

A Woodfuel Strategy for England



Foreword

When the Government asked the Forestry Commission to develop this strategy in its response to the Biomass Task Force Report in April 2006, it was also finalising its Energy Review and was awaiting the result of the Stern Report on the Economics of Climate Change. Stern has now reported, the Energy review has been published and a new Energy White Paper is on the horizon. Clearly things are moving fast.



Such developments reflect the importance Government is giving to energy and climate change. These big issues require big commitments and big targets. However, targets can often seem so big that individuals feel they can't possibly make a difference. The idea of 'one planet living' is a way of framing the big picture of global sustainability, and lays down a challenge to all of us to live within the planet's means. More and more people are embracing the message – and are seeking the chance to make their contribution.

Wood energy works best at a local level. This strategy presents an opportunity for woodland owners, communities, local authorities, schools and businesses to work together to take practical action that makes a real difference.

Whilst renewable energy and carbon saving are the headline objectives for all of us, utilising the resource in England's woodlands achieves a great deal more. At current energy costs, local woodfuel

can save money as well as carbon. Managing more of our woodlands will help biodiversity in one of our richest habitats: research published only last year showed how flora and woodland birds are suffering from lack of management in many of our native woodlands, whilst populations of many woodland butterflies are in steep decline. Most importantly however, individuals and communities need to be empowered to make positive and significant contributions to all of these.

This strategy is about giving people the tools to develop woodfuel. Woodfuel must be a partnership, Government cannot do it alone: to realise the opportunity there must be both the technical skill and broader understanding and support for woodland management and a more sustainable lifestyle from the people who own, live amongst and get their energy from our woodlands. The aim of the strategy is to identify what Government needs to do on its side of the partnership to help business, community and local authorities to make woodfuel work for them.

This is a great opportunity and through this strategy we believe that we all have the chance to turn it from a good idea into a mainstream, sustainable source of renewable energy for decades, and hopefully generations, to come.

Ian Pearson

Barry Gardiner

Executive Summary

The Forestry Commission welcomes the task set by Government to work with the private sector and local and regional partners to prepare a strategy and implementation plan to increase the amount of biomass made available through the woodfuel supply chain.

The target is to bring an additional 2 million tonnes (Mt) to market, annually, by 2020, representing 50% of the estimated unharvested available material in English woodlands. This will be supported by other sources such as arboricultural arisings and recovered wood.

This strategy provides a structure for Government interventions necessary to achieve the target and recommends what type and where these interventions are best placed to achieve optimum impact of both new and existing resources. Ahead of a detailed implementation plan, the strategy sets out a broad direction for delivery focusing on a national support mechanism for projects directed at the regional level and delivered sub-regionally, building on existing infrastructure.

Broadly, the strategy recommends interventions in the following areas:

- Capital investment and support – to accelerate uptake and build a functioning and secure market.
- Outreach and facilitation – to link and give confidence to the supply chain.
- Awareness raising – to bring more woods into productive and sustainable management by engaging with and advising woodland owners, entrepreneurs and communities.
- Utilising an extra 2 Mt of wood, saving 400,000 tonnes of carbon, equivalent to supplying 250,000 homes with energy.
- Empowering communities to understand and practice ‘one planet living’.
- Conserving the woodland resource and reversing the decline in woodland biodiversity by increasing the number of sustainably managed woodlands.
- Creating economic opportunity, particularly in rural areas by developing a vibrant and sustainable biomass industry (see figure 1).

We believe that if these interventions are implemented with an appropriate level of resource the following benefits could be realised:

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Introduction

The Biomass Task Force Report¹ identified a range of barriers to the greater use of biomass as an energy source. In the context of feedstocks the report said that “the Forestry Commission should urgently undertake and publish a full assessment of and set out a strategic plan for, the development and use of short rotation forestry, forestry waste, farm and other woodlands, local authority trees and commercial forestry”.

Background

In its response,² the Government supported the Task Force’s views on the importance of forestry in providing a sustainable biomass supply. The potential benefits that a step change in management of existing woodlands was also highlighted and the Forestry Commission was asked to “prepare a strategy and implementation plan, in conjunction with the private sector and RDAs, in order to increase the amount of biomass made available through the supply chain”.

Cross-cutting issues

The issues associated with using forestry for energy cut across a broad spectrum of Government. In addressing those issues this strategy encompasses the mission of Government to move towards ‘one planet living’ in order to avoid dangerous climate change whilst maintaining and enhancing the natural asset base.

Links between the biomass sector in general and other initiatives were highlighted in the Government response to the Biomass Task Force. These include the Energy Review,³ the Microgeneration Strategy⁴ and the UK’s Climate Change Programme,⁵ Building Regulations, Planning Policy Statements⁶ and the Low Carbon Buildings Programme⁷.

Biomass specifically from forestry (‘woody’ biomass) extends these links even further. It has direct relevance to the revised England Forestry Strategy (due to be published later this year), the England Biodiversity Strategy,⁸ the Sustainable Development Strategy,⁹ the UK Non-Food Crops Strategy,¹⁰ the New Rural Development Programme for England¹¹ and the forthcoming Waste Strategy Review¹².

In view of these links, this document acknowledges that a woodfuel strategy must evolve along side other relevant initiatives so that each will derive the maximum benefit from the other.

Focus of the strategy

As directed by Government, this strategy recognises different sources of woodfuel; existing woodland, arboricultural arisings, sawmill co-products, woodland creation and recovered wood, but concentrates on woodland that is currently under-managed. This focus reflects the added benefits of bringing woodlands into management and that utilisation of material from existing woodland alone has the potential to deliver the 2 Mt target.

This document will therefore concentrate on developing a woody biomass sector that uses material from under-managed woodlands as its primary feedstock. Other materials feed in and provide flexibility to the system and contribute to security of supply. Building a market for woodfuel from under-managed woodlands will also improve the economic sustainability of other elements of the forest products supply chain.

While recognising that the Government will not rule out any potential use of wood energy, for existing woodland, and in the context of this strategy, we view the order of priority as:

1. Local heat generation

It is widely accepted that the greatest contribution biomass can make is through heat generation. Local heat generation is in particular need of support due to the relatively smaller scale and capacity of the developing businesses, and because early replacement of boilers will be essential to generate the scale to establish effective supply chains. The pattern of woodland ownership and associated transport considerations also make local heat generation the most appropriate for utilising feedstock from under-managed woodlands.

2. Small to medium Combined Heat & Power (CHP)

We see a particular role for CHP around towns and cities where there is a mixed supply including recovered clean wood, woodland material and arboricultural arisings, leading to a local concentration of fuel.

1 <http://www.defra.gov.uk/farm/acu/energy/biomass-taskforce/>

2 <http://www.defra.gov.uk/farm/crops/industrial/energy/biomass-taskforce/index.htm>

3 <http://www.dti.gov.uk/energy/review/>

4 <http://www.dti.gov.uk/energy/sources/sustainable/microgeneration/strategy/page27594.html>

5 <http://www.defra.gov.uk/environment/climatechange/uk/ukccp/index.htm>

6 <http://www.communities.gov.uk/index.asp?id=1503250>

7 <http://www.lowcarbonbuildings.org.uk>

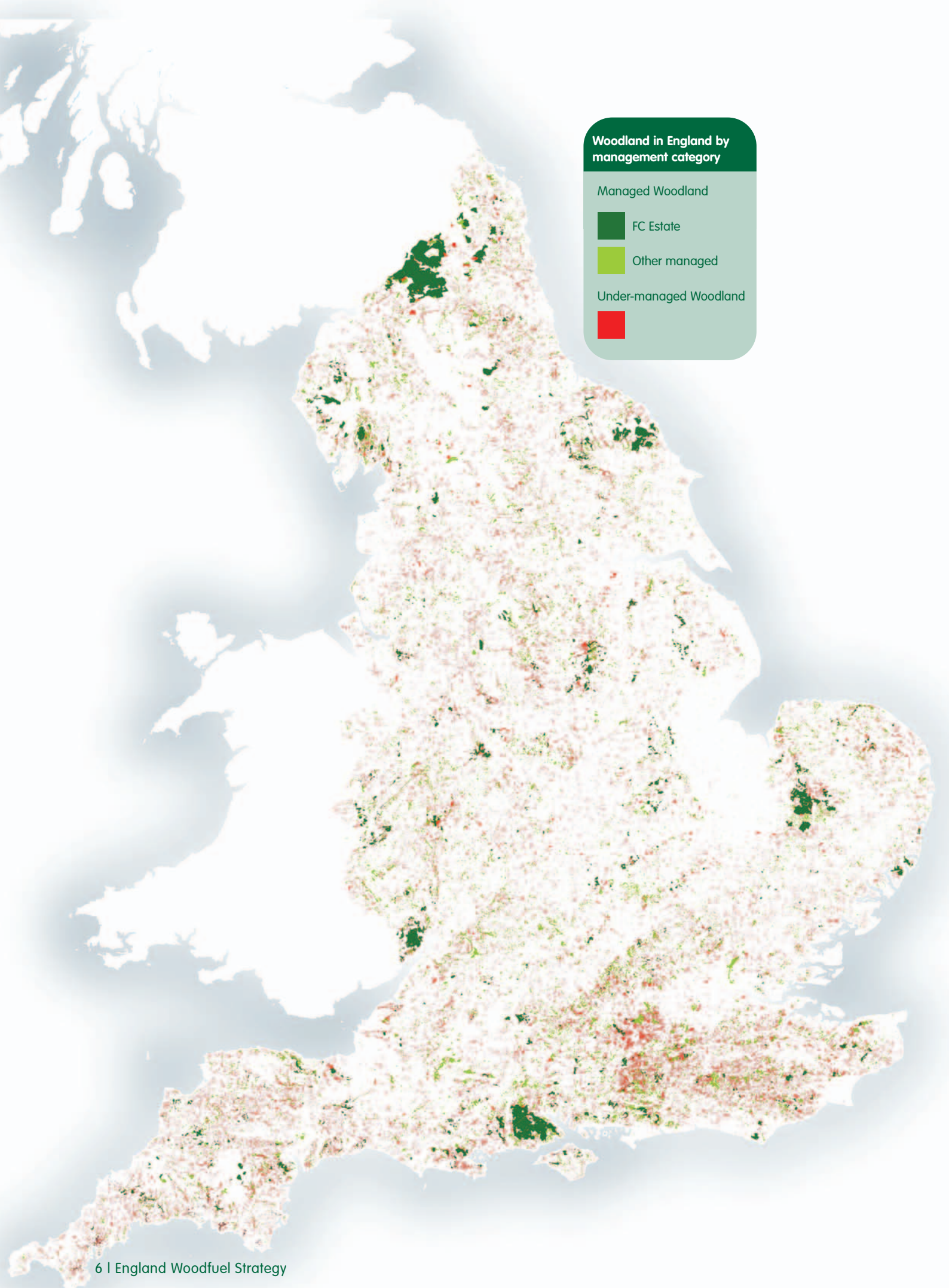
8 <http://www.defra.gov.uk/wildlife-countryside/biodiversity/biostrat/index.htm>

9 <http://www.sustainable-development.gov.uk/publications/uk-strategy/index.htm>

10 <http://www.defra.gov.uk/farm/acu/pdf/nfc-strategy.pdf>

11 http://www.defra.gov.uk/erdp/rdp07_13/default.htm

12 <http://www.defra.gov.uk/environment/waste/index.htm>



Woodland in England by management category

Managed Woodland

- FC Estate
- Other managed

Under-managed Woodland

3. Dedicated electricity generation

In practice, dedicated electricity generation and large scale plants have already absorbed much of the industrially available wood in northern England and Scotland.

4. Large scale generation and co-firing

Biomass has a potentially significant role to play in co-firing and large scale generation. However, the location of current plants linked to the limited availability of biomass means that other choices, in particular local heat, appear to yield greater overall benefit from existing woodland. New energy crops may play a significant role in providing co-firing supply. Particular sensitivities relevant to this are being explored elsewhere.

The strategy does not propose a focus on domestic scale systems because they are generally less efficient and evidence suggests that the market will develop on its own. However, Government does have a role to play in promoting modern efficient systems and ensuring a sustainable supply chain.

Annex II provides estimates of the potential carbon savings associated with substituting wood for fossil fuels in a range of energy and heat systems.

The challenge

The proposals set out in this document represent a major step change in the level of activity required by Government and the private sector. At present, only around 40% of the annual increment in England's woodlands is harvested and utilised within existing markets. Achieving the 2 Mt target represents a 60% increase in wood production in England.

Owners of unmanaged woodland have not responded to traditional levers such as grant aid and many people, including these owners, are concerned that felling trees has a negative impact on the environment. We have to re-establish a cultural understanding of woodland management in a modern context - understanding that management of woodlands will contribute to sustainable development and 'one planet living'. This is a huge task that requires new approaches.

In addition, to be successful, a market must exist to utilise the material being extracted, and market existence is reliant on the presence of a supply chain linking the woodlands to wood-users. It is this element that currently needs support. The supply chain that exists for wood currently cut and marketed in England is not able to meet the requirements of this strategy. However, with support, it has the potential to expand and provide the necessary capacity and link between woodlands and wood-users.

Evidence (e.g. see the case studies throughout this document) supports the view that with appropriate interventions, supported by the correct level of resource, it will be possible to build on the existing infrastructure to achieve the aims and objectives of the strategy.



Strategy aims and objectives

The aims and objectives of this document are to provide a framework;

- for Government to build, in partnership with private business, a viable and sustainable biomass industry that progressively utilises an additional 2 Mt of material from under-managed woodlands. This target represents 50% of the estimated unharvested annual increment in English woodlands.
- to empower businesses and individuals to engage in and practice 'one planet living' through the promotion of a local, sustainable energy source.

Beyond this document

The Government response asked us to work closely with public and private sector partners in preparing the strategy.

We view close collaboration with public and private sector partners, in particular the Regional Development Agencies (RDAs), Local Authorities (LAs) and private business to be central to the delivery of this strategy. We will seek to enhance and develop close collaboration with public and private sector partners as the implementation plan for this strategy is taken forward.

Delivery of Government objectives

The implementation of a woodfuel strategy has the potential to deliver benefits that fit directly into a number of wider Government policy objectives. Broadly, these could be realised in the following areas:



Climate change and 'one planet living'

Carbon saving

Using wood and wood products to substitute for fossil fuels means that sustainably managed woodland can provide an ongoing contribution to climate change mitigation. The 2 Mt target equates to an estimated 0.4 Mt of carbon saved per annum.

Communicating climate change and sustainable living messages

The awareness raising programme central to this strategy is consistent with the messages set out in the Climate Change Communication Initiative¹³ and the UK Sustainable Development Strategy¹⁴. It provides an opportunity to empower communities to view climate change as a local issue where their actions will deliver real benefits through a reduction in carbon emissions, as well as enhancing the condition of local woodlands and boosting the rural economy.

Carbon sequestration and sustainability

Woodland creation contributes to climate change mitigation through increasing long-term carbon stocks, i.e. sequestration, and has the potential to provide a sustainable timber resource for a future low-carbon economy.

Waste management

Incorporating recovered clean wood and arboricultural arisings into woodfuel systems helps to reduce the burden on landfill and turn a waste product into an energy source.

Energy needs, security and consumer choice

Contribution to England's energy needs

Currently, energy from biomass provides 3% of the total UK energy needs. Energy from an additional 2 Mt resource could add to this by supplying the equivalent of 250,000 homes with energy, replacing 3.6 million barrels of crude oil.

Renewable energy targets

Energy from biomass currently supplies 83% of renewable energy, with the contribution from wood being 10%. If the 2 Mt target is realised this would rise to 16% - a significant contribution to achieving the challenging renewables targets set out in the 2003 Energy White Paper¹⁵.

Fuel poverty and security of supply

As well as highlighting the 'carbon challenge' the Energy Review identifies fuel security as a key policy driver. A well-developed local wood energy supply chain has the potential to significantly increase security of supply, particularly in areas with limited options such as rural areas that are off the gas grid. Wood energy could play a role in reducing fuel poverty, for example by delivering heat to new-build affordable rural housing.



Biodiversity and sustainable forestry

Reversing the decline of woodland species

Lack of management is contributing to a decline in the biodiversity of our woodlands. Increasing the level of ecologically sensitive management would help a range of flora and fauna including priority and declining species such as dormice, nightingales and woodland butterflies. This will help deliver the England Biodiversity Strategy and associated national and international biodiversity targets.

Enhancing sustainable forestry and protecting our ancient woodland

The strategy supports the Government's 'Keepers of Time'¹⁶ policy for our ancient and native woodlands and international sustainability standards for forestry. Woodland biodiversity will benefit substantially, particularly from the diversification of woodland structure. An enhanced market for wood will ensure the delivery of the recently revised Habitat Action Plan targets for native woodland¹⁷. A revitalised woodland sector and biomass market is a vital complement to the rural development funding that will fund some, but not all, of the necessary management.

Economic opportunity

Enhancing the rural economy

Stimulation of a sustainable supply chain will require a workforce, including installers, plumbers, forestry staff and small-scale hauliers, primarily concentrated in rural areas. As many of these jobs are likely to be part time they will support other more fragile roles in the countryside. Involvement of private business will be key to realising the economic opportunity presented.

13 <http://www.climatechallenge.gov.uk/>

14 <http://www.sustainable-development.gov.uk/>

15 <http://www.dti.gov.uk/energy/whitepaper/index.shtml>

16 <http://www.forestry.gov.uk/keepersoftime>

17 <http://www.ukbap.org.uk/>





The Material

In identifying where an additional 2 million tonnes of biomass material might be derived, the contribution of a number of potential sources has been considered.

Existing material

Under-managed woodlands

As directed by Government, the focus for achieving the 2 Mt target is on under-managed woodlands.

The available volume of biomass material in England's woodlands has been calculated using a number of sources (see tables 1&2). These suggest that an additional 4 Mt is potentially available. Allowing for difficulties associated with accessing this material, a target of 50% of this (2 Mt) is thought to be achievable. Continued assessment of the sustainably available material will be a key component of the strategy.

Table 1: Estimates of increment and harvest in England in 2001 (Forestry Commission, 2003).

	Million green tonnes per annum		
	Conifer	Broadleaf	Total
Annual increment	3.8	3.3	7.1
Annual harvest	2.3	0.6	2.9
Unutilised	1.5	2.7	4.2

Table 2: Woodland area in England by management category. Calculated from area in receipt of management grant or in Forestry Commission scheme or licence provided by Forestry Commission (England).

	Woodland area (000 ha)		
	Conifer	Broadleaf	Total
Forestry Commission woodland	153	52	205
Non-FC woodland	217	697	914
(Non-FC woodland receiving management grant)			(265)
(Non-FC woodland not receiving management grant)			(649)
Totals	370	749	1,119

Sawmill co-products

The Woodfuel Resource Study¹⁸ assessed the quantity of sawmill co-products produced in England (see table 3) and reported that the bulk of this currently has a market. It is difficult to predict how much of these will go into the woodfuel market, but it is likely to rise. While in the long term the market will dictate where wood goes, it is important in the short term that Government does not take actions that have the effect of encouraging a switch from one industry to



another, spending money but saving no additional carbon. In this context, Government should also be sensitive to the potential for their actions to impact on existing industries.

Increased wood production for energy will generate more material for the sawmilling industry and, through that, an increase in co-products. The sawmilling sector has invested heavily in recent years and is well able to handle increased production.

Table 3: Estimated annual production and use of sawmill co-products in England (figures in thousands of green tonnes, rounded up to the nearest whole).

	Sawdust & slab wood	wood chips	bark	Total
Sold to Wood Processing Industries	150	519	58	728
Sold to Bio energy industry	5	4	0	8
Sold as firewood	1	-	-	1
Other	6	16	11	32
Burnt for heating	2	-	-	2
Total co-products	163	539	69	771

¹⁸ McKay, H., Hudson, J. B. (2003) – Woodland resource in Britain (Forest Contracting Association)

Arboricultural arisings

Arboricultural arisings are the wood from felling, pruning and safety operations carried out on trees in built up areas and along transport corridors. The Woodfuel Resource Study estimated that 68% of this wood does not currently find a market, the majority going to landfill (see table 4). As costs of waste disposal rise, arboricultural businesses are already looking for outlets that avoid landfill. A key issue is the concentration of material, but a number of successful pathfinder projects are demonstrating that this can be a valuable source of energy. Combined with recovered wood, high concentrations of mixed material can be achieved in and around urban areas, and is being used successfully to fuel small to medium sized CHP plants.

Table 4: Estimated annual amount of arboricultural arisings in England (figures in thousands of tonnes at oven dried weight).

Stem-wood	Branch-Wood	Wood Chips	Foliage	Total
213 (54%)	78 (20%)	92 (23%)	13 (3%)	396 (100%)

Case Study

Blaise Nursery and Contract Services, Bristol

Bristol City Council have recently installed a 400 kW woodfuel boiler to provide heat to a series of greenhouses at their Blaise plant nursery. The boiler uses wood chip made from wood 'waste' generated by council and tree surgery activity, kept in a fuel store also newly established on the site. In addition to reducing the Council's landfill burden and saving them an estimated £19,000 per annum in fuel costs, the project is also helping the Council to meet their climate change reduction targets through an annual carbon dioxide saving of 102 tonnes.

Crucially, the installation and provision of a fuel store has led to two further boilers being installed at Florence Brown School and Netham Sports Pavilion. It has also influenced the decision to install biomass boilers in four new secondary schools due to be built in the Bristol area.

Recovered wood

Wood recovered from business and households forms an additional resource estimated at 7.5 million tonnes annually. The majority - 6 Mt (80%) - is currently disposed of to landfill and represents significant lost benefits. 1.2 million tonnes (16%) is recovered or reused by a well-established wood reclamation industry. A further 0.3 Mt (4%) is used to produce energy.

A recent study commissioned by Defra¹⁹ identified that recovering energy from waste wood represents one of the greatest potential carbon saving opportunities in waste management, and is preferable to both landfill and recycling.

Any waste wood can be burned for energy generation, but the level of contamination has a significant bearing on the suitability of combustion plant. Clean, untreated waste wood can be used as a biomass fuel in a range of facilities - from small (and even domestic) wood burning boilers to larger commercial and industrial facilities - whereas plant burning any contaminated wood must comply with the more stringent emissions standards of the Waste Incineration Directive (WID).

England's forthcoming Waste Strategy²⁰ will encourage greater separate collection and utilisation of waste wood as an energy source, and will outline the role of Defra's Waste Implementation Programme in developing sustainable energy markets.

As with arboricultural arisings, recovered wood is likely to contribute to CHP generation. In terms of how recovered wood contributes to the 2Mt target, it adds flexibility to the system by supporting supply chains primarily sourced from under-managed woodlands.

Woodland creation

In preparing their strategy, Government asked the Forestry Commission to consider how a strategic plan for woodland creation could be developed to sit alongside that for woodfuel from existing sources.

England's present woodfuel resource is very unevenly distributed and will not necessarily match future demand, as noted for co-firing. Woodland creation could help fill gaps in supply and add capacity to targeted areas of demand to establish viable supply thresholds, thereby adding flexibility to the system. A strategy for new woodland planting has the potential to:

- Establish a viable long-term resource base for woodfuel alongside that of under-managed woodland securing continuity of woodfuel supply.
- Complement other carbon mitigation and climate change measures.
- Support appropriate woodland creation on a range of scales in line with the priorities and aspirations as identified in the Regional Forestry Frameworks.
- Vary in response to local opportunities for carbon management.
- Deliver wider environmental and social benefits including biodiversity, flood management, water quality and recreation.
- Operate at a large enough scale for significant sequestration of carbon through the development of woodland, its associated habitats and their soils.

An effective strategy for woodland creation would require support in the following areas:

- Capital investment.
- R&D and best practice guidance (in particular to mitigate environmental concerns).
- Inclusion in other initiatives such as regeneration and green infrastructure programmes.
- Awareness raising and advice.

To respond to the issues and opportunities set out above it will be essential that a strategy for woodland creation is introduced alongside that for the management of existing woodland.

Annex I provides an illustration of the carbon balance that could be achieved from five different woodland creation scenarios.

¹⁹ http://www.defra.gov.uk/research/project_data/More.asp?l=WR0602&M=KWS&V=Car
²⁰ <http://www.defra.gov.uk/environment/waste/>

Extracting the material for use in a sustainable market

The previous section shows that, in terms of availability, the 2 million tonnes target is achievable. The challenge for the strategy is to consider how to ensure the material is delivered into a sustainable market. Three components are essential to this process:

- Engaging the end user
- Sourcing and extracting the material
- Stimulating the supply chain

Engaging the end user

Potential end users are a difficult group to define. They could be communities (e.g. community buildings), local authorities (e.g. schools), commercial businesses or private individuals. Whoever the end user, targeting and engaging them will be crucial both to stimulate demand and mitigate potential opposition. To do so a number of issues need to be addressed:

Awareness

A lack of familiarity with woodfuel systems, an inability to access clear, impartial help and advice, and misconceptions associating woodfuel and woodland management with environmental damage are all barriers. Mechanisms that raise awareness and mitigate barriers before they arise will be important.

Case Study

Cumbria – woodfuel supply

It is a common misconception that there is a ready supply of wood fuel, particularly from the public estate. It is often the case that wood fuelled boilers are installed or proposed on the assumption that a secure and sustainable fuel supply is readily available.

For example, the Forestry Commission were recently approached by a business in the North West who were looking to heat a kiln using a woodchip boiler, which was due to be installed in a matter of weeks. Among some other problems associated with the project, a secured fuel supply of the correct moisture content was a major barrier, resulting in an oil-fired boiler eventually being installed. A core component of the strategy is awareness. Had the mechanisms identified in the strategy been in place, the business could have been referred to a local woodfuel contact, for example through the Forestry Commission, who could have helped steer the business to a sustainable local supply chain.



Cost

Efficient woodfuel boilers compare favourably with other energy sources in the cost of heat production (see annex II). However capital costs are significantly higher than those of other boiler installations. Fiscal incentives and a promotion of the long-term economic benefits are needed to facilitate uptake.

Confidence in the supply chain

Users of woodfuel systems are currently faced with a complex supply chain. Simplifying it and therefore making the transition to a woodfuel system much easier and more in line with installing a fossil fuel system will be a key component in building confidence in the supply chain and facilitating uptake. Support mechanisms will also be important, for example, an ability to call on local maintenance expertise that is compliant with an industry standard.

Sourcing and extracting the material

Ownership of England's woodlands splits broadly between those owners whose woods are in management, or have been until recently, and those whose have not been managed for a considerable time. The former are engaged with Forestry Commission regulation and grants, although for reasons such as low timber prices in recent years, many of their woods are producing timber at well below their capacity. For woods that have not been in management for many years, a number of factors in addition to low timber prices combine to act as barriers to management. These include lack of awareness, disinterest, and lack of knowledge to access grants and licenses. This situation raises a number of issues that need to be addressed:

Identifying and engaging owners

Identification and engagement of both groups of woodland owners is essential to achieving the 2 Mt target. To give an indication of the size of the task, it is estimated that the area of woodland outside of Forestry Commission ownership in England is made up of 50-80,000 woodland holdings²¹. A large proportion of these woodlands are under-managed and there is a need to identify and engage the owners through appropriate outreach mechanisms.

Persuading owners to bring their woodland into management

Once identified, persuading owners to bring woodland into management is further complicated because:

- Woods may be owned for many different reasons and profit may not be the most important driver. For owners with whom there is no current contact, a proactive approach is vital to introduce them to the potential opportunities for the use of wood for energy. This must be presented in terms that relate to their interest (e.g. carbon saving, secure energy supplies, improving biodiversity or local heritage) rather than in the language of traditional forestry.

²¹ This estimate is consistent with the MCPFE indicators for Sustainable Management <http://www.forestry.gov.uk/pdf/UKfinaldraftMCPFEforweb.pdf>

- Many of those currently engaged, particularly professional land managers, perceive the grant and regulatory systems to be complex. Addressing this, in addition to establishing a mechanism of support for all owners, will be an important first step.
- Negative perceptions associated with woodland management, particularly in terms of environmental impact, and lack of technical knowledge and skills to manage sustainably are a fundamental barrier. Promoting awareness in addition to the provision of technical support and skills training could mitigate this.
- The woodfuel sector currently lacks confidence. This could be partially addressed by the availability of long-term supply contracts for woodfuel, and further helped by making inventory information accessible to owners and agents.



Case Study

Biomass heating in Austria

Biomass heating currently accounts for 22% of rural heating in Austria and the aim is to increase this to 40% by 2010. Thousands of installations, from under 25 kW pellet fired domestic boilers to 2.4 MW district heating plants that account for a third of a town's heat demand, have been installed over the past 10 years.

Austria has 47% woodland cover, with 60% actively managed. Most holdings are small but many farmers own and manage their own woodlands and have become increasingly involved in biomass energy. Entrepreneurial farmers are one of a number of factors that are thought to have significantly contributed to the success of the Austrian biomass sector. Others include local district heat installations, significant grants demonstrating a clear commitment to biomass for heat from Regional and Central government and an expanding rural market for biomass heat.

Stimulating the supply chain

There is a supply chain for round timber products but it is fragile due to low profitability and uncertainty over wood supply. Woodfuel, being a new market, requires investment in skills and training, knowledge enhancement and specialised equipment. Issues to be addressed include:

Complexity of the supply chain

To exist, the supply chain requires feedstock and an end user, neither of which can exist without a supply chain to link them. This chicken and egg complexity is a well known barrier. The challenge is to advance all of them together. A concentrated sub-regional approach rather than a general support mechanism is the key to joining these up.

Confidence in the sector

For the technology to become mainstream, consumers will need to find woodfuel boilers as simple to install and operate as other forms of energy. Access to impartial advice and support, as well as to sufficient numbers of accredited installers, will be important to build and maintain confidence.

To promote confidence in fuel supplies, it is important that agents and woodland owners are made aware of working methods that optimise woodfuel supply whilst protecting conservation and biodiversity objectives. This includes a research requirement to develop a system to estimate local volumes available locally. It will

require continuity of a skilled, competitive, well equipped and accredited work force. Research into the issues and resource shortages faced by all parts of the supply chain should form the basis of a support and training programme.

Viable margins

Current estimates show medium-scale local heat to be both highly competitive with other forms of energy and the most economic use for biomass, making the prospects of establishing a free-standing market good. As discussed above, however, it is this market sector that needs greatest encouragement. Government intervention, especially through capital grants, needs to be used to direct market development.

Another key issue is the proportion of benefit returning to the grower. If the grower does not share in the benefit of the whole supply and user chain, wood will not come forward. Achieving this may require novel mechanisms such as co-operatives, energy supply companies or long-term contracts, where the woodland owner is firmly plugged in to the total economy of the woodfuel sector.

Case Study

Sheffield Road Flats, Barnsley

The three seven storey flats in Sheffield Road, Barnsley contain 166 individual residences. The coal-fired heating system, originally installed when the flats were built in the 1960s, was replaced in 2005 with two woodfuel boilers with a combined capacity of 470 kW.

The boilers use wood chip sourced primarily from the County Council tree teams and other local tree surgeons, thus allowing Barnsley to operate a 'closed loop' supply chain. Approximately seven tonnes of woodchip are delivered at a time taking just a few minutes in a process that is virtually noiseless compared to the old pneumatic coal deliveries. The chip is supplied through a local woodfuel supply company (Silvapower Ltd), supported by the Yorkshire Forward and South Yorkshire Forest Partnership.

The system has reduced the cost of heat (projected annual running costs are almost half that of the old system) and saves around 1,300 tonnes of carbon to the atmosphere per annum. The scheme is part of a wider programme of work by Barnsley Metropolitan Borough Council that has resulted in them winning the UK 1st Prize Ashden Award for Renewable Energy Generation.

Other considerations - communities

There is a real risk that in some situations there will be significant resistance to increased woodland management, from both communities and the owners of currently under-managed woodland. This may arise due to:

- Perceptions that tree felling destroys woodland and a lack of awareness of the long history of woodland management in England.
- Changes to familiar landscapes.
- Objection to the modification of the woodland environment through more intensive management – including temporarily disturbed ground and damaged access paths.
- Fears about disturbance of woodland wildlife and changes in habitat.

- Opposition to the noise of harvesting and movement of machinery and woodland material.

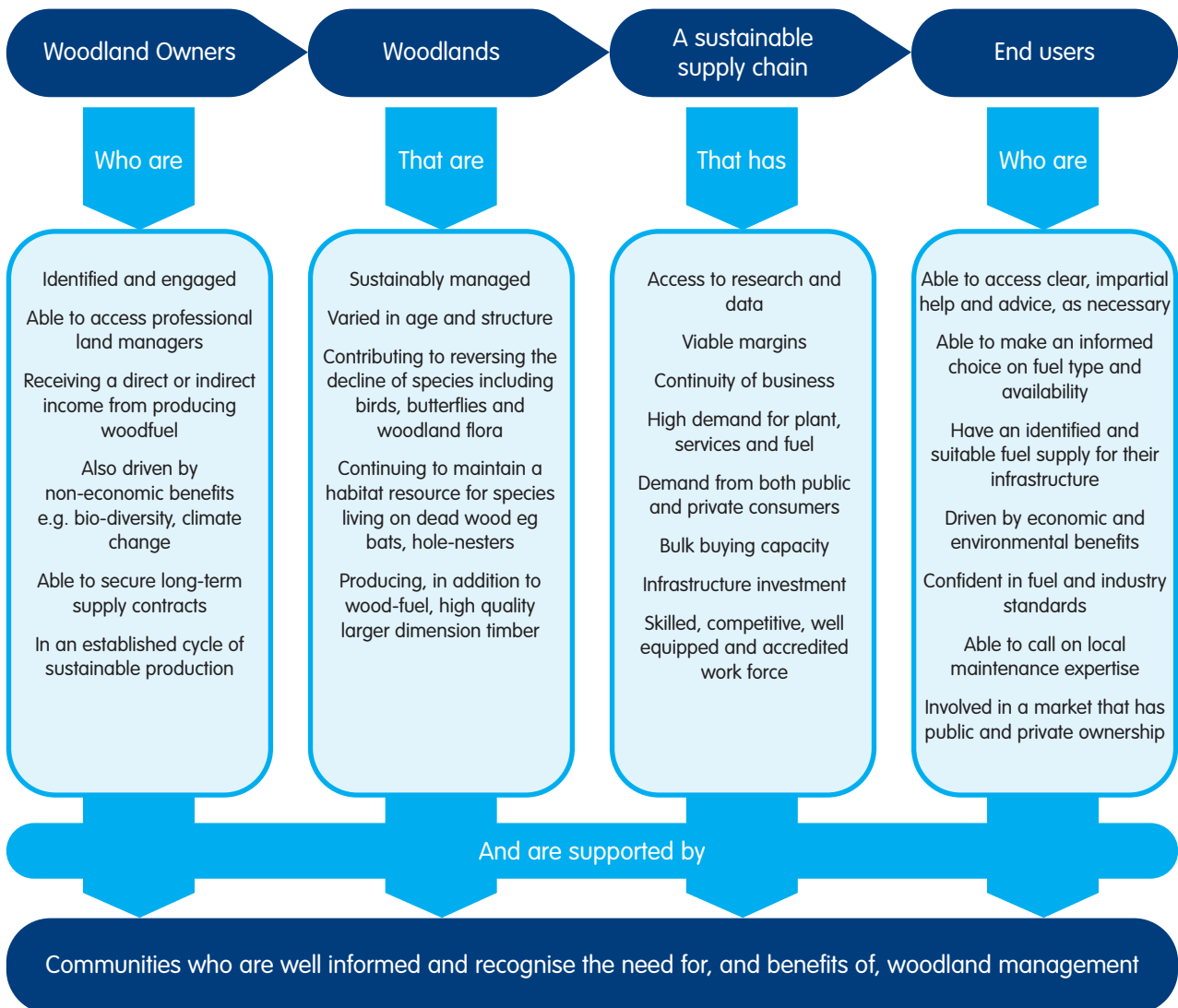
Communicating the understanding that much of our woodland's value has developed through long-term, sustainable management and that there are real amenity and environmental benefits from sensitive management will be both challenging and the key to success.

This is a different type of awareness to the technical understanding needed for the supply chain and some woodland owners.

Conclusions

The discussion above presents a complex picture of stakeholders, barriers and potential solutions. Mapping these against an ideal future woodfuel sector, as presented in Figure 1, has enabled the identification of necessary interventions and where they should be targeted.

Figure 1: The Woodland Strategy in Practice





What is needed, where and why?

A number of key interventions have been identified that, if targeted correctly with the appropriate level of resource, building on existing infrastructure, could stimulate a viable, sustainable sector capable of delivering the wide range of benefits already detailed. The assessment of the interventions required is supported by Government evidence (particularly the Biomass Task Force Report), Forestry Commission experience and the stakeholders consulted during the development of this strategy. These interventions are summarised in figure 2.



Gary Bantell – Suffolk County Council

Increasing demand for woodfuel

The level and effectiveness of the capital grant regime for biomass boiler installation is a key driver for the whole programme. Central to the programme is the total amount of capital available as well as its effectiveness and targeting. Current issues include:

- Capital support regimes have tended to be designed for larger businesses and electricity generation.
- Grants are often short-term and from different sources, making it hard for small to medium businesses currently engaged in biomass to access them.

Consideration should also be given to mechanisms other than direct grant. With payback times on biomass installations falling to 3-4 years, soft loans may be better value for money to Government than conventional grants, while for the supply chain, end-market guarantees may be as valuable as grants.

Capital investment and longer-term support

Capital investment is required to;

- Accelerate the decision to replace a fossil fuel boiler with a biomass boiler.
- Support the technical development of the supply chain, such as through introduction of new or modernisation of existing machinery to increase capacity.
- Assist the provision of physical access to unmanaged woodlands.
- Link the supply chain and therefore support a developing market.

Capital grants are already playing a key part in the development of biomass, including woodfuel²². Grant support for land managers has been available in the form of the Energy Crop Scheme²³ for specific energy crops and wider woodland creation through the England Woodland Grant Scheme²⁴. The Forestry Commission-managed Harvesting, Marketing and Processing Pilot Grant²⁵ and the Defra Biomass Infrastructure Support Grant²⁶ have both supported capital investment in the supply chain.

How these mechanisms may support the delivery of the strategy needs further clarification, but where possible should be channelled to address;

Case Study

Trelowarren Estate, Cornwall

Trelowarren is a traditional privately owned estate situated near Helston, on the Lizard Peninsula. The present owner has embarked on an ambitious plan to develop the estate as a cutting-edge example of sustainable, ecologically sound rural development. When complete, the complex will comprise 31 'eco-built' timber-framed cottages, together with a swimming pool, changing rooms and reception suite. This is in addition to existing buildings in the old stable yard, which house a restaurant, gallery and studios. It is planned to heat the entire development by woodfuel from the 114 hectares of owned and leased woodlands, all within a two-mile radius.

A 500 kW automatic woodchip heating system has recently been installed, heating the first six cottages and the pool. More will be added as the scheme develops. It is expected that the system will eventually need about 600 tonnes of air-dry woodchip per annum, equating to about 750 cubic metres of roundwood, the sustainable production of about half of the woodland resource. All woodland work and woodfuel preparation will be carried out using estate staff. It provides a unique opportunity to bring under-managed woodlands back to full long-term production.

The scheme could not have gone ahead without grant support for the boiler from both DTI (Clear Skies) and European Objective One (Working Woodlands). The purchase of a tractor, forwarding trailer and chipper was also supported by Working Woodlands.

22 For details of capital grant schemes see <http://www.biomassenergycentre.org.uk>

23 <http://www.defra.gov.uk/erdp/schemes/energy/default.htm>

24 <http://www.forestry.gov.uk/ewgs>

25 <http://www.forestry.gov.uk/forestry/infid-6dzh93>

26 <http://www.defra.gov.uk/farm/crops/industrial/energy/capital-grants.htm>



Increasing the supply of woodfuel

The supply chain will require new specialist machinery to address the unique challenges that extracting material from unmanaged woodland represents.

Defra's Biomass Infrastructure Support Grant and the Forestry Commission's Harvesting, Marketing and Processing Pilot Grant are existing support mechanisms for the purchase of new equipment for cutting trees for biomass utilisation. However, physical access to unmanaged woodlands presents a new challenge that will require a one-off investment to open up many woods coming into the programme. In lowland England this may often simply be a hard standing to allow loading away from minor public roads, with a smaller number of short forest tracks.

Linking the supply chain

For the crucial supply chain link to the end user there appear to be significant benefits in concentrating capital investment on producing geographically concentrated 'clusters' of end users. This is a key element in the recommendation that sub-regional projects are the main delivery vehicle (see The Delivery Framework).

Longer-term support

Analysis currently underway into the potential of longer-term revenue support mechanisms for renewable heat (such as a renewable heat obligation) should confirm whether a revenue-based approach is needed for stimulating a sustainable and expanding heat industry and in what form. A vibrant renewable energy industry is recognised as being key to pulling through this additional woodfuel supply – and at the pace needed to meet the 2 Mt target.

Awareness, Outreach and Skills

The Biomass Task Force Report identified knowledge and understanding as key to the development of the biomass market. This is particularly so in the woodfuel sector of the market.

England is exceptional in Europe in the extent to which it has lost its woodland management culture. Many people outside the forestry sector, including the owners of unmanaged woodland, view tree felling as environmentally destructive. Communities near woodlands are concerned at the impact of tree felling and owners of unmanaged woods do not have the technical knowledge to engage with regulatory and woodland management systems. To achieve the 2 Mt target it is essential that:

- Both woodland owners and communities near woodland understand the value of active management, both for carbon saving and the woodland environment – awareness of the benefits.
- Woodland owners have confidence in the operations happening in their woodland and have the technical knowledge and support to ensure these are carried out correctly and to a high standard – technical awareness.

This presents two different awareness challenges: general and technical. Both are crucial. Evidence from the development of other renewables demonstrates that recovering from public opposition is far more expensive than avoiding it in the first place.

General - awareness of the benefits of woodland management

Current evidence suggests that many people are now positively seeking practical opportunities to live more sustainably. Local woodland management, properly communicated, has the potential to become an exemplar of both understanding and enacting 'one planet living' for a large number of people.

The Forestry Commission, with an increasing range of partners, has a growing record of community-led engagement. Rather than persuading people in a traditional top-down approach, the proposal is to inform and support at woodland owner and community level, including school education and active involvement programmes for all sectors of the community.

Case Study

Highcliffe Primary School and Community Centre

Highcliffe Primary School and Community Centre provides learning for 400 primary age children and a large range of facilities and activities for the local community. In 2004, the 35-year-old coal-fired boiler that heated the main school buildings was replaced. A 200kW Thermo wood chip boiler, with stoker-burner and customised fuel feed system, was installed, to provide the peak heating supply for the main school.

The project was financed within the budget, allowed by Leicestershire County Council, for a normal fossil fuel replacement system. This was made possible with the aid of a 50% capital grant from the Clear Skies Community Fund.

Following the installation of the new heating system, an area of the school grounds was planted with poplar cuttings. These are to be grown and coppiced to provide part of the school fuel requirements. Each of the 400 pupils planted a cutting.

Each year, a group of older pupils will be involved in a project to study renewable energy and the role of the school heating system in tackling climate change.

Technical awareness - Outreach and Skills

For woodland owners

Owners of unmanaged woodlands will require support to increase their knowledge to ensure that woodlands are managed sustainably. A higher level of technical support may be needed for inexperienced owners. One possible option is a 'one stop' approach with a full management service from planning and regulatory approval through to timber harvesting.

The Forestry Commission and private sector woodland experts, funded through the English Woodland Grants Scheme,²⁷ currently carry out some of this type of work. To meet the target, however, a step change in scale and new working methods will be needed to deal with the very large increase in numbers of woodland owners involved. Greater resource on the ground, involving both Government and private sector expertise, will be important.

For the supply chain

An expanding biomass business will require more people and new skills – meaning expanded technical training programmes. Business support for novel approaches, such as local co-operatives, may need to underpin the developing sector. The Forestry Commission's Forestry Training Service²⁸ and the land-based sector skills council LANTRA²⁹ currently play key roles in this and have the infrastructure to supply an expanded delivery of training.

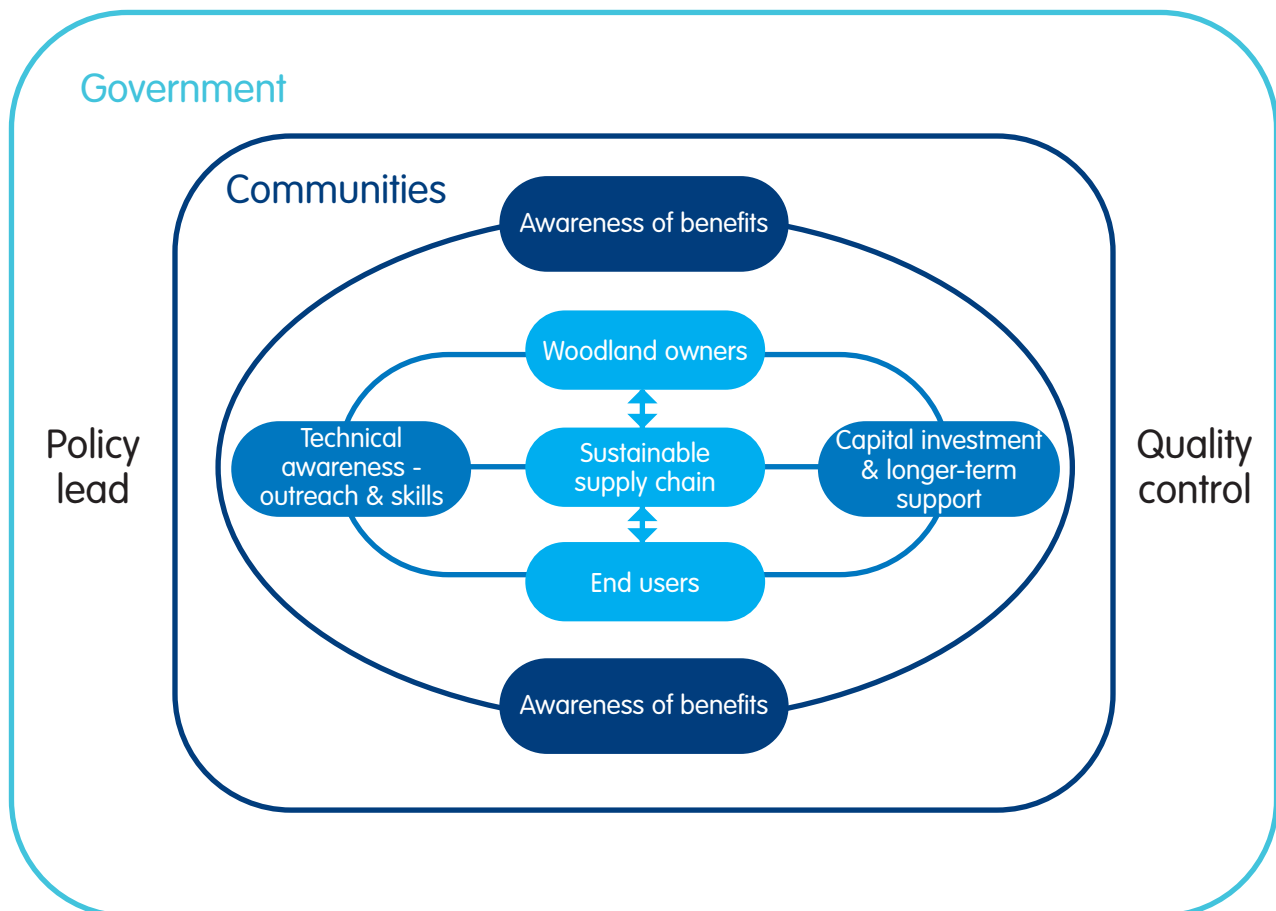
In terms of innovation, a range of issues where further research is required have already been identified that are specific to a stepped increase in the production of woodfuel. For example, management of existing woodland, new energy crops and the impact of forest operations on the environment. As the programme develops other issues will arise. It is anticipated that technical research and development, with continuous improvement through feedback of successes and failures, can generate significant efficiencies through the programme.

For the end user

The skills and knowledge for boiler sourcing and installation are two relatively simple areas currently causing disproportionate problems. Technical training, delivered regionally to national standards, is essential to guarantee successful installation and operation and build confidence in the supply chain.

Currently, a wide range of those engaged in the sector are concerned about the time they spend giving very basic information. The recently launched Biomass Energy Centre (BEC), established within the Forestry Commission's research agency, Forest Research, is a 'one stop shop' able to provide advice to anyone with an interest in biomass derived fuels and associated conversion technologies. **More information on the BEC can be found at www.biomassenergycentre.org.uk.**

Figure 2: Woodfuel – what interventions are needed and where



27 <http://www.forestry.gov.uk/ewgs>

28 <http://www.forestry.gov.uk/forestry/hcon-4yqm8d>

29 <http://www.lantra.co.uk>



Environmental Impact

Emissions

Factors that mitigate concerns over emissions fall into three areas: woodfuel quality; nature of the combustion system; advice and regulation. In particular, the focus of the strategy on the use of clean wood from existing woodlands by small to medium-scale, non-domestic heating systems counters many of these concerns, while abatement technologies are readily available where outstanding issues remain. This strategy therefore supports the existing regulatory framework in ensuring that Government's air quality objectives are not compromised. Increased woodfuel useage in urban areas is of particular concern, and changes to the regulatory framework may be required as the sector expands.

An increased utilisation of woodfuel has been suggested as being in potential conflict with the revision of the Government's Air Quality Strategy³⁰. The Forestry Commission is actively engaged with Defra on this issue.

Environmental impact

There is a range of potential environmental impacts, both positive and negative, that may arise from the harvesting of an additional 2 Mt of woodfuel from under-managed woodland. An overview of these is set out in table 5, along with mechanisms to mitigate potential negative impacts in table 6.

The broad picture shows that the positive environmental benefits are substantial and, that once mitigation measures have been pursued, the adverse impacts are very modest.

Any pursuit of a woodfuel strategy should make provision for a robust and strategic environmental impact assessment. Adherence to the UK Forestry Standard³¹ is mandatory for Felling Licences and Forestry Commission grant schemes. Certified woods must also meet the UK Woodland Assurance Standard³². These standards address the majority of environmental concerns in most woodland situations.

³⁰ <http://www.defra.gov.uk/environment/airquality/strategy/strategy.htm>

³¹ [http://www.forestry.gov.uk/pdf/fcfc001.pdf/\\$FILE/fcfc001.pdf](http://www.forestry.gov.uk/pdf/fcfc001.pdf/$FILE/fcfc001.pdf)

³² <http://www.ukwas.org.uk>

Table 5: Outline of the potential environmental impacts of implementing a woodfuel strategy

Potential positives	Feature	Potential negatives
Could counter 20th century increases in N and P levels in soils; establishment of ground cover to reduce soil erosion.	Soil	Damage to woodland soils and removal of nutrients; enhanced erosion immediately after management activity.
	Water	Increased run-off and impaired water quality (from felled areas and extraction routes/roads)
		Eutrophication from poor disposal or inappropriate use of ash from combustion
Substitution of fossil fuels	Carbon balance	Initial reduction in carbon stored
	Air quality	Smoke, including carcinogens, from inadequate combustion units
Tree regeneration and coppice cycle reinstated	Woodland habitat	Inadequate regeneration following cutting due to deer
Reversing recent increases in shadiness		'Unnaturally' high proportion of younger growth stages
Increase in 'thicker' habitat and temporary open space		Reduction of deadwood and loss of 'old growth' conditions
Increased edge & rides habitat		Loss of woodland to tracks/roads
Acceleration of Plantations on Ancient Woodland Sites (PAWS) restoration		Restoration could be too fast or 'low thinning' could be too common
Improved conditions for declining spp of early successional stages	Species	Disturbance or damage to vulnerable sedentary spp
Removal of invasive trees/scrub from open habitats (rides, heaths, grassland)	Other habitats	
Diversified structure will reduce extent of future storm damage	Landscape	Perception of rapid rates of change to treasured landscapes
Restoration of historic 'coppiced' landscapes		Visual intrusion of new tracks for access to and within woodland
Larger dimension, better quality timber for future generations	Timber	
Reduced risk of windblow disturbing remains	Heritage	Damage to historic environment features from harvesting machinery or woodland tracks/roads
More 'nurtured' appearance and 'open' appearance	Recreation	Unpopular disturbance, damage and intervention in 'natural woodland'
	Noise	Noise of harvesting, chipping & loading within woodland
		Haulage traffic in rural areas and more especially at combustion sites



N.B. The assessment in the above table assumes compliance with existing and forthcoming standards and good practice (particularly the UK Forestry Standard and associated Forestry Commission Guidelines). Compliance with such standards is mandatory under Felling Licences and Forestry Commission grant schemes.

Table 6: Possible actions to mitigate any potential negative environmental impacts

Potential Feature	Mitigation of Potential negatives
Soils	Best practice guidance (Forests and Soil Conservation Guidelines). Avoid whole tree harvesting on sensitive sites
Water	Best practice guidance (Forests and Water Guidelines).
Carbon balance	-
Air quality	Installation of purpose-built woodfuel boilers by qualified heating engineers. Focus on use of clean wood from existing woodlands for non-domestic market. Regulation applied to boiler installation and fuel sources, where a need is identified.
Woodland habitat	Focus on reducing deer impacts in advance of increased felling. Planning and best practice guidance (Forest Nature Conservation Guidelines). Avoid whole tree harvesting on sensitive sites
Species	Best practice guidance (Forest Nature Conservation Guidelines). Avoid whole tree harvesting on sensitive sites
Other habitats	-
Landscape	Landscape scale planning and best practice guidance (Forest Landscape Design Guidelines).
Heritage	Best practice guidance (Forest and Archaeology Guidelines). Avoid whole tree harvesting on sensitive sites
Recreation	Communication messages
Noise	Communication messages Appropriate Siting



Delivery Framework – looking towards an implementation plan

In terms of the woodfuel-relevant infrastructure and resource currently in place, delivery partners (such as RDAs, Forestry Commission, Local Authorities and private businesses) tend to reflect regional variation and so differ from region to region. This, alongside an uneven distribution of industry pioneers, is an important factor in establishing what a delivery framework would look like.

With this in mind, and to provide flexibility, optimise resources and minimise risk, there is a significant benefit in having a co-ordinated approach with a focus on outcomes. Within this context, concentrating effort on raising current levels of activity in already reasonably established areas could quickly build a portfolio of exemplar projects ('pathfinders') and a directory of lessons learned that could be transferred elsewhere.

Figure 3 maps out how this type of delivery could be managed. Broadly, it shows a role for central Government in national level strategic direction and monitoring. At a more practical level this would include production of generic support materials (e.g. for communications) and training standards.

Regions, in the form of co-operating groups such as the Forestry Commission and RDAs, have a role in directing funding to sub-regional 'pathfinder' projects - the delivery mechanism at the local level - providing support and monitoring for these. This includes acting as the pivot in a quality control system assessing factors such as success of projects against expectation and the effectiveness of Government capital support. Pathfinder projects are likely to involve co-operatives of public and private partners, for example, an energy supply company and a Local Authority.

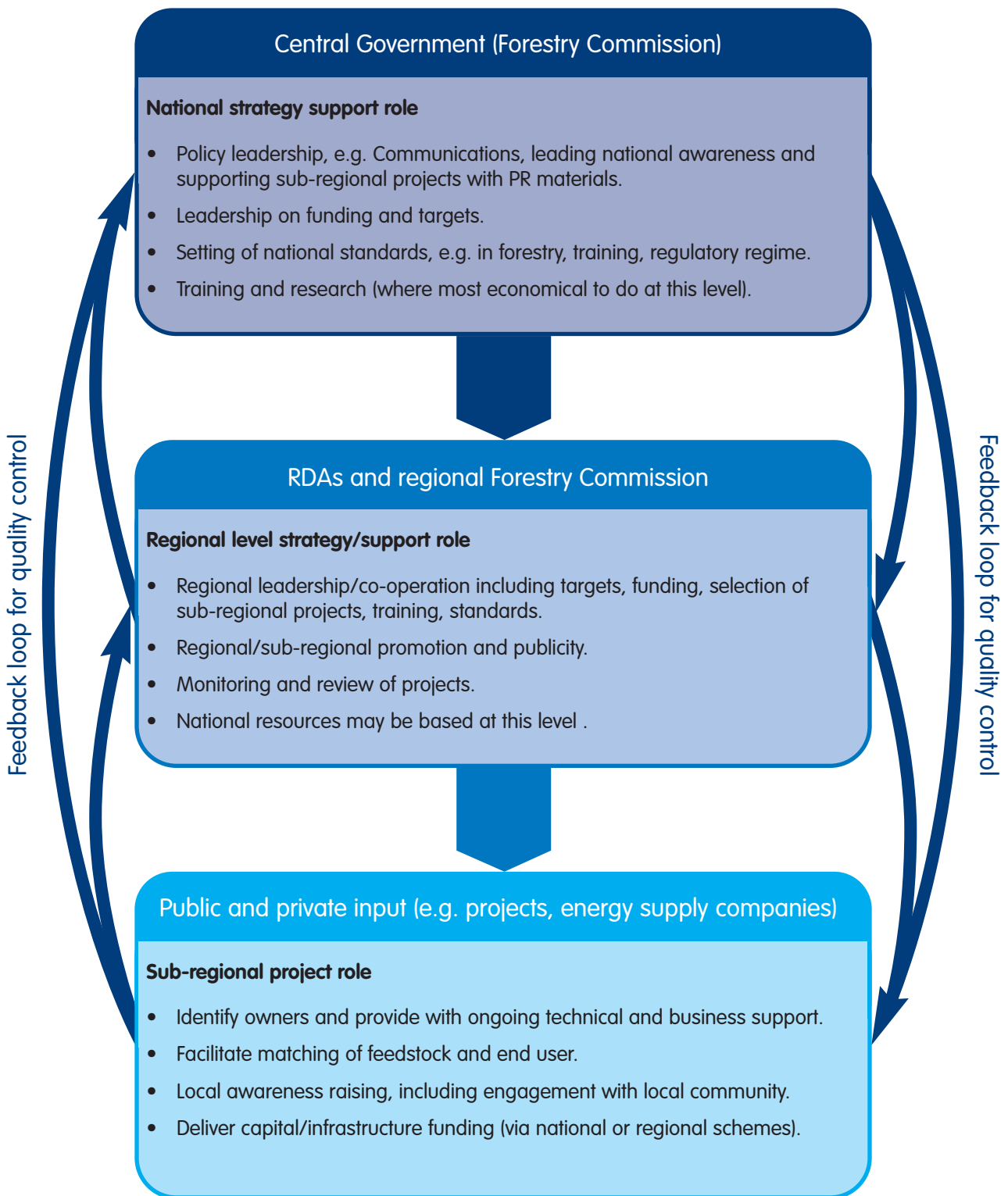
Case Study

A recently funded project in South West England is a good example of a regional co-operative approach. Here, a co-ordinated Woodfuel Initiative (CWI) is focusing on small community based projects in and around many of the Protected Landscape Areas in the region. The initiative will provide a screening and advice service throughout the South West, while in the Protected Landscape Areas, it will proactively identify and support installations for matched funding with their Sustainable Development Funds through an advisory network. These areas tend to be located in well-wooded areas not served by the gas grid. The project will demonstrate that using woodfuel promotes sustainable woodland management and this in turn generates benefits to local communities and landscape character.

The Forestry Commission will continue to work closely with delivery partners to progress a detailed delivery plan to support this strategy, which has both public and private sector support.



Figure 3: Delivery framework



Cost/benefit analysis

As directed by Government, developing this strategy has included an analysis of the costs and benefits of its delivery. This section contains some of the initial analysis, principally focusing on the carbon savings and cost of developing the programme. Further work, including extending this scope, will be conducted as part of the development of the implementation plan.

Figure 4 shows the estimated costs of delivering the strategy against delivery time, demonstrating a pump-priming approach. Figure 5 shows the estimated cost against the carbon benefit, illustrating the cost/benefit principle with rising costs in the short term, tailing off in the longer term, and the steadily increasing benefits growing in the future.

Figure 4: Estimated annual costs over 25 years

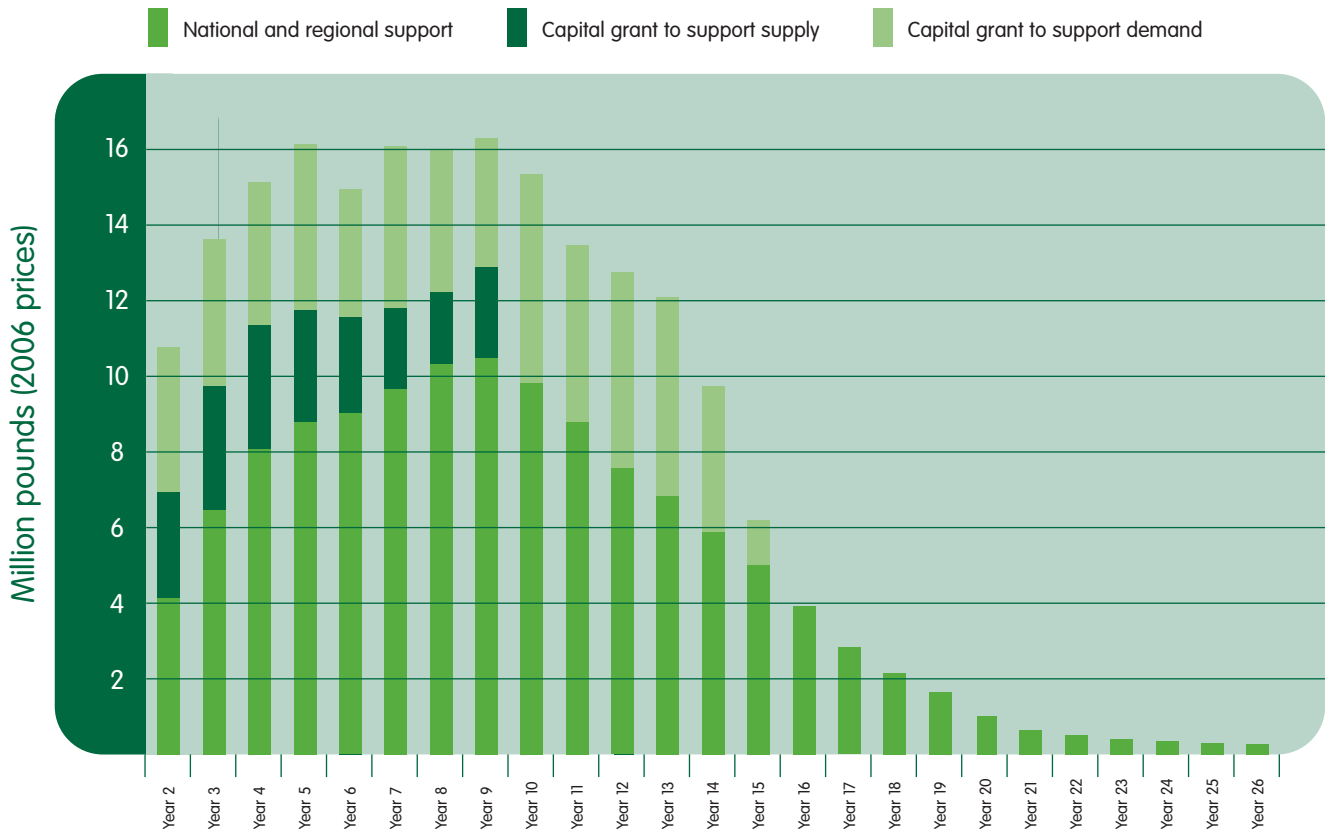
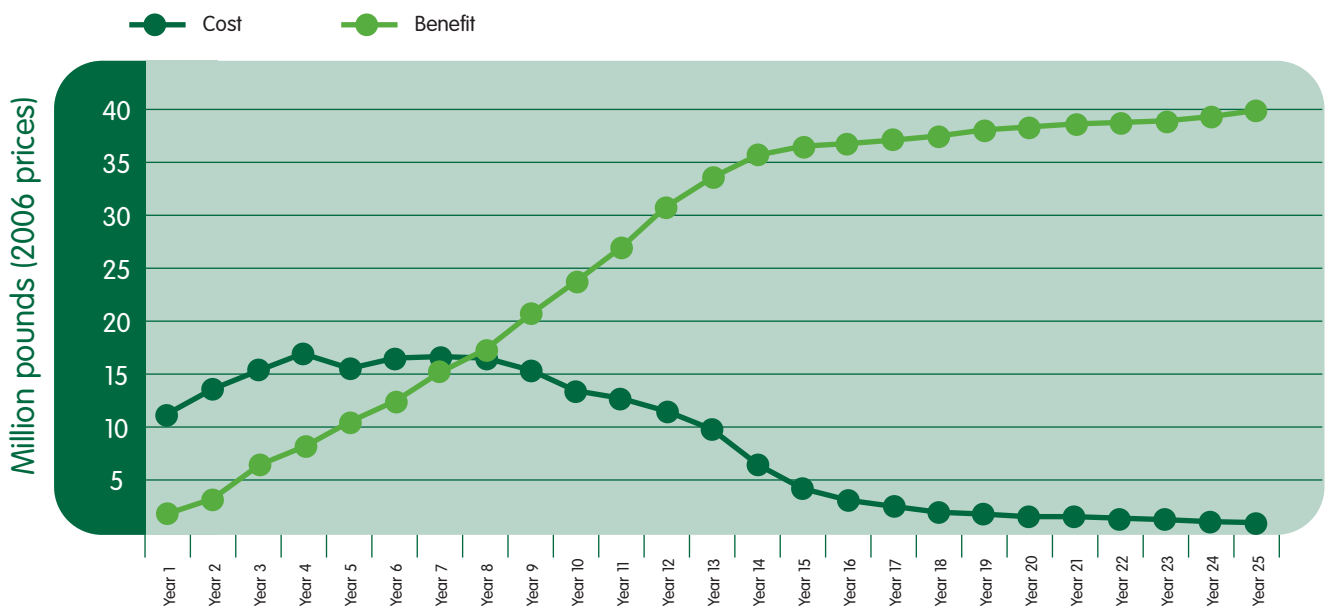


Figure 5: Estimated cost against associated carbon benefit



N.B. The cost/benefit analysis work was done in line with the DTI Energy Review. All monetary costs and benefits were discounted in line with HMT Green Book guidance

Summary and conclusions

This strategy sets out our objectives to work with public and private sector partners to:

- identify 'pathfinder' projects/areas and direct early support towards them - increasing the scale of woodfuel operations locally by encouraging clusters of end users and suppliers to develop, rather than scattering support.
- deliver at regional/sub-regional level, supported by a national core of research & development, advice and advocacy.

- not rule out support to any development, but prioritise the development of local heat.
- manage more existing woodland as a priority but use other woodfuel sources to add support and flexibility to the system.
- maintain high environmental quality in all activities.

These objectives will be taken forward and developed in an implementation plan which will follow and support this strategy.

Annex I

Woodland creation – carbon balance

Table 7 illustrates five different woodland creation options. This preliminary illustrative analysis demonstrates that the total carbon savings of each option depend on the timeframe considered. If there is a short-term requirement, short rotation coppice willow is the only viable option. As the timeframe extends to 20 years, the woodfuel provision and consequent Green House Gas (GHG) emissions savings become similar for Short Rotation Coppice (SRC) and the two Short Rotation Forestry (SRF) options.

However, the total carbon benefits of the system are higher for the two SRF options, because of the higher average carbon stocks in standing biomass. After 100 years, even though the eucalypt SRF option still has the highest associated carbon benefits, all options are relatively 'competitive'. The five options have a range of other public good benefits or disadvantages associated with them, such as biodiversity, landscape and water use, which may be factored into the choice of woodland creation option for bioenergy supply.

Table 7: Woodland creation options.

Public Good	All figures in tonnes of carbon per hectare of woodland				
	SRC Willow	SRF Ash	SRF Eucalypt	Native Woodland	Conifer
Additional carbon stored over 5 yrs	8.6	28.5	45.5	8.9	13
GHG emissions avoided over 5 yrs	16	0	0	0	0
Additional carbon stored over 20 yrs	8.6	70.9	67.7	35.4	52.1
GHG emissions avoided over 20 yrs	64.0	59.2	96	9.8	9.8
Additional carbon stored over 100 yrs	8.6	70.9	67.7	115 (279)	87.2
GHG emissions avoided over 100 yrs	320	296	480	133 (72.8)	220

Note. Figures in parentheses assume no clearfell at the end of the rotation with an objective of continuous cover management.

Annex II

Table 8: Indicative estimates of carbon dioxide savings associated with substituting wood for fossil-fuels.

	Direct CO ₂ emissions	Approx. lifecycle CO ₂ emissions ¹	Total CO ₂ emissions to heat a typical house ²	Total CO ₂ savings to heat a typical house compared with ³		
				Oil	Natural Gas	Grid Electricity
				tonnes	tonnes	tonnes
	kg/MWh	kg/MWh	tonnes	tonnes	tonnes	tonnes
Oil	264	313	6.26	0	-1.96	4.54
Natural gas	185	215	4.3	1.96	0	6.5
Electricity (UK grid)	460	540	10.8	-4.54	-6.5	0
Electricity (wood combustion)	2100	58	1.16	5.1	3.14	9.64
Electricity (wood gasification)	1050	25	0.5	5.76	3.80	10.3
Wood heating (oven dry)	345	5	0.1	6.1	4.2	10.7

- 1 Includes all associated processes including fuel production, processing, transport and storage, and power generation equipment. Lifecycle emission data from "Carbon and energy balances for a range of biofuel options" MA Elsayed, R Matthews & ND Mortimer
- 2 Based on annual consumption of 20,000 kWh
- 3 Negative numbers correspond to greater CO₂ emissions

Table 9: Comparative energy costs for various fuel types.

Fuel	Cost	Energy	Boiler Efficiency	Energy Cost
	Price per unit as charged	kWh per unit	%	Pence per kWh output
Electricity	8.8p/kWh	1	100	8.8
Oil (2,000 litre bulk)	29p/l	10.2	85	3.3
Natural gas	2.8p/kWh	1	90	3.1
LPG (47kg cylinder)	81p/kg	13.8	90	6.5
LPG (2,000 litre bulk)	35p/l	7.1	90	5.5
Wood pellets (bulk)	£120/tonne	5,000	90	2.7
Wood chips (35% moisture) (5 tonne bulk)	£46/tonne	3,300	90	1.5
Wood chips (35% moisture) (27 tonne bulk)	£30/tonne	3,300	90	1.0

Further information on tables 8&9 can be found at www.biomassenergycentre.org.uk

Further information

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