For the attention of:

Gareth Davies, Dave Jenkins, Tabitha Binding – Coed Cymru

Wales Forestry

A Resource Evaluation Study 2015

Client - Coed Cymru

Prepared by:

Gary Newman, Geraint Williams, Graham Hilton – Resource Efficiency Services

RES
Resource Efficiency Services

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EXECUTIVE SUMMARY

Background

Coed Cymru have undertaken projects aimed at increasing the value and utility of low value broadleaf and conifer species in Wales. These projects have been conducted under the Supply Chain Efficiencies Scheme supported under the European EAGGF/RDP funding framework. This report seeks to provide some background context against which to assess the current product development activities of Coed Cymru with a particular focus upon the Ty Unnos timber frame system

Welsh Forestry

Sitka spruce is the main conifer species grown in Wales, as in most of the UK, largely due to its suitability to relatively poor upland conditions, historic market development of public forestry and encouragement from private grants (which were removed in 1988). It is therefore logical that current strategies to add value have focussed upon this species.

Nearly all of the current engineered timber products (including cross laminated timber, I joists) and much of the indigenous wood processing industries are based on softwoods grown outside the UK. In addition, locally grown material suffers from a perception of lower quality which is not necessarily borne out by performance in use.

Although 50% of the Welsh woodland area is hardwood, the small and fragmented nature of the resource makes commercial development difficult. Additionally, hardwood markets, with the exception of local fuel use, appear to be static or in decline throughout Europe. However, it should be stated that there is a lack of reliable data on the harvesting and use of hardwoods.

Softwood processing in Wales has grown from 326,000 green tonnes in 1976 to 1,460,000 green tonnes in 2014.

An increasing proportion of softwood production is derived from private estates.

In recent years, in spite of the main demand being for softwoods, many landowners have chosen to plant broadleaves.

There is no national target in Wales for the increase in woodland cover, although a stated aim of Woodlands for Wales is to maintain conifer productivity at current levels.

Tree disease is having a significant impact on forest management in Wales and will require review of future planting strategies for commercial supply

and amenity use. Current diseases are affecting ash, pines and larch. Sitka spruce can suffer from attacks by the green spruce aphid, which can defoliate the trees and impact growth. The spruce bark beetle can also be a problem. The prevalence of disease challenges the reliance on single species plantations.

Sitka spruce

Sitka spruce, which originates from the Pacific Northwest of the USA and Canada, accounts for 56% of the Welsh coniferous resource. Ty Unnos, has, in part been developed to take best advantage of the properties of this species.

Sitka spruce timber is almost always graded to C16 enabling high yields, with reject rates at less than 10%.

Structural C16 grade UK grown Sitka spruce is used in general construction. However, given that the large sawmills prefer to supply through low risk merchanting routes it is often not possible for the customer to locate and differentiate between imported and home grown timber, and timber framers often prefer to purchase overseas timber from importers due to more favourable conditions of sale.

Strategies to add value to the Welsh resource through technical innovation (such as Ty Unnos) or through market innovations (such as Grown in Britain) are not mutually exclusive. However, external pressures on planting strategies (location and species) and management systems (to maximise benefits not related to production efficiency – such as amenity, biodiversity, water etc.) may impact on the favourability of different approaches. Consideration of these issues is largely outside the scope of this current report which is predominantly focused upon the resource as it currently is, rather than what it might be, or possibly should be, in the future.

Demand

Sawmills provide the primary market for conifer roundwood in the UK – currently 6 times greater than in wood based panels which is deriving an ever increasing proportion of its timber needs from recycled sources. This would indicate that market development aimed at pulling through timber production should focus upon markets for sawn softwood.

As can be expected with initiatives to support biomass energy (ROCs and RHI) the wood fuel market is growing but remains small compared to construction. However, the biomass market is making an increasingly important contribution to overall viability.

Much of the value of wood is derived from the primary and secondary processing and therefore any analysis of the benefits of woodland between amenity, biodiversity and production should include downstream processing

Surprisingly 90% of sawn softwood used in construction is used in markets other than new build housing. This indicates that strategies to increase the use of home grown softwood should include markets other than new build. However, there is limited information available on these other construction markets, and additional work will be required to highlight the new products and opportunities, and to change the generally entrenched and conservative nature of the building industry

The main market for UK construction timber is in England and therefore a strategy to increase the use of Welsh sawn softwood should also focus upon this market

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Construction

The Ty Unnos system when used with natural insulation can be considered to be an extremely high biogenic carbon build system. The widespread deployment of Ty Unnos and similar bio-based construction systems will create a significant carbon store which can be allocated against the UK greenhouse gas inventory. Under the Durban agreement only timber grown and used in the country of origin can be treated this way

There is currently little incentive to use timber in general or local timber in particular within the dominant sustainability standards such as BREEAM, however, it is considered easier to achieve higher standards of thermal performance through the timber frame construction approach.

The core of the Ty Unnos system is around a box section frame system. This approach lends itself to large spans for internal flexibility as well as to adaptation and deconstruction. With further development the Ty Unnos system could be developed to be fully de-constructible and allow for future re-use. The approach then becomes a highly resource efficient system

A focus on the performance gap and the emerging market need to prove or guarantee performance will inevitably favour construction systems for which there are reduced margins for error on site – such as wholly or partially offsite systems such as Ty Unnos. It is also likely to lead to the development of branded solutions such as is common place in Germany (e.g. Baufritz, Huf Haus). This would indicate that Ty Unnos solutions should be provided by one or a number of registered/approved providers

Due to the sensitivities associated with the failure of many new build projects, there is limited hard data available, and much of the 'evidence' is anecdotal. However, it is known that failure has occurred in some non-vapour open polyurethane insulated closed panel systems. It can be speculated that this failure has been caused by moisture ingress which can build up over time as there is no pathway to escape. There is emerging evidence for failure of some houses in the Oxley Woods development built in response to John Prescott's £60k house challenge. The use of vapour open systems using natural insulation such as is used on the Ty Unnos approach may help to mitigate against the risk of failure due to moisture

Procurement tools (such as model procurement clauses) could be developed that would encourage the specification and use of products and systems produced from Welsh grown timber. It may be possible to draw upon the new opportunities facilitated by the Wellbeing of Future Generations Act to encourage the specification of Welsh timber on the grounds of additional economic, environmental and social gains for Wales

Ty Unnos is currently considered to be more expensive than other modern timber frame systems. However, a future predicated upon rising energy prices and changing legislation (based around building performance and resource efficiency for example) is likely to lead to greater market differentiation and growth in demand for high performance, added value and branded approaches. A technical progression to closed panel, possibly followed by a frameless approach for certain building types may also help the Ty Unnos system to become more competitive.

Globalisation and the drive to market efficiency does not generally favour the development of relatively small scale regional approaches and the specification of local timber is to some extent restricted by international trade agreements. However, it is possible that the future will see a greater focus on resilience and more regional solutions, rather than short term market efficiency, but this is not the current reality.

1. Introduction and Background

Coed Cymru have undertaken projects aimed at increasing the value and utility of low value broadleaf and conifer species in Wales. These projects have been conducted under the Supply Chain Efficiencies Scheme supported under the European EAGGF/RDP funding framework. This report seeks to provide some background context against which to assess the current product development activities of Coed Cymru with a particular focus upon the Ty Unnos timber frame system.

Coed Cymru was established in 1985 to bring more, predominantly broadleaves, into sustainable management. Coed Cymru provides support for all aspects of the wood industry from planting through to the development of innovative timber products.

Resources Efficiency Services have been contracted to write a report that sets the Coed Cymru activities within the context of Welsh forestry and timber trends (drawing upon some examples from overseas) as well as within the context of the current and future demand potential of the UK construction industry.

The report contains a review of the of the Welsh forest resource with a focus on the technical properties and processing of Sitka spruce, and considers the merits of Ty Unnos within the context of the current construction drivers and issues. By way of proving some context for an understanding of Welsh forestry, comparisons have been drawn with France, Germany and Ireland. This analysis is contained in Appendix A.

2. Forestry, timber and markets

Woodland Resource Characteristics

Wales is one of the least wooded countries, in Europe, with woodland covering 14.7% of the land area. This area is broadly in line with other parts of the UK, but compares with an EU average of 37 per cent and a World average of 31% (Forestry Commission Wales, 2009). The total area of wood land is shown in Fig. 1 below.

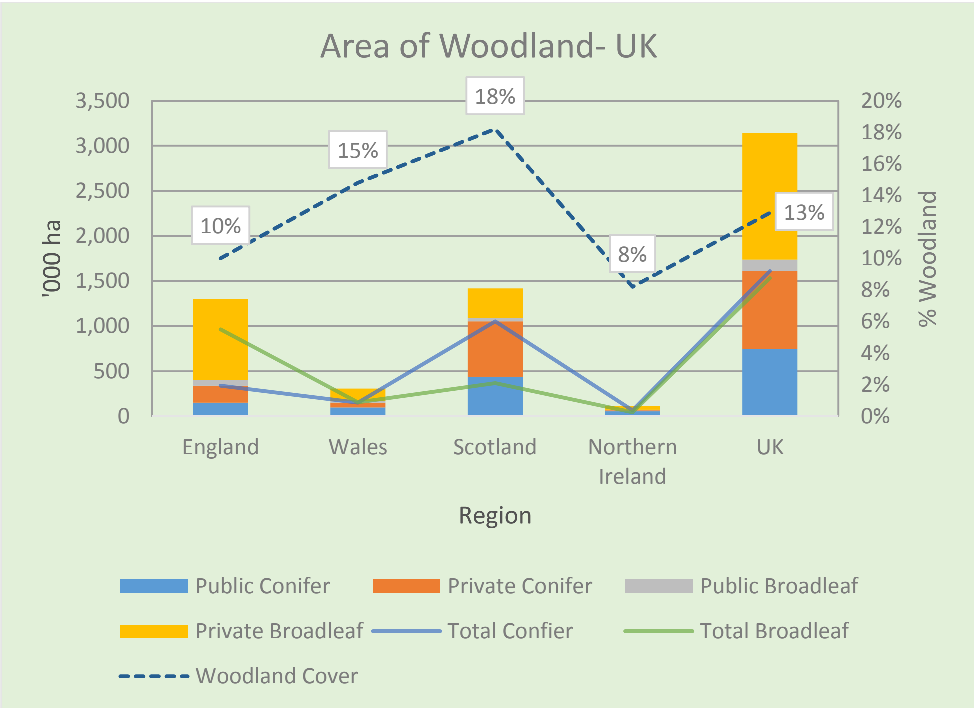

Fig. 1 Woodland Coverage UK, (FC, Forestry Statistics 2014)

Numerous aspirations for increasing woodland cover have been expressed alongside evolving schemes to support both woodland evolution (including farm woodland and plantations on ancient woodland sites) and overall cover.

- Under the Better Woodland for Wales Grant Scheme which ran 2006 to 2010 – 380 Hectares per year of new cover was established. This was mainly in small blocks and at low stocking density.
- The Glastir programme, which started in 2010, references the creation of 100,000 Ha of additional woodland cover, and there is evidence from the Welsh Woodland Indicators report (2013) that net planting may now be as high as 900 hectares/year. This additional 100,000 ha is also referenced in the Welsh Government Land Use Change report (ADAS, 2014) with an aspiration to achieve it by 2030

In Wales the area of broadleaves and conifers is roughly the same at 150,000 ha. However, whilst the majority of conifers are managed by Natural Resources Wales the majority of broadleaves are under private ownership. The ownership structure of Welsh woodland is shown in Fig. 2 below.

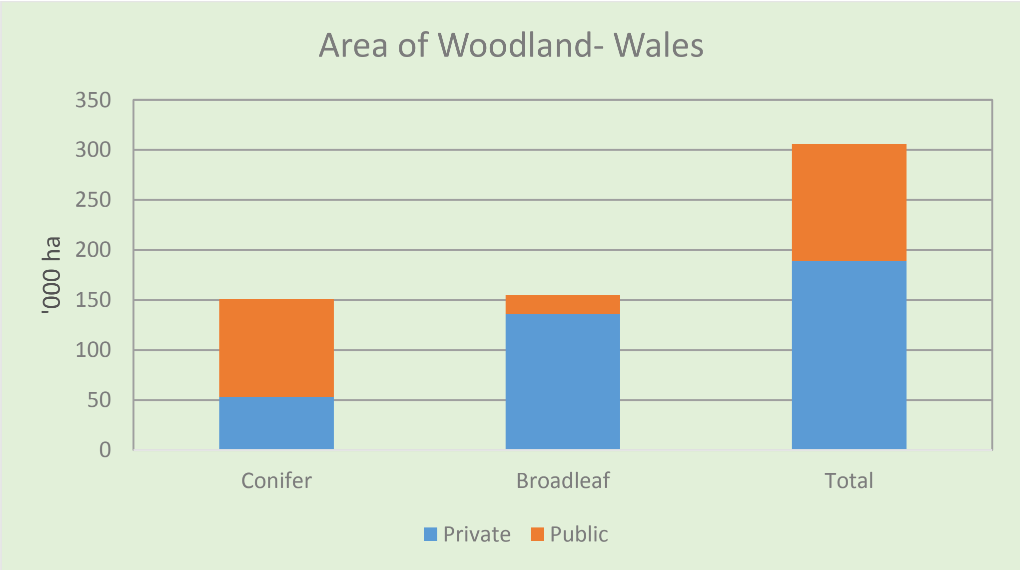

Fig. 2 Woodland Area in Wales (FC, Forestry Statistics 2014)

More than half of the woodland that is not publicly owned has never been part of a formal Woodland Grant Scheme and therefore is unlikely to have been managed for timber production in recent years. There is limited date available on the management of woodland for non-productive purposes such as shelter. Although 50% of the Welsh woodland area is hardwood, the small and fragmented nature of the resource makes commercial development difficult. There is some optimism that the rise of the fuel-wood market may lead to increased woodland management.

Sitka spruce is the main conifer species and forms the basis for Wales's forest industry. The species mix for conifers is shown below in Fig. 3

Fig. 3 Conifer Stocked Area - Wales (FC, 50yr Softwood Forecast 2013)

The species composition of the current Welsh Forest is well understood from the National Forest Inventory. The forest as a whole is dominated by Sitka Spruce (78k ha) with other coniferous plantations made up of larches, Douglas fir and pines. Broadleaf composition is far more diverse. Oak (24k ha) is the largest contributor to broadleaf with ash (16.5k ha) being the next largest single species. Notably the category of "other Broadleaves" (18k ha) ranks 2nd in the top 10 indicating that there are a large number of species with small areas of coverage with the 9th ranking individual species hawthorn having a coverage of just under 5k ha.

The choice of species suitable for growing in Wales varies across the country and, with climate change and disease threat growing concerns, it is vital that decisions made now about planting result in a robust forest in the future. Species planted now must thrive in the current environmental conditions but also be suited to the expected future climate with potentially higher temperatures, more extreme weather incidents and new diseases. An Ecological Site Classification (ESC) of conditions across Wales has allowed a series of maps to be produced showing which areas of land are suitable for growing a number of species of both conifers and broadleaves. This is based on inputs covering

- soil type and quality
- water availability
- wind risk
- mean temperature and seasonal temperature difference

and show the change in suitability of areas of land across Wales for different species based on today's environmental conditions and the expected environmental conditions prevalent in 2050 and 2080 under a number of climate change scenarios.

Whilst ESC considers the suitability of species to different areas of Wales, it does not take into account any silvicultural management, market, land-use competition or social inputs which should also be considered when making a planting choice.

Due to the importance of Sitka spruce to Welsh forestry the properties and processing is considered in more detail in the following Section 3.

Planting and felling

The total area of new woodland planting has been declining in recent years. Fig. 4 indicates that the preference in recent years has been upon broadleaves

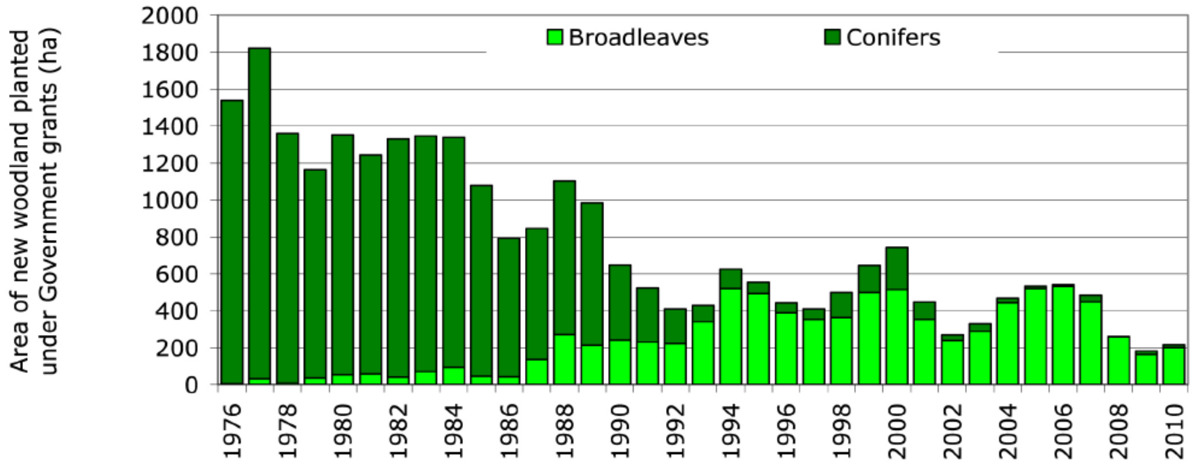

Fig. 4 Planting and Replanting in Wales. (Welsh Government 2001)

This trend away from conifer planting is reflected in the figures for the woodland created under the Better Woodlands for Wales scheme (funded under the EU rural Development Programme) in which 87% of new woodland created were broadleaves. See Table 1 below. The Better Woodland for Wales scheme was run under Axis 2 of the Rural Development Programme – namely 'improving the environment and the countryside' rather than under Axis 1 - Improving the competitiveness of the farming and forestry sectors.

Table 1 Replanting Figures (FC, 2012)

Financial Year	Broadleaves (ha)	Conifers (ha)	Total (ha)
2007/8	31.4	24.2	55.7
2008/9	88.1	7.4	95.5
2009/10	96.2	15.4	111.6
2010/11	100.8	5.0	105.8
2011/12 (to Dec)	20.6	0.8	21.4
All	337.1	52.8	389.9

Despite the fact that the Woodland for Wales report stated that there would be no target set for woodland creation, in 2010, the Welsh Government Minister responsible for Forestry Commission Wales set a target of creating 100,000 hectares of new woodland over the next 20 years – an average of 5000 hectares/year. In 2013 the area of new planting in Wales was 900 hectares of which 800 hectares were broadleaves (Forestry Commission, 2013). This falls well short of the target and the shift towards broadleaves indicates a focus on factors other than production (such as amenity, biodiversity, water resource management etc.).

Planting rates in Wales are low and fall well below felling rates. On the current trajectory the softwood availability will fall to 50% of the current level by 2040.

By way of contrast, since 2009 the area of new woodland planted in Ireland has averaged 7000 hectares/year. The Irish Forestry and Forest Products believe that a sustainable and profitable sector requires afforestation rates in excess of 10,000 hectares / year (Irish Forestry and Forest Products Association , 2013). The state owned and vertically integrated model in Ireland is very different from that of Wales, where processing remains largely separate from growing.

Wood Supply

Fig. 5 below indicates that total availability of Welsh softwoods will reduce to 50% of current levels by 2045. This decline will have an impact upon the existing structure of wood processing in Wales which is currently dominated by three major processors (BSW in Newbridge on Wye, Pontrilas Timber in Hereford on the Welsh border, and Kronospan in Chirk). A reduction in softwood availability may challenge the future viability of these enterprises in commodity markets such as sawnwood.

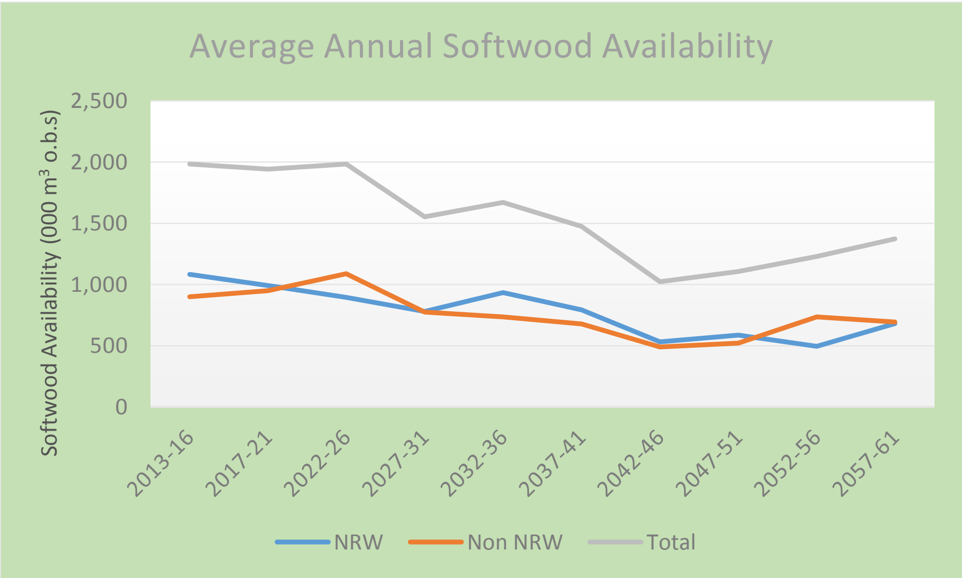

Fig. 5 Annual Softwood Availability - Wales (FC, 50yr Softwood Forecast 2013)

Proposals are being investigated to cover this initial drop of availability include:

- Delaying harvest of some timber during the period up to 2027. This will undoubtedly put pressure on prices in the short term but potentially avoid bigger disturbances post 2027. This would involve clearing any backlog of overdue timber which is problematic as Welsh softwood sawmills technology is set up for efficient processing of 300mm to 600mm diameter logs.
- Harvesting some timber earlier coupled with a planting program to cover the generated shortfall.

Nevertheless, the desired trends according to WG (Welsh Government, 2014) are to:

- Increase diversity of woodland types at a catchment and woodland scale
- Increase the area of non-native woodlands with intimate mixtures
- Planting becoming less dominated by single species
- Planting of a wider genetic base

This will lead to increased emphasis on the need to innovate to add-value. However, there is as yet little detailed analysis of what these changes may mean for the processing sector.

Softwood roundwood production in Wales is shown in Fig. 6 below. In 2012, 1275 thousand tonnes of softwood timber were produced from Wales Forests (Forestry Commission, 2013). Overall there has been a steady rise in production since 1976 but no rise in production over the past 10 years. However, the proportion of softwood coming from non-FC sources has risen in recent years.

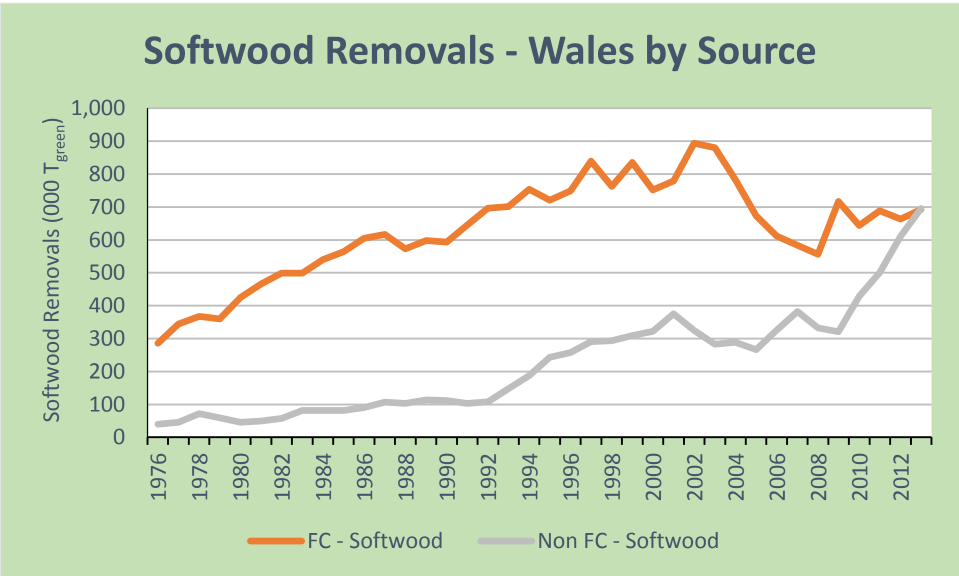

Fig. 6 Softwood Removals - Wales. (FC, Time Series Data Softwood Removals)

The rising proportion of non-FC timber is mirrored in England and Scotland. Since 2002 the proportion of non-FC softwood timber has risen from 25% to 42% in England and from 48% to 59% in Scotland. This shift in timber origin is perhaps surprising given that only 1/3 of conifer woodland in Wales is in non-NRW ownership. Possible explanations for this trend are (1) a difference in age of the woodland and (2) the possibility that the Non-NRW woodlands have a higher level of removals per hectare. The latter explanation would fit with the anecdotal evidence that processors are leaving the lower value trees in the woodland (3) Many private sites are getting rid of larch to avoid Phytophthora Ramorum.

The scale of Welsh softwood production compared to England and Scotland is shown in Fig. 7 below

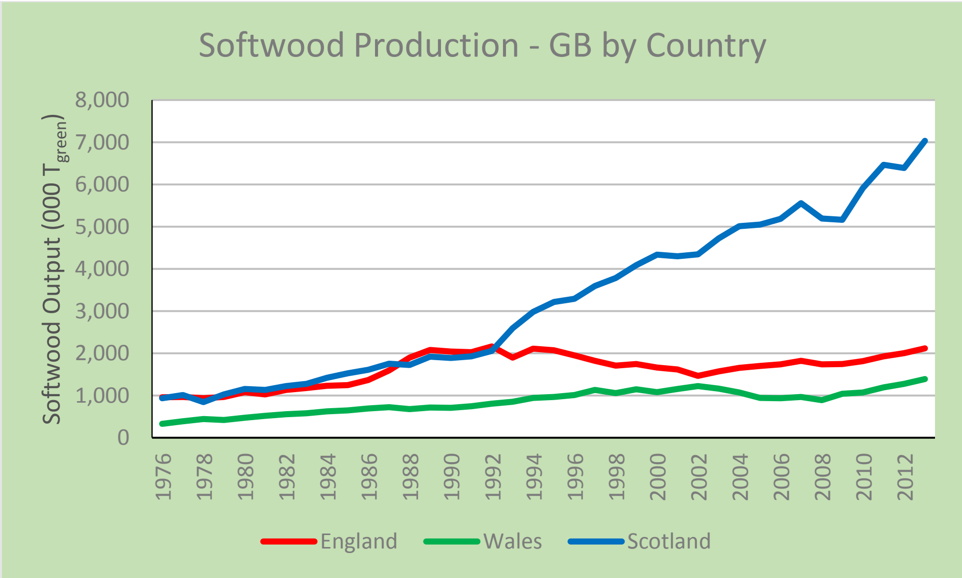

Fig. 7 Softwood Production by GB Region (FC, Times Series Data Softwood Removals)

Based on felling licence data hardwood production has been in steady decline with only 24 thousand tonnes of hardwood produced in Wales in 2012. However, there is some optimism that the rise of the fuel wood market will help to bring unmanaged hardwoods back in to management and help to stimulate a reversal of the downward spiral of low value, low management and low demand.

Softwood processing has grown from 300,000 green tonnes in 1976 to 1,200,000 green tonnes in 2012.

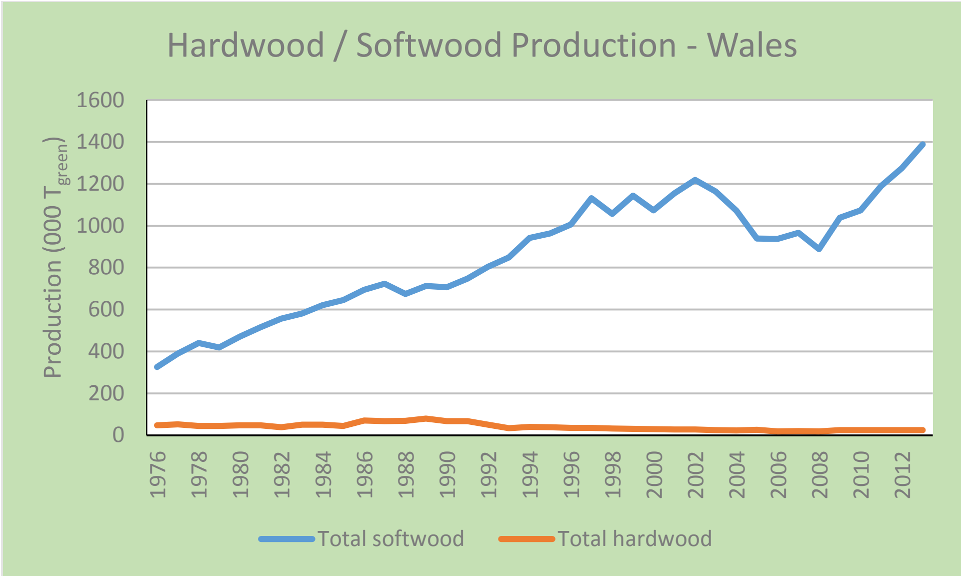

Fig. 8 Hardwood and Softwood Production Wales (FC, Times Series Data Softwood Removals)

Current biotic threats to Welsh forests

A number of serious pests and diseases are currently affecting trees in Great Britain. These may have an impact on the management of forests for timber production, including the harvesting and movement of wood, or the availability of planting stock to replace trees removed during felling. Here we present an overview of some which are of particular concern at present, and which are hosted by commercially important timber species.

Chalara dieback of ash (Chalara Fraxinea)

Chalara dieback is a serious fungal disease of ash trees. The pathogen was first identified in Poland in 1992 where it caused widespread mortality and infected trees have since been found widely across Europe. In February 2012 it was identified in a nursery in Buckinghamshire on trees imported from Holland. Infection has since been confirmed in Norfolk, Suffolk, Kent, Essex and other counties - mainly along the south-eastern seaboard of England but with a smaller number further afield in Scotland, Wales and Northern Ireland.

C. Fraxinea is being treated as a quarantine pest under national emergency measures. Should a statutory Plant Health Notice be served on an infected woodland then ash logs or firewood may only be removed if authorised by the Forestry Commission. Certain restrictions on the import of ash logs have already been imposed by the Northern Ireland Executive and the Irish Government.

Dothistroma needle blight of pine (Dothistroma septosporum)

Infection by the fungus *Dothistroma septosporum* may lead to Dothistroma needle blight (formerly Red-band needle blight) causing defoliation, weakening, reduced timber yield roughly in proportion to the area of crown affected, and sometimes also to mortality. It affects a range of conifer species but most commonly pines with Corsican, lodgepole and

Scots pine all now affected. The disease is now known to be present in all of the Forestry Commission's forest districts in England. It is also widespread in Wales with most plantations affected.

Phytophthora fungus and larch (Phytophthora Ramorum)

Phytophthora Ramorum is a fungal pathogen of trees and other plants that can cause extensive damage and mortality. Thought to originate in Asia, the disease was first identified in the UK in 2002 on *Viburnum* plants and in mature (exotic) oaks the following year. Relatively few trees were subsequently infected until 2009 when it began to appear in Japanese larch in southwest England then followed by south Wales, Northern Ireland, the republic of Ireland and then western Scotland in 2011. Substantial areas of infected trees in plantation have since been felled, subject to statutory felling order issued by the Forestry Commission. This pathogen is highly adaptable and capable of infecting and killing most species of conifer and broadleaf trees. The practice of growing monocultures in the UK leaves plantations vulnerable to this and other pathogens.

3. Sitka spruce

As detailed in Section 2, Sitka spruce is the main conifer species in the UK, accounting for 56% of the Welsh coniferous resource. Ty Unnos, has, in part been developed to take best advantage of the properties of this species. This section considers these properties as a background to considering applications and draws almost exclusively upon a research report published by the Forestry Commission in 2011 – Wood properties and use of Sitka spruce in Britain (Moore, 2011).

Origins

Sitka spruce (*Picea sitchensis*) originates from the Pacific Northwest of the USA and Canada where indigenous people used the roots (for weaving) and resin (as glue). Little use was made of the wood. The discovery of gold near Vancouver in 1858 created a need for sawn timber and a sawmilling industry emerged. However, Douglas fir was preferred with Sitka spruce being a relatively minor species. In the early 1900s, due to its relatively high specific strength (strong and light) Sitka spruce began to be prized by the emerging aircraft industry and there was a rapid rise in demand.

The establishment of the Forestry Commission after WW1 (with a target of supplying 20% of the UK's annual timber requirement) led to substantial afforestation. Sitka spruce became the dominant species after WW2 due to its rapid growth and its ability to grow on a wide range of sites (particularly upon poor upland soils).

Physical Properties

Appearance: The wood of Sitka spruce along with the other spruce species grown in Europe (mainly Norway spruce) is referred to as whitewood by the trade, because of its pale colour. The colour of Sitka spruce wood ranges from creamy white to a pale pink or pinkish brown colour in the central core.

Density: At 12% moisture content (the equilibrium moisture content for indoor conditions) the density of Sitka spruce is 390±40kg/m^3. As with other species density varies radially and longitudinally.

Durability: The natural durability of Sitka spruce is low. On a scale of 1 to 5 (defined by EN350-1) where 1 is very durable and 5 is not durable, the heartwood of Sitka spruce is classified as slightly durable (class 4) and the sapwood is classified as not durable (class 5).

Permeability: The permeability of Sitka spruce is low compared to other species (described as a refractory species) which significantly impacts the ease of preservative treatment and chemical modification.

Thermal conductivity: Thermal conductivity (W/m.K) is measure of the rate of heat flow through a material and in timber correlates closely with density. The thermal conductivity of Sitka spruce is 0.1 W/m.K which is relatively low when compared to other species (e.g. 10%

lower than higher density pines) and is approximately equivalent to that of a typical straw bale.

Bending strength and stiffness: Bending strength and modulus of elasticity (stiffness) are arguably the most important mechanical properties of wood as, along with density, they are used to directly assign structural timber to a strength class according to EN338. The strength varies considerably in the radial direction within a tree.

Effect of Silviculture and genetics

The wood properties of a tree are a combination of nature and nurture or genetics and environment. The key influences are:

Choice of genetic material: Most of the Sitka spruce grown in Britain originates from Queen Charlotte Islands off the coast of British Columbia in Canada**.** A selective breeding programme for Sitka spruce was established in the UK in 1963 where the desired outcome was to 'develop breeding populations well adapted to a range of soil types, with improved stem form and wood qualities satisfactory for the sawn timber market.' Rapid growth was also a key target outcome.

Forest Location: Soil type and nutrient levels have an impact on tree growth. Yield class declines with increasing elevation. Increased wind exposure associated with higher elevations also results in poorer stem form and a higher incidence of undesirable compression wood. Studies have also found that the density of Sitka spruce increases with increasing latitude (approx. 10kg/m^3 for every 1 degree) as well as from west (lower density) to east (higher density).

Initial spacing: In the first substantial period of afforestation (1920-1940) spacing was between 1.0 and 1.5m. From 1960 to 1980 the typical spacing increased to 2.7m (primarily to reduce establishment cost). Wider initial spacing tends to result in increased branch size, deeper living crown, greater stem taper and fewer trees to select for the final crop. Today based on a study that showed that timber strength decreases with increasing spacing the recommended initial planting spacing is 2m (2500 trees/ha) .

Thinning: The aim of thinning is normally to concentrate the growth on a smaller number of trees, so that the target tree size is reached in a shorter period of time, and to improve log quality by removing those trees with poor form. The effect of thinning on wood properties will depend on when in the rotation it is carried out and its intensity (i.e. the number of trees that are removed). Because of the risk of wind damage coupled with the low value obtained for the thinned trees, thinning of older stands of Sitka spruce is becoming less common, particularly on exposed upland sites.

Rotation Length: Increased growth rates achieved through Silviculture and tree breeding has resulted in declining rotation lengths. Nowadays, Sitka spruce is typically grown on 35–45 year rotations and 25 years is being considered. However, as rotation length decreases the proportion of juvenile wood in a tree increases (Figure 2.23), and this wood has lower density, bending strength and modulus of elasticity than wood that is located further from the pith.

Conversion and products

The wood properties of Sitka spruce mean that it is suitable for a wide range of products including structural timber, pallets, fencing, structural poles, panel products and paper. The main primary users for Welsh Sitka spruce logs are 2 main sawmillers, BSW in Newbridge and Pontrilas in Hereford, and Kronospan, a panel product producer in Chirk.

Sawmills process Sitka spruce logs into three main products, structural timber, pallet and packaging timber and fencing components. The shavings and sawdust residue typically find their way into panel products, animal bedding and increasingly for energy, through either on site combustion, or by conversion into pellets. The typical volume of sawn timber produced from a log is between 50 and 60%. Typical cutting pattern is shown in the following Fig. 9.

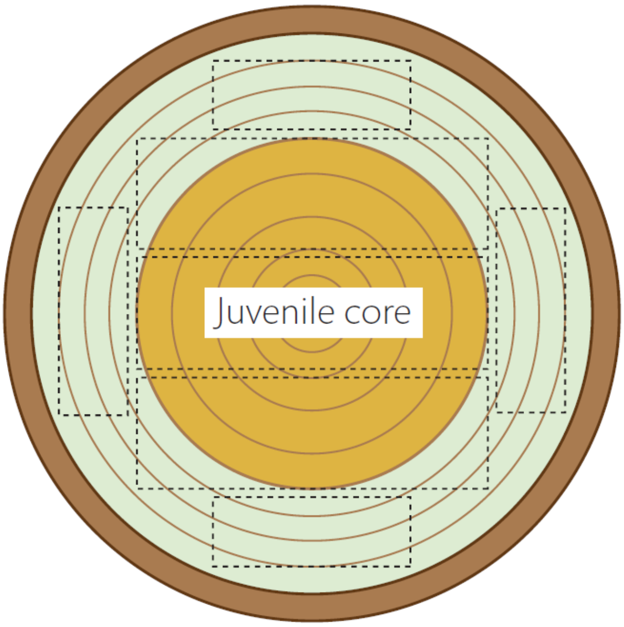

Fig. 9 Typical cutting pattern used for Sitka Spruce logs in the UK

Large dimension structural timber is cut from the centre of the log, which contains the juvenile wood, while smaller dimension sideboards are cut from the outside of the log. Strength graded (to C16) Sitka spruce structural timber is supplied by BSW kiln dried and pressure treated in finished thicknesses of 45mm and 72mm and in widths from 70mm up to 220mm. BSW also supply timber in CLS grade (typically used in modern timber frame) 38mm thick and in widths of 63, 89 and 140mm. Roofing battens are also produced from Sitka spruce. The UK sawmilling industry is currently set up to produce structural timber to the C16 grade. BSW describe the higher grade of C24 as being available on request and subject to availability.

Strength grading: Pieces of timber with similar mechanical properties are grouped together in strength classes, which are characterised by a set of properties for engineering design.

This permits an engineer to specify a chosen strength class and use the characteristic strength values of that class in design calculations. A common set of strength classes are used throughout Europe. The classes are named for the characteristic value of bending strength, and for softwoods range from C14 up to C50. British Sitka spruce timber is almost always graded to C16 enabling high yields, with reject rates at less than 10%.

Discussion

The BSW sawmill group supply structural home grown timber to the UK market. The vast majority of this is graded to C16, although some C24 is available. Small quantities C16 structural timber produced at the BSW sawmill at Newbridge on Wye, enters the supply chain via timber merchants. This timber will be stamped with the species, grade and mill of origin. However, merchants do not differentiate between imported timber and UK grown timber in their stockyard yard and therefore a discerning customer will currently find purchasing home grown timber to be extremely difficult. The Grown in Britain labelling scheme, if successfully implemented, may make it easier to ensure the use of UK grown timber in construction projects. However, as sawmills prefer to supply through lower risk merchanting routes it is often more favourable for timber frame manufacturers to purchase overseas timber. This is the case even when prices are comparable..

High capacity sawmills in the UK are set up to produce the C16 grade of timber. Higher grades, such as C24, can be produced from the UK resource, but it is not currently deemed to be as efficient (in production) or to yield higher financial returns (perhaps due to competition with imports). The C16 grade is sufficient for modern timber frame, but C24 and higher grades will often be specified for non-housing applications, making UK supply difficult.

So the conventional mechanism for the utilisation of UK grown Sitka spruce in construction is through high capacity milling of relatively short rotation sawlogs. The Ty Unnos system is conceived around a different model. It is a system which can be exploited by relatively small enterprises and allows the whole log to be utilised to maximum structural advantage and with maximum yield. The core of the log provides the main timbers for the box beams, the smaller timbers are used to create the walling panels, and in a new innovation the shaving residue can be used as insulation. However, it is necessary to utilise stress graded timber, and the system does require the added value processes of milling, kiln drying, preservative treatment (to satisfy building regulations) and component fabrication. The system is perhaps most appropriate for Sitka spruce logs which have been rejected by the high volume sawmillers due to being oversize. Much of this size of log may come from the private estates where felling has been delayed due to low log prices.

Strategies to add value to the Welsh resource through technical innovation (such as Ty Unnos) or through market innovations (such as Grown in Britain) are not mutually exclusive. However, external pressures on planting strategies (location and species) and silvicultural system (to maximise benefits not related to production efficiency – such as amenity, biodiversity, water etc.) may impact on the favourability of different approaches. Consideration of these issues is largely outside the scope of this current report which is focused upon the resource as it currently is, rather than what it might be in the future.

4. Wood Demand

UK softwood deliveries into the main UK markets are shown in Fig. 10 below. Sawn softwood production has seen recent growth. There has also been a growth in wood fuel market. In contrast the market wood in pulp and paper, fence posts and wood based panels has seen no growth.

Sawn softwood remains the main market for UK grown timber. In 2013 sawn softwood output was approximately 3.5 million m3 and hardwood output was 50,000m3.

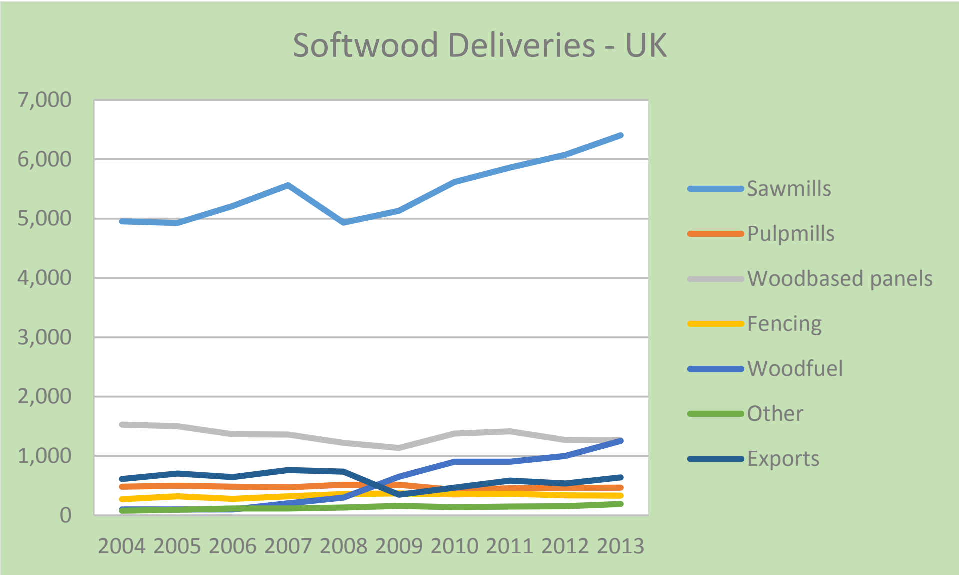

Fig. 10 Softwood Deliveries UK - by Processor Type (FC, Forestry Stats 2014)

The UK sawnwood market is shown below in Fig. 11. The UK sawnwood data comes from sawmill output figures and the import data comes from trade statistics. The figures indicate that approximately 1/3 of UK sawnwood demand is derived from UK production. However, there is no data available to indicate into which markets UK and Welsh sawnwood is able to penetrate. There is a need for more information. By way of contrast Ireland is a net exporter of sawnwood and in 2012 supplied 6.5% of the UK sawnwood market (Irish Forestry and Forest Products Association , 2013).

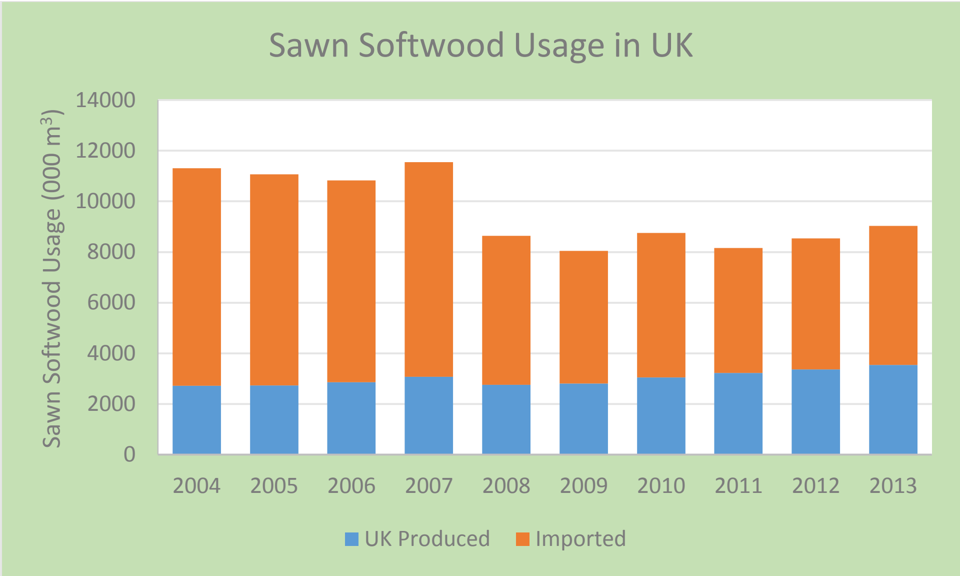

Fig. 11 Sawn Softwood Usage by Source (FC, Forestry Stats 2014)

The sawn softwood market is dominated by the demand in construction. Fig. 12 below indicates that construction accounted for 62% of sawn softwood consumption in the UK in 2011. In 2011 the sawn softwood market was valued at £1.5 billion (Moore, 2012).

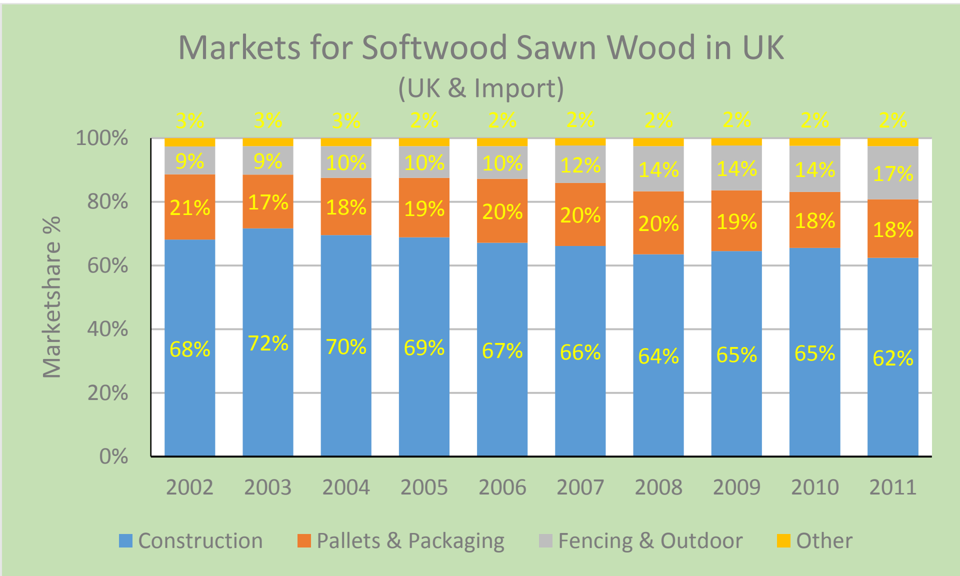

Fig. 12 Market split for Sawn Softwood in the UK (Timber Trends, Moore 2012)

Fig. 13 shows the trend in softwood utilisation in the main UK markets from 2002 up to 2010. Surprisingly the use of sawn softwood in construction appears to have been in decline throughout the early 2000s even before the 28% drop in 2008. One explanation for the reduction in use of sawnwood could be the use of alternative products. These alternatives could include wood based products such as MDF joinery (skirting boards etc.) and engineered wood (I joists).

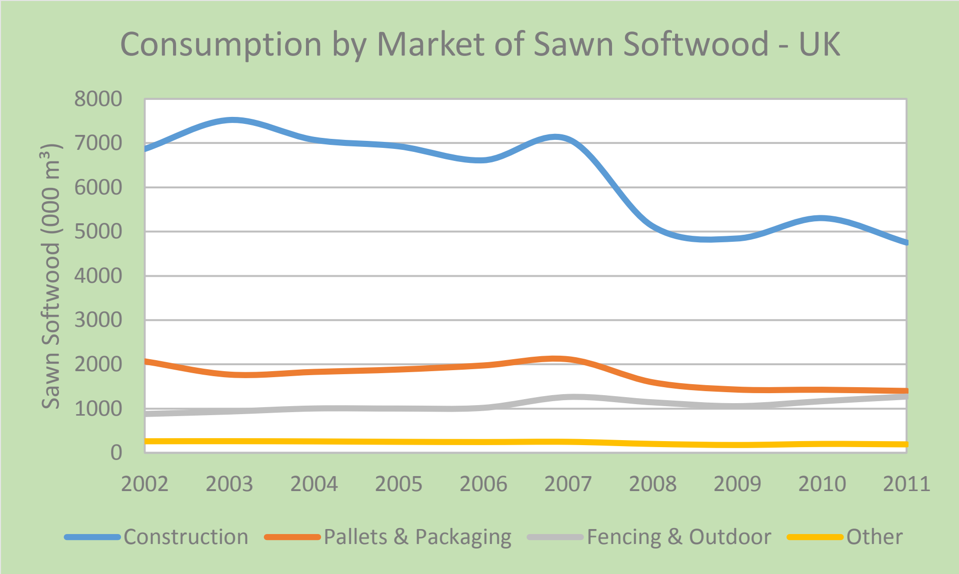

Fig. 13 Market Size for Sawn Softwood in UK (Timber Trends, Moore 2012)

The use of UK grown sawn softwood in construction was 889,000m3 in 2010. Whilst the volume of UK grown sawn softwood has remained fairly consistent, the decline in the total market has resulted in a growth of market share from 12% 2002 up to 17% in 2010. The figure below indicates that consumption of domestic sawn softwood appears to have been resistant to the construction downturn in 2008/09 which is widely believed to be due to a change in exchange rates. This growth in the relative importance of UK produced sawn softwood in construction is matched in the other major markets of fencing and pallets.

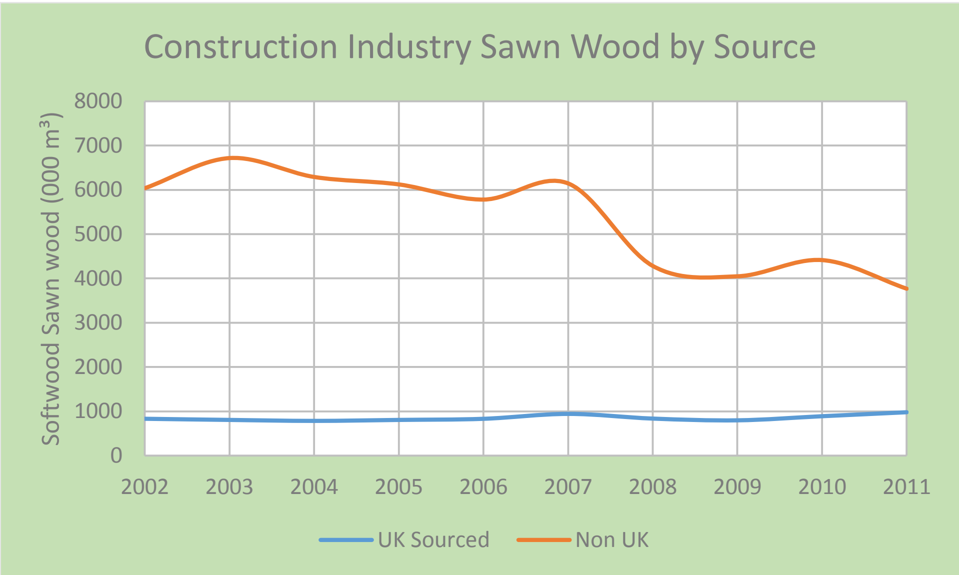

Fig. 14 Construction Industry - Source of Sawn Softwood (Timber Trends, Moore 2012)

The construction market can be segmented into new housing and all other construction (which includes repair, maintenance and improvement). According to Timber Trends, new housing accounts for only 6%-10% of total sawn softwood entering construction. The relative insignificance of the new build housing market for UK sawn softwood helps to explains why the market was little affected by the downturn in 2007/08.

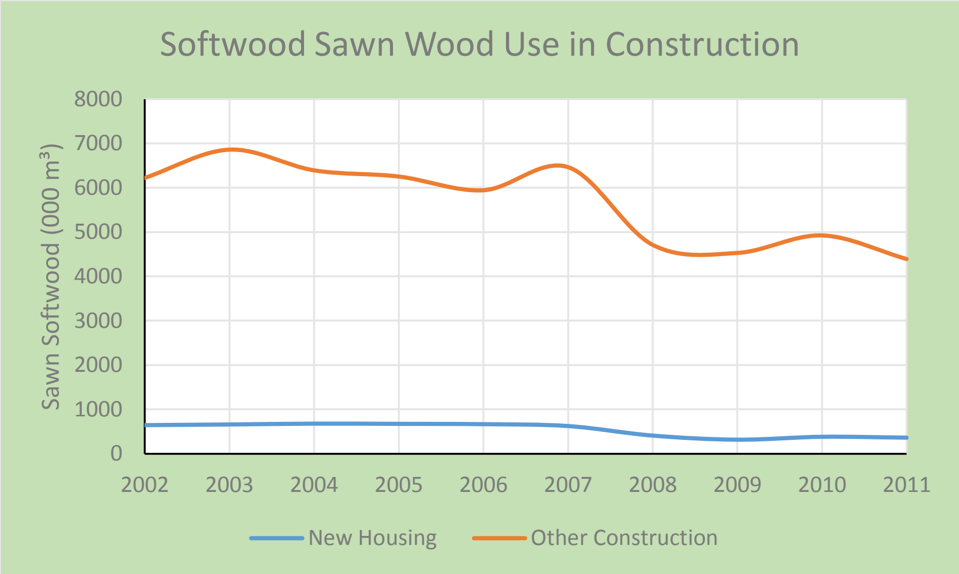

Fig. 15 Uses of Sawn Softwood in the Construction Industry (Timber Trends, Moore 2012)

The market data would appear to suggest that a strategy to increase the volume of Welsh produced sawn softwood in construction should be one focused on general construction (repair, maintenance and improvement) rather than exclusively upon new build housing. However, the Timber Trends report provides insufficient detail to enable firm conclusions to be drawn. Surprisingly there is little segmented analysis available on market applications for sawn softwood in construction. This information gap needs addressing.

Timber Price

The value of standing timber is shown in Fig. 16 below. The big drop occurred between the 1990 up to 2000 after which the price has levelled off. Since 2010 the price is beginning to rise but in real terms remain well below those of the 1980s. The key influences on timber price are exchange rates, UK demand and overseas supply. Global economic trends would indicate that the cost of timber, in line with other commodities, may begin to rise over the coming decades (due to economic growth and population rise). However, how future timber price will impact upon the value of forestry relative to farming (important for afforestation) or the competitiveness of timber relative to other materials is unclear.

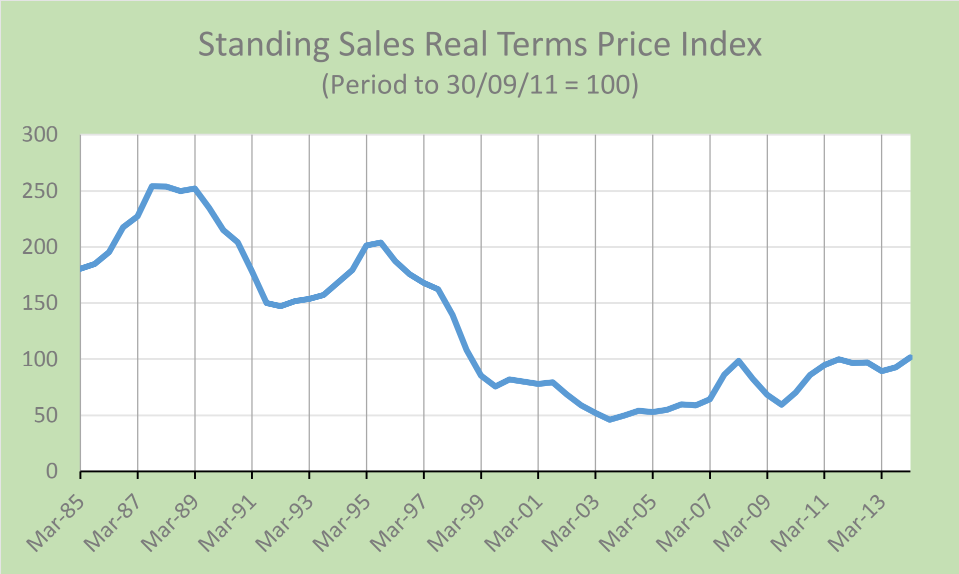

Fig. 16 Standing Sales Price Index (FC, Forestry Stats 2014)

Value of the forest Sector

Based on Standard Industry Classification (SIC) codes, the total GVA of the Welsh forest sector has grown to £455.7 million, approximately 1% of Wales GDP, of which £20 million is in forestry and logging (SIC02), with manufacture of wood products another £147.7 million (SIC16) and manufacture of paper and paper products £288.1 million (SIC17).

However, these figures relate to the forestry sector as a whole and are not a true reflection of the value added from the processing of Welsh grown timber. Specifically the figures for wood products include all activity based on imported timber as well as Welsh grown timber and as the paper and paper products industries no longer use Welsh timber these estimates do not relate to Welsh forests. By contrast no estimates are made for the added value of energy (heat and electricity) produced from Welsh timber.

There is also some economic contribution from the craft, small scale and firewood sectors, but the value is difficult to estimate. The major local development in this sector has been in firewood production. In a recent Welsh study, only 46% of households that heat with solid wood (typically between 2.5m^3/year and 12m^3/year) actually purchase that wood (Wong & Walmsley, 2012). Whilst individually these sectors may make a minor contribution, collectively they may be more significant and could be used to raise public awareness of using Welsh-grown wood.

The woodland economy also contributes to a wide range of smaller enterprises and to the major economic impacts achieved through tourism. Based upon work conducted in England, the rapid changes in exchange rate driven utilisation of domestic production, together with historic focus on low value raw material transactional levels, suggests that there is a significant underreporting of the true value of UK forestry. Current developments in biomass, added value wood products and sustainable building product demand also make correlations between historic value and future opportunity particularly unreliable.

It is widely understood that forests and the wood processing industries create wealth and provide employment and livelihoods. However, perhaps as a consequence of the timber industry being widely considered as making only a minor contribution to international GDP (<1% in Europe, (UN Economic Commission for Europe, 2013)), in recent years there has been greater policy focus on non-monetary services provided by forests (biodiversity, amenity, and climate change mitigation) than upon policies that target growth in the sector.

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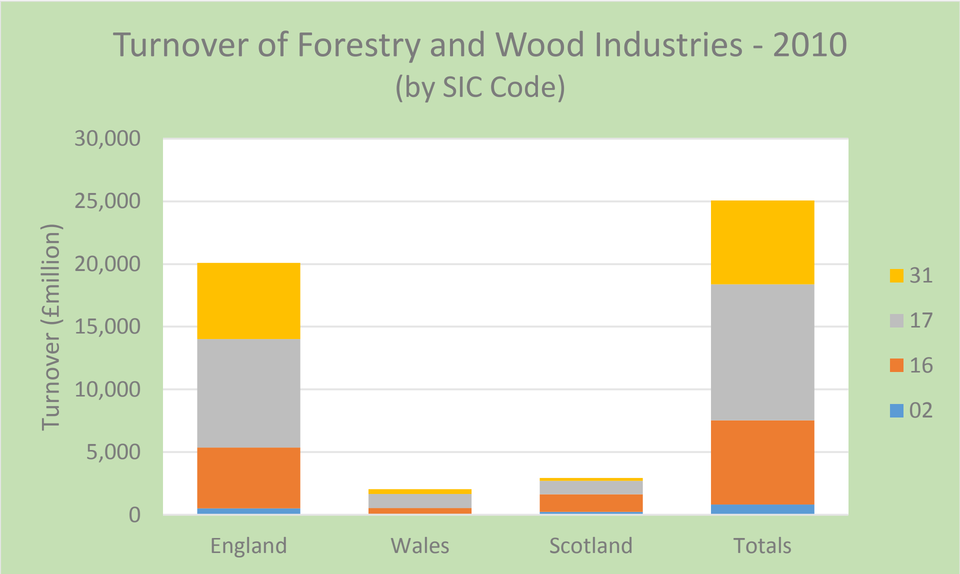

Fig. 17 Turnover in Forest Related Industries 2010 by SIC Code (ONS, 2012e)

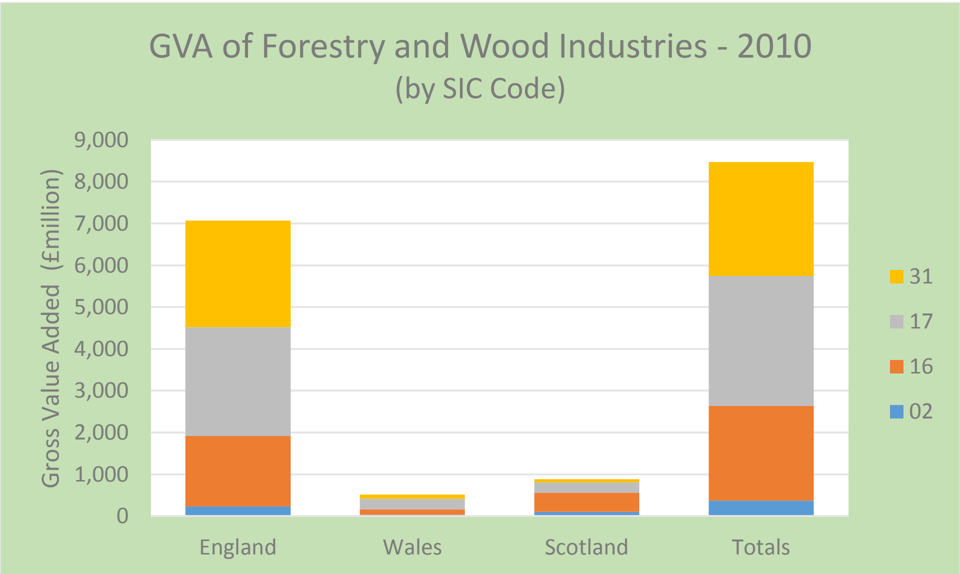

Fig. 18 GVA of Forest Related Industries (ONS, 2012)

The SIC code data can be used to derive a more detailed breakdown of the forestry and forest products sector gross value added (GVA) figures as shown in Fig. 19 below. Using SIC codes, the GVA from the total UK forestry → primary processing → secondary processing value chain was £5.9 billion in 2011.

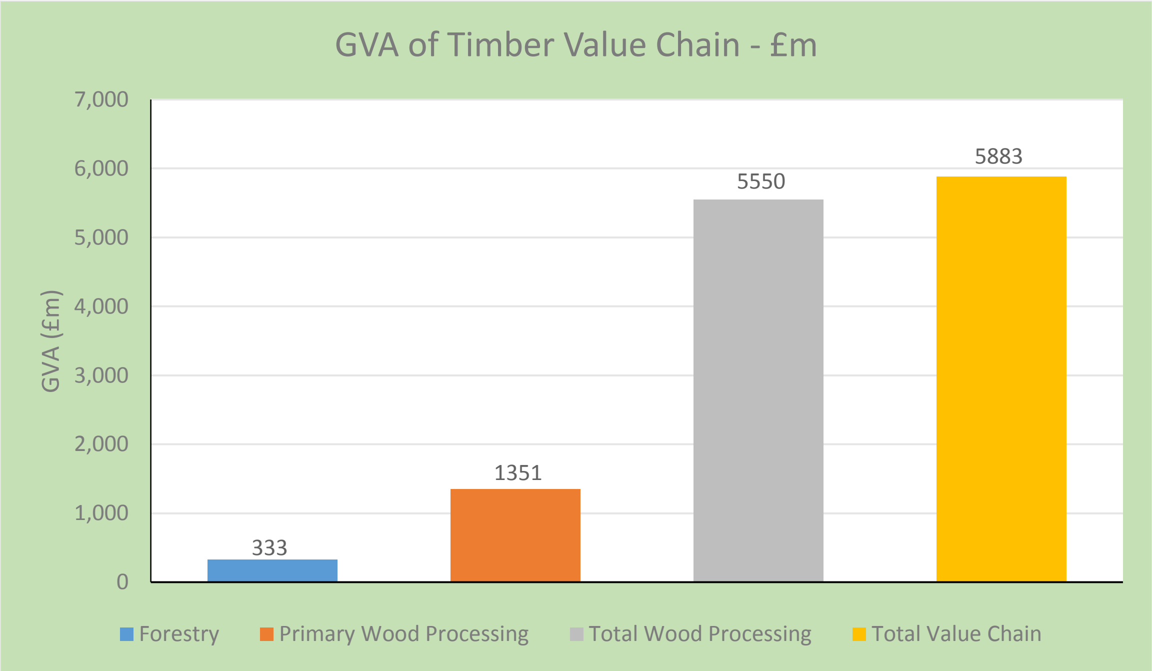

Fig. 19 GVA Breakdown Across Value Chain - UK 2011. (FC, Forestry Stats 2012)

However, these figures relate to the forestry sector as a whole and are not a true reflection of the value added from the processing of Welsh grown timber. Specifically the figures for wood products include all activity based on imported timber as well as Welsh grown timber and as the paper and paper products industries no longer use Welsh timber these estimates do not relate to Welsh forests. By contrast no estimates are made for the added value of energy (heat and electricity) produced from Welsh timber.

Tourism and recreation make a considerable contribution to the economy of Wales (£3.2bn in 2007, 6% of total Full Time Equivalent workforce in 2003) yet little is known about actual GVA or employment figures for those businesses engaged in specifically woodland related tourism and recreation provision although a 2003 study estimated that day visits to forests contributed £51 million to the Welsh economy.

It is clear that significant additional work is required in this area to accurately capture the value of Welsh forestry.

5. Construction drivers and opportunities

Energy Efficiency

Driven largely by the energy Performance of Buildings Directive, sustainable and low carbon construction has risen to become the central theme for the development of construction over the past 10 years. The main thrust of low carbon construction is the reduction of whole life carbon and, so far, the overwhelming focus has been on reduced operational energy during the in-use phase of the building. The need to reduce operational energy does not imply that wood will necessarily become a favoured construction material, although the dominance of timber frame in Scotland and the steadily rising market share in England (from 8% in 1996 to 25% in 2010) (Jeffree, 2010) would indicate that higher energy performance standards are encouraging a move towards timber frame. However, this trend towards increased timber frame is also due to the gradual move towards off-site construction which offers reduced cost and faster construction times.

As reductions are achieved in the energy-in-use of buildings, the relative significance of the embodied energy impact of materials is likely increase in importance. As shown Fig. 20 below fromWorld Green Building Council (WGBC), the balance of materials and energy impacts has altered dramatically from 2002 to the current day.

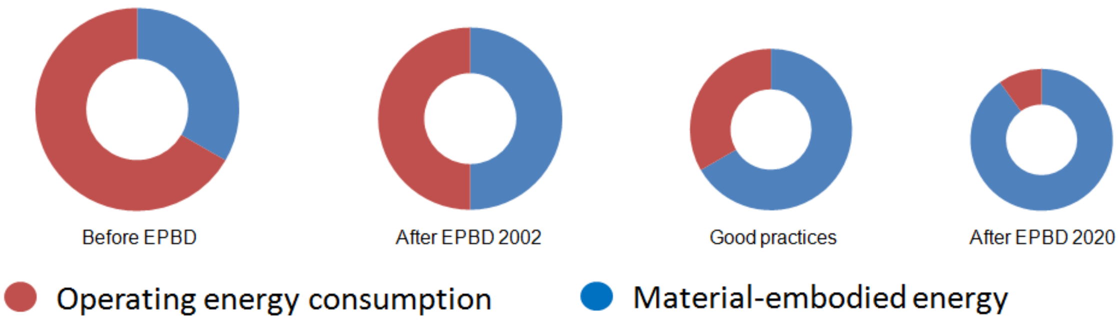

Fig. 20 Lifetime CO2 emissions of new European Buildings before and after Energy Performance of Buildings Directive (EPBD 2002) (credit: World Green Building Council)

Availability of embodied impact data

The CEN TC350 suite of sustainability standards developed as a result of a mandate from the European Commission provides an agreed method of assessing the environmental impacts of our buildings and construction products, and sets out an approach to evaluate a wide-ranging list of impacts across the full building life cycle. Impacts are clearly reported in the life cycle stage where they occur, so it is possible, reviewing a TC350 assessment, to fully understand the differing importance of the impacts from:

- the manufacture of construction products,
- their transport,
- the operation of the construction site
- the manufacture and disposal of products wasted during construction
- the operation of the building – the energy and water used over its life-time
- maintenance over the lifetime
- refurbishment
- demolition and the on-going waste treatment and disposal and
- the potential benefits of recycling, reuse and energy recovery from waste during life and end of life.

The embodied impact of products is reported in an Environmental Product Declaration (EPD) which can now be produced to harmonised product categories rules (PCR) described in EN 15804. The EPD assists in focusing the pressure for sustainability at a commercial transaction point, which is measurable and comparable between competing products or build systems. Other recent and important developments include an embodied impact benchmarking database (established by WRAP and UKGBC), and both the RICS (RICS, 2012) and GLA (Greater London Authority, 2013) have published guides to embodied impact measurement.

Availability of embodied impact interpretation tools

The proposed adoption of Building Information Modelling (BIM) will enable embodied impact data of products and materials (from EPD for example) to be incorporated into whole life decision making processes for buildings. It can be anticipated that the ability to use EPD data intelligently in the design process will shine a light on current wasteful and sub-optimal construction practices. This should encourage greater focus on resources and their deployment and help to accelerate beneficial trends such as towards local resource use, and towards the resource efficient principles associated with the circular economy.

Market drivers for embodied impact reduction

The sustainability gains from embodied impact reduction are substantial, but market drivers remain relatively weak, with the majority of current schemes assessed at house or company level, well away from the commercial decision point of product choice. The recent success of 'embodied carbon week' (established by UKGBC during April 2014) appears to have catalysed a focus upon the development of policies to encourage embodied carbon reduction. The discussion currently surrounds embodied impact as an 'Allowable Solution' as a stepping stone to including embodied impact within the zero carbon definition. Allowable solutions are a means of mitigating the carbon emissions that cannot be achieved through energy efficiency and on-site renewals. However in the recent Queens speech it is clear that the zero carbon homes policy is currently being watered down and the allowable solutions framework may only apply to larger developments.

Timber frame systems such as Ty Unnos that use natural insulation have an extremely low embodied impact which is in a large part due to the biogenic carbon locked-up within the fabric of the building. Furthermore the use of local timber would help to reduce transport impacts. Introducing embodied carbon as an allowable solution could have a dramatic impact on the opportunity for the growth of timber frame and the use of UK grown timber.

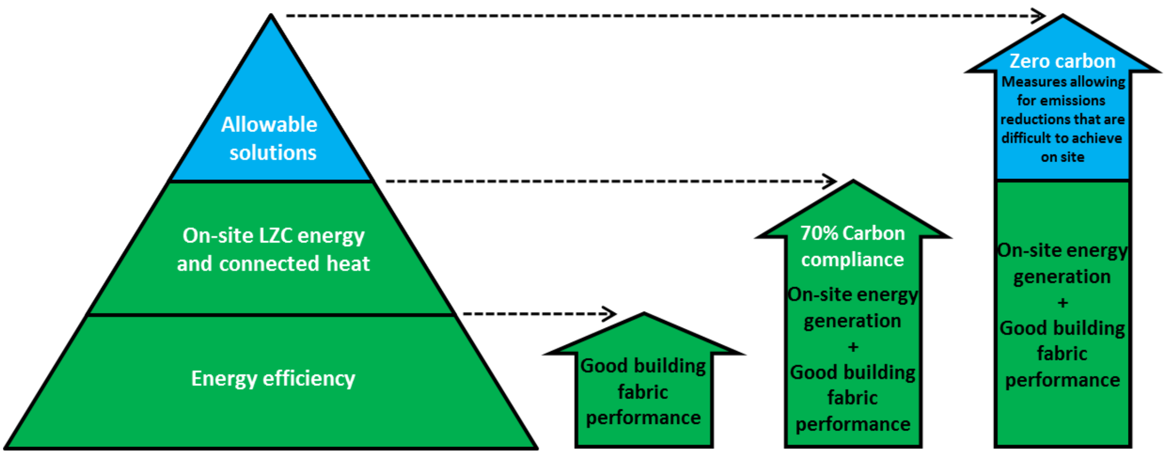

Fig. 21 Embodied Impact as an Allowable Solution

Sequestered Carbon

There have been strenuous efforts to maintain carbon stocks by avoiding deforestation and under the Kyoto protocol 1990 the carbon stored in new forests can be included in national greenhouse gas inventories. However, the one area that to date has not been widely accounted for, or rewarded, is the continuing sequestration of carbon in products made from bio-renewable materials such as timber. While significant data and support schemes exist for forestry, the continuing capture of biogenic carbon in buildings or products is neither recognised for its direct carbon, or the carbon displaced from highly carbon intensive alternatives such as concrete, steel or plastic. Like the fossil fuels on which they depend, these latter products also raise issues of supply security and resource depletion. So, as with financial accounting, we should not just look at the inputs and outputs of carbon, but also the stocks. By managing the expansion of the stock of carbon in harvested forest products, as well as those in forestry, we can significantly extend the quick wins available to short term carbon management and the base for future re-use as products and low carbon fuels. In Durban 2012 the anomaly of accounting for carbon in trees but not products was recognised and it is now possible to include harvested wood products in national greenhouse gas inventories.

Based on extrapolations of current trends in timber frame construction, the annual additional increment of carbon in harvested wood products in building is expected to rise from about 8 $MtCO_2$ in 2005 to 10 $MtCO_2$ in 2020 and to 14 $MtCO_2$ in 2050. If losses from the product pool (disposal and decay) were taken into account these figures would be reduced by about 20-30% (Robson & Sadler, 2011). The potential effects of policies designed to encourage increased use of all biogenic materials (wood, hemp, straw, wool etc.) in all UK buildings suggest that the net (taking into account losses from the product pool) carbon sequestration could be as high as 10 $MtCO_2$ in 2020 and 22 $MtCO_2$ by 2050.

To put this number into context the total embodied (capital) carbon emissions from all UK construction activity in 2010 are calculated to be 33 $MtCO_{2e}$ - see Fig. 22 below

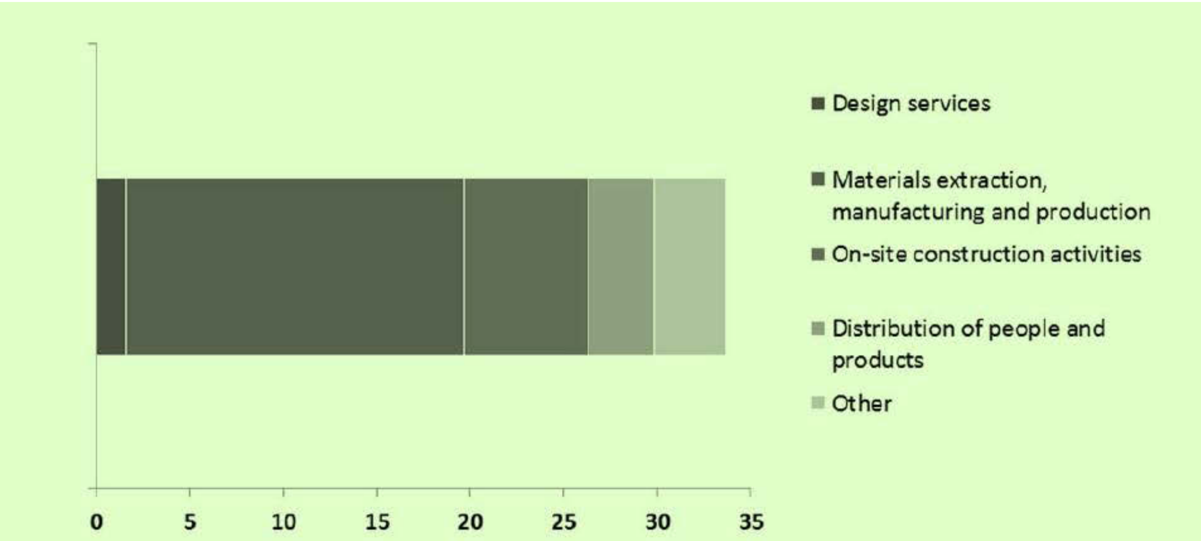

Fig. 22 Capital Carbon Emissions in 2010 ($MTCO_2e$) - Green Construction Board, 2013

The Ty Unnos system when used with natural insulation can be considered to be an extremely high biogenic carbon build system. The widespread deployment of Ty Unnos will create a significant carbon store which can be allocated against the UK greenhouse gas inventory. Under the Durban agreement only timber grown and used in the country of origin can be treated this way.

Sustainability Standards

The main tool driving sustainability in construction in Wales, outside of planning and building regulation is currently BREEAM, which is a voluntary standard. The Code for Sustainable Homes is being would up. And the WG are currently consulting on alternatives. The UK Building Regulations and the voluntary standards do not encourage the use of more timber (or Welsh grown timber). The mandated reference tool for product sustainability (the BRE's Green Guide to Specification) does not allocate any benefit to temporary carbon storage or end of life energy recovery in wood-based products (two key sustainability benefits of wood products).

Although some recent building projects have demonstrated the increasing importance of products that contain biogenic carbon and have low embodied impact, it is still largely ignored. This can lead to significant and counter-productive errors in terms of generating real carbon reduction benefits.

Resource Efficiency

As construction is responsible for 90% of non-fuel mineral extraction and at least 50% of non-fuel timber use, the industry will become a primary focus for resource efficiency measures. It can be anticipated that the EU will drive resource efficiency improvements as it seeks to deliver on one of the EU flagship policies as described in the Roadmap to a Resource Efficient Europe (European Commission, 2011). Although this agenda is in its relative infancy, EU targets and combined with the rise of raw material costs is likely to lead to buildings being designed for flexibility, adaptation, deconstruction and component re-use. It is now expected that European resource efficiency targets, that go beyond simple waste reduction and informed by the benefits associated with the circular economy, will emerge before the end of 2015.

The core of the Ty Unnos approach is around a box section frame system. This approach lends itself to large spans for internal flexibility as well as to adaptation and deconstruction. With further development the Ty Unnos system could be developed to be fully de-constructible and allow for future re-use. The approach then becomes a highly resource efficient system.

The performance gap

Recent studies on building performance have shown that there is a substantial gap between designed and as built performance. The multiple causes of this gap occur at all stages of the construction process from design through procurement, construction and commissioning. The performance gap is a threat to government, industry and consumers and with the lack of a standard for post completion testing there is little incentive for the industry to focus on this problem. Building performance largely falls outside the realm of building warranties. The Zero Carbon Hub has recognised that the performance gap threatens the regulatory drive towards zero carbon and has therefore established their '2020 Ambition'. Which is from 2020, to be able to demonstrate that at least 90% of all new homes meet or perform better than the designed energy / carbon performance?

A focus on the performance gap and the emerging market need to prove or guarantee performance will inevitably favour construction systems for which there are reduced margin for error on site – such as Ty Unnos. It is also likely to lead to the development of branded solutions such as is common place in Germany (e.g. Baufritz, Huf Haus). This would indicate that Ty Unnos solutions should be provided by one or a number of registered/approved providers.

Health, durability and moisture

The control of moisture within dwellings and within the fabric of dwellings is becoming one of the key challenges to achieving healthy, durable low carbon buildings. Increasing insulation levels combined with increased air-tightness driven by the building regulations and grant supported mechanisms such as the Green Deal and ECO is altering the interaction between moisture in buildings – and failures as defined by excessive condensation (within dwellings and fabric), mould growth, fabric decay are common. It is increasingly recognised that existing design tools such as BS5250 (2011) Code of Practice for Control of Condensation in Buildings are inadequate.

Industry and government now acknowledge that a new approach is required. This has in part been driven by the need to address perhaps the most important challenge in delivering low carbon building – that of upgrading the performance of the existing building stock. Many of these buildings are pre 1919 solid wall construction and as such are 'vapour open' structures. This means that external and internal moisture can pass in and out of the structure. Damp is avoided through the constant drying effect of internal heating and external dry weather and through the high ventilation rates associated with old buildings. When this 'equilibrium' is altered through retrofit measures such as draft proofing, internal or external insulation then there is a high risk of fabric failure cause by interstitial condensation.

Due to the sensitivities associated with the failure of new builds, there is limited hard data available, and much of the 'evidence' is anecdotal. However, it is known that failure has occurred in some non-vapour open polyurethane insulated closed panel systems. It can be speculated that this failure has been caused by moisture ingress which can build up over time as there is no pathway to escape. There is emerging evidence for failure of some houses in the Oxley Woods development built in response to John Prescott's £60k house challenge. The use of vapour open systems using natural insulation such as is used on the Ty Unnos approach may help to mitigate against the risk of failure due to moisture.

Construction Procurement

It may be possible to have a substantial impact on the specification and use of Welsh timber through a focus on public and private sector procurement. An area of material use that has received significant policy attention in recent years is in waste reduction. According to a recent report by the Waste Reduction Action Programme (Waste Resources Action Plan, 2011) 'The construction industry is responsible for over 100 million tonnes of construction, demolition and excavation (CD&E) waste every year – around one third of all waste in the UK. Recognising the environmental and economic impacts of these levels of wastage, the joint Government-industry Strategy for Sustainable Construction established a target of a 50% reduction in construction, demolition and excavation waste to landfill by 2012. The most significant interventions that are helping to drive waste reduction are through taxation (the landfill tax) and through the provision of WRAP tools (such as model procurement clauses, and online design tools).

Procurement tools (such as model procurement clauses) could be developed that would encourage the specification and use of products and systems produced from Welsh grown timber. It may be possible to draw upon the new opportunities facilitated by the Wellbeing of Future Generations Act to encourage the specification of Welsh timber on the grounds of additional economic, environmental and social gains for Wales. The labelling scheme for home grown timber proposed by Grown in Britain, if successfully implemented, may also help to facilitate procurement driven growth of Welsh timber

Discussion

The market data analysed in the previous section indicates that there is a substantial opportunity to increase the amount of Welsh wood in construction through both the increased use of timber in general and through the increased market share of home grown timber in particular.

In a previous report for DEFRA (as yet unpublished) the authors concluded:

- The UK manufacturing turnover of wood products for use in construction is more than £4 billion/year.
- The sustainable construction agenda is likely to lead to a 40-50% increase in the use of timber in construction in the UK
- The sequestered carbon dioxide in wood, and particularly in long-lived construction products, is a small but significant % of the UK's national carbon accounts (and a large proportion of embodied emissions from construction).
- The use of BIM systems, EPD and LCA may help designers and specifiers to understand, quantify and value the whole life benefits of using low embodied impact materials such as sustainably sourced local timber in the future.
- That off-site assembly of construction components and greater 'resource efficiency' (increased re-use and recycling) will increase efficiency in construction.
- Barriers included the green credentials of wood not being recognised, particularly in construction.
- Opportunities to link environmental properties of wood products to revised building regulations; increased public procurement of wood products.
- Market and demand growth could be through: increasing local/national public procurement of wood; increasing the use of Welsh wood used for timber frame construction; promoting the carbon story of wood; promoting wood as an energy efficient construction material; and, getting wood recognised as a sustainable construction product; developing factory manufactured construction components; stimulating more wood use through the building regulations.
- New products focused on Engineered Wood Products (EWPs) and that new products need to be supported with marketing and education.
- Resource efficiency (increased recycling, re-use and innovative design) came through in three out of the four future scenarios we developed.

There is much evidence that interventions in the construction sector have worked before, for example: rapid market driven transformation in the products and materials used in construction is common place (uPVC windows, timber frame, foam insulation, etc.). The UK tall framed structure market was dominated by reinforced concrete until the 1970's. This market is now dominated by steel. The transformation was driven by a combination of strategic investment (in design information, technical support, and education) and made possible by market conditions that required more rapid construction and through a significant technical innovation in the form of composite metal decking. We may now be on the verge of a market transformation away from reinforced concrete in multi-story housing projects to cross laminated timber (CLT) which has the advantages of fast erection, tight tolerances, low weight and low on-site noise and disruption.

Legislation and building codes and standards have a key role in directly or indirectly influencing the market. The deployment of on-site renewable technologies such as solar power is an example of a dramatic market change almost entirely driven by policy, whereas legislative requirement for ever higher levels of insulation performance has indirectly influenced a move away from mineral fibre based insulation products to petrochemical foam products which can achieve lower levels of thermal conductivity. Now, with increasing evidence of moisture risk in low energy homes (DECC, 2014), there may be a move towards the use of hygroscopic materials (such as natural insulation and vapour open construction methods).

Ty Unnos is currently considered to be more expensive than other modern timber frame systems. However, a future predicated upon rising energy prices and changing legislation (based around building performance and resource efficiency for example) is likely to lead to greater market differentiation and growth in demand for high performance, added value and branded approaches. A technical progression to closed panel, possibly followed by a frameless approach for certain building types may also help the Ty Unnos system to become more price competitive.

Globalisation and the drive to market efficiency does not favour relatively small scale regional approaches and the specification of local timber is substantially restricted by international trade agreements. However, it is possible that the future will see a greater focus on resilience and more regional solutions, rather than short term market efficiency, but this is not the current reality.

APPENDIX A

Comparison of forestry approaches across a number of countries

With the purpose of providing some international context within which to understand Welsh forestry, the following section seeks to compare the approach in Wales with those in Germany, France and Ireland.

	Wales	Germany[1]	France	Ireland
Brief evolution of current Forest	Largely cleared from a prehistoric level of around 60% coverage to a low of under 5% at the end of the Napoleonic Wars (1815) however Britain had been reliant on imported timber from the Baltic and N. America since the 1700's. The 1700's also saw increasing levels of industrialisation using first charcoal and subsequently coal increasing timber usage as pit props. Despite a call for planting in 1815 by 1900, land cover had only recovered to 5% however both Douglas Fir and Sitka Spruce had been introduced. WWI stretched this meagre resource to its limit and resulted in the Forestry commission being set up in 1919. Whilst a modest recovery took place between the wars, WWII again put pressure on resources and a large planting campaign took off post WWII.	Up to c15 largely unmanaged. C15 saw the first attempts at sustainable forest management with first coppicing being practised on managed 15 year cycles then the inclusion of higher forests on longer rotations. Increasing industrialisation through c17 and c18 saw the forest largely decimated by early c19. The starting point for the current wealth of the forestry in Germany is a low estimated to be around 3.2% of land coverage. Concerted reforestation happened in the period 1815-1860 and is continuing today at a regional level.	Large areas of forests cleared for agricultural production as population increased and then the development of the first factories. Early c19, 8m ha were degraded, overexploited and burnt-out. Recovery began with the Forest Law of 1827 with a forest protection authority established. Major reforestation (particularly in the Aquitaine massif, Sologne and montane rehabilitation). The prime objectives were ecological re-establishing forest cover on eroded slopes to control torrential floods. A more commercial focus has been applied since WWII with funding from the National Forestry Fund[2], 2m ha of planting over 40 yrs. plus big increase in quality of existing forest.	Ireland saw a big decline in forest coverage c17 – c19 due to population increase, increasing industrialisation and changes in land use. First planting grants offered 1740 by Royal Dublin Society. Forestry continued to decline however even with the introduction of state forestry in 1903. By 1908 forest coverage was 125k ha (1.5%) and bottomed out at around 89k ha in the interwar period. Since this time an almost continual afforestation and reforestation programme has been undertaken by the state together with increasing levels of subsidised planting by private owners.
Forest Cover	303k ha. 15%	11.1m ha. 32%	16.1m ha. 30%	731k ha. 10.5%

	Wales	Germany[1]	France	Ireland
Forest Split Public/Private	38:62 land area	34:66 land area basis	29:71 – growing vol. basis	53:47. Land area based. The 47% is split further as 34% grant aided (post1980) and 13% other.
Forest Split Broadleaf/Conifer/Other	38:41:21[3]	25:52:23[4]	71:29 – AREA 64:36 – VOL.	26:74. (>80% of public and grant aided forest is Conifer)
Nature of Private forest owners	60% of woodland areas in Wales are under 2ha and account for only 7% total woodland coverage. Owners range from farmers, private companies and individuals and corporate bodies (Church, Uni's).	Corporate (towns, church etc.) – 32% Private enterprises – 34%. Only 3% of these >1000ha. 70% are <50ha.	Of the private owners ~23% own < 6 ha With a similar level owning > 100ha. 64% of forestry in France is owned by individuals or families.	Majority of private estate is disjointed. There are 19,500 private owners owning on average 8ha. Around 75% of these are classed as farm foresters.

[1] Based on a report prepared by Sabine for Resource Efficiency Services

[2] The Fund is replenished through a tax levied on forest and sawmill products, and earmarked for production forest investments.

[3] 14% Recently felled and Young Tree,4% Mixed.

[4] 28% Spruce, 24% Pine, 15% Beech, 10% Oak, 2% each Larch, Douglas Fir and other species. (Total 26 deciduous, 7 confer species grown commercially out of 72 species in total

	Wales	Germany[1]	France	Ireland
Nature of Public Forest Owners	Natural Resources Wales was recently created from the amalgamation of FCW, CCW and EAW. NRW is responsible for the mgmt. of the public forestry, forest policy and monitoring of the private forest owners.	Federal government sets policy and owns around 410k ha. State government (Länder) own most which are managed by commercial organisations on behalf of the state. (typ. 8000-15000 ha chunks) State government also provides stewardship and monitoring function.	Around 11% of the forest is owned by national government and a further 18% by local and regional government organisations.	Coillte is a private company who own and manage the public forest in Ireland. All the shares of Coillte are owned by the government but it operates as a fully commercial entity. It has developed into an integrated wood products company adding sawmilling and board manufacturing to its foresting activity.
Growth Information	Growing Stock – 60.5m m^3 36.5m m^3- Conifer (278m^3/ha) Annual Increment – 1.5m m^3 (11.4 m^3/ha) 27.3m m^3 - Broadleaf (199m^3/ha) Annual Increment – 0.524m m^3	Stocking information 3.5Gm^3 (320m^3 /ha) Annual Increment: 100m m^3 (9.5 m^3 / ha)	Growing stock estimated to be at 2.5Gm^3 (160 m^3/ha) Annual increment : 75-98 m m^3	Growing stock estimated to be 97.5m m^3 (153 m^3/ha) 59% Sitka, 22.8% other cons, 18.2% broadleaf. Tripled since 2006 reflecting the age class of the post 1980 grant funded forest. Annual Increment : 7.6m m^3(11.5 m^3/ha/yr)
Harvesting	2013 timber harvest in Wales is estimated at 1.3 m T (~1.58m m^3 o.b.s) of softwood (50:50 NRW:private) Hardwood – 24kT (~26.64k m^3 o.b.s) nearly all (20kT) from private forests.	Private – Typically under-utilised using traditional techniques Public – High utilisation using mechanical whole tree harvesting techniques. Harvest 2012 – 52.34m m^3	33% of French forest cover is classified as difficult or extremely to harvest. 2011 total harvest was 54m m^3 of which only 5.2m m^3 hardwood. H/W steadily dropping over 20 years.	Mean harvest volume 2006-2012 is 3.6m m^3 around 47% of annual increment. 87% of this as from the public estate. 97.8% of the harvest was conifer. 76.8% of the harvest was undertaken through clearfelling.

	Wales	Germany[1]	France	Ireland
Contribution to GDP	Forest and Wood Products £1.7bn pa £400m GVA 8000 Jobs. (World Bank Forest only <0.1%)	Forestry and wood products: €170bn turnover pa. 1.3m jobs (World Bank Forest only 0.1%)	Forestry and Wood products €60bn turnover 450k jobs. (World Bank Forest only 0.2%)	Forestry and Wood Products Turnover €2.2bn turnover (€673 forestry only) 15.8k jobs (5.5k forestry) (World Bank Forest Only<0.1%)
Market & Trends	Within the UK, only 27% of home produced timber is utilised in the higher VA categories in construction. 68% of all sawmill production is for the pallet & packaging and Fencing &outdoor marketing. Declining pulp market but energy and board markets becoming more buoyant.	Strong markets for all timber uses including energy, high value timber construction and a pulp market.	The hardwood sawn wood market decreased by 50% over the period 2000-2009 stabilising at around 1.3M m^3. Softwood market demand is healthy at around 9.6M m^3	Huge export market especially to UK for board and sawn wood. 44% market share of MDF in the UK. Forecast for market is to grow 2.68m m^3 (2011) to 6.95m m^3 (2028). Strong energy market as well as sawlogs and board.

	Wales	Germany[1]	France	Ireland
Incentives/Support Mechanisms	Main mechanism for support is Glastir Woodland Scheme offering support for Creation and management of woodlands. Wales Forest Business Partnership is a govt. funded business led group promoting the advancement of the wood industry in Wales. UK govt. RHI and FIT provide support for biomass heat and electricity generation. The WEBS2 scheme has supported wood energy related schemes in Wales covering both heat, CHP and Fuel production facilities. It is however now closed to new schemes.	Subsidies for the support of : ▪ Regional reforestation (e.g. Bavaria and Thuringia) ▪ R&D projects at the Federal level – 'Expert Agency for Renewable Raw Materials' ▪ Firewood burner (wood gas), pellet and wood chip furnaces ▪ Use of thermal insulation derived from renewable raw materials ▪ Energy supply from renewable resources (EEG). Governments also promote the forestry and forest products industry in Germany to form formal clusters, mainly at a State level.	▪ State-funded advisory service for forest owners ▪ RDP funding to support the forestry sector ▪ Strategic Investment Fund for Wood for development and consolidation of companies across the value chain. ▪ Grant to modernise and revive the competitiveness of sawmills. ▪ Contribution Volontaire Obligiatoire – a voluntary but mandatory tax across the timber value chain, which is used to promote development across the sector. ▪ Initiatives to promote greater use of wood in construction – including public procurement guidance and branding.	Grant Support is available for ▪ Afforestation ▪ Woodland Improvement ▪ Woodland reconstitution ▪ Native Woodland Establishment ▪ Forest Environmental Protection Scheme. ▪ Creation of forest roads. A number of training initiatives are funded by the state : ▪ Teagasc provides training and advisory services to the farm forestry sector. ▪ FTEI manages a skills training programme ▪ Specific schemes for Native Woodland and Landscape design. Investment by the state of €82.94m in the panel industry and €24.32m into Sawmilling. (1980-2012) Investment into forest sector research is around €14m per annum including COFORD €4m pa

Case study – Germany

The formation of clusters in most states has been supported by local government to enhance the activities of the forest´s productivity by connecting various stakeholders in local regions in order to create a higher added value and jobs. By EU-definition “Clusters are powerful engines of economic development and drivers of innovation in the European Union. They provide a fertile business environment for companies, especially SMEs, to collaborate with research institutions, suppliers, customers and competitors located in the same geographical area.” Starting in 2003 state governments supported this development by funding advice to the companies seeking to become part of a cluster.

In 2006 the State of Thuringia together with Göttingen University assessed the annual balance between state subsidies and tax revenues. This study shows where subsidized branches of the forestry industry do not give the state a return of the investment but within the context of the cluster, by bringing the stakeholders together who are involved within the value added chain, they maximize a tax return for the state beyond the money spent for subsidies.

Table 2 Subsidy and Tax Balance of German Forestry Sector

Industry	Tax Income (million €)	State Subsidy (million €)	Balance (million €)	Balance (€per felled m^3 o.b R/W)	Jobs maintained (per $100m^3$ o.b R/W)
Forestry	17.8	34.4	-16.6	-5.56	0.081
R/W Transport	3.2	0.0	3.2	1.08	0.007
Sawmill, Planing and Impregnation	-6.3	3.1	-9.3	-1.92	0.029
Veneer, Ply, Fibre and Board	2.6	2.2	0.4	0.09	0.012
Wood Processing and Craft	187.8	14.7	173.1	58.04	0.875
Pulp and Paper	18.1	4.4	13.7	4.25	0.094
Publishing and Printing	42.5	10.3	32.2	5.41	0.100
Energy from Wood	0.6	0.3	0.3	0.07	0.003
Entire value chain	**266.5**	**69.5**	**197.0**	**61.46**	**1.200**

For example, forest management raised a tax income for the states of €17.9m whilst being subsidized by €34.4m which means that a deficit of €16.6m was generated in one year. The wood processing and wood craft industry however generated €187.8m of tax income with a balance of only getting €14.7m in state subsidy. As a total the tax surplus amounted to €197m after the deduction of all state subsidy for the whole value added chain.[5]

[5]proWald, Sept. 2008, p. 10, Tabelle 1: JährlichesSteueraufkommen und Förderzahlungen …bereinigteSteueraufkommen.

Case Study – Ireland

The Irish have supported the development of private forest estate for an extended period of time through the provision of grants. This has resulted in a significant proportion of young forest cover which is just starting to become available for market which is almost all softwood and predominantly Sitka Spruce. Over the period 1981 – 2012, 250,000ha of new forest have been planted by private forest owners and a vibrant and successful downstream export orientated market has developed for sawn timber, panel and fuel wood products.

Table 3 Planting in Ireland – Grants Applied for, Approved & Planted (Irish Government 2013)

	2009	2010	2011	2012
	Area in Hectares			
Applied for Planting	16,467	25,110	14,043	18,008
Approved for Planting	16,463	19,306	10,551	12,221
Actual Planting	6,648	8,614	6,653	6,652
Actual vs. approved	40.4%	43.1%	63.1%	54.4%

The Irish government target for afforestation rose from 10,000 ha pa 2005 – 2010 to 14,700ha for 2011 onwards as a commitment of the National Recovery Plan of 2010. Despite significant interest in the afforestation grant scheme by landowners, investors and farmers (as per the table left), the afforestation target has now been missed (see below) by a significant margin since 2006.

Table 4 Afforestation Rates in Ireland (Irish Government 2013)

Year	Ireland Afforestation (ha)				
	State	Private	Total	Target	Var.
2005	64	10,032	10,096	10,000	+96
2006	25	8,012	8,037	10,000	-1,963
2007	0	6,947	6,947	10,000	-3,053
2008	67	6,182	6.249	10,000	-3,751
2009	35	6,613	6,648	10,000	-3,352
2010	4	8,314	8,314	10,000	-1,686
2011			6,653	14,700	-8,047
2012			6,652	14,700	-8,048

The Irish Government supports the afforestation grant with an allocation of around €110m - €120m pa. Planting grants essentially cover all planting costs through the first 4 years of the establishment. Annual premium payments are also paid for period of 20 yrs. to cover maintenance costs and provide a level of income from what is a long term investment. The premium payments to Farmers are higher again to compensate for loss of income from agricultural crops. These premium payments effectively provide an overhead to scheme which is included within the total allocation of around €80m. It is unlikely therefore that new afforestation grants beyond the level of around 7000 ha pa currently being achieved.

The original target for Irish forestry was to grow to around 17% of forest cover (1.2m ha) is seriously in doubt without significantly increasing current afforestation rates (to around 25,000 ha pa to 2030 which would be a return to pre 2000 planting levels).This level of forest coverage is a major commitment of the Irish Government in meeting 2 key objectives:

Achieving self-sufficiency in timber and wood fibre for internal use and provide critical mass to support a vibrant wood products industry.

Meeting CO_2 sequestration commitments under the Kyoto protocol.

Table 5: Survey result of landowners not continuing to afforest their land.

Reason	Area (ha)	%
Economic	779.03	20
Un-enclosed land	606.49	15
Environment	585.69	15
Delay to Autumn	495.46	12
Could Not Decide	388.53	10
Bureaucracy	348.3	9
Unconvinced	287.10	7
Legal	270.01	7
Land unplantable	209.62	5
Total	3,970.56	100

Actions are currently being hampered by the general state of the public finances in Ireland and a number of factors identified by the Irish Forestry and Forest Products Association (A cross sector trade association supporting both upstream and downstream timber sectors throughout the value chain) together with a number of short, medium and longer term actions to address these.

Case Study – France,

Formed in 2009 the Centre National de la Propriété Forestière (CNPF-National Centre for Private Foresters) is a national organisation publically funded to support the large number (~3.5m) private forest owners in France. It is an amalgamation of the 18 CRPF (regional organisations set up in 1963) and l'Institut pour le développement forestier. It is the co-ordinating body of the private forest industry in France and has 3 main objectives.

- **Guide** the management of private forests in developing regional patterns of forest management (SRGS), and codes of good forestry practices of private forests (CBPS), as well as accrediting mandatory basic management plans (PSG), or voluntary types or management regulations (RTG), established by cooperatives and forest experts.
- **Advise, improve and train** popularizing silvicultural methods supported by studies and field experiments.
- **Group** developing all forms of owners' associations, including cooperation for the management of forests, the sale of products, the implementation of forestry work or improvement of land structures.

To achieve these objectives it has an action plan to 2016 consisting of 6 work programmes covering 22 objectives as listed overleaf in Fig. 23.

Axis 1
Improving the Mobilistion of Wood

- Objective 1.1 Undetstanding the Resource and the Producers
- Objective 1.2 Improving Land Structure
- Objective 1.3 Developing Strategies For Local Forestry Development (SLDF)
- Objective 1.4 Promote and Support the Pool Of Producers

Axis 2
Increasing the Area of Private Forest Administered by a Document of Sustainable Management (DGD)

- Objective 2.1 Increase the Number and Coverage Of PSG*
- Objective 2.2 Deploy Effective Procedures for approval of PSG under the Environmental Regulations
- Objective 2.3 Optimize Procedures and Training for Approval Of PSG's
- Objective 2.4 Improve Monitoring of PSG Applications
- Objective 2.5 Continuing Development of CBPS and RTG

Axis 3
Developing Knowledge and Innovative Models of Sustainable Forest Management

- Objective 3.1 Enhance the Co-ordination between Scientist and the Transfer of Research to the Industry
- Objective 3.2 Aquire New Knowledge and Skills
- Objective 3.3 Produce Operating Models for Sustainable Forest Management

Axis 4
Disseminate the Progress and Practice of Sustainable Forest Management Techniques

- Objective 4.1 Restructure Information and Training Provsion
- Objective 4.2 Test New Methods of Training and Reaching Wider Audiences
- Objective 4.3 Enhance Coordination between Regional Forestry Development Programmes

Axis 5
Strengthening the Position of the Private Forestry in the Economy, the Regions and Society by CNPF Expertise.

- Objective 5.1 Enter the Work of the Indistry "Forest>Wood" to better understand interactions/markets/opportunites
- Objective 5.2 Assist in the preperation of Regional and National Forestry Policy and Support Implementation
- Objective 5.3 Support Actions for Certifying Forests (PEFC&FSC)
- Objective 5.4 Promote the Sustanainble Forest Management Undertaken by the Private Forest Owners to the General Public

Axis 6
Adapt and modernise the function of the CNPF

- Objective 6.1 Capitalize the expected creation of CNPF profit
- Objective 6.2 Improved monitoring of CNPF activity
- Objective 6.3 Change business practices and services of common interest

Fig. 23 Centre National de la Propriété Forestière – Current Action Plan

Conclusions.

Significant investment has been made in both the forestry sector and downstream processing of wood products by the countries looked at.

A strong emphasis on clustering is prevalent across the 3 countries, recognising that the Value adding steps are in the wood products market as opposed to wood production and primary processing.

Trees and forestry represent a significant national resource and when managed sustainably, economic, environmental and social benefits can all be achieved from the resource.

Interventions need to be planned across sector such that implications are understood throughout the value chain and across the economic, environmental and social outputs.