the other environmental and socio-economic concerns mentioned above should indeed **begin to be addressed** and their real price paid for wherever charcoal may be produced.

It would appear that the import system exists for a relatively low value product such as charcoal primarily because no real cost has to be paid for any environmental impacts or mitigation such as airborne pollution control or biodiversity protection. Labour costs are also extremely low from a developed world's perspective, in many respects they are often very low within the social framework of the overseas producer countries.
If as consumers in the developed world we had to begin to meet the full life cycle price for such a product, then undoubtedly UK charcoal would be in a position to compete on a level footing. In such a scenario, transportation costs would take on an even greater significance and market forces would surely dictate that local production for local consumption was in fact economically more effective.

Developed countries should certainly be committed to achieving such goals. The most effective step that they can take with respect to charcoal consumption is, where raw materials allow, to encourage, develop and expand their own sustainable home produced charcoal industries.
It is not doubted that the economic price for such a fully sustainable product would be more than the current cost of the imported product, it may even be slightly more than the current cost of the UK product.
However a real commitment to global sustainable development would seem to suggest that that is a price we must expect to pay.

- **Study Concept**

The report analysis for both the import and home produced systems presents figures for the actual energy loss associated with the transportation of the product through its whole chain of custody from producer to retail outlet.

For each supply scenario the charcoal quantity transported over each leg of its typical journey is broken down into units of available energy in Megajoules per kilogram (MJ/kg). The actual fuel consumed on each associated transport stage is also converted to its base energy value (MJ/kg).

From these two divisible figures, a percentage loss in terms of energy is then calculated for each transport stage. i.e. Total MJ Fuel used in Transport Stage/ Total MJ Charcoal Transported x 100 = Percentage Theoretical Energy Loss.

By analysis over the whole product route to the retail stores, a total theoretical energy loss in terms of charcoal product is then presented.
It is shown that the UK production scenario analysed is currently 4.7 times more product energy efficient than the Brazilian scenario and 5.9 times more energy efficient than the South African scenario.

South Africa is currently the second largest exporter of charcoal to the UK, supplying around 20% of our yearly demand. For this import scenario, the calculated theoretical energy losses are also reinterpreted in order to determine the actual transport fuel consumption figure for a whole years import tonnage. (Figures for 1996 have been used). This is then compared with the theoretical transport fuel used if that same quantity of charcoal were to have been produced in the UK via the existing system of production from coppiced woodlands.
It is shown that UK production from such a system of supply would be 6.4 times more transport fuel efficient.
A final account is also given of other options that we have in the UK to produce charcoal for our home market

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Introduction

The Monetary Value of UK Barbecue Charcoal And A Justification of the Life Cycle Energy Analysis Approach.

From a purely monetary perspective the business of charcoal supply need only concern itself with transportation costs in relation to their subsequent effect on the final profit margin.
Conventional economics dictates that profit margin is the prime factor driving retail supply.
In order to move towards a more sustainable economic approach, society must increasingly consider the full cradle to grave environmental impacts of consumer products. Transport plays a very important part in the charcoal trade. Charcoal is light and bulky, from a monetary sense around 40% - 50% of the retail cost of the import product goes towards transport costs.
A large retailer can expect to pay around £500 per tonne (in 3kg labelled bags, delivered to the retailers central wharehouses). The bulk supply cost to the importing wholesaler is in the region of £150 - £200 per tonne (dock landed price). The current price for a tonne of UK coppice produced charcoal is approximately £900 per tonne, bagged and delivered to the retail outlets.
Imported charcoal currently retails at around £3.00 per 3kg bag, the UK product sells at £4.75 per 3kg bag.

The profit margin to the retailer selling barbecue charcoal is therefore similar for both supply systems, but the UK product has to be sold at a premium cost and labelled to attract the "green consumer" market. With expansion, the UK production industry would be able on one hand to improve output quantities and system efficiency and thus begin to reduce costs per unit sold. On the other hand it would become increasingly accountable for the costs in a developed countries legislative framework for airborne pollution mitigation, ecological management and waste residue disposal.

Since it is surely only right that such environmental costs should be considered - wherever charcoal is produced - transportation costs in fiscal and environmental terms do to some extent stand in isolation as a major factor that can significantly improve the effective sustainability of this trade on a global scale.

Figures For The Current Charcoal Import Market To The UK

Charcoal Import Figures for the UK: 1995/1996

Country	1996 (Tonnes)	Country	1995 (Tonnes)
Nigeria	12957	Nigeria	10911
South Africa	10430	South Africa	10403
Indonesia	7329	Indonesia	10118
USA	5989	Brazil	2885
Norway	4365	Malaysia	2172
Argentina	4134	Argentina	1874
Malaysia	3753	USA	1394
Ghana	1095	Singapore	295
Brazil	838	India	164
Philippines	833	China	96
Mexico	640	Liberia	42
Iceland	126	Canada	34
TOTAL	52489	TOTAL	40388
VALUE UK (£1000's)	10045	VALUE UK (£1000's)	8850
Full Charcoal Total To UK (Tonnes)**	52937	Full Charcoal Total To UK (Tonnes)**	40449
Full Value To UK (£1000's)	10242	Global Value To UK (£1000's)	8863
Cost/Tonne (£)	193.47	Cost/Tonne (£)	219.12

** The Full ImportationTotal Includes smaller export supplies from various other producer countries.
Source: Charcoal Import Figures to the UK 1995/96 via the UK Department of Trade and Industry.

Methodologies:

- **Introduction**

The research project is clearly split into two appraisals of barbecue charcoals **'theoretical energy value'** as a commodity used by the purchaser.

One appraisal, split into two studies looks at imported charcoal from A: Brazil and B: South Africa. The other appraisal considers UK production from coppice woodlands.

The calculated assessment looks at the value of charcoal solely as an energy source, without involving any fiscal resolution or further assessment of environmental impact, either within the UK or overseas. The Life Cycle Energy Assessment comparisons developed here eliminate subjectivity from the evaluation as the product and fuel used in transportation are broken down into mathematically quantifiable and comparable units of energy.

Analysis Method.

- **Appraisal One:**

Part A: A Calculation Of The Theoretical Charcoal Energy Loss Due To Transportation For A Charcoal Import Scenario To UK Retail Outlets From Brazil.

Part B: A Calculation Of The Theoretical Charcoal Energy Loss Due To Transportation For A Charcoal Import Scenario To UK Retail Outlets From South Africa.

- **Appraisal Two:**

A Calculation Of The Theoretical Energy Loss Due To Transportation For UK Produced Charcoal From Coppiced Woodlands And Distributed To Retail Outlets Via A Network Of Local Suppliers.

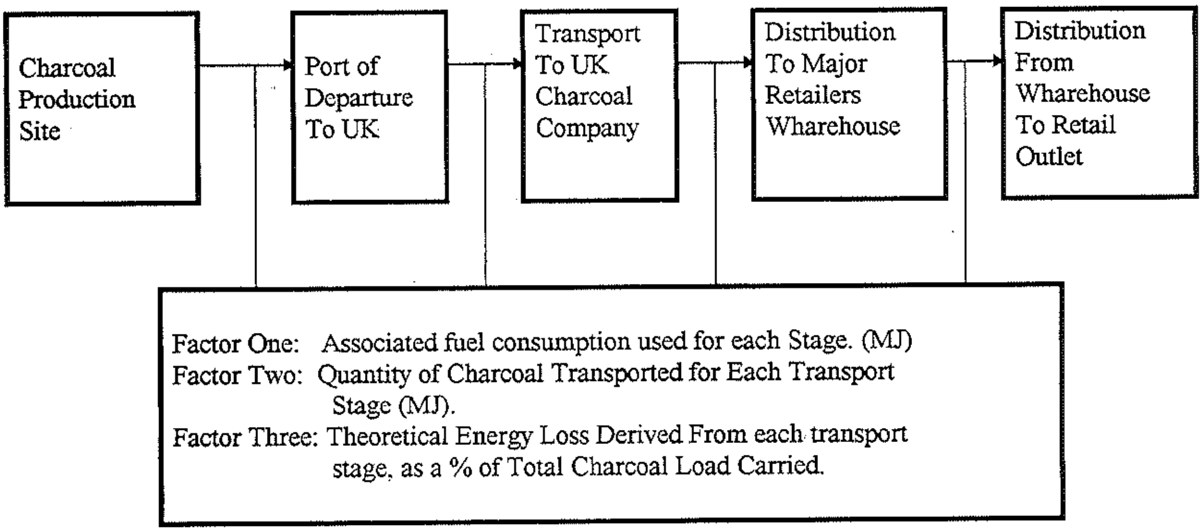
Theoretical Energy Value Methodology.

A Charcoal type has a definable energy content derived from obtaining its gross calorific value in MJ/kg A gross calorific value can thus be determined for a Kilogram unit of Charcoal.

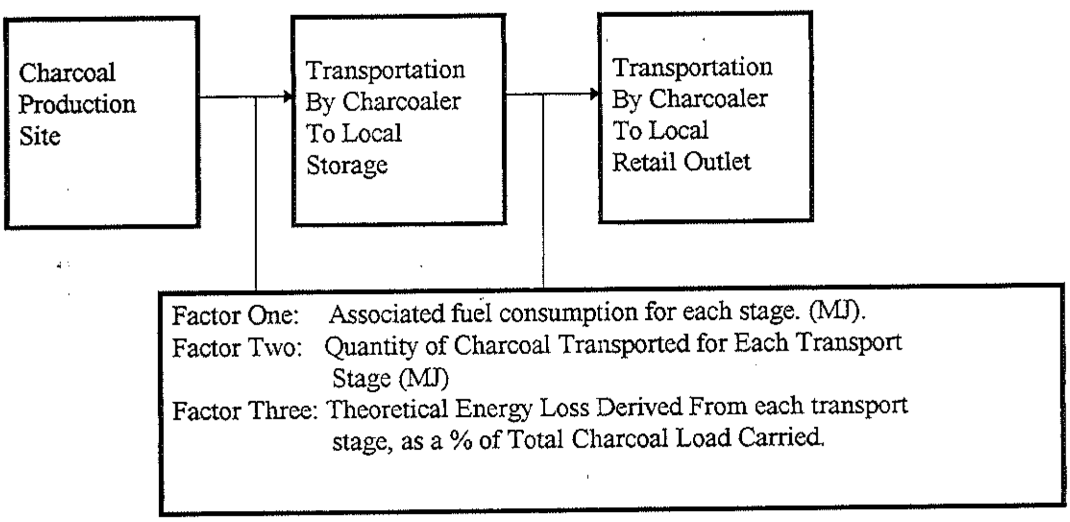
Determination of the theoretical gross calorific value of the charcoal that actually reaches the consumer can then be determined by calculation of the associated fuel consumption (MJ) involved in the individual typically encountered stages of transportation from site of production to the consumer.
The fuel loss (MJ) from transport can then be divided out among the total energy value (MJ) of charcoal transported. Thus, at each stage of the transport chain an allocation of lost energy can be assigned as a percentage figure. This method is repeated over each journey stage to provide an accumulated percentage theoretical energy loss for the charcoal delivered to the retail store.

Idealised Flow Diagram Of Energy Loss Through Transport Chain

Import Scenario



UK Charcoal Production From Coppiced Woodland.



Whilst it can easily be appreciated from the above flow diagrams that the import scenario involves the greater expenditure in transport fuel. The central theme to this report is to determine how much higher the fuel use/energy loss is for the import system compared to local UK production. The import system involves bulk supply over long distance, whilst UK production/supply involves smaller volumes delivered directly to retail stores with short transport requirements.

Before these appraisals can be made, the specific calorific values for charcoal from each production centre must be determined via a simple sampling strategy. Also the transportation types, fuel types and fuel consumption's used for each phase of transportation must be determined.

Calculations and Conversions.

- **The Energy Value of Charcoal.**

Charcoal has a typical gross calorific value in the order of 25 MJ/kg to 30 MJ/kg Deglise & Magne (1987).
The gross calorific value given to charcoal in Technical Data on Fuel, Rose (1977) is given as 33.7 MJ/kg for a "typical commercial charcoal".
It is known that the gross calorific value varies according to the fixed carbon quantity, the production process and original wood type.
In view of the variation in this reference data and the fact that the central theme of this study revolves around the calorific value of charcoal and its subsequent transportation from various specified production localities. It was deemed appropriate to determine the gross calorific values for the specific locations by bomb calorimeter tests from verified typical samples derived from each country.

- **Sampling Strategy for Charcoal Gross Calorific Value Determination.**

Representative samples have been taken from typical stocks of charcoal from Brazil, South Africa and the UK.
The samples from Brazil, South Africa and the UK originated from wholesale suppliers. Tree species and production type has been verified by the overseas and UK producers.

- **Sample Selection Methodology**

Initial sample sizes in the order of 3 kilogram's were randomly extracted from the original stock supplies. Each chosen sample was initially visually inspected to confirm normal and satisfactory appearance.

The initial samples were laid out individually on a clean uncontaminated surface and broken down to produce charcoal fines and lumps no larger than 25mm diameter. A 50 gram test sample was then extracted from the original sample supply by application of the standard "cone-and-quarter" method.

- **Calorific Value Analysis Of Charcoal**

The calorific value of charcoal is determined by calculation of the heat provided by the combustion of a specified quantity of the sample product in a standard apparatus (bomb calorimeter).

The complete test procedure carried out is based upon that laid out in British Standard 1016 Part 5 1977.

Transportation Calculations Methodology.

- **The Energy Value of Transportation Fuels.**

The following data on transport fuels is extracted from Technical Data on Fuel, Rose 1977.

Transport Fuel Gross Calorific Values

Mode of Transport	Fuel Type	Gross Calorific Value at 15°C/(MJ/kg)
Truck/Lorry	Diesel	45.7
Van/Car + Trailer	Petrol	45.85
Cargo Ship	Medium Fuel Oil	43.1

Overview of Transportation Systems Involved in Study

- **Overland Transportation in Brazil and South Africa**

Generalisations have had to be made about the transportation systems in Brazil and South Africa. Whilst the size of product loads and distances travelled are felt to be representative in this report, not enough is known about the transportation system efficiency.
One key issue not confirmed for both countries is whether the vehicles used in the overland transport stage make return journeys to the charcoal centres with no payload. The calculations have been made assuming the best case scenario whereby all vehicles, after discharging their charcoal loads at the port are then used efficiently to transport something else and do not simply return to the charcoal site empty.

- **Shipping Transportation**

Calculations for shipping transport fiscal costs involve an incorporation of **Volume** and **Weight** factors. Charcoal is a bulky product, as such in practice its load cost factor is calculated with reference to its bulk volume. However, no ship to the UK transports just charcoal. The hold would comprise a variety of products, most of which would be weightier than charcoal. A fair representation of the fuel used in transporting charcoal as an integral part of a mixed ship load has been derived by determining the fuel costs by volume and by weight and producing a mean figure from the two independent values.

- **Overland Transportation For Imported Charcoal within the UK. From Port of Arrival to Wholesaler Depot and then to Retail Group Central Store.**

As above, the same best case assumption is made for the transport phases of the import scenarios within the UK. In the majority of cases in the UK this will hold true. Transport system logistics are finely planned in order that vehicles move as much as possible with a payload on board.

- **From Retail Group Central Store to Retail Outlet.**

This phase of the journey is complicated by the fact that the charcoal demand by stores over the six month charcoal sales season is variable. Also, charcoal is only one of a vast array of products transported to the retail stores.
From the data provided by major retail groups it has been possible to determine the impact of charcoal deliveries upon transport energy consumption over the seasonal sales period.

- **Transportation For UK Produced Charcoal.**

The transport calculations for the UK production system assume that all charcoal deliveries result in a round trip with an empty return leg.

- **Transportation From Retail Store to Consumer.**

In all cases no analysis is made of the average final leg of transportation from retail outlet to home. It is felt that the energy impact is common to both the import and UK production scenarios and therefore it is not necessary to evaluate any impact for the purpose of this assessment.

Verification Of Transport Calculations And Associated Assumptions.

Owing to the sheer volume and commercial nature of the charcoal trade, the associated road haulage and shipping transportation detail is provided hypothetically in terms of values that are typically encountered. The figures used have been verified by reference to existing papers and various organisations and with the input of overseas charcoal producers, shipping agencies and consultants, charcoal wholesalers, major retailers and UK charcoal producers.

Existing Evidence Of High Cost Associated With Transportation Of Charcoal

It is recognised that the transportation costs for timber and charcoal movements are a significant financial factor to the charcoal industry.
UK wholesale importers consider that transportation costs make up 40-50% of their operational costs. The only published data found on the subject concern themselves with the cost of transport within overseas producer countries.

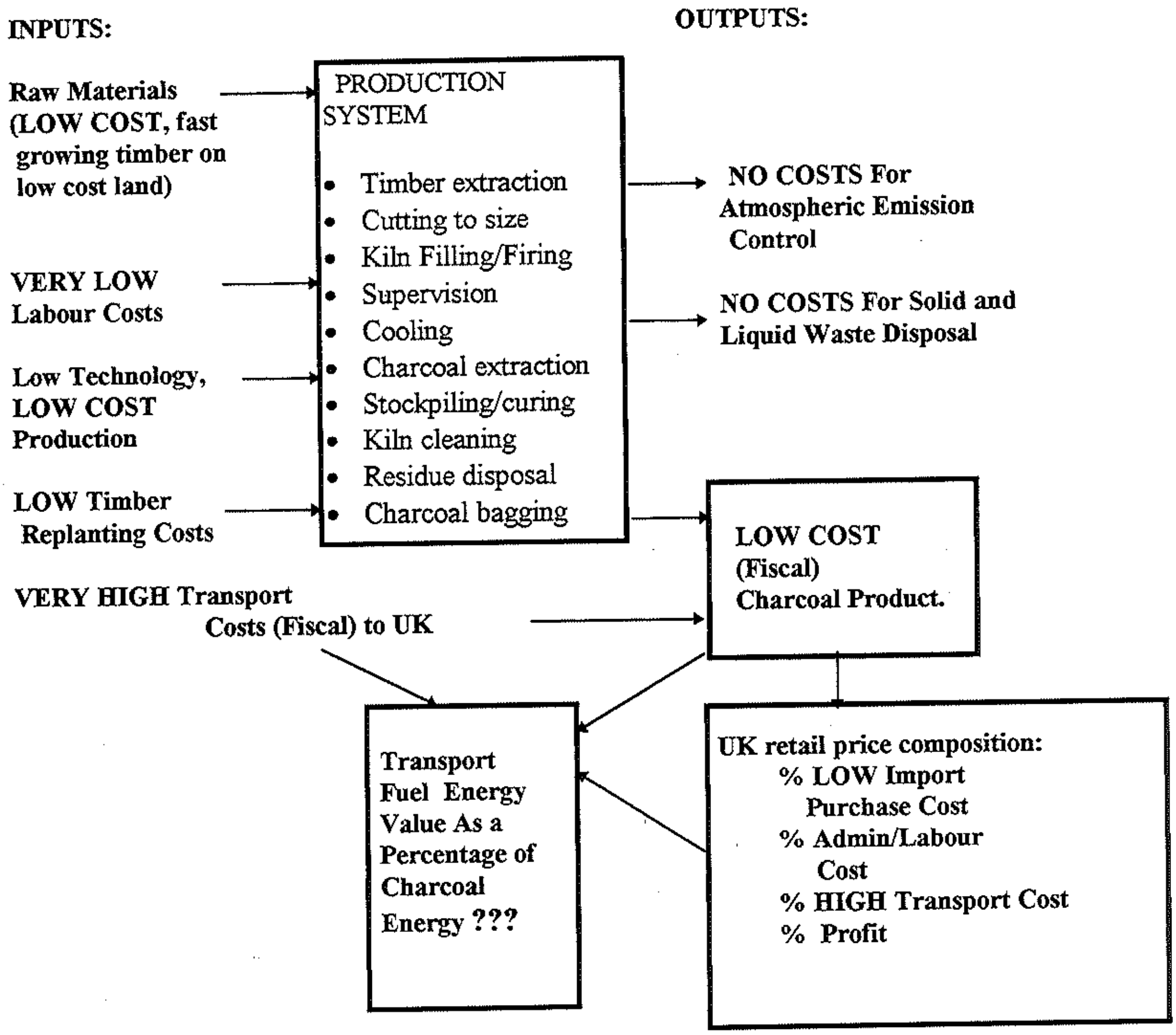
- Within Brazil, for their own industrial market, transport costs are given in the range of 14 - 40 % in fiscal terms. Furtado (1992), Cardoso Vale (1993) and Belio Elian (1993).
- Furtado (1992) also calculates a 5% loss of charcoal during the transportation phase. This is a result of vibration and reduction to fines and wind blown loss.
  No product loss data can be verified for the export process. The product does however loose some of its fiscal value due to vibration and the resultant charcoal fines. From an energy sense these fines are not lost since they are utilised to make charcoal briquettes.
- Chidumayo & Chidumayo (1984) talk of the major problems associated with charcoal haulage within Zambia to serve the Lusaka market.
  The problems typically encountered included:
  - High volume product.
  - High demand for charcoal transport vehicles results in elevated cost leviable to Charcoal producers compared to other haulage sectors.
  - Long distances often involved from producer to market.
  - Poor roads encountered resulting in high vehicle breakdown incidence and product loss.

These above mentioned research studies have involved the fiscal implication of transport inputs. Unlike this study, they include cost allocations for transport labour costs, maintenance allocations and the associated depreciation in the vehicle fleet.

General Problems of Charcoal Transportation

Charcoal is a notoriously difficult product to transport for the following reasons:
- It is a low value product.
- Its bulk density is low (taken to be 260kg/m^3), large volume transportation is required to meet consumer demand.
- Charcoal can be a fire risk. Freshly produced charcoal cannot be immediately transported. It tends to absorb oxygen which can cause self ignition. Forwarders usually require certified proof of sufficient curing time before transportation is allowed. Emrich (1985)
- Transportation results in some lumpwood degradation to charcoal fines. These are used to make charcoal briquettes. As such no energy value is lost but some fiscal value loss results.
- Charcoal is a dirty product. If it is at normally acceptable moisture content (approx. 8% by volume) dust is a problem. If the product is significantly damper then an oily soot residue is a problem. This is particularly the case if the charcoal is contained in airtight bagging, such as plastic, where condensation of the moisture content can result in a very damp and undesirable surface to the charcoal.

Overview of Fiscal Considerations for Import Trade



Presentation OF Results

Determination Of Charcoal Calorific Value

The mean gross calorific values to be applied to the transportation energy loss calculations have been determined from the following sample strategies:

Brazil: Mean of 3 x Bomb Tests of *Eucalyptus camaldulensis*

South Africa: Resultant Mean of: 3 x Bomb Tests for *Acacia Mearnsi* and 3 x Bomb Tests for *Casuarina Equisitifolia*

UK: Resultant Mean from 3 x Bomb Tests for each Hardwood Mix from: Toys Hill, Kent. Cucknells Wood, Surrey. Croydon Council, Surrey.

The following charcoal samples have been used in this study:

Details of Charcoal Samples Used And Resultant Mean Gross Calorific Values To Be Applied In Transportation Energy Loss Appraisals.

Country of Origin	Tree Species	Species Comments	Production Areas	Production Process	Mean Gross Calorific Value (MJ/kg)
Brazil	*Eucalyptus camaldulensis*	FSC approved Plantation timber	Minas Gerais/ Espirito Santo	Clay Beehive Kilns	**29.497 MJ/kg**
South Africa	*Acacia Mearnsi*	FSC approved Forest timber	Lidgetton	Steel/Brick/ Ashcrete Kilns	**Combined Mean = 27.635 MJ/kg**
South Africa	*Casuarina Equisitifolia*	FSC approved Forest timber	Lidgetton	Steel/Brick/ Ashcrete Kilns	
UK	*Hardwood Mix: Primarily Ash, Hazel, Chestnut.*	FSC approved Forest timber	Toys Hill, Kent	Steel Ring Kilns	**Combined Mean = 26.469 MJ/kg**
UK	*Hardwood Mix: Primarily Beech, Ash, Hazel.*	FSC approved Forest timber	Cucknells Wood, Surrey	Steel Ring Kilns	
UK	*Hardwood Mix: Primarily Beech, Ash, Chestnut, Plane, Lime.*	Council Roads and Park Tree Thinnings	Croydon Council, Surrey	Steel Ring Kilns	

It is important to note that charcoal produced for the barbecue market does not undergo a calorific value test. In view of this no comparison figures were readily available.

Presentation Of Results For Theoretical Charcoal Energy Losses From Transportation

APPRAISAL ONE: Part A: A Calculation Of The Theoretical Charcoal Energy Loss Due To Transportation For A Charcoal Import Scenario To UK Retail Outlets From Brazil.

Results Overview

Transport Phase		Percentage Theoretical Energy Loss For Charcoal Transported
1	**Overland Road Haulage in Brazil** (From Charcoal Production Centres for Export Product : Minas Gerias and Espirito Santo to Port of Departure: Rio de Janeiro). -Mode of Transport: Bulk Carriage Diesel Fuelled Haulage Vehicle -Average Transportation Distance: 350km. -Average Vehicle consumption for diesel use: 16km/gallon. -Average Vehicle Charcoal Capacity: 15m^3	3.32 %
2	**Ship Transport to Typical English Ports** (i.e. Sheerness, Tilbury, Southampton, Dover). -Mode of Transport: Bulk Carriage Container Ship. Type modelled, Medium size. -Dead Weight Load: 38,500 Tonnes. Net Dead Weight 34650 Tonnes -Hold Max.Volume 41685 m^3. Net Max.Volume 37516 m^3 -Transportation Distance: 9,537 km. -Average Fuel consumption, medium fuel oil: 34.5 Tonnes per Day. Plus 2.8 Tonnes per day Diesel fuel for auxiliary power -Average Passage Duration at 13.5 knots: 16 Days	5.755%
3	**UK Bulk Road Haulage to Wholesale Merchants.** (i.e. UK Midlands Location). -Mode of Transport: Bulk Carriage Diesel Fuelled Haulage Vehicle -Average Transportation Distance: 320km. -Average Vehicle consumption for diesel use: 11.2km/gallon. -Average Vehicle Charcoal Capacity: 60m^3	1.08%
4	**UK Bulk Road Haulage from Wholesale Merchants to Retail Warehouses** -Mode of Transport: Bulk Carriage Diesel Fuelled Haulage Vehicle -Average Transportation Distance: 240km. -Average Vehicle consumption for diesel use: 11.2km/gallon. -Average Vehicle Charcoal Capacity: 44m^3	1.11%
5	**UK Retail Warehouses to Retail Outlet** -Mode of Transport: Container Carriage, Diesel Fuelled Haulage Vehicle -Average Transportation Distance: 405km. -Average Vehicle consumption for diesel use: 15.2km/gallon. -Typical (1996) Proportion of Charcoal Transported as part of Total Vehicle Load Capacity over Charcoal Season: = 2.48%. -Average Vehicle Load Capacity: 21.4m^3 -Average Charcoal Capacity per Load (m^3): 0.53m^3	2.84%
	TOTAL PERCENTAGE THEORETICAL CHARCOAL ENERGY LOSS FROM TRANSPORT	**14.105%**

APPRAISAL ONE : Part B: A Calculation Of The Theoretical Charcoal Energy Loss Due To Transportation For A Charcoal Import Scenario To UK Retail Outlets From South Africa.

Results Overview

	Transport Phase	**Percentage Theoretical Energy Loss For Charcoal Transported**
1	**Overland Road Haulage in South Africa.** (From Charcoal Production Centres for Export Product : i.e. Lidgetton region to Port of Departure: Richards Bay). -Mode of Transport: Bulk Carriage Diesel Fuelled Haulage Vehicle -Average Transportation Distance: 400km. -Average Vehicle consumption for diesel use: 16km/gallon. -Average Vehicle Charcoal Capacity: $15m^3$	4.05 %
2	**Ship Transport to Typical English Ports.** (i.e. Sheerness, Tilbury, Southampton, Dover). -Mode of Transport: Bulk Carriage Container Ship. Type modelled, Medium size. -Dead Weight Load: 38,500 Tonnes. Net Dead Weight 34650 Tonnes -Hold Max.Volume 41685 m^3, Net Max.Volume 37516 m^3 -Transportation Distance: 9,537 km. -Average Fuel consumption, medium fuel oil: 34.5 Tonnes per Day. Plus 2.8 Tonnes per day Diesel fuel for auxiliary power -Average Passage Duration at 13.5 knots: 21.5 Days	8.26%
3	**UK Bulk Road Haulage to Wholesale Merchants.** (i.e. UK Midlands Location). -Mode of Transport: Bulk Carriage Diesel Fuelled Haulage Vehicle -Average Transportation Distance: 320km. -Average Vehicle consumption for diesel use: 11.2km/gallon. -Average Vehicle Charcoal Capacity: $60m^3$	1.16%
4	**UK Bulk Road Haulage from Wholesale Merchants to Retail Warehouses.** -Mode of Transport: Bulk Carriage Diesel Fuelled Haulage Vehicle -Average Transportation Distance: 240km. -Average Vehicle consumption for diesel use: 11.2km/gallon. -Average Vehicle Charcoal Capacity: $44m^3$	1.18%
5	**UK Retail Warehouse to Retail Outlet.** -Mode of Transport: Container Carriage, Diesel Fuelled Haulage Vehicle -Average Transportation Distance: 405km. -Average Vehicle consumption for diesel use: 15.2km/gallon. -Proportion of Charcoal Transported as part of Total Vehicle Load Capacity over Charcoal Season: 7692 m^3 Charcoal of Total Product Load of 309479 m^3 = 2.48%. -Average Vehicle Load Capacity: $21.4m^3$ -Average Charcoal Capacity per Load (m^3): $0.53m^3$	3.03%
	TOTAL PERCENTAGE THEORETICAL CHARCOAL ENERGY LOSS FROM TRANSPORT	**17.68%**

APPRAISAL TWO: A Calculation Of The Theoretical Energy Loss Due To Transportation For UK Locally Produced Charcoal From Coppiced Woodlands And Distributed To Retail Outlets Via A Network Of Local Suppliers.

Results Overview.

Transport Phase		**Percentage Theoretical Energy Loss For Charcoal Transported**
1	From Woodland Charcoal Production Centres to Charcoalers Storage Facility. See Note 1 Below. **Under present size of operation this element is ignored as insignificant.**	0.00 %
2	Charcoal Producer to Retail Outlets. See Note 2 Below. -Mode Of Transport: Light Diesel Fuelled Haulage Vehicle. Product On Board Or On Trailer -Average Transportation Distance: 48km round trip. -Average Vehicle consumption for diesel use: 40km/gallon. -Average Vehicle Charcoal Capacity: 100 x 3kg Bags	2.88 %
	TOTAL PERCENTAGE THEORETICAL CHARCOAL ENERGY LOSS FROM TRANSPORT	**2.88%**

Note 1. It is estimated that there are up to 500 steel ring kilns in existence in the UK.
Of this total number, perhaps 400 are currently in operation and supplying charcoal to various local outlets on a seasonal basis.
The Bioregional Development Groups Charcoal initiative has effectively brought together approximately 200 - 250 of these Kilns and their 70 -75 operators into a Group that through centralised order processing is able to deal with major national retail organisations. The vast majority of charcoalers store their bagged product at the production centre. Under the present relatively small size of the UK coppice - charcoal operation, storage and transport to storage detail can be ignored as insignificant. However, it is acknowledged that should this UK system grow, storage and associated transport would become more involved.

Note 2. Average transportation detail has been determined by the Bioregional Charcoal Company. Their network of charcoal suppliers has been planned and selected in order to provide localised coverage that matches consumer demand. The product is purposely sold as "local lumpwood charcoal". The average distance travelled is determined as 15 miles to retail outlet. The usual delivery volume per trip is 100 x 3kg bags.

Interpretation of Transportation Energy Results.

Introduction

The calculated results do show that the imported product does exert a heavier transport energy cost than the UK produced charcoal. Whilst the import transportation energy losses are not dramatically high in relation to a percentage comparison with the actual charcoal energy quantities imported, the specific results obtained can be interpreted in various ways in order to provide simple and easier to quantify comparisons.

Interpretation Of Energy Losses In Terms Of Theoretical Energy Loss From Charcoal Purchased By The Consumer.

If one considers the net energy loss associated with a single typical 3 kg bag purchased by the consumer.

- A typical 3 kg bag derived from South Africa will have lost the equivalent of 0.53 kg in transportation.
- A similar bag from Brazil will have lost the equivalent of 0.42 kg in transportation.
- A 3 kg bag purchased by a consumer that had been produced from UK coppiced woodlands will have lost the equivalent of 0.09 kg in transportation.

This product related description of the results can be interpreted to state that the UK production scenario analysed is currently 4.7 times more product energy efficient than the Brazilian scenario and 5.9 times more product energy efficient than the South African scenario.

Interpretation of Energy Losses in Terms of Transportation Fuel Used.

The transport energy losses can be usefully interpreted on a large scale to assign a theoretical total for the transport fuel used for a complete year's supply from an export location to the UK.
South African currently supplies the UK with around 20% of its charcoal demand, this export scenario will be reinterpreted in order to assign quantifiable values for the transportation fuel consumed from a whole years trade to the UK. The results presented apply to the 1996 South African export total of 10430 Tonnes.

If one then assumes the same charcoal production quantity figure and applies it to the existing UK production scenario, the associated transportation fuel that would then theoretically be used can be determined.

Subtraction of the theoretical fuel used in the UK calculation from that used in the South African production scenario for 1996 would give the net theoretical saving in transport fuel if UK production were to have replaced the South African import market.

Overview of transport fuel savings.

South African Import Scenario	**Fuel (Tonnes)**	**Fuel (MJ)**
Shipping Fuel Used to import 1996 total product from South Africa	552.39 Tonnes	23808046
Road Transport Fuel Used to import 1996 total product from South Africa	594.13 Tonnes	27151549
Total	1146.52 Tonnes	50959595
UK Replacement Production Scenario		
Road Transport Fuel Used to produce 1996 South African total product in the UK by the coppice woodland scenario	174 Tonnes	7950864

Total Savings.

Fuel (Tonnes)		**Fuel (MJ)**
552.39 Tonnes of Shipping fuel.		23808046
420.13 Tonnes of Diesel Fuel from road transportation.		19199941
	Total (MJ)	43007987

Analysis of the South African results in this manner, as a transport fuel saving for a complete years export, demonstrates a large saving in total transport fossil fuel consumption if the charcoal were to be produced in the UK from the coppice woodland production scenario.

By comparison of the transportation fuel energy (MJ) values, in percentage terms, the UK production system would consume only 15.6% of the total fuel used in transporting the South African charcoal to the UK retail outlets. In other words, such a UK production system would currently be 6.4 times more transport fuel efficient.

Discussion

If the UK were to expand its production of charcoal in order to meet its own needs, whilst benefits would definitely arise from reduced transport impact, rural work development and ecological improvements to woodlands, such issues as pollution mitigation within a western framework of controls would also have to be seriously taken on board.
The current UK production system from coppiced woodlands is only at a basic level for the very reason that it is at present unable to compete on an economically fair footing with very cheaply produced overseas charcoal.
The two production centres chosen i.e. Brazil and South Africa are currently among the very best on offer in the world in the sense of product cost and environmental accountability.
Retail groups in the UK are justifiably proud that charcoal purchased by them from these locations represents a step towards sustainability with FSC certification for the product. This step however is made generally just in terms of the timber raw materials employed in the process.
Under the harsh audit of a full LCA one can begin to appreciate that whilst sustainable forest products are a good move to protect original forest habitats, the actual export trade derived from these newly certified sustainable timber resources is still kept buoyant by paying no real environmental costs for very relevant issues to sustainable development such as pollution control from charcoal production, ecological/biodiversity management and transport impacts.
The charcoal trade like so many other cash crop exports is reliant upon low labour costs and environmental consequences that are currently not paid for and not wanted in our own back yard.

One fundamental question raised by the concept of Sustainable Development is what account should be taken of the environmental damage caused by the production and subsequent trade in such a commodity? Does such a trade actually help third world economies, or will we eventually find that very real issues such as uncontrolled pollution outputs and possible biodiversity losses in these countries from charcoal demand will actually result in a higher cost to not only their economies but also the global commons?
The export trade in charcoal only makes up a fraction of the total world demand for this fuel type. By importing it as a luxury product for our barbecue consumption the developed world is not aiding any solution to these problems
The many environmental impacts associated with transport surely help force the Sustainable Development debate towards countries adopting policies of localised production wherever possible.

It is with this belief in mind and in view of the timber resource available in the UK and the fact that new markets are needed to be found for this resource in order to improve the ecological wealth of our woodlands, that growth in the production of UK charcoal is worthwhile.
The Bioregional Development Group recognise that UK charcoal production is at a very early stage in its re-evolvement as an industry.
It also recognises that growth in production output is a complex equation.

There are two main elements to any move towards a growth in sustainable UK charcoal production:

- **Product Cost**

Currently the UK product sells well as a result of labelling that attracts environmentally conscious buyers by flagging up its local production and environmental advantages.
If UK production is to grow beyond an environmentally friendly niche market to a product that is readily bought by all consumer groups, its price must become equitable with the imported product. For that to begin to occur, a fuller account of barbecue charcoal's environmental impacts must take place on a global scale.
If that were to happen, whilst labour costs would still no doubt be higher in the UK, the impact of transport fiscal costs would be rightly reflected in a local producers favour, whilst environmental costs would be met wherever the product was derived.
These facts are duly recognised by the UK industry. New developments in UK production systems using advanced technology is seen to be the key to tackling labour cost improvements/unit of output, production efficiencies and pollution control.
Currently woodland charcoal is produced using low technology steel ring kilns. The maximum yearly output from one charcoaler utilising two kilns is around 50 tonnes.
The next step would be to change to small retort technologies that would be still localised but would enable 500 tonne outputs per year to be achieved.
Such a retort size would still relate in size to a woodland estate, thus still keeping to a minimum the transport impacts of timber delivery to process and charcoal delivery to localised retail outlets.

- **Pollution Control**

Steel Ring Kilns, like similar kilns used overseas for our imported product, have no effective pollution control.
Smoke emissions with high particulate and carbon monoxide/dioxide contents are therefore to be considered. Tar by-products also have to be properly disposed of.

In its present small scale form the UK industry encompassing the Bioregional Development Group umbrella has not had to significantly address the issues concerning pollution outputs, but in line with its own policies of sustainable development it recognises that this must be tackled if the industry is to expand.

Whilst retort technologies begin to enable pollution control to be achieved and at the same time enable sufficient product to be made to produce more competitive sales prices, the UK producers would be confronted with a "catch 22" situation. In order to achieve competitive sales prices and mitigate pollution outputs, major investment would be needed in the first place in order to be able to compete from the very outset with the imported product.

Other Possibilities For UK Production.

- **Local Authority Production**

local authorities in their parks and street tree pruning operations produce a wealth of timber with charcoaling potential. Currently this timber is either burnt or transported to paper mills to be converted to pulp. After accounting for transportation costs, the value of this timber is very low, current prices for delivered timber to paper mills are in the region of £20 per Tonne.
Croydon Local Authority in Surrey have joined the Bioregional Development Groups charcoal initiative and this could be replicated around the country.
The same price problems and pollution concerns still prevail but inward investment and regional

co-operation may enable Local Authorities to take on board retort technology to produce charcoal more efficiently. Since the raw material is in effect free and the resultant charcoal value per tonne is very much higher than the present timber value, the prospect may prove appealing if it can be shown to work or if Government grants enabled trial schemes to be introduced.

- **Major Industrialised Production Plant**

Major industrialised retort technology, such as the continuous Lambiotte process, capable of an output of 5,000 Tonnes per year for a single plant no longer exists in the UK.
A proposed scheme in Norfolk has recently foundered due primarily to investment concerns.
Approximately £1.5 milliom in capital cost would be needed to commission a Lambiotte Retort system.
Whilst the technology is proven, the problem encountered was that the product is low value and the payback period on the investment would be unacceptably long. FCRD (1991). The current economic bias towards the cheap imported product would seem to prohibit such a venture.
Such a large plant offers benefits in terms of point pollution control and by-product extraction.
It also could offer some disadvantages from a transport sense in that the timber raw material has to be transported to the production site. Also the finished product, in contrast to the localised woodland system, has to then be transported nationally to retail outlets.
This of course is still far better in terms of sustainable development than importing the product from overseas. Timber resources for such a scheme could be sourced from local authorities, industrial wastes and woodland management.

- **Charcoal From Alternative Raw Materials.**

Alternatives to timber as a raw material for barbecue production are feasible. Anthracite coal can be utilised to make barbecue briquettes. Biomass extrusion systems that produce a solid bar from a variety of biomass wastes such as wood chips, agricultural wastes and seed husks can also be used to provide a suitable product that can be pyrolised to produce a charcoal alternative.
Both alternatives merit research and development in order to further their possible potential.

Conclusion

It has been demonstrated that the UK woodland charcoal production system is in fact more transport energy efficient than the import systems analysed.
It is also clear that any increase in production within the UK will need to become more competitive in order to expand, it must also overcome the inevitable concerns with pollution control as an integral part of sustainable development.
The UK demand for charcoal is approximately 50,000 Tonnes per year and consequently coppice woodland charcoal and the three production types mentioned above all have potential to grow significantly to meet this demand.
FSC certification is one issue that will, if it is fully successful, ensure that all imports are at least derived from sustainable forests. That important step change will probably result in some price increases for the import product as plantations have to be managed and maintained and certification fees have to be paid.
FSC is also a mechanism that must be adhered to within the UK, the Bioregional Development Group have received FSC certification and exert strict audit controls on their network of charcoalers in order to ensure FSC compliance.
Whilst consumer awareness campaigns among progressive retailers and relevant NGO's will focus attention on the real environmental benefits of buying FSC certified products. Further effort is required of the developed world in order to avoid falling short on the full concept of sustainable development.
There is no doubt that the UK has the wood biomass available (be it from woodland management, Local Authority or factory waste wood, or even from alternatives to wood) in order to become self sufficient in such a base commodity as charcoal. What is now required in order to force the necessary step changes is a greater national and international acceptance and implementation at government level of environmental

and economic controls such as product life cycle assessment that take on board the full concept of sustainable development.

In June of this year, the United Nations General Assembly will meet to examine and then build on what has actually resulted from the first Earth Summit in Rio in 1992. One major issue that will dominate this "Rio Plus 5" summit is what happens when the ideology of free global trade clashes with laid down environmental targets.
Michael Meacher, the UK Secretary of State for Environmental Protection has recently stated that what is clear from the declarations of the original 1992 Summit is that respect for the environment should be paramount in developing a sustainable trading system. Such protection should be applied to product production processes, as well as to the product itself. Nation States have an obligation to protect the natural environment. This protection should extend not only to resources within the jurisdiction of the signatory state, but also to the global commons.

This statement provides a clear message that national governance should not ignore the environmental damage of products bought in from other nations.
If that is truly to be the case then perhaps we are not far away from a time when a fuller recognition of, and subsequent mitigation for, the full environmental impacts of products are more strongly considered as part of new economic mechanisms.

Recommendations.

This study has only barely touched upon the complete issue of the environmental impact of charcoal production.
There are many avenues of research that could be further pursued:

Within the UK, the various issues concerning charcoal that could be explored in greater detail include:

- Clearer research into the full extent of our existing woodland potential, with particular respect to the amount of unmanaged and outgrown coppice woodland.
- Pollution control research for the various charcoal production systems. What is the actual pollution impact of charcoal production from steel ring kilns? Is it an acceptable production process with respect to Local Authority controlled APC (Air Pollution Control) legislation? What would be the environmental impact if this production process were greatly extended within the UK?
  How effectively can a major process such as the Lambiotte retort be controlled? What would the capital costs be? How much would process efficiency be reduced?
- Research into the potential of charcoal production from industrial wood wastes and anthracite coal.
- Feasibility studies with respect to Local Authority wood wastes-to-charcoal plants.
- One issue not mentioned at all in this study, but worth serious consideration. How would the full environmental impact of charcoal production and consumption for barbecues compare with LPG gas barbecues?

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