Forestry Commission England

Biomass in a low-carbon economy. Committee on Climate Change November 2018

Annex 1. Sustainable Forest Management

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Introduction

This annex was prepared by Forest Services to support the Committee on Climate Change report 'Biomass in a low carbon economy'. It is based on a review of literature and is informed by foresters and researchers with experience of managing forests and woodland in the UK and overseas. The annex summarises the principles of sustainable forest management, current trends in forestry and considers types of forest based supply chain that might provide biomass and timber on a long term, sustainable basis.

1. Forests - what they are and how they are used around the world

Forests cover 31% of world's land area[1], they regulate the climate, atmosphere and water cycle. They support a huge range of fungi, plant and animal species. They store carbon and provide timber and fuel. Around 3 billion m^3 of wood is harvested annually, or around 0.6% of the total growing stock. Approximately 50% of the wood harvested is used as fuel[2].

There are many definitions of what a 'forest' is. The UN Food and Agriculture Organisation (FAO) define 'forest' as "land with tree crown cover of more than 10% and an area of more than 0.5 hectares (ha)"[3]. There are numerous types of forest. These can be classified by climatic zone and species assemblage e.g. tropical rain forest, temperate coniferous forestry. Other classifications use the level of disturbance or modification placed on the forest by humans. The FAO defines 'pristine forest' as 'forest of native species where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed'. This method of classification goes on to describe:

- **Naturally regenerated forest** – forests of native species, visible signs of human activities.
- **Semi-natural forest with assisted natural regeneration** – natural regeneration of native species assisted by silvicultural practices such as thinning, weeding and fertilising.
- **Semi-natural forest with a planted component** – native species established via planting, seeding or coppicing.
- **Productive plantations** – comprised of native or introduced species planted or seeded to produce timber and non-timber goods (e.g. food).
- **Protective plantations** – comprised of native or introduced species planted or seeded to provided services (e.g. to manage water quality or quantity)

Areas of forest or woodland may be owned privately or by the state. Globally, around 86%[4] of forest area is in public ownership. There are significant variations around this figure at the

[1] http://www.fao.org/forest-resources-assessment/en/
[2] https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2017/international-forestry/wood-removals/
[3] http://www.fao.org/docrep/006/ad665e/ad665e06.htm
[4] Siry, J.P., Cubbage, F.W., Newman, D.H. (2009) Global Forest Ownership: Implications for Forest Production, Management, and protection. XIII World Forestry Congress, Buenos Aires, Argentina.

national level. In China, Russia and Indonesia all forest is owned by the state. In Canada and Brazil around 90% of the forest is publicly owned. In Australia this falls to around 73%. Lower proportions of publicly-owned forest are found in Germany (53%) and Sweden (20%).

Nationally there may be variations in ownership between regions or states. For example in Southern USA, publicly-owned forests account for 12% of total forest area compared to the 42% national average. Private forests might be owned by large businesses involved in timber production, by families or by conservation groups. In the USA an estimated 15 million (ha) of forest is owned by conservation driven organisations or in conservation easements.

1.1 Trends in global forestry

In some parts of the world (including Central and South America and Africa), deforestation, principally for agricultural land, remains a prevailing trend. However, there has been a decrease in the rate of net forest loss from 7.3 million ha a year in 1990 to 3.3 million ha a year in 2015.

In contrast, the area of forest in Europe, USA, Russia, China and India is increasing. China planted an additional 1.5 million ha of woodland a year in 2010 – 2015[5]. For context, the total area of woodland in England is 1.3 million ha.

These trends reflect a pattern commonly encountered at a national or subnational level as countries develop. This begins with exploitation of natural forest resources to support growing populations. It is followed by forest clearance for agriculture and development. The third step, and one that many countries in Europe, North America and Scandinavia are making, is a period of forest protection and afforestation. For example, in England forest cover fell from around 15% in 1086 to 5% in the 1900s[6]. Over the past century this trend has been reversed and forest cover increased to 10%. Policies remain in place to increase this further.

In Mississippi, USA, forests covered around 90% of the state prior to settlement by Europeans in the 1800s. This fell to 55% in the middle of the 20th century. Since then around 1 million hectares of forest has been planted or restored and forest cover increased to around 65%[7].

In the 19th century the volume of wood harvested from Norwegian forests exceeded annual increment. As a result, policies were introduced to restore the growing stock. This has led to the volume of timber standing in Norwegian forests doubling during the 20th century.

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https://www.pefc.org/images/stories/documents/external/global_forest_ownership_FD.pdf [Accessed 30/10/2018]

[5] FAO Global Forest Resources Assessment 2015 http://www.fao.org/3/a-i4793e.pdf [Accessed 01/11/2018]

[6] Forestry Commission Statistics 2018 https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/woodland-areas-and-planting/woodland-area/area-of-woodland-changes-over-time/ [Accessed 14/11/2018]

[7] Oswalt, S.N. (2014) Mississippi's Forests, 2013. Resource Bulletin SRS-204. US Forest Service https://www.srs.fs.usda.gov/pubs/rb/rb_srs204.pdf [Accessed 14/11/2018]

1.1.1 How wood is used

The way in which wood harvested from forests is used varies around the world. In general terms larger proportions of harvested wood are used for energy production in countries with less developed energy infrastructure and distribution systems. For example, 97% of wood harvested in Ethiopia and 89% of wood harvested in India is used as fuel (Table 1). In India around 385 million m^3 of woodfuel is harvested each year. This is equivalent to around 1000TWh of energy or roughly twice the energy consumed by UK households annually[8]. As energy infrastructure becomes more developed, demand for firewood to cook food and heat buildings tends to decline. This means more wood might be left in the forest, available for non-energy uses or for international trade. In countries with stronger energy infrastructure, such as China, Canada and Sweden the proportion of wood used as woodfuel falls to below 10%. In these countries a larger proportion of harvested wood might be suitable for use in construction while non-energy wood processing supply chains are likely to be more developed.

Table 1. Top 10 countries by wood removals in 2011[9].

	Wood removals (thousand m3)	Woodfuel as % of total wood removals	Volume of woodfuel (thousand m^3)	TWh
India	434,766	89	385,203	9,630
USA	324,433	13	40,554	1,014
Brazil	228,929	51	116,067	2,902
Russian Federation	197,000	22	43,734	1,093
Canada	149,855	3	3,746	94
Ethiopia	104,209	97	101,291	2,532
DR Congo	81,184	94	76,638	1,916
China	74,496	9	6,928	173
Nigeria	72,633	87	63,191	1,580
Sweden	72,103	8	5,912	148
			750,000	18,750

Forest management and wood processing businesses vary from country to country and these differences are often driven by the characteristics of tree species best suited to local growing conditions.

In many parts of the world the most valuable part of the tree is the sawlog. Sawlogs are cut from the part of the stem with the widest diameter. Local specifications will define the length,

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8 Energy Consumption in the UK https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/729317/Energy_Consumption_in_the_UK__ECUK__2018.pdf [Accessed 25/01/2019]

9 From Table 8 in FAO Global Forest Resources Assessment 2015. How are the world's forests changing? http://www.fao.org/3/a-i4793e.pdf [Accessed 14/11/2018]

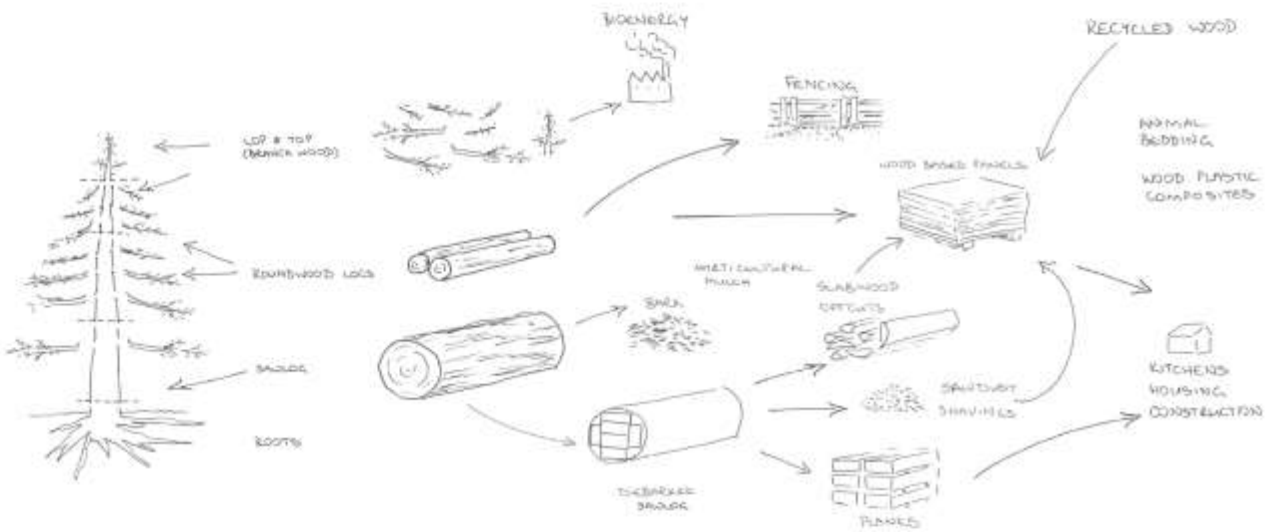
taper, diameter and sweep of saw logs. In some cases sawlogs might be harvested when they are relatively small and used to produce a single square section beam. In other parts of the world several sawn products are produced from a single log.

Co-products such as slabwood (that part of the log removed when the round cross section is cut into a square), woodchips and sawdust from the processing of sawlogs might be used to generate energy on site or could be used to produce panel board.

Smaller diameter roundwood could be used to produce panel boards or sold into energy markets. Bark removed prior to processing is sold to the horticultural market or used as fuel. In some circumstances it might be appropriate to harvest branch wood removed at the time the tree is felled and use this component as fuel.

A range of products that a single tree can produce is illustrated in Figure 1.

Figure 1. A single tree can produce a range of products to different markets.[10]



1.2 Trends in British Forestry

No pristine woodland is present in the UK. Historically nearly all woods have been managed to produce timber and fuel and this has shaped habitats and the biodiversity present in woodlands. The area of woodland in the UK has increased significantly over the last 100 years following a long period of deforestation and overexploitation. Afforestation was initially driven by the need to develop a 'strategic timber reserve'[11] following shortages of wood in the first world war. Implementation of government policy led to large areas of conifer forest being created and the size of the public forest estate increased significantly. Private land owners were encouraged to establish woodland via planting grants. Woodland creation grants are

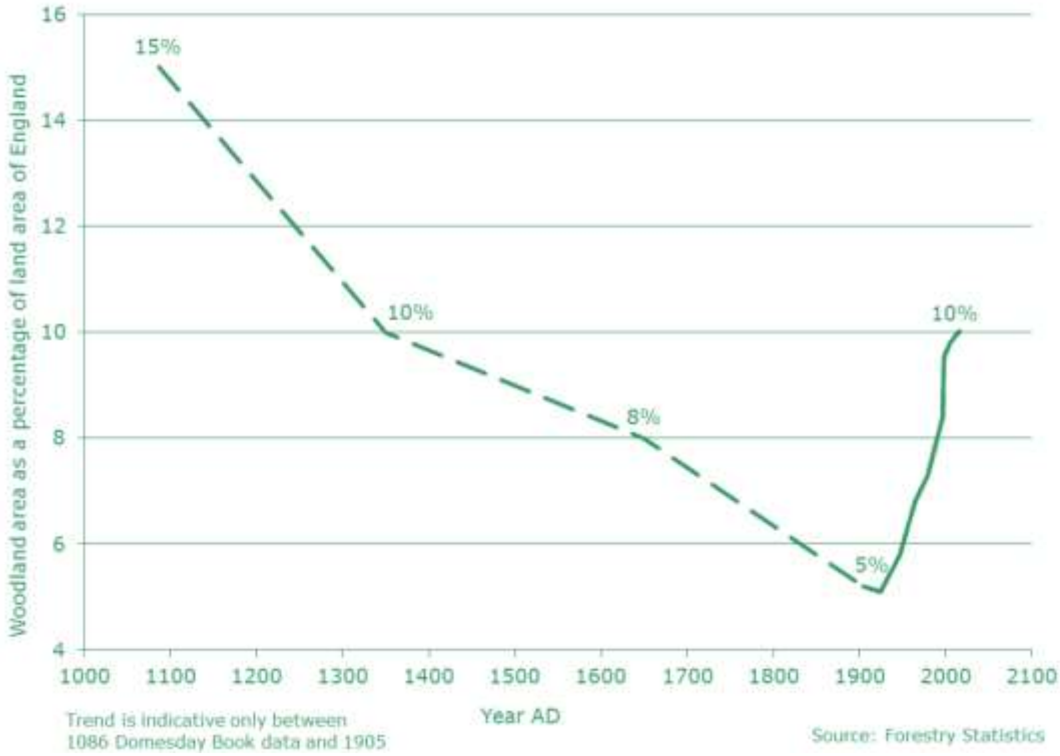
[10] From 'Wood in construction in the UK: An Analysis of Carbon Abatement Potential'. A report by University of Bangor for CCC.
[11] Forestry Commission https://www.forestry.gov.uk/forestry/cmon-4uum6r [Accessed 14/11/2018]

available in each part of the UK in 2018. This period of afforestation is illustrated in Figure 2 which shows how woodland cover has changed over time in England.

Today the area of UK woodland is 3.17 million or 13% of land area[12]. Of this 1.62 million ha is conifer woodland and 1.55 million ha is broadleaf woodland. In Scotland, conifer woodland dominates with over 1 million ha planted compared to 0.38 million ha of broadleaved woodland. In England there is 0.97 million ha of broadleaf woodland and 0.34 million ha of conifer.

As conifer forests established in the 20th Century matured softwood timber production has increased from 2.4 million green tonnes in 1976 to 10.9 million green tonnes in 2018. Around 65% (or 7 million green tonnes) of UK softwood reaching market is harvested from woodlands in Scotland. As more softwood has become available, international timber processing companies such as Egger and Norbord have invested in processing facilities.

Figure 2. Changes in the proportion of land covered by woodland in England



Timber production in broadleaf woodlands has declined significantly since 1976. Many privately owned broadleaved woodlands are not actively managed. This follows changes in local markets (e.g. paper mills switching to recycled fibre or closing). As the management of broadleaf woodland became less profitable many woodlands fell into neglect. Around 42% of woodland in England is regarded as unmanaged[13]. In recent years policies such as the

[12] Forestry Statistics 2018 https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/woodland-areas-and-planting/woodland-area/area-of-woodland-2017/ [Accessed 14/11/2018]

[13] Corporate Plan Indicators. Headline Performance Update 30 June 2018. Forestry Commission England https://www.forestry.gov.uk/pdf/FCEHEADLINEPERFORMANCEINDICATORS30JUN18.pdf/$FILE/FCEHEADLINEPERFORMANCEINDICATORS30JUN18.pdf [Accessed 14/11/2018]

Renewable Heat Incentive have provided more opportunities for owners to make money from timber production. Some environmental organisations regard these new markets as key to increasing woodland management levels and restoring woodland habitats[14]. These organisations have been supportive of policies designed to increase levels of harvesting in woodlands to supply energy markets[15]

2. What is Sustainable Forest Management?

The term 'sustainable forest management' is often used to describe forests managed to provide social, environmental and economic benefits simultaneously. Although there is general consensus around this principal, there is no universally recognised definition. To many professional foresters, sustainable forest management means planning and carrying out operations that maintain the flow of goods and services provided by forests as environmental and socio economic conditions change.

The concept of Sustainable Forest Management in the 20th century originates from the 1992 Earth Summit at which a 'Statement of Forest Principles' was agreed following increased interest in conservation and sustainable development that emerged during the 1980s. In 1993 the Ministerial Conference on the Protection of Forests in Europe (MCPFE) agreed on a number of resolutions that built on commitments made at the Earth Summit. These included this definition of sustainable forest management:

'the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems.'

MCPFE, now known as 'Forest Europe' went on to agree a number of criteria and indicators against which progress towards sustainable forest management can be measured. The Forest Europe process is endorsed by 46 signatory countries including Russia.

As the work of MCPFE progressed, a parallel set of negotiations and conferences, known as the Montreal Process, involving an additional 49 countries (including the USA and Canada) agreed a similar set of criteria and indicators against which progress towards sustainable forest management can be assessed. The countries involved account for 90% of the world's temperate and boreal forests and 49% of global roundwood production. Table 2 summarises the indicators agreed by Forest Europe and the Montreal process. Voluntary schemes such as the Programme for Endorsement of Forest Certification and the Forest Stewardship Council use broadly similar criteria. Forest governance is covered in more detail in Chapter 3 of the 'Biomass in a low-carbon economy' report.

[14] 'Forestry Recommissioned: Bringing England's woodlands back to life' (2011) https://www.plantlife.org.uk/uk/our-work/publications/forestry-recommissioned [Accessed 14/11/2018]

[15] Position Statement by the Wildlife and Countryside Link on the Forestry Commission's Woodfuel Strategy for England https://www.forestry.gov.uk/pdf/eng-woodfuel-linkstatement-030709.pdf/$FILE/eng-woodfuel-linkstatement-030709.pdf [Accessed 14/11/2018]

These internationally agreed criteria and indicators are often used to develop national forestry policies and guidance for woodland owners and managers. For example, the UK Forestry Standard sets out the approach of UK governments to sustainable forest management and describes legal requirements, good forest practice and guidelines that must be taken into account when planning and implementing woodland creation and woodland management operations. Regulations protecting wildlife, water and forest cover are enforced by a number of government regulatory agencies and criminal prosecutions may be undertaken if protected species or habitats are damaged, water is polluted or trees felled illegally. Land owners are encouraged to plant more trees (subject to a regulatory framework designed to avoid negative environmental and social impacts) to improve biodiversity, manage water, produce timber and increase carbon stocks through a series of grants that help off-set costs. In some parts of the UK, active woodland management is encouraged via grants designed to cover the costs of preparing a UKFS compliant management plan.

Table 2. Summary of indicators agreed by Forest Europe and the Montreal Process

Forest Europe Indicators	**Montreal Process Indicators**
Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles.	Maintenance of forest contribution to global carbon cycles.
Maintenance of forest ecosystem health and vitality.	Maintenance of forest ecosystem health and vitality.
Maintenance and encouragement of productive functions of forests (wood and non-wood)	Maintenance of productive capacity of forest ecosystems.
Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems.	Conservation of biological diversity.
Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)	Conservation and maintenance of soil and water resources.
Maintenance of other socioeconomic functions and conditions	Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies.
	Legal, institutional and economic framework for forest conservation and sustainable management.

3. Silvicultural systems used in sustainable forest management

There are a number of ways in which forests can be managed to produce timber and fuel. The silvicultural system used will be influenced by the species and age structure of trees present on the site, the topography of the site, soil conditions, the product assortment required by local timber markets, and the longer term management objectives of the woodland owner. Not all owners want to manage their woodlands for timber production and instead may focus on using their woodlands as a recreational resource or to protect or screen other land uses.

3.1 Clearfell

Many plantations established in the UK over the past century have been managed as even aged, monocultural forests. Under this system trees are planted by hand or machine, to create new forests or to restock harvested stands of trees in existing forests. Stocking density will vary depending on species, climate and anticipated growth rate. In the UK around 2000 - 3000 trees per ha is a typical stocking density for a new conifer forest planted to provide a range of products including sawlogs and woodfuel. After a few years growth, a proportion of these trees will be harvested. This operation is known as a 'thinning'. Trees with forked stems and other features which might reduce their ability to produce good quality sawlogs in future are often removed at this point. Several thinnings might take place before the final crop is 'clear felled' and all remain trees are harvested. The stocking density at the time of final harvest, perhaps 40 – 50 years after planting, might be in the region of 300 trees per ha.

In other parts of the world stocking densities and rotation lengths might be quite different and are tailored to local growing conditions and market requirements. For example, in the South East of America, stands of loblolly pine might be established at around 1,200 trees per hectare with the final crop harvested 20 – 25 years later. During this time between two and four thinnings might have been taken to supply pulp and energy markets.

Regardless of rotation length and stocking density, each thinning is designed to generate some income and improve the quality and productivity of the remaining trees. Thinnings can be used to provide a range of products including panel board, paper pulp and fuel. If markets for this material do not exist, or the price is low, then thinning operations might be postponed. This may have a negative impact on the economics of the forest overall as well as the quality of the final crop. Clear fell systems can help minimise management costs and tend to 'capture' new sites quickly as closely planted trees produce a dense canopy, supressing competitive weeds and maximising light interception and hence growth rates. Monocultural clearfell systems generally provide a uniform product to market as all of the trees harvested will be of similar dimensions.

In most commercial forests different stands of trees will be at different stages of the process. Some stands will be ready for final harvest, others will be ready for thinning and some will be recently harvested or recently restocked. Clearfell systems work well where growth rates are relatively high and rotations are short. The area of forest felled at any one time might be influenced by local regulations and best practice designed to protect soil from erosion and ensure ongoing provision of other services. In some places the area of each clear fell coupe might be designed to mimic natural disturbance.

In the UK, clearfell and recently restocked sites provide important habitat for some bird species associated with open space and clear-ground such as the nightjar[16]. In broadleaf woodland patches of clearfell can increase species richness of ground flora[17] and are important to some butterfly species such as pearl-bordered fritillary[18].

Care must be taken on clearfell sites to avoid soil erosion after harvest and before the next crop has captured the site with well-developed root and canopy structures. Damage to soil can be avoided by using branch wood and the tips of trees to cover routes used by machines to harvest and extract timber. These 'brash mats' help prevent soil compaction, rutting and surface water run off that may carry soil into local water courses. On flat sites where soil damage may be less of a risk it may be possible to harvest some brash for use in biomass markets. This is not always economically viable and is not commonly practiced in the UK. Stump harvesting is generally not desirable as this may lead to the loss of soil carbon. The exception might be on very sandy soils where removal of stumps helps to limit the damage caused by fungi such as *Heterobasidum annosum* which colonises cut stumps and spreads into neighbouring stands of trees via the root system[19].

The cost of restocking after a clearfell harvest can be high. Mechanical ground preparation may be required and planting stock is generally bought in and planted by hand. Chemical or mechanical weeding is often required in the first few years of establishment and protection from deer and other browsing mammals is essential in some areas.

3.2 Coppicing

Traditional coppicing of species such as sweet chestnut is, in some respects, similar to clearfell. In the UK chestnut coppice has been used to provide hop poles, paper pulp, fencing and firewood. Demand from pulp mills collapsed as more use of recycled fibre was made in the 1990s. Large areas of sweet chestnut coppice fell out of management at this time. Emerging energy markets in Southern England might help restore this resource over the next few years. Chestnut coppice is generally planted as a monoculture and stems in each block (coupe) of coppice are all the same age. Once planted and established, shoots attached to the coppice stump or stool are harvested every 10 – 20 years, depending on what stem dimensions are required by the local timber market. After harvest new shoots are produced

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[16] Conway, G. and Henderson, I. (2004) The status and distribution of the European Nightjar *Caprimulgus Europeaus* in Britain in 2004. BTO Research Report No. 398 https://www.bto.org/sites/default/files/shared_documents/publications/research-reports/2005/rr398.pdf [Accessed 14/11/2018]

[17] Kirby, K.J. (1990) Changes in the Ground Flora of a Broadleaved Wood within a Clear Fell, Group Fells and a Coppiced Block. Forestry: An International Journal of Forest Research, 63, 3, pp 241- 249

[18] UK Butterflies in partnership with Butterfly Conservation http://www.ukbutterflies.co.uk/species.php?species=euphrosyne [Accessed 14/11/2018]

[19] Moffat, A., Nibet, T., Nicoll, B. (2011) Environmental effects of stump and root harvesting. Forestry Commission Research Note. Forestry Commission, Edinburgh. https://www.forestry.gov.uk/pdf/FCRN009.pdf/$FILE/FCRN009.pdf [Accessed 14/11/2018]

by the coppice stool and grow vigorously over the first growing season, perhaps 1.5 – 2.0 m in favourable conditions. Neighbouring coupes of coppice are generally at different stages of the rotation. This can help improve cash flow to the owner (an area of coppice might be harvested every year if the overall holding is large enough) and provides several types of habitat from bare ground to areas of heavy shade beneath stems that are perhaps 15 m tall.

3.3 Coppice with standards

In England large areas of broadleaf woodland have been managed as 'coppice with standards'[20]. This system generally comprises of several species with the potential to provide a very wide range of products from hazel bean poles, through firewood to oak sawlogs. Coppice is harvested perhaps once every 10 years and a number of the 'standards', or single stem trees, will be removed at similar intervals. If this type of woodland is neglected it is known as stored coppice and will eventually revert to high forest. This can result in the loss of some plant and animal species that favour the areas of woodland that receive more light and warmth from the sun through gaps in the tree canopy. In the UK, there has been an increase in the proportion of high forest compared with woodland managed as coppice with standards and much of the hardwood resource is either unmanaged or under-managed[21,22].This lack of management has led to a decline in habitat quality[23] and these woodlands represent a significant underutilised resource that would benefit from being brought into management.

3.4 Continuous Cover Forestry

Coppice with standards could be regarded as a form of 'continuous cover forestry'. As the name suggests, continuous cover forestry (CCF) is designed to maintain a tree canopy across the forest at all times. This approach to management is often associated with broadleaved woodland. In recent years there has been increasing interest in the use of CCF to restructure existing even age conifer plantations. CCF is practiced widely throughout Europe and there is growing acceptance of the approach in the UK where some publicly owned and private woodlands (e.g. Longleat Estate) have moved from clearfell to continuous cover. This conversion has the potential to bring more diversity to the structure of the woodland, creating more ecological niches for plants and animals to exploit. Often woods managed with a CCF approach will contain a number of much larger trees than those encountered in typical clearfell systems. These might be more valuable when eventually harvested and may provide

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[20] Forestry Commission, Call Card Coppice with Standards https://www.forestry.gov.uk/pdf/FCCallingCardsCoppice.pdf/$FILE/FCCallingCardsCoppice.pdf [Accessed 03/10/2018]

[21] Forest Research Woodland Map Report 2011 https://www.forestresearch.gov.uk/tools-and-resources/national-forest-inventory/what-our-woodlands-and-tree-cover-outside-woodlands-are-like-today-8211-nfi-inventory-reports-and-woodland-map-reports/ [Accessed 18/12/19]

[22] Locke, G.M.L. (1987) Census of Woodlands and Trees 1979-82. Forestry Commission Bulletin 63. Forestry Commission, Edinburgh.

[23] Kirby, K.J., Smart, S.M., Black, H.I.J., Bunce, R.G.H., Corney, P.M., Smithers, R.J. (2005) Long term ecological change in British woodland (1971-2001). English Nature Research Reports 653. English Nature. ISSN 0967-876X

favourable habitat for some species of raptor. Species that require open ground may be less attracted to CCF compared to areas of woodland managed on a clearfell basis.

Where sufficient natural regeneration exists (generally where shade tolerant species are present) CCF can reduce establishment costs while high stocking densities can help improve timber quality in the longer term. CCF can also make use of 'enrichment planting' of tree seedlings in increase stocking density or introduce new species to the woodland to improve resilience or productivity. This will be increasingly important where adaption to climate change and disease is required. CCF woodlands tend to be more resilient to storm damage and drought and provide generally more favourable conditions for seedlings to become established and grow on. CCF requires careful management and although the cost of planting stock is removed, natural regeneration will generally need protection from browsing mammals. Respacing operations may be required and harvesting and extraction may be more expensive compared to even age clear fell systems.

3.5 Short Rotation Forestry and Short Rotation Coppice

In addition to these well-established silvicultural systems, around the world more use is being made of short rotation forestry (SRF) and short rotation coppice (SRC). SRF is generally managed as a single stem crop and managed on a clearfell basis on a rotation of 20 years or less. SRC is generally managed on shorter rotations (typically three years) and each coppice stool produces multiple shoots. Coppice stools are expected to last for several rotations before they need replacing. These systems can produce large volumes of wood fibre suitable for a number of end uses including paper production and energy generation. Just as with conventional woodland creation, the land use displaced by the establishment of new short rotation plantations may or may not be regarded as 'sustainable'. For example, it is unlikely to be desirable to clear primary forest to establish SRF plantations. However, SRF and SRC might be beneficial to biodiversity or soil and water condition if established on degraded land or on poor quality agricultural land where it is not economically viable to produce food. In these situations SRF or SRC could rapidly increase carbon stocks, help manage water quality and flood risk and improve soil condition. In the UK the paperboard manufacturer, Iggesund, is recruiting farmers to grow willow SRC in Northern England to provide fuel for combined heat and power generation at its factory in Workington[24].

The yield of SRC and SRF is often much higher than that achieved by conventional forestry. This means less land is required to supply a given volume of fuel. The IEA estimate that Brazil has in the region of 200 million ha of pasture land, much of which is degraded, and there may be potential to increase the area of pine and eucalypt SRF on this land whilst also maintaining some agricultural activity such as cattle grazing, within plantations as they mature[25]. In the UK, high growth rates (more than 40 m^3/ha/yr over a 10 year rotation) can be achieved by

[24] Iggesund, 'Short Rotation Coppice' http://biofuel.iggesund.co.uk/category/biodiversity/ [Accessed 03/10/2018]

[25] IEA (2011) Promising resources and systems for producing bioenergy feedstocks Short Rotation Eucalypt Plantations for Energy in Brazil http://www.ieabioenergy.com/wp-content/uploads/2018/01/IEA_Bioenergy_Task43_PR2011-02.pdf [Accessed 03/10/2018]

Eucalypt SRF, but the highest yielding species tends to be limited to south and southwest England by its sensitivity to winter cold. Concerns have also been raised over its impact on water yield, wildfire risk, landscape and biodiversity.

3.6 Agroforestry

Land use which combines both agricultural production and timber production is referred to as 'agroforestry'. There are many variations ranging from 'alley cropping' of cereal crops between widely spaced rows of hardwood trees and silvo-pastoral systems where livestock graze under single stem poplar in Europe through to coffee production beneath the canopy of Ohia forest in Hawaii. Improved integration of forestry and agriculture could enhance delivery of services such as water regulation and soil protection.

3.7 Accommodating trade-offs in sustainable forest management

When managing a forest there will nearly always be a trade-off between the goods and services that can be delivered. The nature of the trade-off will be shaped by the objectives of the owner, the species present and site conditions. If short term carbon sequestration is the main goal of the woodland owner then the tree species used to create new woodland or restock existing woodland might be fast growing speices planted at close spacing with little open ground. Although carbon capture would be optimised, the benefits to wildlife, amenity and the landscape might be low. Owners of broadleaved woodland often want to maintain or improve biodiversity in the woodland. In many UK woodlands (most of which have been managed for timber and fuel production in the past) this means increasing the amount of light reaching the forest floor to encourage plant life that supports insects, birds and mammals currently valued by society. However, removing significant volumes of timber from these woodlands to restore habitats also reduces the carbon stock of that woodland.

Such trade-offs are also present in other land uses. For example, restoration of heathlands that have been colonised by birch or pine often means that trees will be removed permanently, reducing the carbon stock of that area of land. However, the resultant habitat will support a number of species that may be in decline either locally, nationally or internationally. From a carbon perspective it would be preferable to leave that heathland to revert to forest despite the impact that this may have on the habitat.

In countries operating within the Montreal Process and Forest Europe agreements, Government regulation, incentives and guidance often play a part in shaping the behaviour of landowners and ultimately how woodlands are managed. At a landscape scale this helps to ensure that woodlands are managed for a number of reasons including timber and fuel production, habitat improvement, amenity and water management. In countries such as the UK, it means that even those woodlands designed for timber and fuel production above all else make some concessions to the delivery of other services. For example the establishment of new woodlands is only approved by the forestry regulator where forest design plans incorporate open space to provide more woodland edge habitat for wildlife (the UKFS requires at least 10% of a woodland to be managed as open ground or ground managed for conservation and enhancement of biodiversity).

3.8 Which silvicultural system is best?

All of the approaches to forest management mentioned can provide long term benefits to the environment, society and economy. One approach is not intrinsically ‘better’ than any of the others and all have their pros and cons. It is down to the forester to ensure that the approach used to manage a woodland is backed by careful planning and that harvesting, timber extraction and ongoing maintenance operations fit with the principles outlined by Forest Europe or the Montreal Process. To maintain functioning forest ecosystems as the climate changes and new threats to tree health arise, foresters must adopt a flexible approach planning.

To meet future demand for wood fibre society may need to decide whether to introduce management into currently pristine and semi natural forests or establish new plantations on land currently assigned to other uses. This is an issue that WWF have explored as part of their ‘Living Forests’ model[26]. International initiatives such as New Generation Plantations[27] are designed to share best practice between organisations in different parts of the world and improve standards of plantation forestry. As more knowledge of sustainable forest management is gained, so best practice changes. Over the past 40 years plantation clearfell forestry in the UK has improved considerably and has moved away from simple ‘timber factories’, sometimes planted in inappropriate areas, towards a resource that is used for sport and recreation, encourages biodiversity and produces fuel and fibre for industry. This evolution has been driven by the adoption of internationally agreed criteria and indicators for sustainable forest management. This is encapsulated in the UK Forestry Standard, first published in 1998, which sets outs legal requirements and guidelines that forest managers should follow while planning and implementing forest management operations.

Expansion of the UK plantation resource whilst at the same time bringing existing, neglected woodland into back into management, perhaps using a CCF approach, could help increase the volume of timber and fuel available to end users, improve woodland biodiversity, increase resilience and increase forest carbon stocks.

4. Improving woodland resilience to climate change

As the climate changes, growing conditions will change. Generally, projections for the UK climate over the next 50 years suggest that much of the country will experience hotter, drier summers and milder, wetter winters. Where soil types are favourable, higher levels of atmospheric CO_2 and warmer winters will benefit some species increasing both growth rates

[26] WWF Living Forests http://wwf.panda.org/our_work/forests/forest_publications_news_and_reports/living_forests_report/ [Accessed 04/10/2018]
[27] New Generation Plantations https://newgenerationplantations.org/en/ [Accessed 08/10/2018]

and spatial distribution range[28]. Other species may become more drought stressed resulting in reduced productivity, greater susceptibility to pest and disease outbreaks and higher levels of mortality. In time, other tree species suited to the changed conditions might become established and provide tree cover. However, the rate of climate change is likely to exceed the dispersal rate of many tree species able to colonise sites left vacant as other species decline. If functioning, productive, woodland ecosystems are to be maintained, alternative species or more southerly provenances of commonly used species, should be considered and used on appropriate sites. Advocates of this 'assisted migration' approach suggest sourcing provenances or species suited to current growing conditions between two and five degrees latitude south of the woodland in question. In general terms more southerly climes are likely to be warmer and drier and emulate the UK climate of mid to late 21st century. When planting stock is sourced internationally, care needs to be taken to ensure exotic pests and diseases are not imported along with seeds, plants and soil.

Sourcing planting stock in this way does not automatically mean a change of species is required. Species which are commercially important in the UK such as Douglas Fir (*Psuedotsuga menziesii*) and Sitka Spruce (*Picea sitchensis*) have a large native range and genetic resource which has not yet been fully utilised in commercial forestry. Sitka grows along the west coast of North America from Alaska to California. Different provenances of the species can grow well under very different climatic conditions. Historically, most Sitka spruce planted in the UK has been sourced from seed collected from stands growing on Queen Charlotte Island, near Vancouver, Canada. Trials and commercial plantings suggest that seed sourced from Washington state, USA performs well in current UK conditions and is perhaps more likely to maintain productivity in the climate of the 2050s and beyond.

The last ice age significantly reduced the number of native tree species present in the British Isles. Many species that were present before the ice age did not recolonise the islands after the ice retreated but are still present in main land Europe. Today, UK softwood forestry uses a highly restricted range of commercial species only one of which is native to parts of the UK (Scots pine, *Pinus sylvestris*). This places the forest resource at risk to both the impacts of climate change and pest and disease outbreaks. A much wider range of species have been trialled (some of which were present prior to the last ice age) and planted on a limited commercial basis in the past, with some success. These species could help increase diversification of the timber resource and enhance resilience.[29,30]

In highly modified landscapes that already contain non-native species (whether present by accident or design), increased levels of intervention to maintain or enhance delivery of ecosystems services may be acceptable to society. In other parts of the world where pristine forests still exist, the case for introducing management regimes that remove timber or

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[28] Broadmeadow, M. and Ray, D. (2005) Climate Change and British Woodland. Forestry Commission, Edinburgh. https://www.forestry.gov.uk/pdf/fcin069.pdf/$FILE/fcin069.pdf [Accessed 18/10/2018]
[29] Spencer, J. (2018) Forest Resilience in British Forests, Woods and Plantations – the ecological components. Quarterly Journal of Forestry, 112, 1.
[30] Spencer, J. (2018) Forest Resilience in British Forests, Woods and Plantations 2. Plantation forests of spruce and other conifers. Quarterly Journal of Forestry, 112, 3.

change species composition in an attempt to preserve ecosystem function in the face of climate change or disease outbreaks may be less palatable and outcomes less certain. Interactions between the species present in these forests may be complex and not fully understood. Intervention, however well meaning, may have unintended consequences that degrade rather than improve the functioning of the forest in the long term. Non-intervention could mean that environmental degradation occurs anyway as species struggle to adapt to different climatic conditions or are exposed to new pest and disease pressures.

5. The impact of pests and diseases on forests and how to increase resilience

In some parts of world the risk posed by pests and disease to carbon to carbon stocks is more significant than the risk posed by over exploitation for timber and fuel.

There is some evidence that the behaviour of some pests is being influenced by the changing climate. Outbreaks of mountain pine beetle (*Dendroctonus ponderosae*) in British Columbia, Canada, intensified during the 1990s and into the new millennium. Cumulative timber losses amount to an estimated 752 million m^3 (or 58%) of merchantable pine volume[31]. This volume is roughly three times the annual allowable harvest in Canada. This lost volume could supply current UK wood pellet consumption for more than 50 years and provide in the region of 1880TWh of energy.

Wood pellets used for power generation do not present a significant biosecurity risk because of the heat and pressure involved in their manufacture. The global trade of live plants and use of wood packaging material continues to act as vector for pests and disease.

The current outbreak of emerald ash borer in the USA and Canada started in 2002, probably as a result of the beetle arriving on wood packaging material from Asia, and now extends to 35 American states. In September 2018 the beetle was discovered in Nova Scotia, Canada. The beetle has cost the economy hundreds of millions of dollars and has killed millions of trees[32]. It is likely that the pest will continue to spread and cause more damage across North America.

The Dutch elm disease pandemics of the 1920s and 1970s accounted for between 30 – 50 million trees in the UK alone and caused damage across Europe and North America. The disease *Cryphonectria parasitica* all but wiped out American Chestnut after its unintentional introduction via imported plants from Asia in 1908. This disease was found in Italy in the 1930s and has spread to several countries in Europe. It was found on young chestnut trees in England in 2011[33]. These trees were imported from France in 2007.

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[31] Natural Resources Canada Mountain Pine Beetle (factsheet) https://www.nrcan.gc.ca/forests/fire-insects-disturbances/top-insects/13397 [Accessed 04/10/2018]
[32] Emerald Ash Borer Network http://emeraldashborer.info/ [Accessed 14/11/2018]
[33] Hunter, G.C., Wylder, B., Jones, B. and Webber, J.F. (2012) First finding of *Cryphonectria parasitica* causing chestnut blight on *Castanea sativa* trees in England. New Disease Reports, 27, 1. https://www.ndrs.org.uk/article.php?id=27001 [Accessed 01/11/2018]

In Europe the Common Ash (*Fraxinus excelsior*) is being lost to 'ash dieback' (*Hymenoscyphus fraxineus)*. This disease is thought to have reached Eastern Europe via the plant trade within Russia. The disease has spread west and has caused significant damage in several countries. The disease was first identified in the UK in 2012 although it may have been resident for some years before. In the UK an estimated 40 million m^3 of ash timber is present in woodlands. Although not likely to disappear from the landscape entirely, significant numbers of ash trees will die over the next 20 years and how this is best managed is something both government and industry are considering.

These examples suggest that it is unlikely that the threat of exotic pests and diseases will decrease significantly whilst current trading practices are in place[34]. The cumulative impact of pest and disease species unintentionally introduced to forest ecosystems outside their natural range is unlikely to be fully understood at present. Levels of damage are likely to increase in the short term as emerging diseases such as *Xylella fastidiosa* become established in Europe and insects such as the Polyphagous Shot Hole Borer (*Euwallacea fornicatus* species complex) take hold in California and South Africa. Often little is known about the range of susceptible hosts exotic species can infect or infest. It is likely that a number of pathogenic fungi, and their potential impact, have yet to be identified even though they might be present in plant material, wood and soil traded between countries[35]. It addition it is possible that some species that do not cause significant levels of damage at present could become much more damaging as the climate changes.

Moving away from the practice of establishing commercial plantations with just one major timber producing species could help to provide some protection against pests and diseases in the future. Introducing new tree species that are not susceptible to diseases currently damaging woodlands can help to ensure woodland cover in maintained in the long term. Care should be taken to ensure planting stock used is free from disease. Planting stock is often moved between countries to maximise the length of growing season and to reduce production costs. This practice increases the chances of unintentionally moving pathogens between countries. Woodland owners, forestry contractors and members of the public can help reduce the spread of pests and diseases by minimising the amount of soil, water and plant material moved between sites on vehicles, footwear and livestock[36].

5.1 The impact of fire, pests and disease on carbon stocks and carbon sequestration

Annual variations in the area damaged by pests, disease and wildfire can have a very significant impact on the strength of the carbon sink or carbon source of the forest. For example in 1992 it is estimated that the forests of Canada removed 101 million tonnes carbon dioxide equivalent (Mt CO_2e) from the atmosphere. In 1995 in the region of 2 million ha of forest was damaged by wildfire and carbon emitted from the nation's forests was in the

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Braiser, C.M. (2008) The biosecurity threat to the UK and global environment from the international trade in plants. Plant Pathology, 57, 5.

[35] Tubby, K. V. & Webber, J. F. (2010). Pests and diseases threatening urban trees under a changing climate. Forestry Vol. 83, p. 451-459.

[36] https://www.forestry.gov.uk/forestry/beeh-a6tek3 [Accessed 18/12/2018]

region of 181 Mt CO_2e[37]. The forests became a carbon source again as a result of more than 6 million ha being affected by fire and pests each year between 2002 and 2004. Throughout the period 1990 – 2005 harvesting activity was constant at just below 1 million ha per year and had very little impact on the carbon balance of the forest. This variation in just one part of the global forest resource highlights the risks posed by biotic and abiotic disturbance to carbon stocks and rates of carbon sequestration. It is likely that climate change may exacerbate this variation further. 2018 saw significant wildfires in Europe, North America and north of the arctic circle in Sweden. Other land uses such as heathland, moorland and grassland have also been affected by wildfire during dry summers. In 2017 a large area of tundra in Greenland was burned.

Mitigation measures such as management of fuel loads and diseased trees might reduce the risk and impact of fire but are unlikely to eliminate annual variation altogether, especially in remote areas where interventions are difficult to make or where conservation and cultural services provided by the forest take precedence. Previous attempts to stop forest fires altogether have not been universally successful. In some cases fire suppression has led to increased fuel loads building up which subsequently burn hotter for longer when fires inevitably break out. This can cause more environmental damage that lower intensity more regular fires which local species might be well adapted to or even rely on as part of the seeding process. More attention to fire might be required when designing and establishing new plantations. Ensuring adequate clearance around infrastructure such as roads, houses and power supplies might reduce the risk caused to human life. Using a mix of species and incorporating access tracks and firebreaks could help slow the rate of spread and facilitate more effective fire fighting with reduced risk to fire fighters and their equipment. Incorporating broadleaf trees in other land uses such as grassland and moorland could also help slow the spread of wildfire in these environments

6. Supply chains most likely to deliver carbon savings and adhere to SFM principles

To reduce the risk of unsustainable land management practices occurring as a result of UK energy policy, sustainability criteria for biomass feedstocks have been developed and implemented by the UK government. The sustainability criteria for bioenergy uses of woody feedstocks are broadly aligned to Government Timber Procurement Policy, which is designed to ensure that government buys wood products sourced from supply chains that do not cause environmental damage. Alignment of timber procurement policy and bioenergy sustainability land criteria was desirable as fibre from the same tree could be used in the refurbishment of a government building and in fuel used to generate heat or power incentivised by government policy.

[37] Canada's forests: CO_2 sink or source? Canadian Council of Forest Ministers. https://www.sfmcanada.org/images/Publications/EN/C02_Sink_EN.pdf [Accessed 18/12/18]

Schedule 3, Land Criteria of the Renewables Obligation Order 2015[38], sets out how sustainability might be demonstrated and makes specific reference to Forest Europe Sustainable Forest Management Criteria. Provided appropriate environmental laws exist and are enforced, this framework provides an internationally recognised base on which to develop bioenergy supply chains that do not harm forested areas. Paragraph 4 of the Order is reproduced in Annex A.

Compliance with Forest Management Criteria reduces the risk of harm to forest soils, water, biodiversity and long-term productivity but does not guarantee bioenergy supply chains reduce carbon emissions when used in place of fossil fuels. A number of Life Cycle Analysis studies have been conducted over several decades to identify those forest based supply chains that are most likely to reduce carbon emissions and those that do not. One recent study commissioned by the European Climate Foundation[39] suggested 15 criteria that could be used to ensure bioenergy.

The proposed criteria are based on two mandatory conditions:

Scale of forest bioenergy use - *Aim for levels of forest bioenergy use that are well within the long-term sustainable-yield capacity of the supplying forest areas. When setting levels for bioenergy use, that are well within the long-term sustainable-yield capacity of the supplying forest areas. When setting levels for bioenergy use, take account of the consumption of biomass for other uses (i.e. materials) and levels of biomass consumption outside the EU region*

Stumps including roots - *Strongly disfavour supplies of forest bioenergy from stumps including roots.*

A further five forest management criteria and eight associated 'optional' conditions describe supply chains that should be favoured or disfavoured, restricted or disallowed to ensure carbon savings are made.

Favour supply chains that:

- *Are explicitly associated with afforestation activities (but avoid afforestation on soils with existing high organic content and where there is a high risk of indirect land use change).*
- *Are explicitly associated with activities to conserve and enhance forest growing stock, carbon stocks and forest productivity*
- *Use post-consumer waste wood. Particularly favour such sources where the waste wood would otherwise be burnt or put in landfill without energy recovery. Also favour*

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[38] Renewables Obligation 2015, Schedule 3, Land Criteria. https://www.legislation.gov.uk/ukdsi/2015/9780111138359/schedule/3 [Accessed 04/10/2018]
[39] Matthews, R., Hogan., G. and Mackie, E. (2018) Carbon Impacts of Biomass Consumed in the EU. Supplementary analysis and interpretation for the European Climate Foundation. https://europeanclimate.org/wp-content/uploads/2018/05/CIB-Summary-report-for-ECF-v10.5-May-20181.pdf [Accessed 04/10/2018]

use of waste wood at levels that do not compete with current levels of consumption of such feedstocks for material uses (e.g. wood-based panels).

- *Use industrial residues. Particularly favour such sources where the residues would otherwise be burnt as waste without energy recovery. Also favour use of industrial residues at levels that do not compete with current levels of consumption of such feedstocks for material uses (e.g. wood-based panels).*
- *Are from fast decaying forest residues (i.e. apart from stumps including roots or other large residues) provided this avoids levels of extraction of forest residues that lead to high risks of degradation of site/soil quality).*
- *Are from salvage logging where a simply calculated but robust estimate of GHG emissions meets a defined minimum threshold.*
- *Use small roundwood at levels that do not compete with current levels of consumption of such feedstocks for material uses. Particularly favour such sources where the small roundwood would otherwise be burnt without energy recovery or sent to landfill.*
- *Use of by-products from wood harvesting for the supply of long-lived material wood products. However, it is very important to ensure that flanking measures are in place to ensure that other feedstock criteria above are met and to encourage the disposal of material wood products at end of life with energy recovery and/or in a way that ensures low GHG emissions.*

Supply chains that should be disallowed, restricted or disfavoured:

- *Disallow supplies of forest bioenergy that lead to deforestation*
- *Restrict supplies of forest bioenergy from whole tree stems to small/early thinnings with the aim of improving the quality of the remaining growing stock. Favour situations in which, otherwise, there would be limited incentives to thin and improve forest stands. Alternatively, favour supplies of wood biomass from small/early thinnings where a simply calculated but robust estimate of GHG emissions meets a defined minimum threshold.*
- *Strongly disfavour supplies of forest bioenergy from wood feedstocks suitable for use for sawn timber products.*
- *Disfavour forest bioenergy production from forest areas with low growth rates. Tentatively, low growth rate is defined as 2 m^3 ha^{-1} yr^{-1} or less. Possible exemptions in some cases, e.g. disease infested forest areas.*

Although these criteria are not recognised by Government, applying these criteria to UK forest-based bioenergy supply chains suggests that current practice broadly complies:

- Establishment of commercial forests for fuel and fibre production are supported by government grants. Afforestation on deep peat does not comply with the UK Forestry Standard and is not supported.

- Grants for restocking woodlands suffering from disease are available to help maintain woodland cover, timber production and carbon stocks in the long term.[40]
- The volume of recycled wood (from industrial and post-consumer waste streams) used to generate energy is increasing.[41]
- The volume of recycled wood and sawmill co-products used to produce panel board products is broadly stable[42].
- Guidance on selecting suitable sites for brash harvesting whilst protecting soil and water are available (in the UK brash harvesting and stump harvesting is not generally considered to be economically viable at most sites, regardless of environmental constraints).
- Energy supply chains based on salvaging ash infected with ash dieback are being developed in Southern England.
- The volume of softwood sawlogs and small roundwood delivered to sawmills and panel board mills is broadly stable[43].
- The average growth rate of UK forests exceeds 2 m^3 ha^{-1} yr^{-1}.

Policy commitments outlined in the 25 year Environment Plan and Clean Growth Strategy to increase the use of timber in construction and increase the area of woodland cover are also consistent with these criteria.

The UK does not source all of its biomass domestically. Around 7 million tonnes of wood pellets were imported to the UK[44] in 2017. Around 80% of this volume was sourced from the USA and Canada[45]. This brings into question the scale of the UK biomass market compared to the scale of the forest resource from which it is sourced. The total carbon content of the imported pellets is in the region of 3.5 million tonnes or 0.0035 Giga Tonnes (*G*t). Data published by the FAO suggests carbon stocks in Central and North America increased from 33.9 to 35.9 *G*t between 1990 and 2015[46]. FAO data shows that forest Area of Central and North America decreased by 0.4 million ha between 1990 and 2000 and that around 0.2 million ha of woodland has been created between 2000 and 2015. A total of 136 million m^3 of

[40] Woodland Tree Health grant https://www.gov.uk/government/collections/countryside-stewardship-woodland-support#woodland-tree-health- [Accessed 04/10/2018]
[41] Recycled wood used for woodfuel 2010 – 2017 https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/uk-grown-timber/woodfuel-and-pellets/ [Accessed 04/10/2018]
[42] Inputs to wood based panel mills https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/uk-grown-timber/wood-based-panels/inputs-for-wood-based-panel-products/ [Accessed 04/10/2018]
[43] Softwood deliveries https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/uk-grown-timber/deliveries-of-uk-grown-roundwood/softwood-deliveries/ [Accessed 04/10/2018]
[44] Pellet imports https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/trade/uk-import-quantities-by-product/ [Accessed 04/10/2018]
[45] Origin of pellet imports https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2018/trade/origin-of-wood-imports/ [Accessed 04/10/2018]

woodfuel was harvested from Central and North American forests in 2015 compared with 162 million m^3 in 1990 and 129 million m^3 in 2000. Overall, total roundwood production in Central and North America has varied from 757 million m^3 in 1990 to 765 million m^3 in 2005 and 652 million m^3 in 2015. This variation is driven, at least in part, by prevailing economic conditions, the rate of construction and refurbishment in domestic and international markets. Over the last 20 years there have also been changes in regional and global demand for virgin fibre used to produce pulp and paper. Significant volumes of wood were supplied to this market by forests in South East America, providing revenue to woodland owners and local communities. This market has declined and wood from the same forests is now often supplied to energy markets that have developed over the last 10 years.

In broad terms, these data suggest that the total current supply of biomass for energy generation is well within the long term sustainable yield capacity of Central and North American forests and that there is scope to increase production.

[46] Carbon Stocks in Forest Biomass https://www.forestresearch.gov.uk/tools-and-resources/statistics/forestry-statistics/forestry-statistics-2017/international-forestry/carbon-stocks-in-forest-biomass/ [Accessed 04/10/2018]

Annex a. Extract from the Renewables Obligation Order 2015, Schedule 3, Land Criteria.

Sustainable source

6.—(1) For the purposes of paragraph 3, woody biomass is obtained from a sustainable source if it—

(a)was grown within an area of forest or other land which is managed—

(i)in a way that is consistent with—

(aa)the Forest Europe Sustainable Forest Management Criteria, or

(bb)a set of international principles for the sustainable management of land which meet the requirements specified in sub-paragraph (2); and—

(ii)to meet the requirements specified in sub-paragraph (4);

(b)was residue from arboriculture carried out in an area which was not a forest;

(c)was added to the fuel for an exempt purpose; or

(d)was removed for the purpose of creating, restoring or maintaining the ecosystem of an area which was not a forest.

(2) The requirements specified in this sub-paragraph are that—

(a)the principles have been adopted following a process ("the principle setting process") which sought to—

(i)obtain a balanced representation of the views of interest groupings,

(ii)ensure that no single interest grouping could dominate the principle setting process, and

(iii)ensure that no decision on the contents of the principles could be made in the absence of agreement from a majority within each interest grouping involved in the principle setting process; and

(b)can be changed by a process ("the change process") which seeks to ensure that:

(i)no single interest grouping can dominate the process, and

(ii)no decision on changes to the principles can be made in the absence of agreement from a majority within each interest grouping involved in the change process.

(3) For the purposes of sub-paragraph (2), each of the following is an interest grouping in relation to the forest or other location where the wood was grown—

(a)persons with interests which are predominantly economic in nature;

(b)persons with interests which are predominantly environmental in nature;

(c)persons with interests which are predominantly social in nature.

(4) The requirements specified in this sub-paragraph are—

(a)harm to ecosystems is minimised, in particular by—

(i)assessing the impacts of the extraction of wood from the area and adopting plans to minimise any negative impacts,

(ii)protecting soil, water and biodiversity,

(iii)controlling the use of chemicals and ensuring that chemicals are used in an appropriate way,

(iv)wherever possible, using integrated pest management, and

(v)disposing of waste in a manner that minimises any negative impacts;

(b)the productivity of the area is maintained, in particular by—

(i)adopting plans to avoid significant negative impacts on productivity,

(ii)adopting procedures for the extraction of wood that minimise the impact on other uses of the area,

(iii)providing for all of the contractors and workers who are working in the area to be adequately trained in relation to the maintenance of productivity, and

(iv)maintaining an adequate inventory of the trees in the area (including data on the growth of the trees and on the extraction of wood) so as to ensure that wood is extracted from the area at a rate which does not exceed its long-term capacity to produce wood;

(c)compliance with the requirement in paragraph (b) is monitored, the results of that monitoring reviewed and planning updated accordingly;

(d)the health and vitality of ecosystems is maintained, in particular by—

(i)adopting plans to maintain or increase the health and vitality of ecosystems,

(ii)adopting plans to deal with natural processes or events such as fires, pests and diseases, and

(iii)taking adequate measures to protect the area from unauthorised activities such as illegal logging, mining and encroachment;

(e)biodiversity is maintained, in particular by—

(i)implementing safeguards to protect rare, threatened and endangered species,

(ii)conserving key ecosystems in their natural state, and

(iii)protecting features and species of outstanding or exceptional value;

(f)those responsible for the management of the area (and any contractors engaged by them) comply with the local and national laws relating to health and safety and the welfare of workers;

(g)those responsible for the management of the area have regard to—

(i)legal, customary and traditional rights of tenure and land use,

(ii)mechanisms for resolving grievances and disputes including those relating to tenure and land use rights, forest or land management practices and working conditions, and

(iii)safeguarding the health and safety and rights of workers;

(h)there is regular assessment of the extent to which those responsible for the management of the area have met the requirements set out in paragraphs (a) to (g).