Circular Biobased Construction in the North East and Yorkshire

MaterialCultures

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Cover image: Material assemblage: Woofibre insulation, JJI Joists, Woodwool board and lime render © Material Cultures 2021

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Executive Summary

The built environment is responsible for almost 40% of global energy-related carbon emissions. If we intend to halt the progress of the climate and ecological breakdown, we must find new ways to design and to build.[1]

Until recently, little attention has been paid to the carbon impacts of construction and refurbishing buildings, with the majority of focus on the operational performance of buildings. Yet our buildings are constructed using materials, components, and products. All of this material has to be extracted from the ground or grown, transported to a facility to be processed, transported again (perhaps numerous times) to be fabricated into a product, transported to site, and craned into place. All of these processes result in the emission of greenhouse gases. This associated embodied carbon makes a significant contribution (30-70%) of a typical building's total lifecycle emissions.

Substituting carbon intensive technical materials with regenerative resources and materials from the biosphere – absorbing and storing natural carbon – has become a key approach to decarbonizing our built environment. The techniques and technologies for bio-based manufacturing and construction are well established, but the infrastructure and frameworks are not established in scale to support them.

The North East and Yorkshire region is well positioned to lead the UK in this shift. Not only could this reduce the overall carbon impact of construction within the region, but it could also produce tangible positive outcomes, including improvements in biodiversity, indoor air quality and the safety, security and desirability of jobs in construction. It could also lead to a range of wider benefits, including the re-shoring of jobs in the supply chain and creation of opportunities for regional investment.

1 Abergel, T. Dean, B and Dulac. J (2017). UN Environment Global Status Report 2017 Towards a zero-emission, efficient, and resilient buildings and construction sector. (ISBN No. 978-92-807-3686-1).

The North East and Yorkshire (NEY) has much of the existing agricultural and industrial infrastructure required to make the shift from carbon-intensive to bio-based construction, as well a wealth of knowledge and skill in the private sector in either appropriate or adjacent areas.

Potential benefits to such a transition can be categorised in three key themes:

1 Protecting the environment

Many local authorities within the North East and Yorkshire Region have signed up to Net Zero targets beyond the national policy requirements, with some targeting Net Zero by the year 2030. To reach net zero by 2030, we need to reduce UK carbon emissions from 420MtC0_2e to around 29MtC0_2e by 2050[2]. This will require a direct reduction in emissions from buildings from around 85MtC02e in 2017 to 4MtC02e in 2050. [3]

The challenge of meeting both house building targets and climate related targets are set to dominate local and national policy in both the short and long term. Appropriately diverse and well managed bio-based supply chains and construction can help to reduce net carbon emissions by locking carbon into the building fabric. So rather than pitting these needs in opposition to one another, new regional-level strategies for nurturing and enabling bio-based supply chains and construction could deliver both better homes and accelerate the push to net zero. Building the number of new homes

2 Stark, C. and Thompson, M. (2019). Net Zero:The UK's contribution to stopping global warming.London: CCC
3 Stark, C. and Thompson, M. (2019). Net Zero:Technical Report.London: CCC

required in the NEY region over the next 17 years using biobased materials could save up to 2.88 megatonnes of $C0_2$.

Beyond reductions in carbon emission in shifting from conventional to bio-based supply and construction methods, there are also a wider range of ecological benefits that could be realised. Crops required for bio-based methods can include deliberate bio-diversity gains and improved soil quality through mixed and rotational cropping, smaller scale production and local processing.

2 Driving economic growth

To meet the growing housing need within the NEY region, over 520,000 new homes need to be built and 2.8 million homes retrofitted[4] over the next 15 years. There is a strong economic argument for developing the regional supply chains around the provision and application of locally produced materials. A growing biobased industry would bolster the regional economy and support agriculture, manufacturing and construction whilst generating new skills, opportunities and jobs. A shift from current supply chains and methods to regionally grown and processed biobased construction in the delivery of these homes could generate up to £1.9 billion, with the gross value added to the economy having the potential to reach £14.8 billion. Even a partial shift would have a profound economic impact on the region.

3 Improving Human Well-Being

With the UK population spending on average around 80-90% of their time inside buildings, and up to 65% of their time in their homes[5] indoor air quality is increasingly recognized as a critical health determinant, not just in developing countries, but also in the UK and EU. Many indoor air pollutants are related to chemicals that are emitted from the products that are required to finish a range of commonly used construction methods, but which can readily be designed out of bio-based buildings. Other sources of pollution that affect general population human health include dust from industrial processing, heavy vehicle road traffic used in high volume haulage and dust and debris as well as noise pollution from demolition. Biobased construction, supply chain and improved building life cycle planning has the potential to significantly reduce all of the above.

Increasing jobs in biobased construction and supply chains could result in contractors being exposed to fewer contaminants during construction and many jobs being moved off site. Off-site jobs can be up to 80% safer[6] with working conditions often significantly improved. Finally, landscape and biodiversity improvements can have a positive impact on human well-being. Some of these will be local benefits but it is worth remembering that regional change could have national impact.

This report presents an overview of the current biobased materials construction industry in the NEY region and explores the potential to scale. If a measure of these proposals are implemented, the North East and Yorkshire could be at the forefront of an urgent and effective decarbonisation of the built environment within the UK.

4 Wheeler, J. Huggett, E. and Alker, J. (2016). Health and Wellbeing in Homes. London: UK Green Building Council
5 Dimitroulopoulou, S. Shrubsole, C. Foxall, K. Gadeberg, B and Doutsi, A. (2019). Indoor Air Quality Guidelines for selected Volatile Organic Compounds (VOCs) in the UK. London: Public Health England, page x - x

6 Krug, D. Miles, J. (2013) OFFSITE CONSTRUCTION: Sustainability Characteristics

1

The North East and Yorkshire today

While numerous examples of biobased construction exist within the North East and Yorkshire today, they remain a small proportion of the total construction and renovation projects within the region. Projects such as LILAC[1], and the Climate Innovation District by CITU[2] in Leeds, and the work of Native Architects in York[3] all demonstrate how biobased architecture can be applied at scale, and provide comfortable and affordable homes.

Like the rest of the UK, the NEY is preparing for the challenges of the climate crisis. Within the region, 19 local authorities have declared a climate emergency[4], with varying target dates for these plans. This demonstrates a collective ambition to surpass the national net-zero target date of 2050, with many aiming to reach this target significantly earlier, some as soon as 2030.

Over the last few decades, the region has seen significant decline in many of the industries that made it the centre of the industrial revolution. Coal, steel, iron, and textiles were powered by the region's rich mineral and natural resources. However, industrial decline has created some of the most deprived areas in the country, many of which are in urban centres (although some sit in rural locations). The iron mines of Redcar and Cleveland created many jobs, eventually evolving into the steel mines that shut their doors in 2015. Similarly, at their peak in 1920 the Northumberland and Durham Coalfields employed between 60,000 and 170,000 people,[5] having fallen to only 190 today.[6] Between 1981 and 2004, 107,000 jobs were lost in coal mining.[7] This accounted for 27% and 32% of total male job

1 See Case studies, Section 8.8
2 See Case studies, Section 8.3
3 See Case studies, Section 8.9
4 Local authorities within the NEY to have declared a climate emergency so far are: Barnsley (2045), Bradford (2038), Doncaster (2040), Durham (2050), Gatehead, Harrogate (2038), Kingston Upon Hull (2030), Newcastle Upon-Tyne (2030), Northumberland (2030), North Tyneside (2050), Redcar & Cleveland (2030), Rotherham (2025), Ryedale (2050), Scarborough (2030), South Tyneside (2030), Sheffield (2030), Sunderland (2030), York (2030), Leeds (2030)
5 Statistics at 60,900 and 170,600 (Northumberland and Durham),refer to: Coal Mining Industry Northumberland and Durham. Retrieved September 27, 2021 from https://api.parliament.uk/historic-hansard/written-answers/1927/jul/11/coal-mining-industry-northumberland-and
6 Musariri, D. (2020). Here's where the UK's last remaining mines are still being operated - and where others are planned. Retrieved September 27, 2021, from https://www.nsenergybusiness.com/features/coal-mining-uk/
7 Twenty Years on: Has the Economy of the UK Coalfields Recovered?. Environmental and Planning A: Economy and Space 2007, V39(7), pages 1654-1675.

Figure 1.1: The industrial heritage of Yorkshire is still evident in the urban fabric as demonstrated in Leeds

losses in the Yorkshire and Northumberland coalfield regions respectively. Of these lost jobs, 83% have been replaced in the Yorkshire Coalfield. However, additional jobs losses have occurred in this sector in the Northumberland Coalfield area, including right up to 2004.

The rural area of East Riding of Yorkshire has some of the highest levels of deprivation in the region. However, it is also ideally located for biobased feedstock production, in particular hemp, which is being grown effectively by East Yorkshire Hemp,[8] and numerous farmers involved with the work of the Carbon Farm. Expanding the region's capacity to produce and utilise biobased construction materials would help tackle inequality within the region. Biobased feedstocks would aid this process by providing lucrative farming opportunities in rural areas, as well as contributing towards the number of processing and construction jobs across Yorkshire and the North East.

Innovative research centres already exist across the region. They are commonly nestled amongst university institutions, such as in York, Sheffield Hallam, Northumbria, and Newcastle. Furthermore, BioVale, the BioRenewables Development Centre, Yorkshire Environmental Sustainability Lab, and the Hub for Biotechnology in the Built Environment all work alongside the construction industry. All of these groups are aiding innovation in biobased construction by helping the development of new products and technologies. These groups are complemented by the emerging networks of the Supply Chain Network, Grow Yorkshire, and Yorkshire Circular Lab, who are playing an important role in connecting stakeholders across the biobased supply chain to ensure fast and efficient sharing of knowledge. Construction colleges within the region currently offer some natural material and biobased courses, such as those at the

8 East Yorkshire Hemp have produced yields of up to 9.5 tonnes p/ha significantly higher than the average of 4-5 tonnes p/ha, detailed in interview on 21st Aug. 2021

Figure 1.2 : The rich and verdant landscape of Yorkshire

Construction Skills Village in Scarborough, and Hull College, with Todmorden Learning Centre soon to follow. However, all of these institutions are held back in differing ways. This is mostly due to lack of funding to support teaching, the prohibitive cost of resources, and a lack of curricula that focus on sustainable modes of construction.

The rich industrial history of the region is inseparable from the landscape. It is the streams and rivers that powered the mills, and coal drawn from the ground that powered the industrial revolution. Through the increased cultivation of biobased feedstocks, this landscape could renew productivity within the region, doing so in sustainable and ecological ways. Increase in timber growth can help to improve biodiversity and also alleviate the risk of flooding. Similarly, the expansion of hemp cultivation can provide the region with a profitable break crop which would also help to reduce fertilisers, fuel costs, and labour hours associated with maintenance.

Located at the centrepoint of the UK and flanked by the long North Sea coast line, containing the large ports of Hull and Middlesborough/Hartlepool, the NEY is a strategic location for both domestic and international exports. This could be utilised to transform the region into a global hub for the manufacture of biobased construction materials.

As with other regions of the UK, the NEY is facing a housing crisis. Addressing this challenge through the use of biobased construction materials can create new jobs in locations where they are needed, while simultaneously reducing the region's carbon footprint, accelerating its route towards net-zero.

Figure 1.3: Increasing pressures within the thriving centres of cities such as Leeds are increasing housing demand across the region

Settlement in the NEY

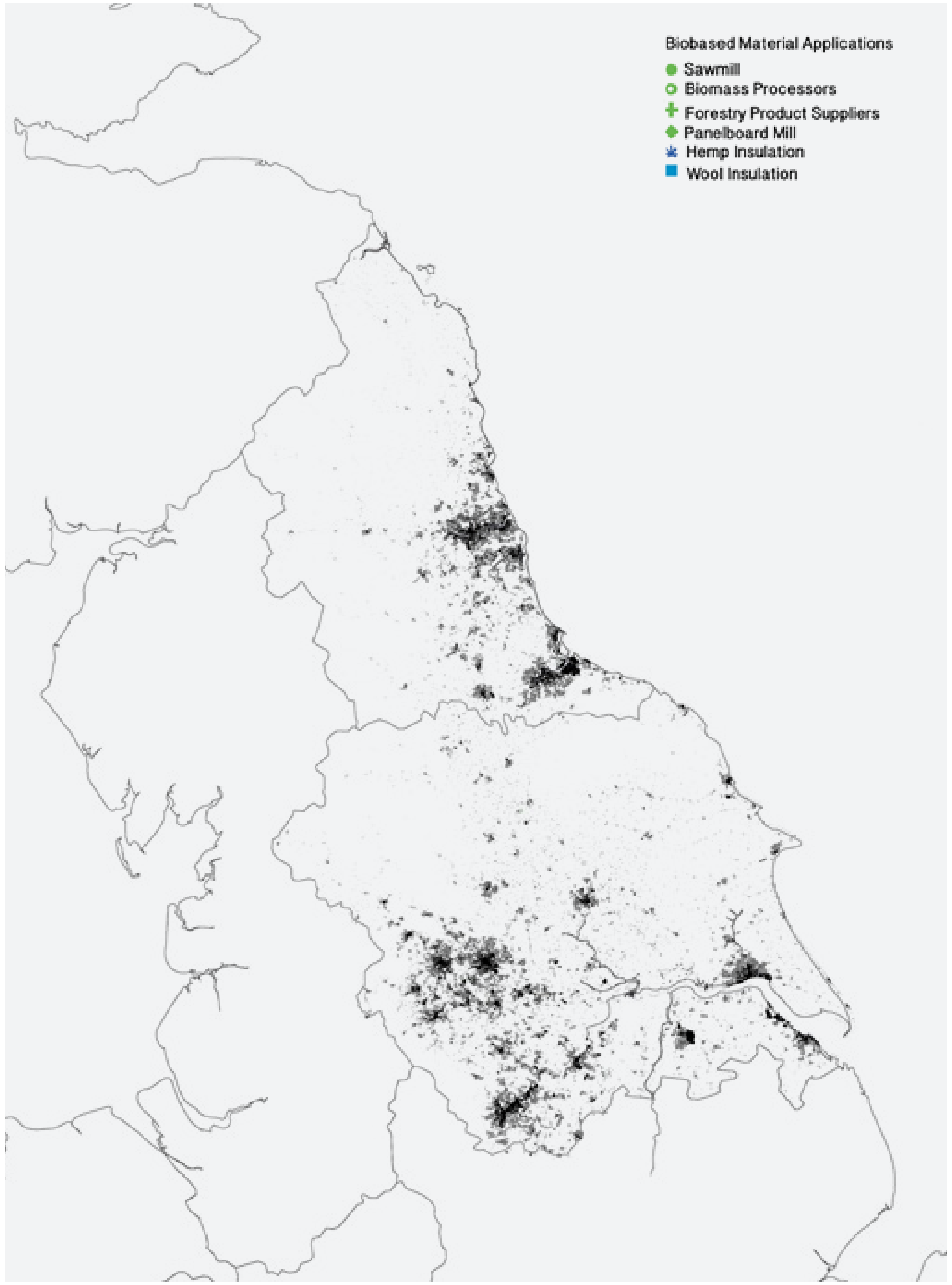


Figure 1.5: Settlement in the North East is concentrated around the Tyne, Wear and Dee rivers, while in Yorkshire around the Humber Estuary and inland around the industrial urban centres of Leeds and Sheffield

Woodland in the NEY

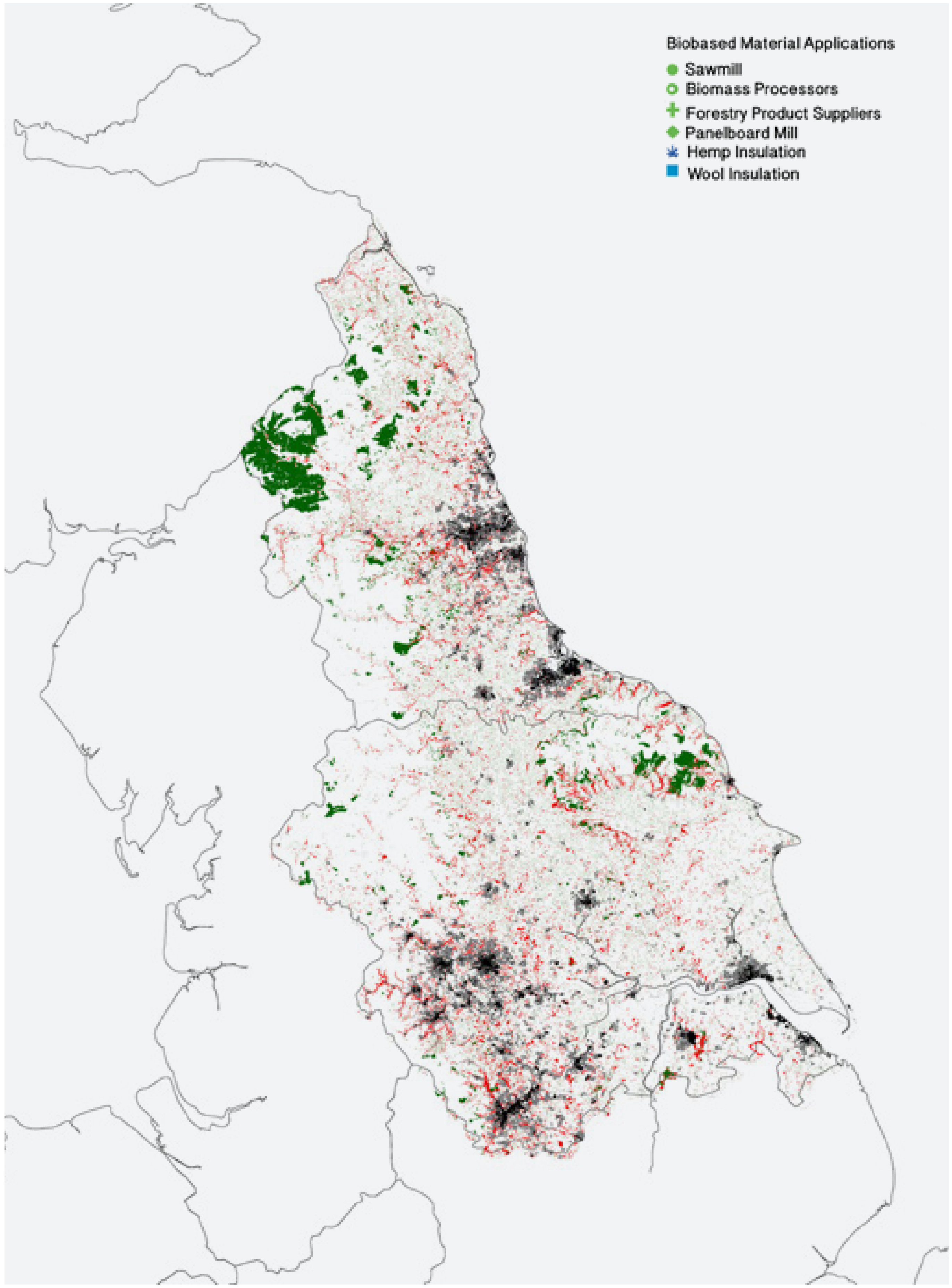


Figure 1.6: Conifeerous woodland is concentrated in the North East towrds the Scottish Border and in North-East Yorkshire towards the coast. Broadleaved woodland is spread throughout the region, less common in the higher, wetter land to the west

Pastoral land in the NEY

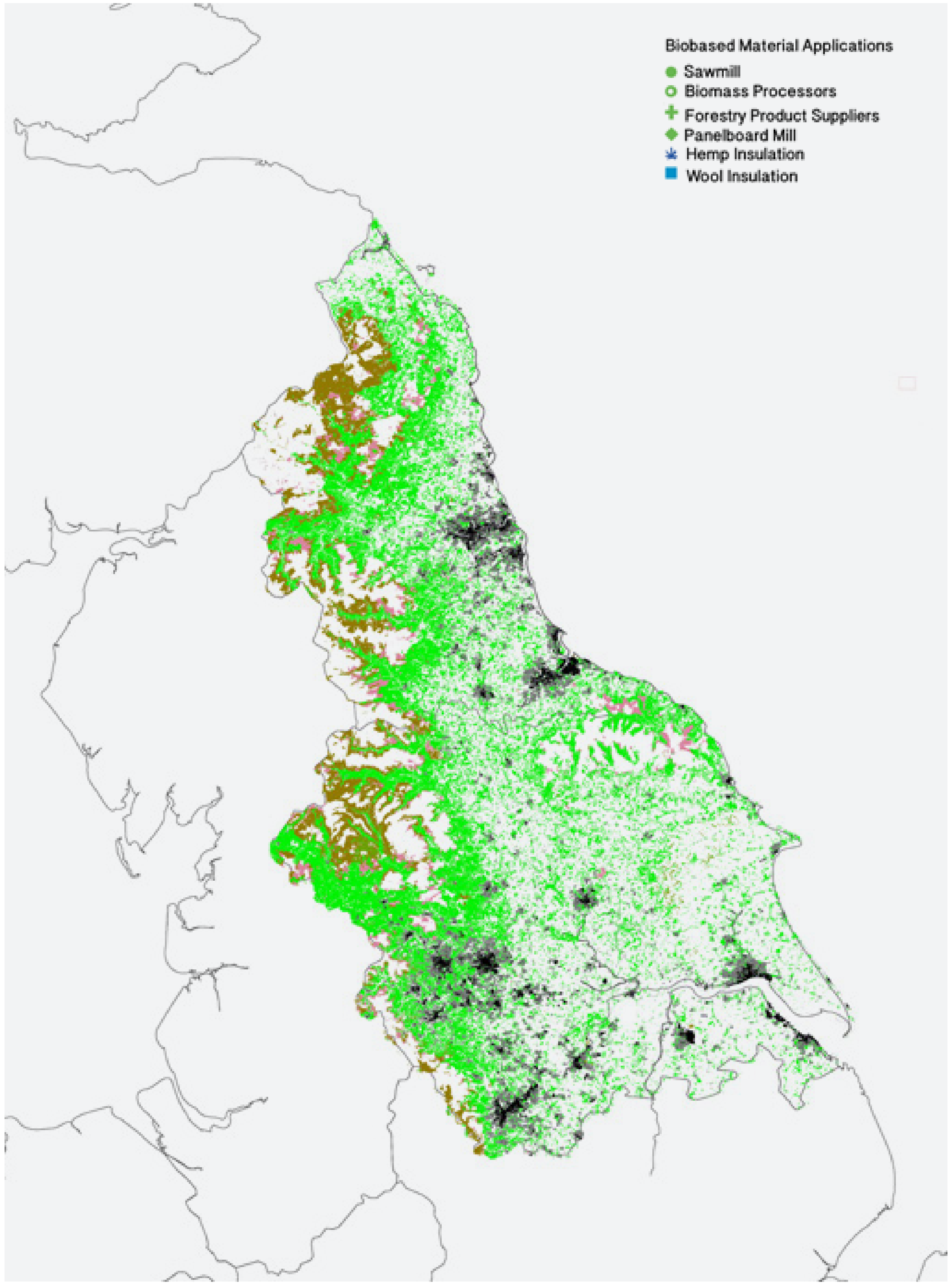


Figure 1.7: Grazing land exists throughout the region but is concentrated to the higher terrain to the west of the region, where sheep farming is common

Arable land in the NEY

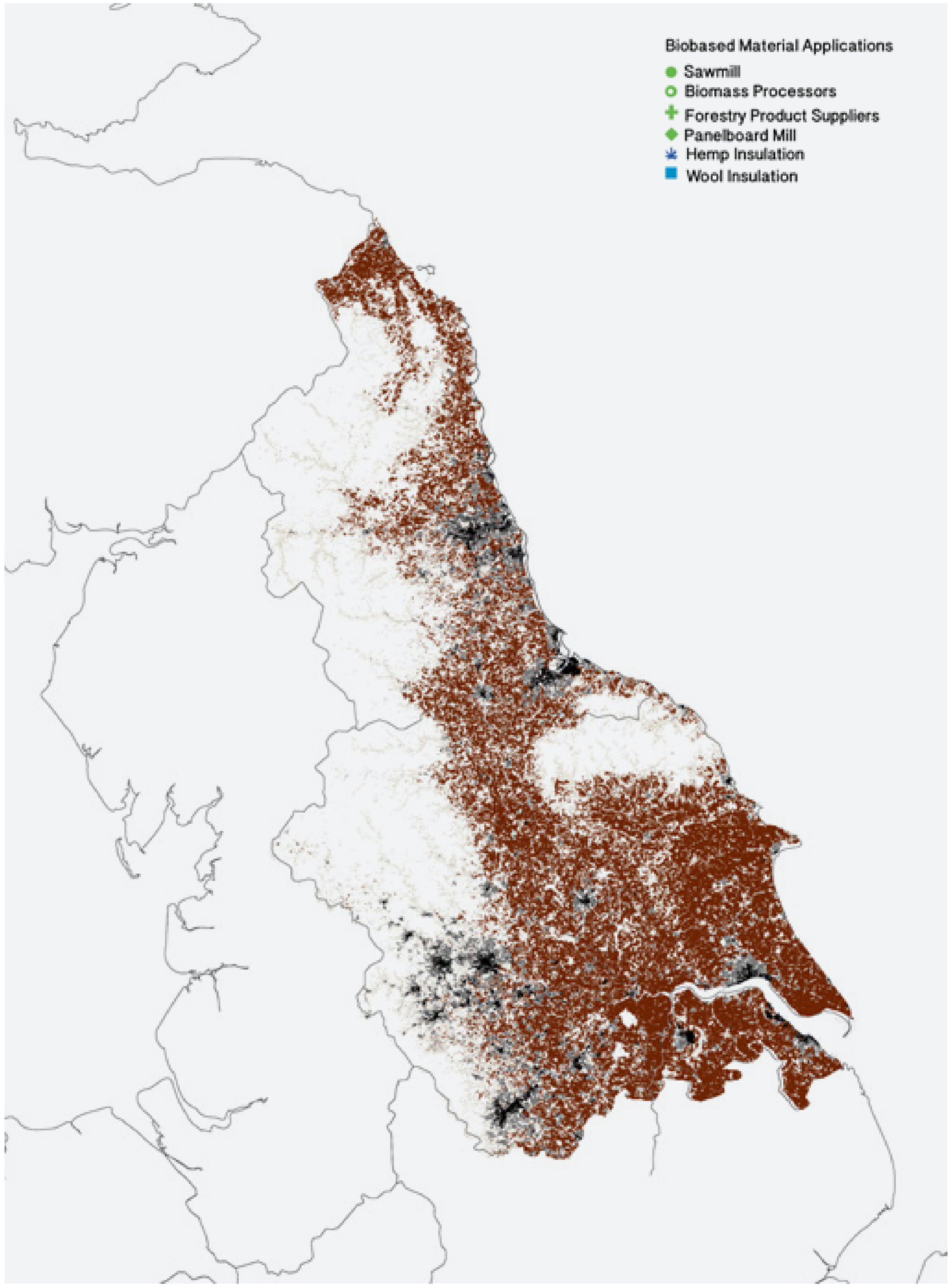


Figure 1.8: Arable farming is common in the lower flatter land towards the eastern North Sea coast. The large and important wheat producing area of East Riding of Yorkshire can be seen to the south east of the region below the higher Yorkshire Moors that appears white

2

What are biobased materials?

Biobased materials are those that are derived from living organisms such as plants, which have been processed into a functional product. Biobased construction refers to the use of such materials and their application and use in construction. It is increasingly considered an effective means of decarbonising the building industry.

Not all biobased materials used in construction are grown and harvested specifically for that purpose. A biomaterial input could be a by-product, waste from another manufacturing process, or even recycled material. In general, the use of waste, recycled, or by-product materials is preferable to virgin materials grown specifically for the purpose. This is because the use of these existing materials simultaneously increases efficiency and minimizes the need for production of new materials. Examples of recognised biobased materials in construction include timber (used in multiple applications), hemp (commonly used as a plant-based aggregate and insulative material), straw (typically wheat straw, the stalk of which is a waste material) or wood-fibre (used as sheathing and insulation board).

Biobased materials can take many forms and perform different roles, with the required levels of initial processing varying with each material and application. Other materials that fall into this category might include sawn softwoods or manufactured plywood, cross-laminated timber and other plant fibre insulations, to name a few examples.

Biobased materials are not new. They have been used in construction for thousands of years. We can draw from this inherited knowledge as the biobased material industry grows. It’s only in the wake of the development of the petrochemical industry that they fell out of use. However, biobased materials are neither old-fashioned nor antiquated, they can offer contemporary solutions to the design problems of today.

Figure 2.1: Material assemblage: Woofibre insulation, JJI Joists, Woodwool board and lime render

2.1 Biobased materials have low-embodied carbon

The sum of all the greenhouse gas (GHG) emissions associated with the production, use and disposal of a material/product is known as it's embodied carbon.

One major benefit of biobased materials, particularly those grown from plants, is that the plant may absorb carbon dioxide (CO2) while growing. This sequestered CO2, also referred to as biogenic carbon, is then trapped in the material when it is harvested. When the biogenic CO2 sequestered by a biomaterial is greater than the fossil CO2 expended in its harvest and processing, the biomaterial can be considered carbon negative. The same effect can occur for an entire product, rather than just one of its material inputs, if the sequestered CO2 outweighs that expended not only in material harvest and processing but subsequent manufacture and product distribution. It must be noted that sequestered carbon needs managing at end-of-life. End-of-life options include reuse, recycling, biomass energy extraction through combustion or landfill. The sequestered CO2 will be released if the material is sent to landfill or burned for energy, and further GHG emissions may occur.

Choice of end-of-life option may be limited by chemical adhesives, preservatives and coatings.

Figure 2.2: East Bros Timber Yard, Wiltshire (above)
Figure 2.3: Flat House, Cambridgeshire (overleaf)

Biobased materials sent to landfill will retain only a small fraction of the carbon sequestered during growth of the material.

Additionally, construction materials made from plants or crops generally require much less energy in their production than more conventional materials, such as aluminium, concrete and steel. Accordingly, biobased materials typically have a low embodied carbon. The embodied carbon of different construction materials, both biobased and otherwise, are shown in Figure XX.

Biobased materials may also contain non-biological material components, e.g. as a binder.[1] These may negatively impact the environmental profile of the materials, not only because they may be petrochemical based and have a high associated embodied carbon, but also because they may negatively impact the recyclability or compostability of the material at end-of-life.

1 A substance used to hold material particles to one another and create a uniform consistency or surface

2.2 Biobased materials can create healthy environments

The health benefits of using biobased materials can be realised across the supply chain, from people involved in their production and application, to the end-users of spaces they create.

The topic of Indoor Air Quality in the UK is gaining increasing public attention. In September 2019, the government conducted a review to propose guidelines to improve population health and raise awareness of selected volatile organic compounds (VOCs) in UK homes and offices. In their use within buildings, biobased materials can contribute towards creating a healthy indoor air quality. In conventional construction, issues often occur as a result of moisture being trapped in between materials, causing issues of mould and rot within the inside of the wall. Biobased construction is predominantly breathable,[2] or moisture permeable, enabling moisture to pass in and out of the building, which in turn helps to regulate humidity and air quality within the home. One factor influencing Indoor Air Quality is contaminants introduced by materials and fittings in the home, including volatile organic compounds (VOCs), Endocrine Disrupting Chemicals (EDCs), and mould. The presence of VOCs and the associated health risks in residential and public buildings are well reported.[3] VOCs are widely used in construction and building products like paints, varnishes, adhesives, solvents and flame retardants. Whilst these contaminants are not emitted from the palette of materials which this report analyses (namely: structure, insulation, lining boards), the use of paints, solvents and adhesives are commonly applied to or used with conventional construction materials.

As well as the benefits to their inhabitants, biobased materials have implications for the health and well-being of construction workers. Yorkshire-based insulation manufacturer Thermafleece report that “Unlike their direct competitors, materials like sheepswool and hemp batt insulation are harmless and can be installed without gloves or protective clothing, nor are they irritating to the skin, eyes or respiratory tract”.[4] As these materials are safer for the occupant to maintain and adapt, there are therefore positive benefits for both the builder and the inhabitant.

2 Breathability is the ability of a material to allow passage of moisture in order to prevent the accumulation of harmful water within the building fabric or its surroundings.

3 Vardoulakis, S. Giagloglou, E. Steinle, S. Davis, A. Sleeuwenhoek, A. Galea, S.K. Dixon, K. and Crawford, O.J. (2020). Indoor Exposure to Selected Air Pollutants in the Home Environment: A Systematic Review. International Journal of Environmental Research and Public Health, V17(8972), pp 2-24.
4 Thermafleece: Nature's finest insulation. Retrieved September 27, 2021, from https://www.thermafleece.com/product/thermafleece-natrahemp

2.3 Biobased materials can support a circular economy

When sustainably and responsibly sourced, biobased construction materials can be described as renewable. In the context of biobased construction, renewable materials are those that can be harvested and regenerated within years or decades rather than the centuries or longer associated with non-renewable bio-materials, such as specific hardwoods.

If biobased materials can be sourced locally, their use can also reduce the transportational carbon impact associated with the construction of a building, further reducing the environmental impact. This emphasis on the sourcing of local materials also brings with it additional benefits, such as creating local employment, helping to retain economic value in the region, and supporting diverse economic distribution across the supply chain.

At the end of a use cycle, such as when a building is dismantled, materials such as timber can be used again (sometimes in the same application). They can also be transformed into new materials, such as an insulation or structural timber board. At the very end of a life cycle, when no further recycling is practically or economically possible, these materials can be burnt to create energy, with any waste product returned to the soil as fertiliser.

Although biobased materials may primarily be made from biological material, this does not necessarily make them biodegradable. Whether a biobased material can be biodegraded depends on the other materials to which the biological content is bound and the nature of this bonding. In order to biodegrade, biological content must be separate from non-biodegradable materials. In some cases, such as where biological and non-biological materials have been blended together or combined with mineral additives, this may not be possible.

Figure 2.4: Biobased materials can return to the ground (above)
Figure 2.5: Hemp cultivation on Margent Farm, Cambridgeshire (overleaf)

2.4 Biobased materials can be grown alongside existing crops

Increasingly farmers across the UK are turning to more diverse methods of farming that involve the growing of numerous different crops in closer proximity to one another. This diversification could offer alternative revenue streams, as well as benefits to ecology and biodiversity. Biobased materials can be grown in this way alongside existing crops—and in the case of hemp, have been shown to increase yields of follow on crops.[5]

Increasingly, farmers are turning to growing shelter belts, hedgerows or infield trees in order to generate new revenue streams, as well as providing health benefits for grazing livestock. This practice of silvopastoral agroforestry can provide domestic animals with benefits, including shelter and shade, as well as supplementing their diets with tree browse or fodder. A recent study by the Woodland Trust demonstrated that amongst other plants, willow can be considered good source of a number of key minerals for livestock which are otherwise deficient in grass.[6] A recent innovative twelve year trial into Silvopasture aims to demonstrate that greater variety of cropping within fields yields greater biodiversity that benefits both the wider ecosystems, as well as improving crop yields.[7]

Hedgerows, trees and shelter belt woodland can be used in the manufacture of woodfibre insulation and sheathing materials. Crops like hemp can be grown in rotation with other crops, helping to improve soil structure and nutrients with their particularly deep tap-roots. Hemp is therefore a valuable biobased construction material, with applications in insulation and board manufacture. Yorkshire based business East Yorkshire Hemp state that hemp has great benefits as a rotational crop for improving yields of follow-on wheat crops, as well as for increasing biodiversity—it does not need pesticides. This has a noticeable impact on insect and bird life.

5 Gorchs, G. Lloveras, J. Serrano, L and Cela, S. (2017). Hemp Yields and its Rotation Effects on Wheat under Rainfed Mediterranean Conditions. V109(4), pages 1551-1560
6 N.R. Kendall, J.Smith, L.K. Whistance, S. Stergiadis, C. Stoate, H. Chesshire and A.R. Smith, 2019. Tree leaves as supplementary feed for ruminant livestock. Woodland Trust Research Briefing.
7 Innovative Farmers. (2021). Twelve year field lab into the benefits of Silvopasture launched. Retrieved September 24, 2021, from https://www.innovativefarmers.org/news/2021/february/18/twelve-year-field-lab-into-the-benefits-of-silvopasture-launched/#:~:text=The%20new%20field%20lab%2C%20involving,of%20integrating%20trees%20and%2-0livestock.

3

Biobased construction in the region

The NEY has a strong bio-based feedstock growing and processing base, with potential for these burgeoning businesses to grow. With the right support, the region can become a national leader in the use and production of low-embodied carbon construction materials.

As this chapter illustrates, over 500,000 new homes need to be built in the NEY region over the next 15 years[1]. A regional transition towards the supply and installation of biobased materials could generate between £0.5 billion to £1.9 billion per year. This equates to 10-36% of the region's total economic output of the region's housing sector. The total value of the output generated for the region through the supply and installation of biobased materials over this time could range from £4.3 billion to £14.8 billion. A growth of this scale would not require great change to existing land uses. Only 3.5 kha of additional woodland would need to be harvested every year to meet the region's timber supply needs, beyond that already proposed by the North and West Yorkshire Emissions Reduction Pathways Report,[2] which proposed that forest area within the region should increase by 37 kha by 2038. What is crucial is for this afforestation to be implemented more rapidly, and to develop productive woodland alongside national parkland. A culture of sustainable forestry needs to be cultivated over the next decades to supply and source the new biobased industry. This will involve promoting positive public attitudes towards the necessary softwood species required to meet these targets.

The NEY has a temperate climate, an ample supply of rainfall, and fertile, flat arable land on which to grow biobased crops. The NEY is home to 1760 kha of farmed land, representing around 19% of the UKs total. Arable farming makes up 32%

1 See Appendix 9.4 for Local Authority housing projections
2 By 2024, In the Max Ambition Scenario Published in February 2021, in line with the Northern Forest and White Rose Forest Initiatives. In the report it is proposed that the forest area within the region increases by 37 kha, from 54 to 91 kha by 2038.

Figure 3.1: Afforestation initiatives are being enacted within the region such shown in the partnership between Broughton Sancturary and White Rose Forest

of the total farmed area in the NE and 52% in Yorkshire. The agricultural industry is also a significant employer within the region: 32,000[3] people are employed in agriculture in Yorkshire and 10,000[4] in the NE. Increased use of biobased materials has the potential to provide additional local jobs, particularly further down the supply chain in processing and manufacturing of construction materials, and in construction itself.

The NEY is already a significant grower of grain crops, such as wheat, that can be used for straw in construction. It is also the producer of 35-40%[5] of the UK's homegrown hemp. The addition of more hemp to the landscape as a rotational crop can provide direct biodiversity benefits, improving the soil as well as delivering potential economic benefits. To provide enough hemp fibre for all new build homes within the NEY, 207 kha[6] of land is required to be given over to hemp cultivation every year as a rotational crop. This would replace existing summer rotational crops such as Oil Seed Rape, which at present is under serious threat from pests such as the Cabbage Stem Flea Beetle[7]. If an additional area of approximately 5.5 kha[8] of land is given over to the growth of hemp during the summer months, the NEY could become a significant national supplier and even a global exporter of hemp, generating an industry worth millions of pounds[9].

Across the region, new-build housing and the retrofit of existing homes over the next 15 years represents a significant spend. However, the NEY suffers from a Construction Skills gap, exacerbated by an ageing workforce.[10] More skilled labour

3 32,397 – Department of Environment & Rural Affairs, 2021. Defra Statistics: Agricultural Facts England Regional Profiles. Tork: Defra, p.15.
4 10,610 – Department of Environment & Rural Affairs, 2021. Defra Statistics: Agricultural Facts England Regional Profiles. Tork: Defra, p.7.
5 Gough, E. (2021). Yorkshire Hemp Supply Chain Map. Nantwich: Promar International Ltd, page 2.
6 See Appendix, Section 9.5 for Land Use Calculation Methodology
7 Thursfield, L. (2019). What is the Cabbage Stem Flea Beetle? Retrieved September 27, 2021, from https://www.jic.ac.uk/blog/oilseed-rape-and-the-cabbage-stem-flea-beetle/
8 5.5 kha refers to projected hemp growth up to year 5, Section 3.7: Strategic Plan
9 Based on information in the Yorkshire Hemp Supply Chain Map (above), the UK imported c. 100,000 tonnes of hemp products in 2019 at a value of £150 million. This provides an indicative value of hemp of £1,500/tonne. Yields of 4.5 tonnes/ha from 5 kha could therefore possess a value of somewhere in the region of £33 million.
10 Saini C., El-Haram M. and Bennett M. (2018). Construction Skills gap analysis for the York, North Yorkshire & East Riding area. Norfolk: CITB, and Construction Industry Training Board. (2017). Industry Insights Construction Skills Network Forecasts 2017-2021.

Figure 3.2: As a rotational crop, Hemp can provide direct biodiversity benefits, improving the soil as well as delivering potential economic benefit

is required to meet this housing need. Furthermore, secure jobs will need to be provided for the region to retain this labour force. With support, colleges in the region, such as the Construction Skills Village and Hull College, could develop courses on the use of new biobased and low-embodied energy construction materials.

There are already leading examples of biobased housing and development in existence across the region. Examples include: LILAC, a co-housing community of timber frame and straw bale insulated homes in West Leeds; and CITU, exemplary prefabricated and sustainably minded developers and contractors working in both Leeds and Sheffield. For the NEY to lead the way in sustainable housing and construction nationally, the region needs strong support in best practice housing design and development. The rest of this chapter outlines how new biobased materials can be implemented in housing construction at a regional level, and how the manufacturing capacities of the region can be expanded to make the NEY a leader in the production of these materials.

Figure 3.3: The LILAC co-housing community in Leeds exemplifies the possibilities of contemporary straw construction

3.1 Housing and construction need

Direct greenhouse gas (GHG) emissions from buildings were 87 Mt CO2e in 2019, accounting for 17% of UK GHG emissions.[11] 27% of which comes from housebuilding. The construction of the average house generates 50 tonnes of carbon[12], but the use of biobased materials can significantly reduce the levels of embodied carbon. It does so by using materials that sequester carbon over their lifetime. This chapter investigates what impact the transition to biobased materials in housing and construction projects would have on the carbon footprint of the NEY. Considering the significant amount of housing development set to take place, and in response to a growing housing need, this is a necessary step towards the region's goal to reach Net Zero Carbon by 2038.

The RIBA 2030 Climate Challenge target metrics set out that by 2025 the construction industry should reduce the levels of embodied carbon within buildings from the current benchmarks of 1200kg/CO2e/m2 to less than 800 kg/CO2e/m2 (RICS modules A1-A5, B1-B5, C1-C4). By 2030 this should be reduced to less than 625kg/CO2e/m2.[13] In order to achieve this 50% reduction of embodied carbon, there will need to be drastic changes.

Through detailed analysis of the locals plans for the 31 local authorities within the NEY, it is estimated that approximately 30,700[14] homes need to be built annually, or 520,000[15] homes by 2038. In embodied carbon terms, and using today's benchmarks, this would generate more than 26 million[16] tonnes of embodied carbon from the petrochemical derived and carbon-intensive non-renewable material palette currently in use.

In addition to the impact of new-build housing on carbon emissions, in order to meet its climate targets the UK aims to retrofit all homes to EPC band C standard by 2035. Only 29% of homes today meet this standard. The remaining 71% represent a significant potential market for the biobased material industry.[17] The North East and Yorkshire (NEY) Energy Hub has received a total of £53.2 million of Government funding as part of Phase 2 of the Local Authority Delivery scheme (LAD 2), which will run until 30 December 2021. Under this programme approximately 5000 homes will be retrofitted by March 2022. There are however between 2.8 million and 3.7 million homes within the NEY which will still require upgrading.[18]

Whilst the retrofit market is significant, there are a number of variables in the assessment and analysis of retrofit projects. This report therefore takes as its basic model the new-build three bedroom semi-detached house, analysing the impact of this generic type of suburban home on the landscape of the region. This analysis is carried out by reviewing the impact of switching out three crucial material applications in the building: structure, insulation and lining.

11 Page 5 of this document https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Buildings.pdf
12 Footnote needed
13 Royal Institute of British Architects. (2021). RIBA 2030 Climate Challenge Version 2, page 9.
14 See Appendix 9.4 for Local Authority housing projections
15 See Appendix 9.4 for Local Authority housing projections
16 (50 times 520,000) Calculations in appendix, cite here (26,056,100)
17 Green Alliance. (2019). Reinventing retrofit: How to scale up home energy efficiency in the UK. London: The Green Alliance
18 Footnote from data from alan millar to be extended

29%

Only 29% of homes today meet the EPC band C standard.

2.8 million

Homes within the NEY need to be retrofitted to meet EPC band C standard.

520,000 Homes required

30,700 homes need to built annually accross the region, or 520,000 homes over the next 17 years.

26,000,000 Tonnes of carbon

Using today's benchmarks this would generate more than 26 million tonnes of embodied carbon.

Figure 3.4: Sheffield

3.2 Three applications of biobased materials in housing

From the ground up, all construction,[19] whether residential or commercial, is predominantly made up of three constituent parts: the structure of the building⍰—its bones, which might be either a lightweight frame or a series of load-bearing walls; the insulation; which gives the building envelope its thermal performance; and the lining materials; which form the internal surfaces of the habitable rooms. As they constitute the bulk of the construction material used in erecting a single house (or retrofitting an existing home), this analysis focuses on these three material applications. The analysis considers the impact of substituting a conventional construction material palette for a biobased one, as well as using materials that are low in embodied energy. It also outlines whether these materials are currently manufactured within the NEY region, or if they could be, with further support, education and the appropriate infrastructure. Within each area of application: structure, insulation, and lining, we have focused on materials which have been employed, sourced or manufactured at scale, representing a balance of tested scalable solutions with positive environmental, social and ecological benefits.

The diagram opposite illustrates the conventional construction palette of a typical three bedroom semi-detached house. This is one of the most commonly built housing types within the UK[20].

Conventionally, this house is built of precast concrete block; insulation materials—in this instance a rigid foam insulation derived from polyurethane; and its rooms are lined with plasterboard made of gypsum.

In Figure [x], the same house is shown constructed from a biobased material palette. Structural timber, whether sawn or engineered, is an efficient, circular and low embodied energy alternative to concrete blocks or steel frame construction. In this instance a timber frame structure is proposed, infilled with both rigid and batt-form biobased insulation, sheathed in new and innovative hemp-lime lining boards. Whilst a bio-based material palette can draw from various feedstocks and express itself in construction in different ways, the biobased home shown here is designed to sit within the existing skillsets of traditional contractors and developers, using forms of construction with which they are familiar and for which no significant retraining is necessary.

19 For the purposes of this analysis the foundations of the home have not been included and they are assumed to be consistent between the 'business-as-usual' model and the biobased model.

20 (https://files.bregroup.com/bretrust/The-Housing-Stock-of-the-United-Kingdom_Report_BRE-Trust.pdf. The UK housing stock is dominated by houses, with over half ((52%) of homes being conjoined (built in terraces or in pairs

A Conventional Structure
Concrete Block

Biobased Structure
Structural Timber

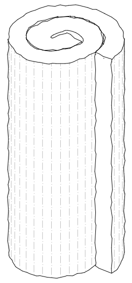
B Conventional Insulation
PIR

Biobased Insulation
Hemp batts

C Conventional Lining
Plasterboard

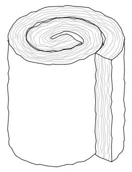
Biobased Lining
Hemp and Lime board

GWP of different building materials



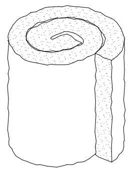
Rockwool[1]
Insulation

GWP ($kgCO_2e/kg$)	0.86
Biogenic carbon	1.28



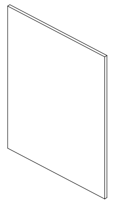
Sheeps wool[2]
Insulation

GWP ($kgCO_2e/kg$)	46.81
Biogenic carbon	-



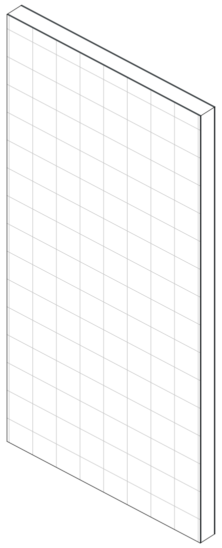
Hemp fibre[3]
Insulation

GWP ($kgCO_2e/kg$)	0.62-1.27
Biogenic carbon	Yes



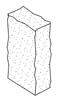
PVC[3]
Other

GWP ($kgCO_2e/kg$)	3.1-3.23
Biogenic carbon	-



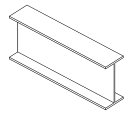
PIR[4, 5]
Insulation

GWP ($kgCO_2e/kg$)	3.1-5.4
Biogenic carbon	-



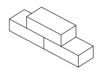
Hempcrete[6, 7]
Insulation

GWP ($kgCO_2e/kg$)	0.22-0.57
Biogenic carbon	Yes



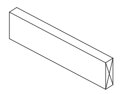
Structural steel[8]
Loading structure

GWP ($kgCO_2e/kg$)	1.55
Biogenic carbon	1.55



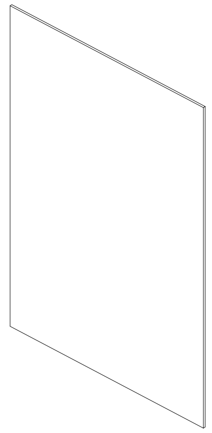
Masonry[8]
Loading structure

GWP ($kgCO_2e/kg$)	0.18 to 0.35
Biogenic carbon	-



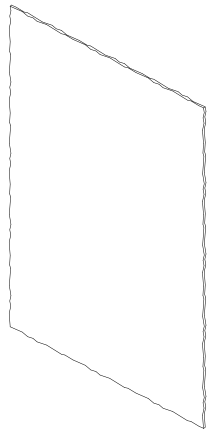
Structural timber[8]
Loading Structure

GWP ($kgCO_2e/kg$)	0.263 to 0.483
Biogenic carbon	-1.53 to -1.55 ($kgCO_2e/kg$)



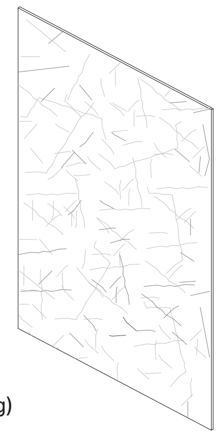
Plaster board[9, 10]
Sheathing

GWP ($kgCO_2e/kg$)	0.16 to 0.23
Biogenic carbon	-



Adaptavate breatheboard
Sheathing

GWP ($kgCO_2e/kg$)	-
Biogenic carbon	Yes



Wood wool board[11, 12]
Sheathing

GWP ($kgCO_2e/kg$)	0.34 to 0.98
Biogenic carbon	Yes

1 Rock wool insulation for ETICS and flat roofs, R=1 m2K/W, L=0.044 W/mK, 44 mm, 0.97 kg/m2, 22 kg/m3, Lambda=0.044 W/(m.K) (Rockwool)
2 Insulation, sheep wool, in bats for ceilings, French average, R=10m2.K/W, L=0.042W/mK, ép. 420mm, Lambda=0.042 W/(m.K), DONNEE PAR DEFAUT
3 OneClick
4 PIR insulation boards, aluminium foil faced, <= 160 mm, L = 0.0215 W/mK, dens. = 32 kg/m3, Various products (Xtratherm)
5 PIR insulation boards, coated, glass tissue faced, 72 mm, L = 0.024 W/mK, R = 3 m2K/W, 2.3 kg/m2, 32 kg/m3, TR27, TT47 (Kingspan)
6 Hemp concrete masonry unit, 300 mm, R = 4.22 m2K/W, 90.75 kg/m2, biogenic CO2 not subtracted (for CML), BIOSYS (VICAT)
7 Hemp masonry unit with lime based binder (hempcrete), packaging included, 390 kg/m3 (IsoHemp)
8 ICE
9 Gypsum plasterboard, high strength, 12.5 mm, 12 kg/m2, 984 kg m3, Habito (British Gypsum Saint Gobain)
10 Gypsum plasterboard, 12.5 mm, 8.985 kg/m2 (average product weight) (Etex Building Performance)
11 Acoustic wood-wool cement panel, 25 mm, 10.4 kg/m2, 400 kg/m3, R=0.3 m2.K/W, biogenic CO2 not subtracted (for CML), Lambda=0.083 W/(m.K), ORGANIC BETON 25mm (KNAUF)
12 Wood wool insulation, lightweight boards, L = 0.08 W/mK, 8-100 x 500/600 x 600-2400 mm, 11.5-12.5 kg/m2, Heraklith Homogeneous (KNAUF)

3.3 'Business as Usual' vs 'Biobased' Home

An embodied carbon assessment of the superstructure of both a business-as-usual and biobased small-scale residential home was carried out. This excluded the analysis of the substructure - the foundations, which are typically concrete and high in embodied carbon. The purpose of the assessment was to estimate the potential carbon emission savings associated with the shift to bio-based construction. The methodology of this analysis can be found in Section 9.2 (Appendix 2).

The analysis considers the 'cradle to gate' emissions of construction materials used in the building's superstructure. A 'cradle to gate' boundary condition considers the impacts associated with the production of a product or material that is ready to ship to the construction site, including emissions from raw materials extraction, transport (excluding transport to site), and manufacturing.

As shown in the schematic, the wall build-up of the business-as-usual home is a masonry cavity wall with a cement-mortar brickwork outer leaf, concrete block inner leaf, PIR insulation, PVC breather membrane and gypsum plasterboard for the internal liner. The exposed roof material is concrete tiling.

The build-up of the biobased home favoured the use of bio-based and lower embodied carbon components over business-as-usual components. The wall build-up of the biobased home consists of a timber frame and timber cladding, wood fibre insulation board, breathable wood based sheathing board, hemp fibre insulation, wood wool insulation, and clay plaster internal finishes.

For the purposes of parity the same concrete foundations were assumed to be used in the construction of both houses. In addition, elements such as windows, doors, etc were assumed to be identical to those specified in business-as-usual construction.

The external wall build-ups of both homes as shown in the schematic provide a U-value of 1.5 W/m²K.

The evaluated global warming potential of the business-as-usual home superstructure is 176 kgCO2e/m2 (A1-A3) on plan. The biogenic carbon sequestered in materials is 66 kgCO2e/m2.

The global warming potential of the biobased superstructure is 134 kgCO_2e/m2 (A1-A3) on plan. The biogenic carbon sequestered in materials is 243 kgCO_2e/m^2.

The biogenic carbon associated with the building may or may not be preserved depending on what happens to the materials at the building's end-of-life stage, as discussed in Section 2 - Biobased materials have low embodied carbon. Assuming all biogenic carbon is preserved at the materials end-of-life, the net emissions associated with the superstructure of the business-as-usual home and biobased home are 110 kgCO2e/m2 and -109 kgCO2e/m2, respectively.

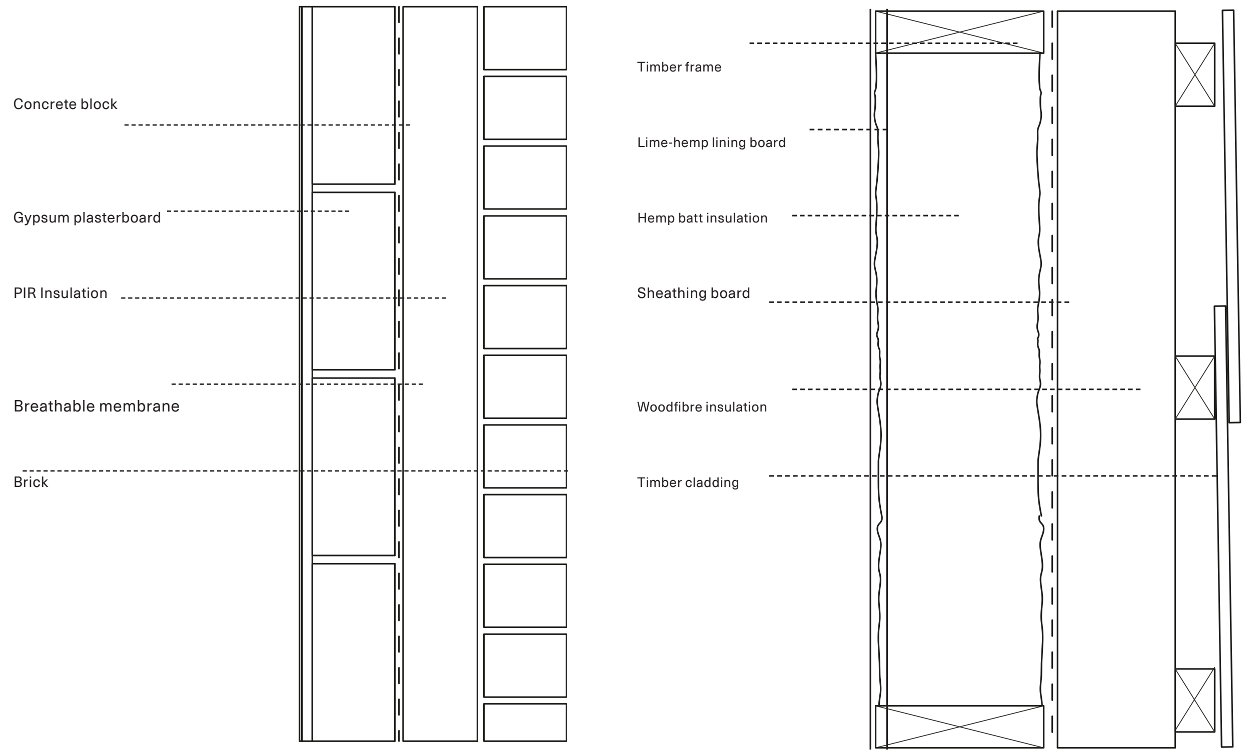
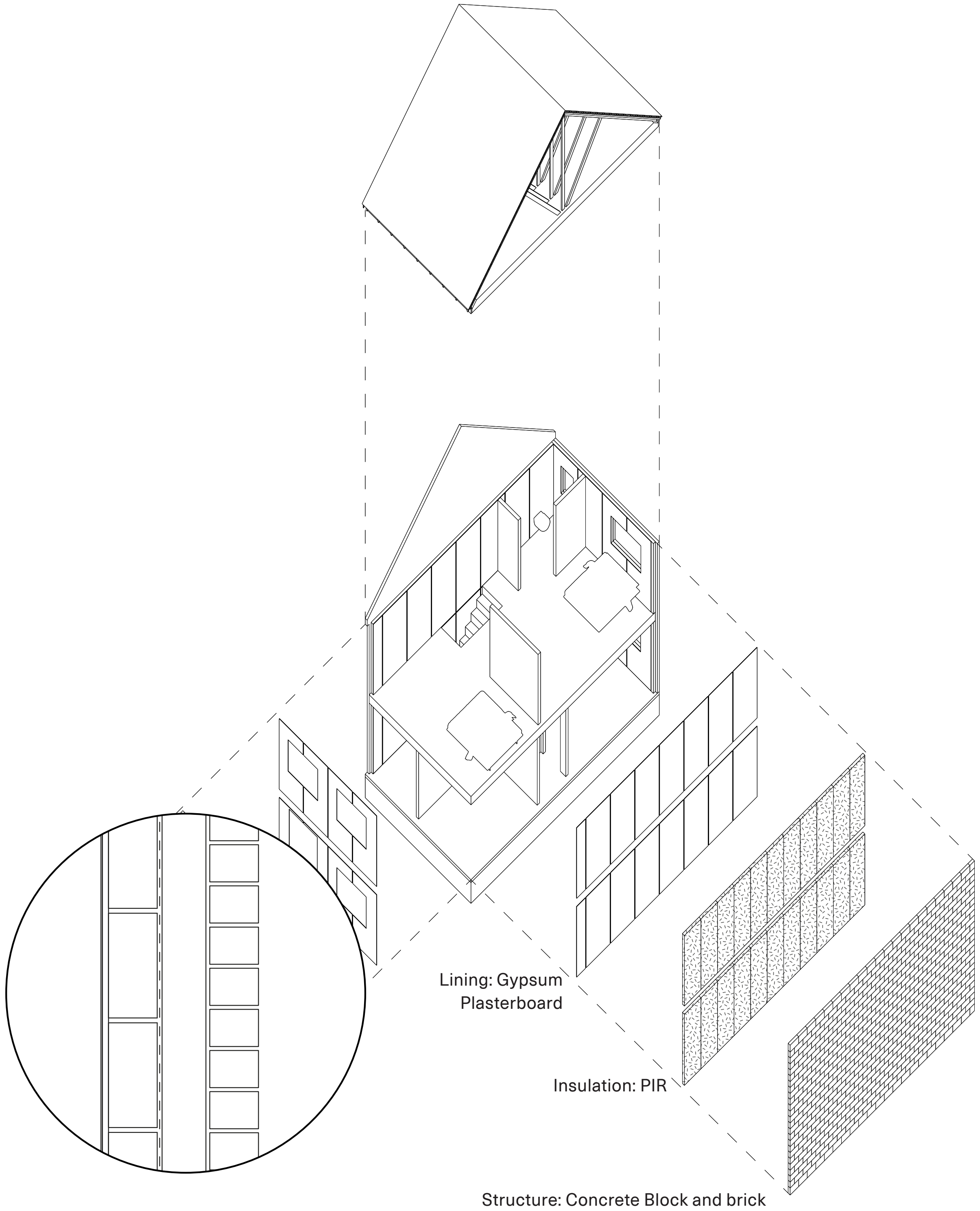


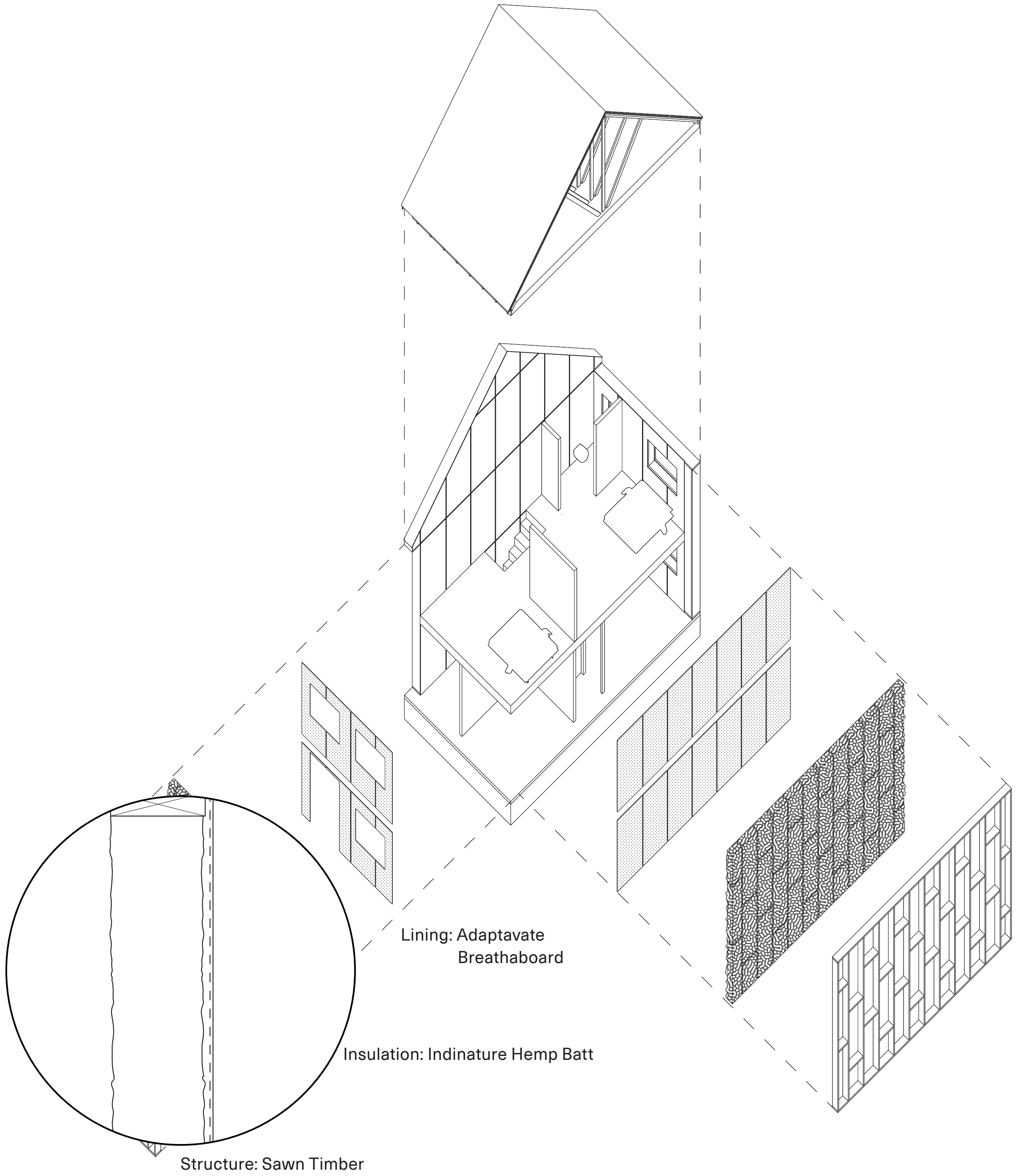
Figure 3.12: Sectional diagram of the external wall build up of the 'business-as-usual' home

‘Business as Usual’ house 110kg CO_2e/m2



The evaluated global warming potential of the business-as-usual home superstructure is 176 kgCO_2e/m^2 (A1-A3) on plan

Biobased House -109kg CO_2e/m2



Assuming all biogenic carbon is preserved at the material’s end-of-life the net emissions are -109kgCO_2e/m^2

3.3 ‘Business as Usual’ vs ‘Biobased’ Home

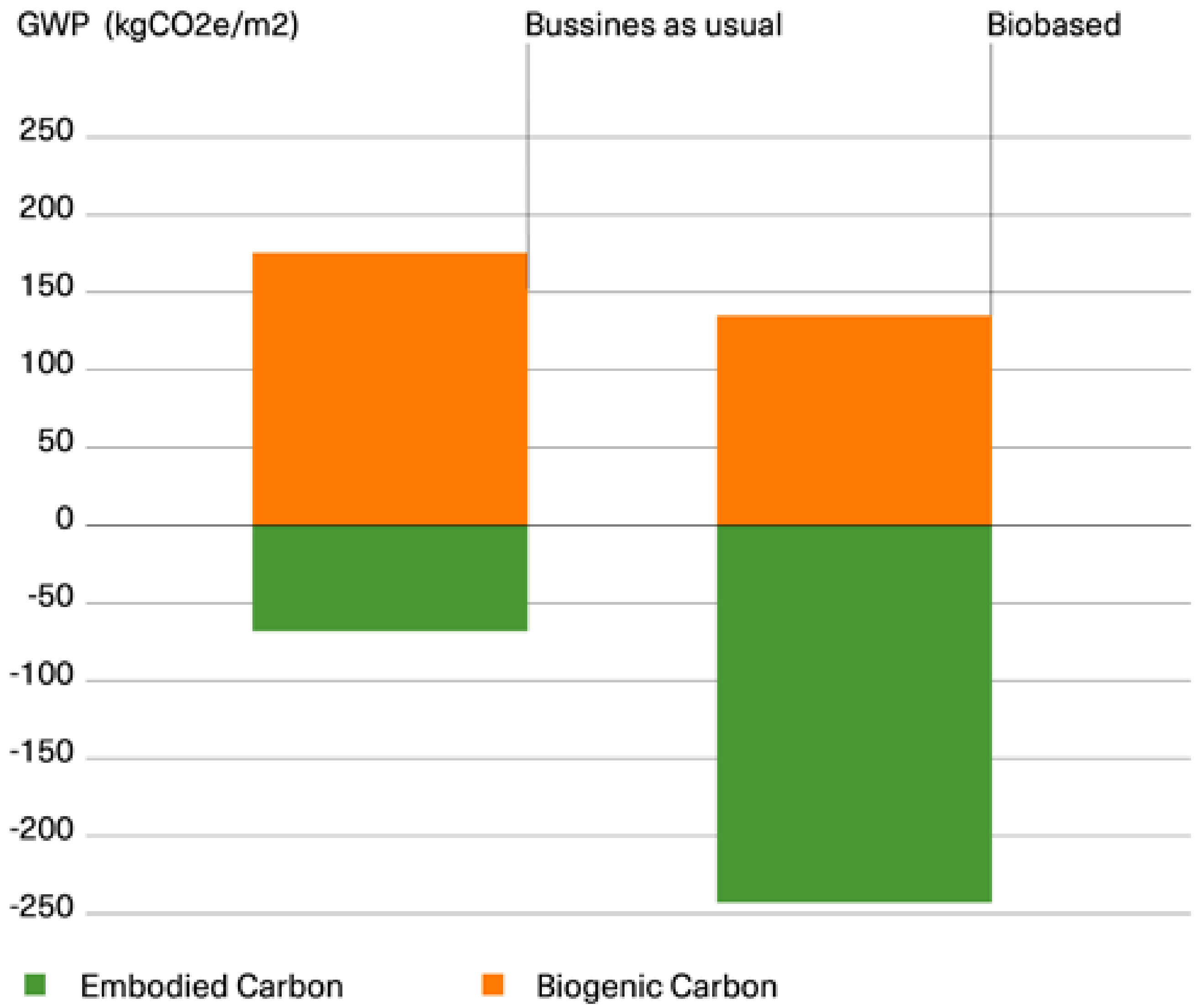


Figure 3.15: Net embodied carbon associated with both the ‘business as usual’ and biobased homes

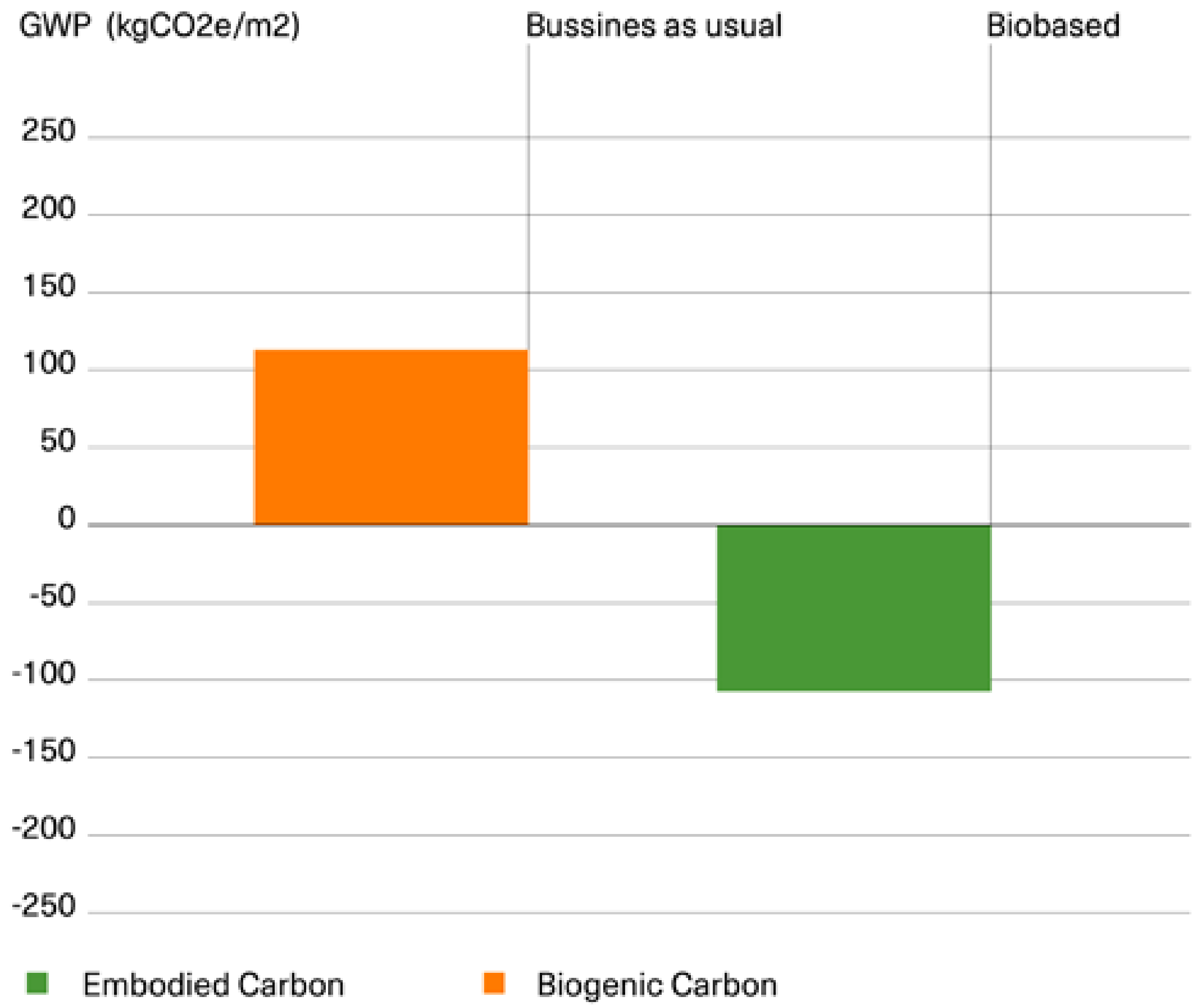


Figure 3.16: Net embodied carbon associated with both the ‘business as usual’ and biobased homes

3.4 Carbon impact at scale

1=4

Each home built with biobased materials could save as much carbon as the annual operational carbon of 4 UK homes.

–198%

A Biobased Home represents a 198% reduction in embodied carbon

The assessment of the business-as-usual home and the bio-based home show that through the use of a biobased material palette for structure, insulation and lining - a saving of 42 kgCO2e/m2 (24%) per house can be achieved when excluding the effect of biogenic carbon, and 218 kgCO2e/m2 (198%) per house when including the effect of biogenic carbon.[21]

As explained in Section 3.1, it is anticipated that the NEY region will need to build 500,000 homes over the next 17 years. Based on this study and the 3 scenarios outlined in Section 3.6, the shift to use of bio-based construction materials has the potential to save between 19 and 70 ktCO2e/year by year 17 when excluding the effect of biogenic carbon, and between 97 and 365 ktCO2e/year by year 17 when including the effect of biogenic carbon. This is the equivalent of the annual operational carbon of 91 thousand homes.[22]

Over the whole 17 years a total emissions saving between 0.16 to 0.56 MtCO2e could be saved when excluding the effect of biogenic carbon and between 0.84 and 2.88 MtCO2e could be saved when including the effect of biogenic carbon.

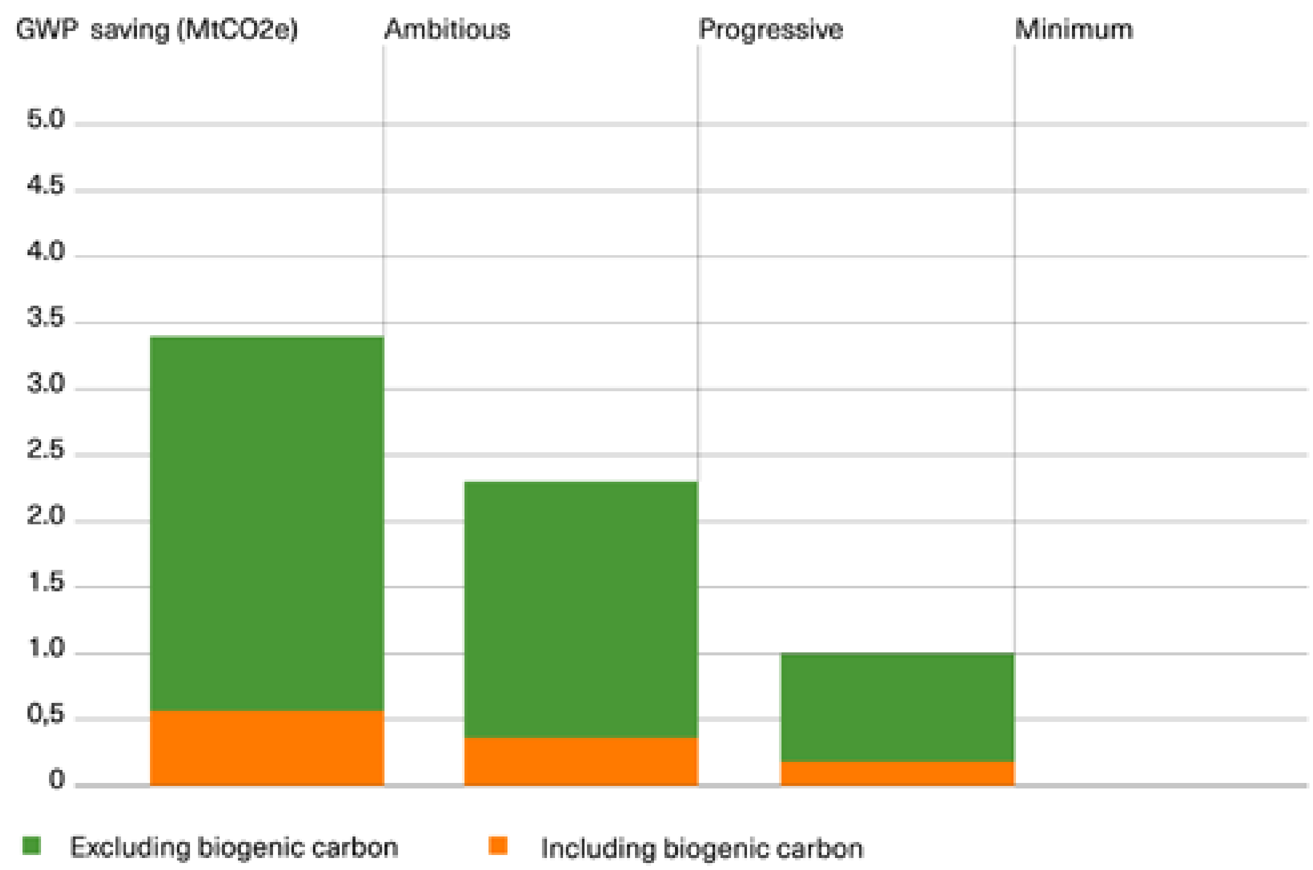
Whilst this study has focused on a single-family dwelling, the same process could be carried out to evaluate the savings for different building typologies; whilst the savings will vary depending on the extent of use of biobased materials and building type, savings will almost certainly be realised.

In June 2021 the Royal Institute of British Architects (RIBA) laid out the RIBA 2030 climate Challenge targets which set an embodied carbon reduction target for domestic and residential buildings (among targets for other building typologies). The target aims to transition from a business-as-usual scenario of 1200 kgCO2e/m2 to a 2030 target of <625 kgCO2/m2 (RICS modules A1-A5, B1-B5, C1-C4) including carbon sequestration, a reduction of 48%. Such a reduction in embodied carbon could be achieved through a range of approaches such as the use of low embodied carbon materials or use of low carbon transport networks. Replacing traditional building materials with bio-based materials in line with the assessment carried out in Section 3.3 and Section 3.4 has the potential to have a significant impact in reaching this target.

Each home built with with biobased materials could save the equivalent amount of carbon as an individual flying from London to New york and back 27 times.[23]

Each home built with biobased materials could save as much carbon as the annual operational carbon of 4 UK homes.[24]

21 Biogenic carbon refers to carbon that is sequestered from the atmosphere during biomass growth and may be released back to the atmosphere later due to combustion of the biomass or decomposition.
22 Based on data from the Committee on Climate Change - the average operational energy of a UK home is 4 tcO2e. Committee on Climate Change. (2020). Reducing UK emissions 2019 Progress Report to Parliament. London: CCC
23 According to the International Civil Aviation Organisation carbon emissions calculator.
24 Based on data from the Committee on Climate Change - the average operational energy of a UK home is 4 tcO2e. Committee on Climate Change. (2020). Reducing UK emissions 2019 Progress Report to Parliament. London: CCC



	Total emissions savings over 17 years (MtCO2e)	
	Excluding biogenic carbon	Including biogenic carbon
Ambitious	0.56	2.88
Progressive	0.37	1.95
Minimum	0.16	0.84

Figure 3.17: Total GWP savings over 17 years (above)
Figure 3.18: Comparitive Scenario emissions savings over 17 years (below)

A. Structural timber in the NEYH

Structural timber refers to timber that is strength graded for construction use. The classification system gives reasonable predictions of the structural performance of the individual piece of timber, ensuring it can withstand the highest anticipated load.[25] The grading is regulated by Building Standards,[26] in accordance with BS EN 14081. Structural timber can be either sawn directly from logs, or it can be processed into Engineered Timber.

Structural timber is increasingly used in residential construction. In the year 2016, 28.1% of homes in the UK were built with timber frames[27]. It has also been demonstrated that timber construction systems have the potential to contribute to reducing embodied carbon and that they store sequestered carbon in the fabric of buildings long term.[28]

Our maritime climate limits the growing season of trees in UK forests. In addition, the more fertile soils and easy-to-maintain lowlands are often designated for use as arable land or national parks. As a consequence, Britain's productive forests are often in the highlands where trees are affected by high-wind loads. Therefore, they do not grow to the diameter and height of productive forests in mainland Europe. These limiting climatic factors mean that most British grown construction grade timber is classed only at construction grade C16, which has a lower characteristic bending strength than C24 at 16 N/mm2 and 24 N/mm2, respectively., which has a lower characteristic bending strength than C24 at 16 N/mm2 and 24 N/mm2, respectively. In order for construction to make more use of the timber in our forests, it is necessary to design with lower-graded timber.

Figure 3.19: British forests (overleaf)

25 The Timber Research and Development Association. Structural Timber. Retrieved September 21, 2021, from https://www.trada.co.uk/start-here/structural-timber/

26 The building standards set out technical requirements applicable to building work to protect the public interest

27 Egan Consulting, 2016. Annual survey of UK structural timber markets. Alloa: Structural Timber Association, page 7.

28 Committee on Climate Change. (2020). Reducing UK emissions 2019 Progress Report to Parliament. London: CCC

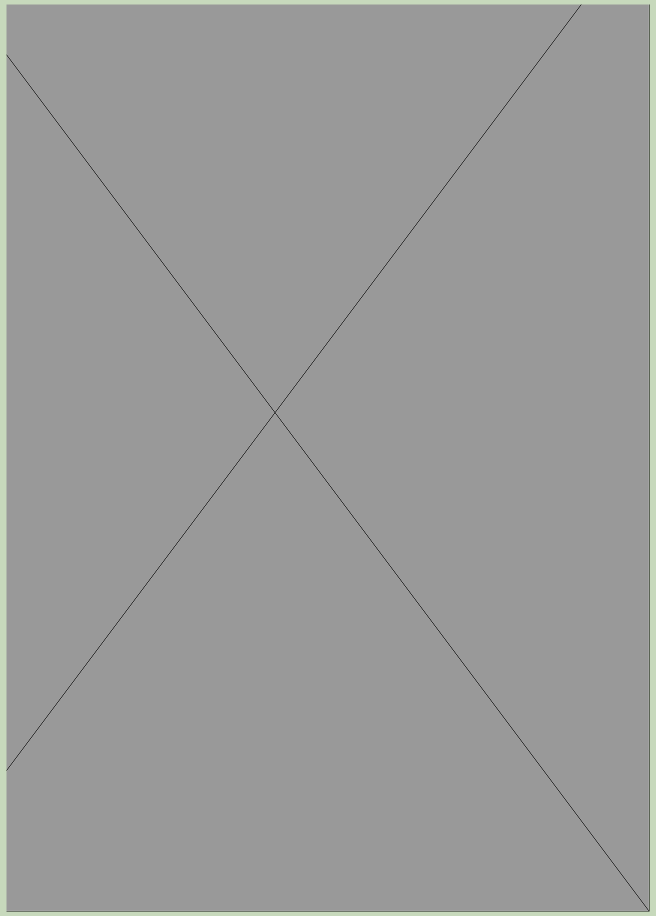
As a consequence of its lower grade, the bulk of British timber is processed, chipped and formed into sheathing and particle boards (see 'Linings /'page XX), products that incorporate adhesives[29] to bind the chipped timber together. These processes are energy intensive but make good use of waste, such as timber thinnings harvested from forests.

Engineered Timber is another form of structural timber. A broad term, it can refer to timber processed to make use of waste, or to timber processed to improve the performance of the construction product. Commonly used engineered timbers are Engineered Joists, Cross Laminated Timber (CLT), Glue Laminate Timber (Glulam), and the innovative new Dowel Laminated Timber (DLT). DLT replaces the adhesives in the lamination with the use of dowels. This reduces both the embodied energy and the toxicity of the product.

Engineered timber can also be used to form Structurally Insulated Panels (SIPS). SIPS are a prefabricated, modular component of a building system, such as a wall or floor module. They are made from pre-insulated, structural cassettes. They can be manufactured offsite and are increasingly common; the efficiency of the offsite construction can reduce onsite costs as well as increasing safety on site. Developers like CITU in Leeds have demonstrated that construction using SIP panel systems is efficient and sustainable.[30]

29 Common adhesives are Urea Formaldehyde adhesives (UF). See - Biobased materials are healthy.

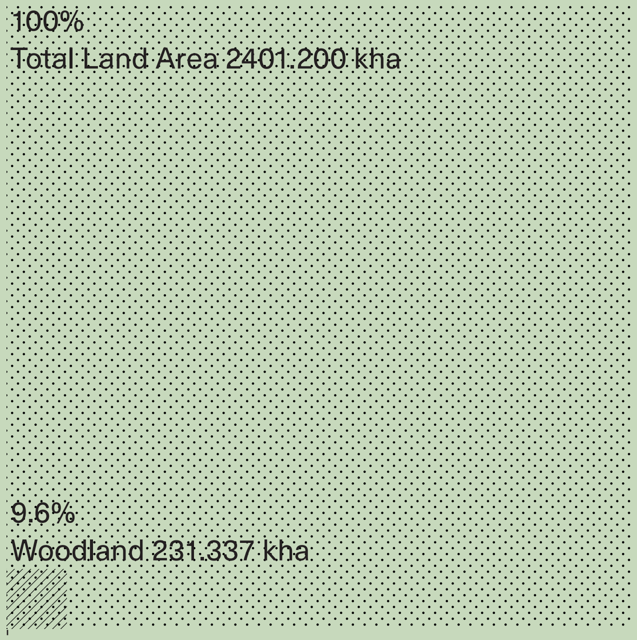
The use of structural timber in the UK is growing. In 2016 it constituted up to 28.1% of the market share for new-build homes.[31] This chapter explores the capacity of the region to support greater use of Structural Timber, examining its existing use regionally and investigating its potential at all levels of the supply chain.



30 See Section 8.3 for CITU Case Study.

31 Structural Timber Association. (2017). Annual survey of UK structural timber markets. Alloa: Egan Consulting, page 7.

A. Land use for Structural Timber



0.14%

of total land area, or an annual harvest of Sitka Spruce 3.41kha

850,000[32] m^3 of softwood were harvested in the NEY on average between 2011-13, with this expected to rise to 1.03 million m3 by 2023[33]. This represents approximately 7.5% of the total UK timber harvest, which currently stands at 13.29 million m3[34,35]. Between 2011-12 timber imports to the UK stood at a little under 40 million[36] m^3, demonstrating the scale of demand, and also the potential market for an increased domestic supply. This will have the knock-on effect of ensuring local jobs as reliance on imports decreases. Two of the primary woodland sources within the UK are shown on the map overleaf, which include the Kielder Forest, as well as the Galloway Forest in Scotland.

Currently 231,337 ha of land within the NEY region is forested[37], containing more than 40 million[38] m^3 of standing timber. The region contains the majority of English Sitka Spruce stock, the primary stock for boards and sawmills[39]. It is for this reason the region has extensive processing infrastructure already. Roughly 60% of woodland is currently under management, leaving the remaining 40% undermanaged, but with the potential to be managed[40].

In order to meet the housing need identified for the region 3.41 kha of Sitka Spruce (or equivalent softwood timber) would need to be harvested, and thus managed and replanted every year. This equates to around 1.5% of the existing woodland cover within the region.

32 847,259
33 RDI Associates, Cumbria Woodlands and Glynn, M. (2014). Roots to Prosperity Summary and Action Plan for the Growth and Development of the Forestry Sector in Northern England, page 8
34 The timber harvest of Softwood in England is 2,455,859m3 annually, refer to: RDI Associates, Cumbria Woodlands and Glynn, M. (2014). Roots to Prosperity, A strategy and Action Plan for the Growth and Development of the Forestry Sector in Northern England, page 12
35 2,455,859
36 RDI Associates, Cumbria Woodlands and Glynn, M. (2014). Roots to Prosperity, A strategy and Action Plan for the Growth and Development of the Forestry Sector in Northern England, page 20
37 RDI Associates, Cumbria Woodlands and Glynn, M. (2014). Roots to Prosperity Summary and Action Plan for the Growth and Development of the Forestry Sector in Northern England, page 4
38 Ibid., p.3
39 Ibid.
40 Ibid.

Figure 3.20: Diagram showing required timber production in relation to land area (overleaf)
Figure 3.21: Map showing required timber production in relation to regional land area

A. Structural timber supply chain

Due to the large amount of productive woodland already present in the NEY, the region has an extensive processing sector and associated supply chain. It is proposed that by beginning to make unmanaged woodland productive, the region could increase annual softwood timber production by 100,000 m3[41]. It is also noted that 'peak wood' is a concern, a point expected to be reached around 2030[42]. This has the potential to interrupt growth between now and then, and will likely therefore require imports until production begins to increase again in the mid 21st century. An additional concern is resistance by some groups, as suggested in interview with CEI Bois, the European Woodworking Industry Confederation, to the planting of productive and fast growing species such as Sitka Spruce. CEI Bois recognize though these monocultures may not support the breadth of biodiversity as native woodlands, they sequester large amounts of carbon, and are comparatively fast growing. In this way they provide a ready material source, and carbon sink, meeting material and carbon reduction demands efficiently at the same. Combining the existing timber resources with a robust and expansive recycling supply chain, feeding timber board mills such as that run by Egger in the NEY, along with timber grown alongside farmland, as promoted in the new Environmental Land Management Schemes (ELMS), can help the region to work towards a more circular industry, with the aim to becoming self sufficient towards 2050.

Proposals:

- Support afforestation, implement the region's Max Ambition scenario from the "Carbon Abatement Pathways" documents.
- Support innovative R&D into products making use of low value timber and fibre material grown alongside arable crops as part of ELMS initiatives.
- Support innovation and testing of biobased adhesives for use in engineered timbers, for example using locally sourced sugar-crops.
- Support SME testing of biobased materials by national bodies like the BRE to prepare them for market use.
- Generate demand for these materials through policy change and local authority requirements.
- Educate architects and contractors of the relative benefits of structural timbers and woodfibre products.

41 RDI Associates, Cumbria Woodlands and Glynn, M. (2014). Roots to Prosperity Summary and Action Plan for the Growth and Development of the Forestry Sector in Northern England, page 4

42 This is the point at which timber harvests across the UK will peak due to the time it takes trees to come to maturity and the fact that most commercial woodlands were planted in the 1950s to 1980s.

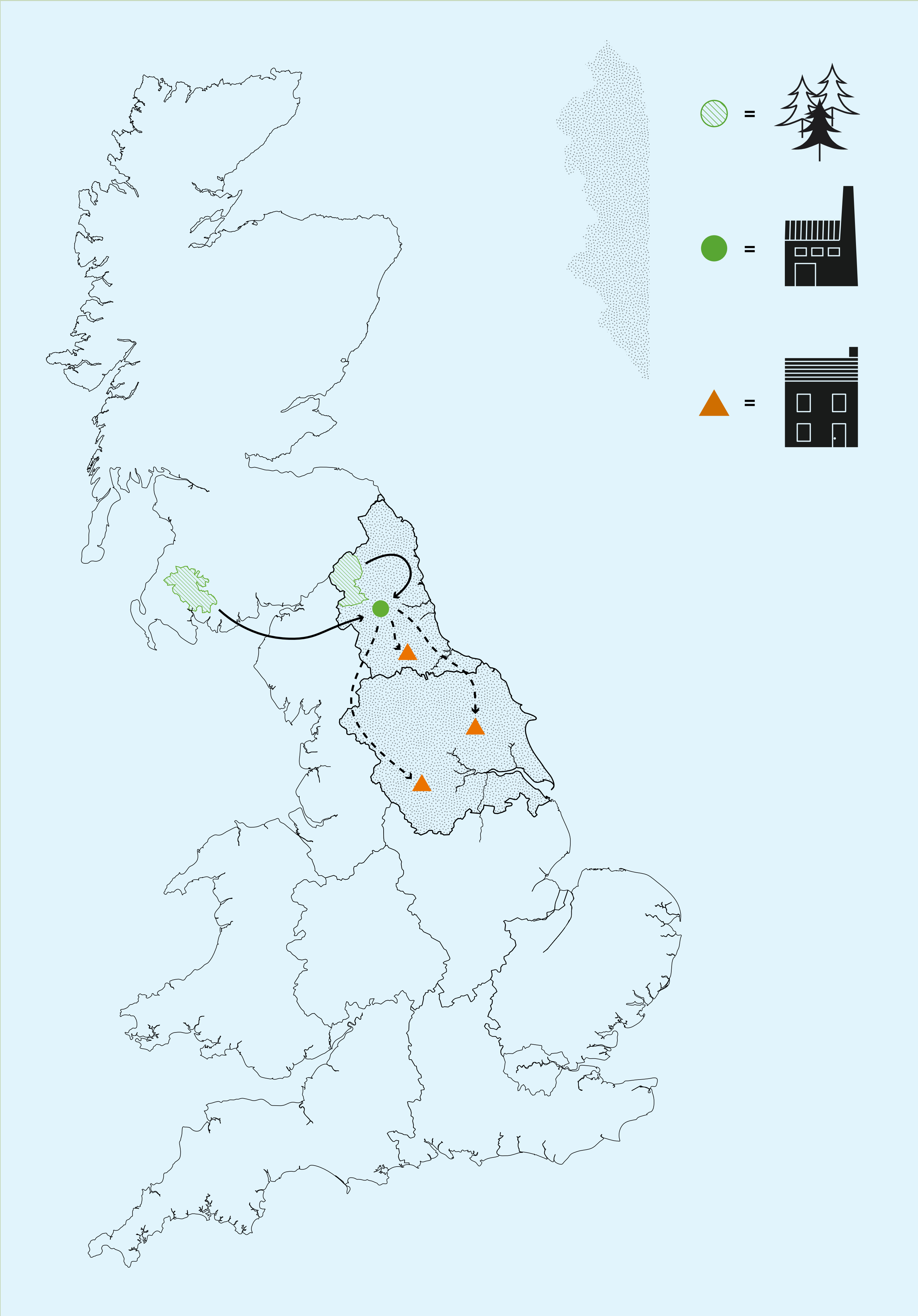


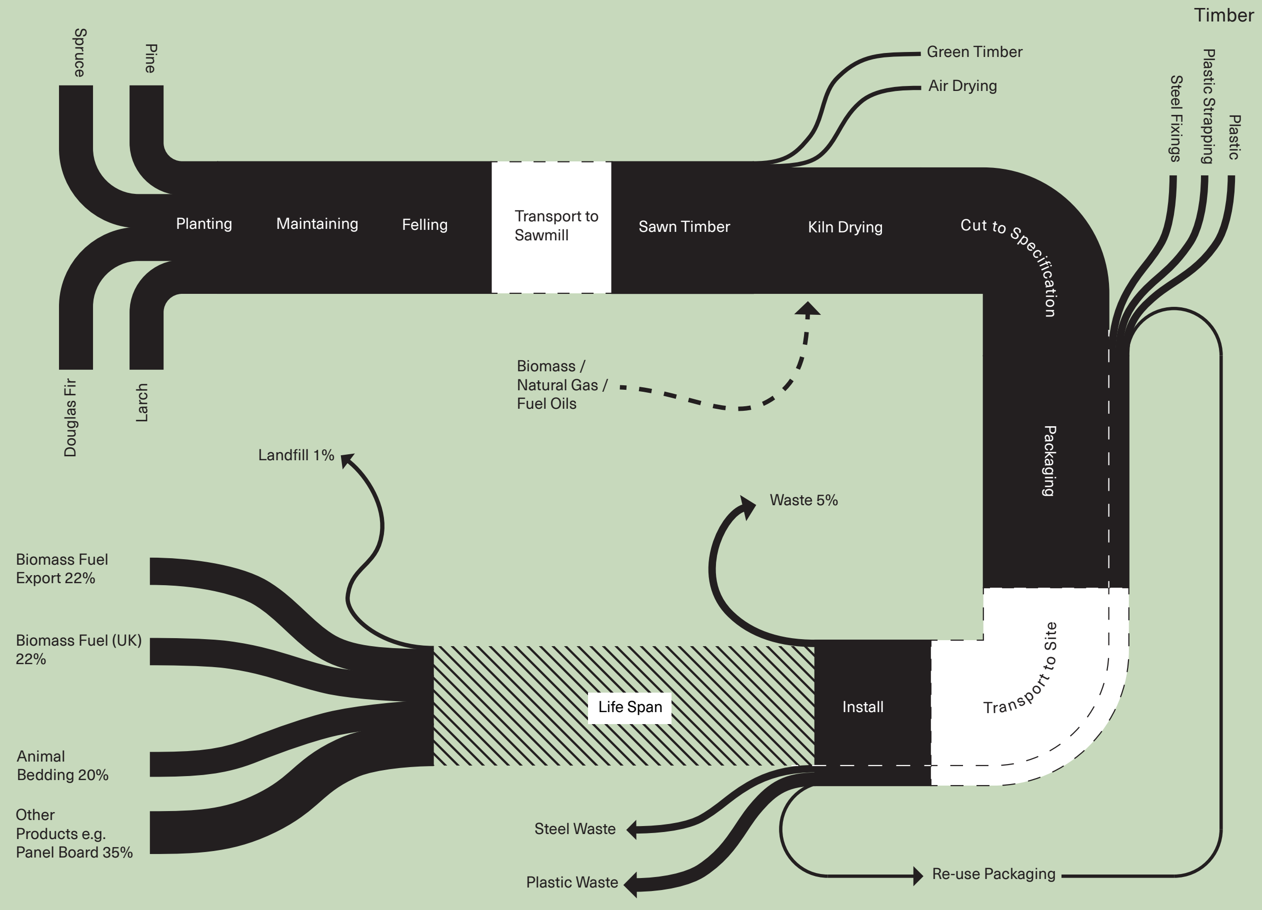
Figure 3.22: Map showing timber supply chain within region

A. Structural timber processing

The material flow diagrams opposite illustrate the relative manufacturing processes, inputs and waste generated by the manufacture of Concrete blocks (Fig X) and Structural timber (Fig X), the two structural materials used in the analysis for business-as-usual and biobased houses, respectively.

As is made clear by the diagrams, at their end-of-life concrete blocks must be reused or recycled unless they are destined for landfill. The reintegration of concrete blocks into the manufacture of new concrete blocks is an ideal outcome for this carbon heavy material, but this recycling process also requires additional energy. At the of its end-of-life structural timber can be reused, processed into other products such as panel boards or animal bedding or used as biomass fuel (which returns the sequestered carbon back to the atmosphere).

These diagrams are based on the information provided in Environmental Product Declarations (EPDs) that describe the journey of a material through a prescribed series of stages, A1-C4, known as “cradle-to-grave”. Stages A1-A3 relate to “Raw Material Supply”, “Transport” and “Manufacturing”. As with the other stages a series of metrics are used to describe how various materials perform. One clear metric is Global Warming Potential (GWP), for which concrete blocks have a value of of 0.0912 kgCO2e/kg and timber 0.22 kgCO2e/kg (-1.49 kgCO2e/kg including sequestration). Looking at the “Raw Material Supply” stages of both materials, A1, the constituent elements of a concrete block (Limestone, glass sand and cement typically) require intensive processing to extract these materials from the ground and process them into usable raw materials. We know that the production of cement in particular releases significant quantities of greenhouses gases into the atmosphere. On the other hand, timber actively sequesters carbon as it grows, and requires some heavy machinery to fell and process. The respective GWP figures demonstrate how timber has a negative carbon impact, while concrete blocks have a positive one.



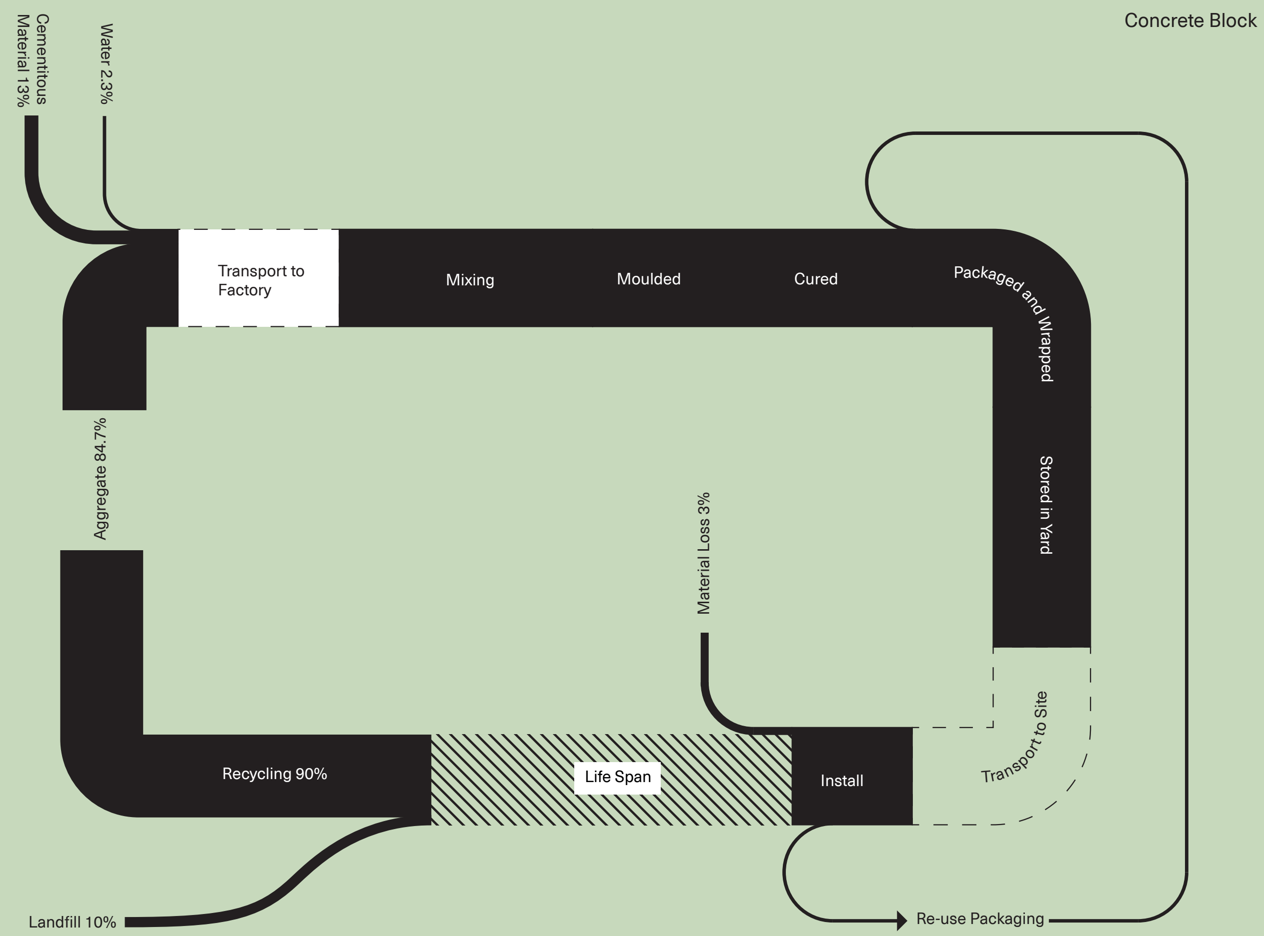


Figure 3.23 Conventional concrete block supply chain - opposite
Figure 3.24 Biobased timber supply chain - above

B. Insulation in the NEYH

Wall / Roof Insulation

Insulation in construction, whether applied inside a wall cavity, internally or externally, limits the transition of heat through the building envelope. Consequently, it reduces the energy required to operate a building. Biobased wall and roof insulation materials can be made from renewable sources such as animal fibres (e.g. sheeps wool) and plant fibres (e.g. hemp, straw, woodfibre or flax). These materials can replace petrochemical-derived building insulation without any loss of thermal performance. However, in order to achieve comparative U-Values,[43] some of these materials necessitate thicker walls and structural systems. This report explores the potential of the following materials in the context of the NEY region.

Hempcrete

Hempcrete is a non-structural, composite material made from mixing hemp shiv (the woody inner portion of the hemp stalk) with a wet lime binder. It provides a natural, vapour-permeable insulation material. It can be used in various forms in walls, floors and roof build-ups. Unlike some lighter insulation materials, hempcrete has a considerable thermal mass. It is therefore very effective as an insulation material because it regulates temperature throughout the day, especially when used on the room-side of an external wall. Hempcrete can be cast into formwork around a timber frame, or precast in block form, where it is air-dried and laid with lime mortar. As a block, Hempcrete has advantages in the current construction culture as a standardized and familiar construction product.

43 The U-value is a measure of heat transmission through the building envelope.

After the Hemp crop has been harvested, baled and sent for primary processing, the hemp plants are separated into fibre and shiv. The fibre can be made into user-friendly biobased loft insulation, and the shiv mixed with a binder to create Hempcrete. As well as this, the by-products of this processing, the hemp dust, can be used to make finishing plasters[44] and biomass briquettes.

Until recently Hempcrete blocks were manufactured in Buckinghamshire. But at the time of writing the only prefabricated hempcrete products on the UK market are imported. A significant opportunity exists, therefore, to supply hempcrete products to the region from within the region, with the potential to export.

Hemp Fibre Batts

Rigid and flexible insulation batts can be manufactured from hemp fibre. Some of these fibrous batts are mixed with supplementary materials, such as recycled polyester. This market-ready batt insulation product could replace more energy-intensive materials such as rockwool and polyurethane insulation. This could happen with relative ease as its installation methods and application is consistent with the commonly used alternatives.[45] By July 2022 the Indinature manufacturing plant established in the Scottish borders is expected to produce hemp batt insulation manufactured using hemp fibre sourced and processed by East Yorkshire Hemp.

44 See - Adaptavate Breathaplaster - https://adaptavate.com/breathaboard-breathable-plasterboard/
45 See - Indinature Hemp batts - https://www.indinature.co/specifications

Straw Panels and Boards

More than 625,000 tonnes of surplus straw from the NEY could be made available to the construction sector[46]. If we assume a typical 3 bed home requires 8.75 tonnes of straw to construct[47] more than 71,000 homes could be built in this way.

Straw is a good insulator with uses in a number of construction components. When compacted, straw bales can be used as external wall insulation: they are highly insulative and low in embodied energy. They are commonly paired with a timber structural frame and lime (rendered both internally and externally). Straw can also be combined with earth and clay to improve its insulative properties. This can help with binding strength and stability. Prefabricated compressed straw SIPs are also an efficient use of straw in construction. A variety of different systems using SIPs have proven to be efficient and sustainable.[48] These include compressed straw board systems, which have been used in construction for several decades (products like Stramit straw board are extremely efficient), and load-bearing partition wall systems which are both fire-resistant and acoustically absorbent. Although no longer manufactured in the UK, there is potential to reintroduce this established manufacturing process to the UK in the NEY.

46 Copeland, J. and Turley, D. (2021). National and regional supply/demand balance for agricultural straw in Great Britain. York: Central Science Laboratory, page 9
47 Jones, B. (2015). Building with Straw Bales. New York: UIT Cambridge Ltd.
48 See : Modcell (https://www.modcell.com/) and EcoCocon (https://ecococon.eu/gb/)

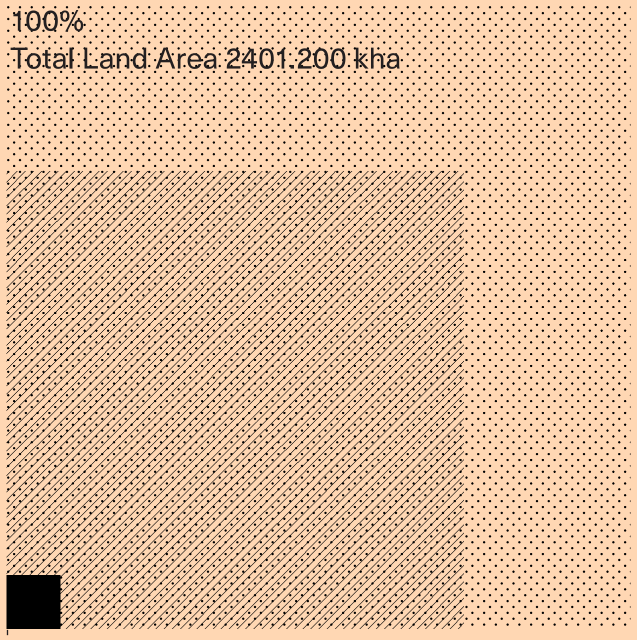
Wood Fibre

Woodfibre insulation can be both a rigid and flexible biobased product. It is primarily made from waste coniferous and deciduous wood, using the residual wood and non-sawable thinnings produced in the production of construction grade timber. It provides either a rigid or flexible insulation for floors and roofs as well as studs and rafters. It is also very effective as retrofitted insulation. It can be treated to be water repellant for use as an insulation layer, where it sits below rainscreen cladding. Furthermore, it is useful in its ability to provide an airtight seal to a building, if properly installed. Wood fibre insulation is manufactured on a wider-scale by European companies such as Steico and Pavatex, and is currently imported into the UK. There is potential in the British construction industry to use waste wood from processing here, in combination with productive broadleaf margins to farming land, as source material for locally manufactured wood-fibre insulation.

Sheeps Wool Insulation

Sheeps Wool insulation is a type of flexible and rigid batt form insulation already available on the British market. Manufactured in Yorkshire using British wool, a great proportion of it is sourced from grazing land in Yorkshire. Manufactured by Thermafleece, it is made using 75% British Wool and 25% recycled polyester. It has applications in new-build wall, floor and roof insulation and it is also suitable for use in retrofit projects.

B. Land use for Insulation Feedstocks



8.6%

of total land area, or an annual harvest of Hemp (Fibre) of 207 kha

The UK accounts for just 2% of the total area planted with Hemp across the EU. However, Yorkshire alone accounts for 35-40% of this area, of which 97% is spread between the two largest producers of hemp in the region: East Yorkshire Hemp and Harrison Spinks[49]. The remainder of Yorkshire's crop is grown by small-scale farmers who typically grow it as a rotational crop, with some looking to increase the size of their yield. With average yields between 4 and 5 tonnes per hectare[50] (EYH has reported yields of up to 9 tonnes) it is estimated that Yorkshire produces 1,600 tonnes of hemp per annum[51]. This hemp crop is used, amongst other uses, to manufacture hempcrete insulation and could be used to manufacture hemp batt insulation.

Currently 230-320 ha of the land within the NEY region is used to grow hemp exclusively[52]. In order to meet the housing need identified for the region, an additional 207 kha[53] would be required, where the hemp could be farmed as a rotational crop using existing arable land. As a portion of land, this represents 26% of the existing arable farmed land within the region. This figure would decrease as yields increase. As previously mentioned yields nearly twice the figure used here have been recorded in Yorkshire by East Yorkshire Hemp.

49 Gough, E. (2021). Yorkshire Hemp Supply Chain Map. Nantwich: Promar International Ltd, page 3
50 Ibid., p 20
51 Ibid., p2
52 Ibid.
53 See Appendix, Section 9.5 for Land Use Calculation Methodology

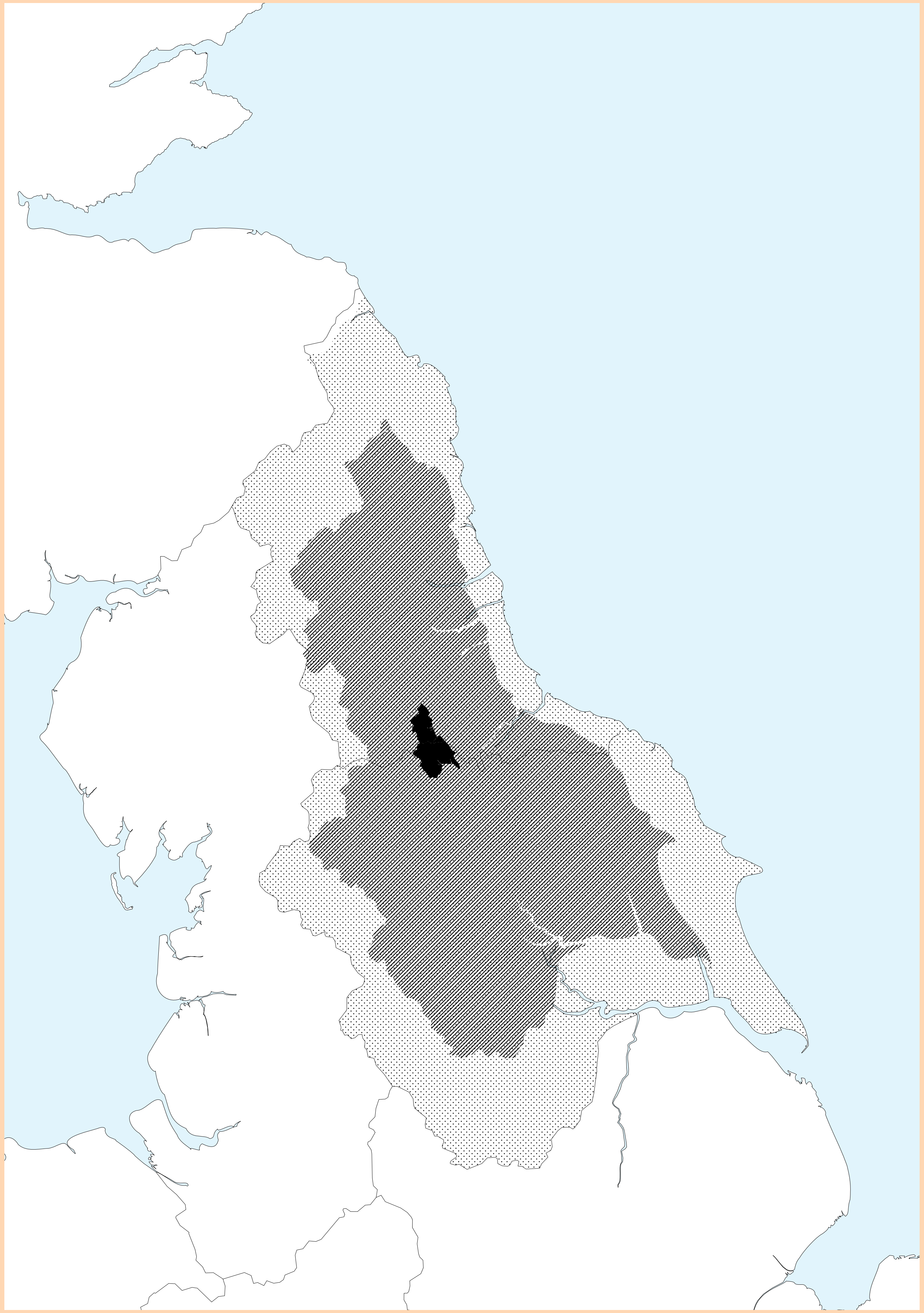


Figure 3.25: Proposed hemp production to meet regional housing need - opposite
Figure 3.26: Map showing proposed hemp production in relation to regional arable and land area - above

B. Insulation supply chain

Hemp

East Yorkshire Hemp estimates that, with their current processing machinery, they could expand their annual yield of 200 hectares of hemp to 500 hectares before requiring any additional processing machinery within the region. According to Tatham, the Bradford based machinery manufacturer producing hemp decortication machines, their machines typically process up to 4 tonnes of raw hemp per hour, and could potentially run 24 hours a day, 7 days a week, 365 days a year. Taking yield figures from the Yorkshire Hemp Supply Chain Map report[54] this suggests it would be possible to process hemp from an area covering 7.78 kha per year. The estimated capital outset of establishing a new processing plant, including warehouse for storage, is approximately £2million. This plant would process the shiv and fibre, as well as producing dust that can be used in products such as hemp-lime board. A further £2million is needed for the equipment to cottonize the hemp fibre for the textile market, a lucrative additional market for the crop.

Straw

As a climate and landscape particularly suited to the crop, the NEY generates 625,000 tonnes of surplus wheat straw every year. According to the strawboard manufacturer Stramit, 500,000m2 of strawboard can be produced by one machine in a year. A modern European compressed strawboard plant can be run with a production staff of six to eight persons. Companies like Modcell and Stramit[55] have demonstrated that efficient prefabricated housing systems can make good use of this waste stream.

Proposals:

- Support changes to hemp licensing from central government to increase production (licenses currently need to be applied for 18 months in advance, unless seed is ordered at risk by growers).
- Support the establishment of businesses like Thermafleece within the region and aid new businesses like them.
- Support local processing of hemp fibre batt insulation by businesses like Indinature.
- Support innovative R&D into wood fibre insulation products that make use of low value timber and fibre material.
- Support testing of biobased materials by national bodies like the BRE to prepare them for market use.
- Generate demand for these materials through policy change and local authority requirements.
- Educate architects and contractors on the relative benefits of biobased insulation.

Insulation processing

54 Ibid.

55 According to Stramit records 280,000 homes have been built in the UK with their products, though not in recent decades, detailed in interview on 19th May. 2021

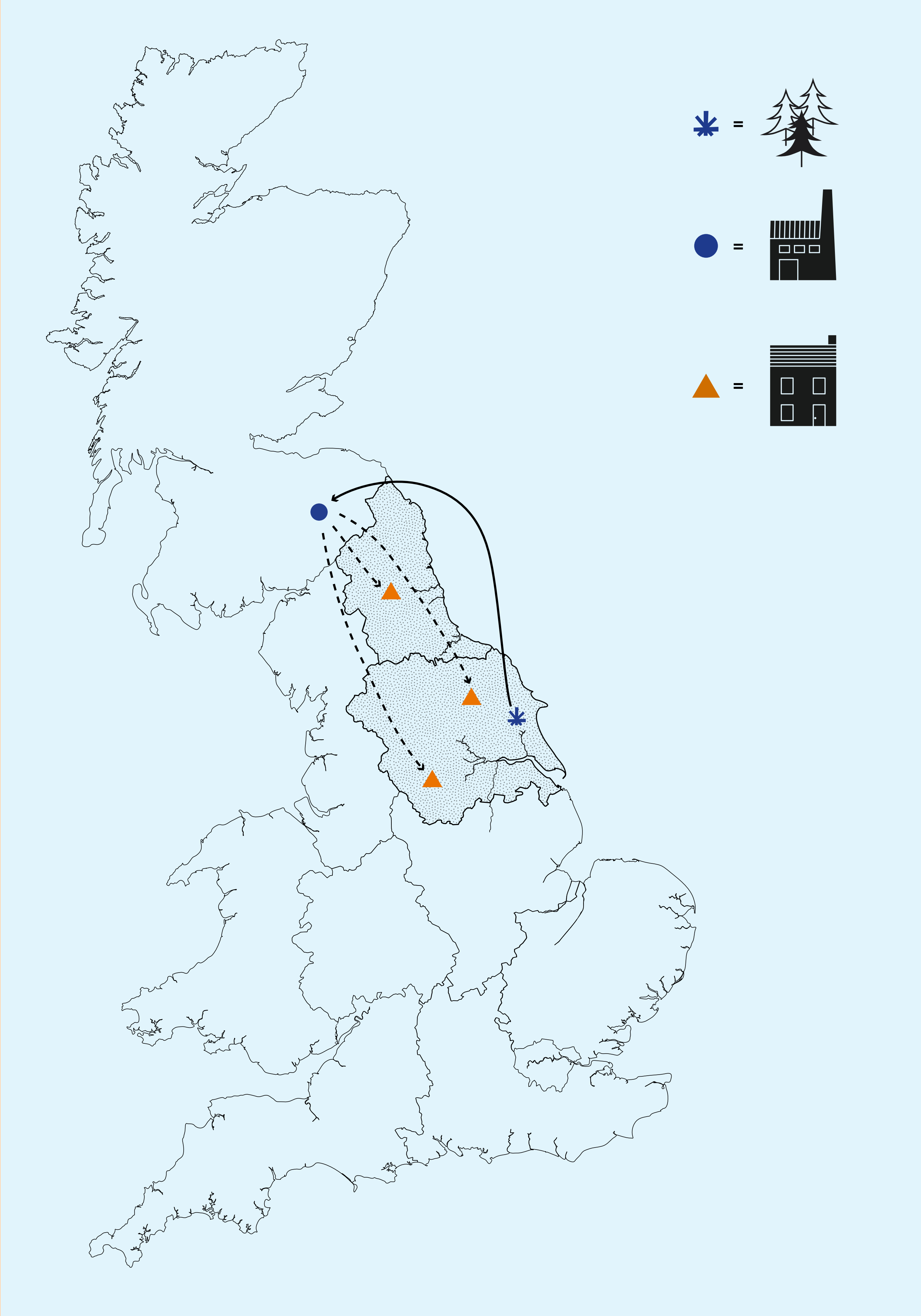


Figure 3.15 Map showing proposed hemp batt insulation supply chain within the region

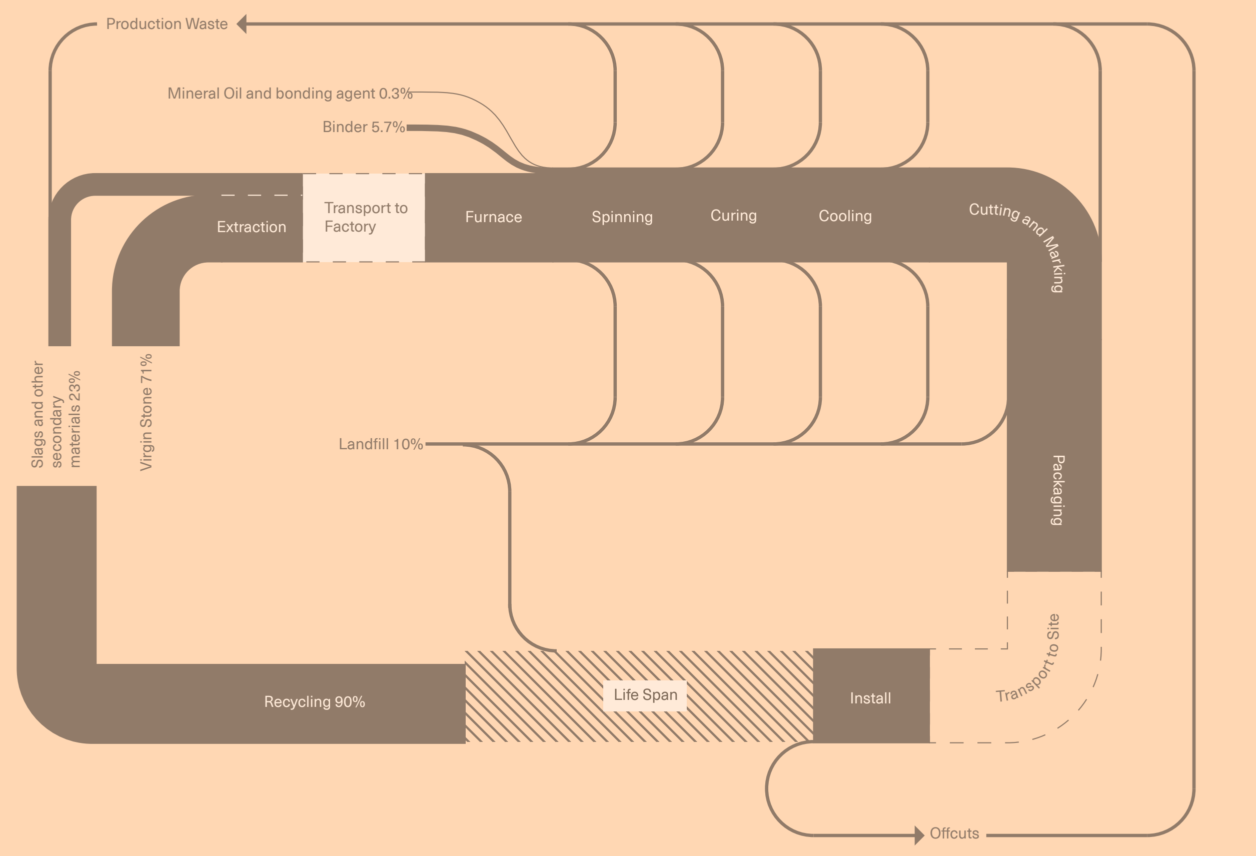
B. Insulation supply chain

The material flow diagrams opposite illustrate the relative manufacturing processes, inputs and waste generated by the manufacture of PIR Insulation (Fig X) and Hemp Batts (Fig X), the two insulation materials used in the analysis for business-as-usual and biobased houses, respectively.

As is made clear by the diagrams, at the end-of-life its life PIR insulation is either taken to landfill or incinerated. No recycling is recorded in the EPD. At the of its end-of-life hemp batts can be recycled into new hemp batts, with any remainder composted and used as a fertiliser.

These diagrams are based on the information provided in Environmental Product Declarations (EPDs) that describe the journey of a material through a prescribed series of stages, A1-C4, known as “cradle-to-gate”. Stages A1-A3 relate to “Raw Material Supply”, “Transport” and “Manufacturing”. As with the other stages a series of metrics are used to describe how various materials perform. One clear metric is Global Warming Potential (GWP), for which PIR insulation has a value of 3.3 kgCO2e/kg and hemp batts 0.62 kgCO2e/kg(or -0.63 kgCO2e/kg if biogenic GWP is considered, which includes carbon sequestered during hemps growth stage). Looking at the “Raw Material Supply” stages of both materials, A1, PIR is manufactured from the mixing of a number of chemicals which expand between two facing layers. Once the desired thickness is achieved it is cooked, before being moved to an additional oven, where it develops a bright pink colour. It can then be cut to size and packaged. By comparison hemp batts are manufactured from raw hemp bales. These are separated into shiv, fibre and dust. The fibre is mixed with a binder (3% caustic soda), and formed into a board with the addition of heat, before being cut to size.

Rockwool



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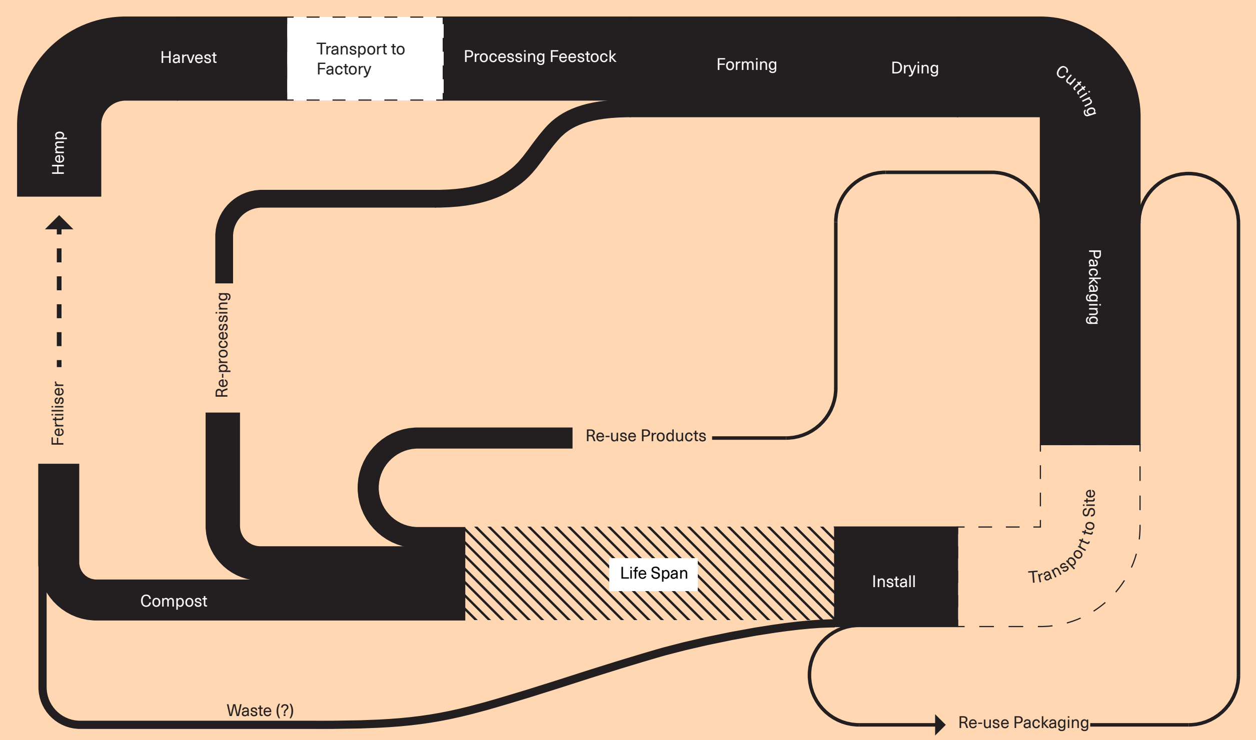


Figure 3.16 Conventional PIR supply chain diagram
Figure 3.17 Biobased hemp batt supply chain diagram

C. Lining

Sheathing and lining board is used as part of floor, wall or roof build-ups. Common examples include Plasterboard, OSB and sarking boards. Lining boards are conventionally used on the internal side of a wall build up. They act as a render-carrying board, onto which the plaster can be skimmed and then painted. Sheathing boards refer to those that are fixed to a primary structure; they can aid with both structural racking as well as air-tightness. This report focuses on select products which have been demonstrated as viable alternatives to the most commonly used interior lining boards in the UK, Gypsum. Gypsum based plasterboard is drawn from finite mineral resources and is energy intensive to recycle. It also generates large amounts of waste. It is currently estimated that 300,000 tonnes of plasterboard per year are wasted as a result of a combination of over-ordering by contractors, incorrect specifications, material damage on site, and off-cuts arising during construction.[56]

Adaptavate Breathabord is an innovative hemp-lime board. Manufactured from predominantly hemp dust, mineral binder, and a small amount of natural additive such as recycled paper, it is a plasterboard alternative that is both lower in embodied carbon and also can be manufactured using region-specific biobased aggregate matter. In different contexts, it can also be made using hemp shiv, oilseed rape, post consumer cellulose, or straw. Using hemp products from Yorkshire, they have worked with the Biorenewables Development Centre to develop a product that can be adapted to suit the available mix of aggregates, while providing the consistency necessary to bring it to the mass-market. This type of hemp-lime board has the benefit of being used in exactly the same way as a gypsum based plasterboard. The weight and size are the same which means its uptake and application is not limited by architectural specification or current construction methods and skills.

Compressed straw boards are manufactured by placing straw under intense heat and pressure. This creates a reaction in the natural resins within the straw that binds the materials together. The materials are bound at the edges with paper to create a board material that can be used for a number of applications, such as partitions or lining boards. Until fairly recently a product known as Stramit was manufactured in the UK (See: Insulation page XX above). There is the potential for local manufacturing to be re-established within the region, to develop further biobased alternatives to sheathing boards. This production system would have the advantage of using existing feedstocks and waste streams from the agricultural industry.

Wood wool boards have been used in buildings for decades. They are an effective lime render substrate that can be used as an alternative to plasterboard. They are made of wood strands, bound together with Portland cement. Wood wool boards are effective at eliminating thermal bridges around junctions in construction, providing acoustic insulation in walls and floors. They also have applications in the insulation of flat and sloping roofs, and can be used in fire resistant coverings. They are vapour permeable, vermin and fungus resistant, and are made using timber from sustainably managed forests.[57] Panelvent is a low-impact alternative to OSB and MDF. It is designed to improve vapour transfer in the external lining of a building. Its water resistant properties and ultra-low formaldehyde levels of less than 0.03ppm make it a good alternative to conventional products.

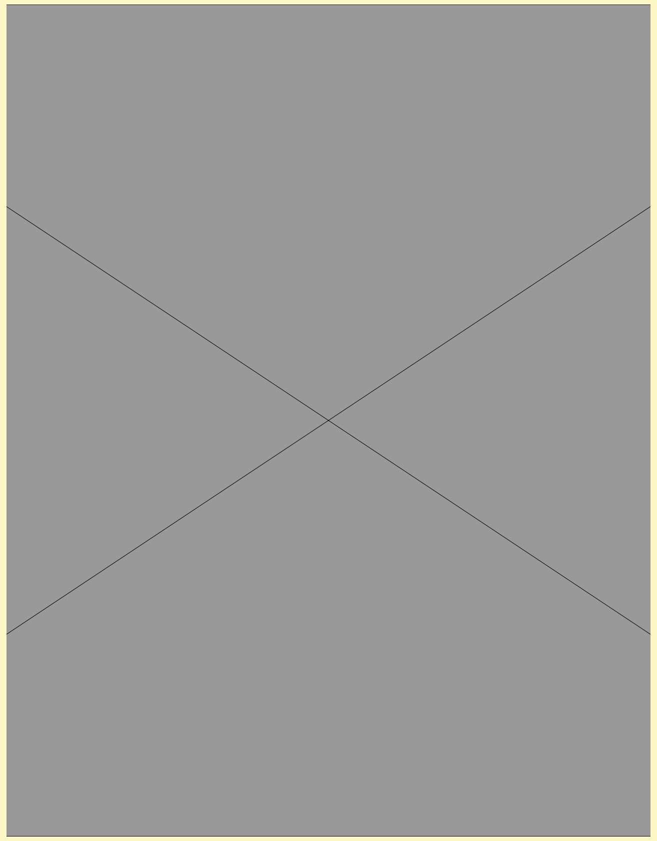
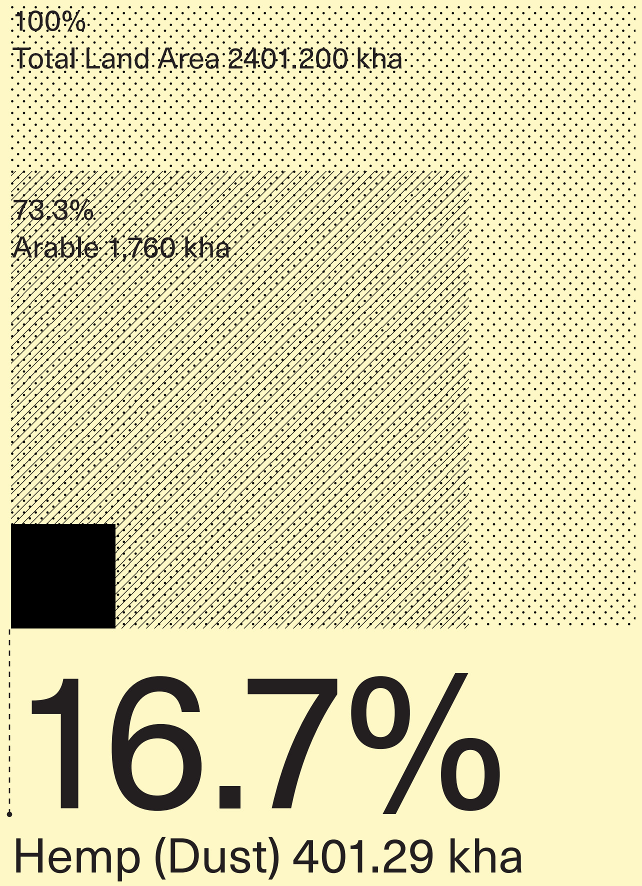


Figure 3.X: (overleaf)

56 The Roy Hatfield Group of Companies. About Plasterboard Recycling. Retrieved September 24, 2021, from http://www.royhatfield.com/plasterboard-recycling/information/about_plasterboard_recycling.asp

57 Wood Wool Boards. (2018). Celenit N Wood wool board. Retrieved September 24, 2021, from https://www.lime.org.uk/applications/timber-framed-insulation-system-timber-clad/wood-wool-building-boards.html

C. Lining in the NEYH



Land use for manufacturing Lining boards
Manufacturing lining and sheathing boards within the region would be possible with better feedstock supply chain management and capital investment in processing plants. Growth in the hemp industry would generate more material to supply hemp-lime board manufacturing. A beneficial characteristic of the product being developed by Adaptavate with the Biorenewables Centre in York is the ability to alter the composition of the mix to suit different agricultural waste streams in different locations. This means the Breathaboard boards could be produced with varying amounts of hemp and straw waste for example, whilst maintaining the same performance. The establishment of regional processing plants that draw directly from the available feedstocks would help generate local jobs.

Currently 230-320 ha of the land within the NEY region is used to grow hemp exclusively[58]. In order to meet the demand for biobased lining boards for the NEY's housing need, 207 kha[59] of land would be required to be given over to hemp as a rotational crop in the warmer months, rehabilitating the soil for the wheat crops that would typically follow. This represents 26% of the total existing arable land within the NEY. This figure would decrease as yields increase. As previously mentioned yields nearly twice the figure used here have been recorded in Yorkshire by East Yorkshire Hemp.

58 Ibid.
59 See Appendix, Section 9.5 for Land Use Calculation Methodology

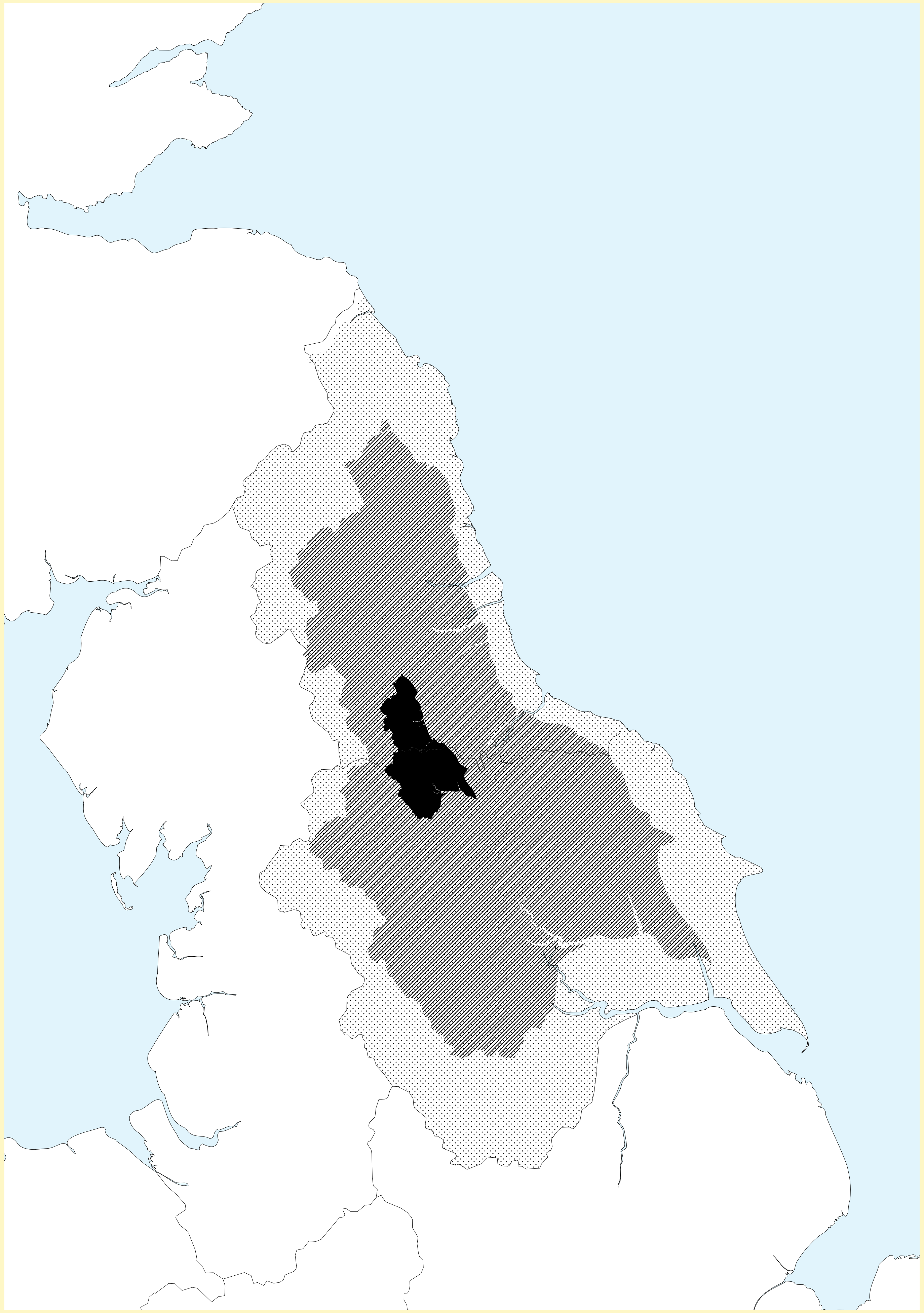


Figure 3.19 Diagram showing proposed hemp farming in relation to arable and land area - opposite
Figure 3.20 Map showing proposed hemp farming in relation to arable and land area - above

C. Lining supply chain

The existing supply chain infrastructure would support the use of more locally manufactured biobased lining boards in construction, provided enough demand can be generated. What needs to be established is an evenly distributed and sustainable supply chain model at a regional level. Currently biobased lining boards are either imported (wood wool), manufactured in the UK (chipboard or particle board), or in the case of hemp-lime boards: made in Gloucestershire using Yorkshire hemp products.

Proposals:

- Fund a feasibility study on establishing a new Compressed Straw board manufacturing plant within NEY.
- Support the establishment and uptake of businesses like Adaptavate within the region.
- Support innovative R&D into alternative structural sheathing boards which make use of material waste streams from agriculture.
- Support testing of these materials by national bodies like the BRE to prepare them for market use.
- Generate demand for these materials through policy change and local authority requirements.
- Educate architects and contractors of the relative benefits of biobased lining boards and renders.

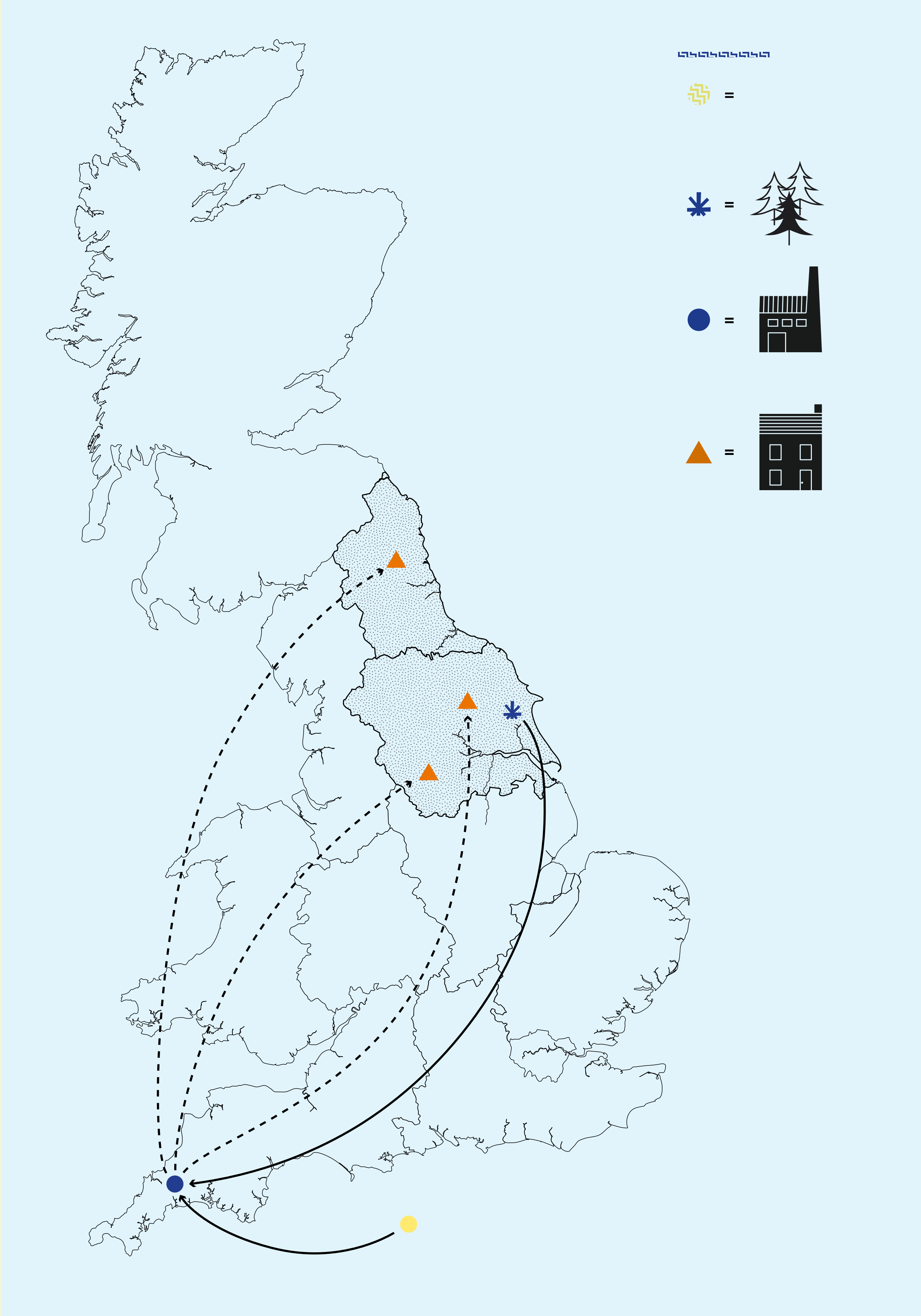


Figure 3.21 Hemp lining board proposed supply chain map

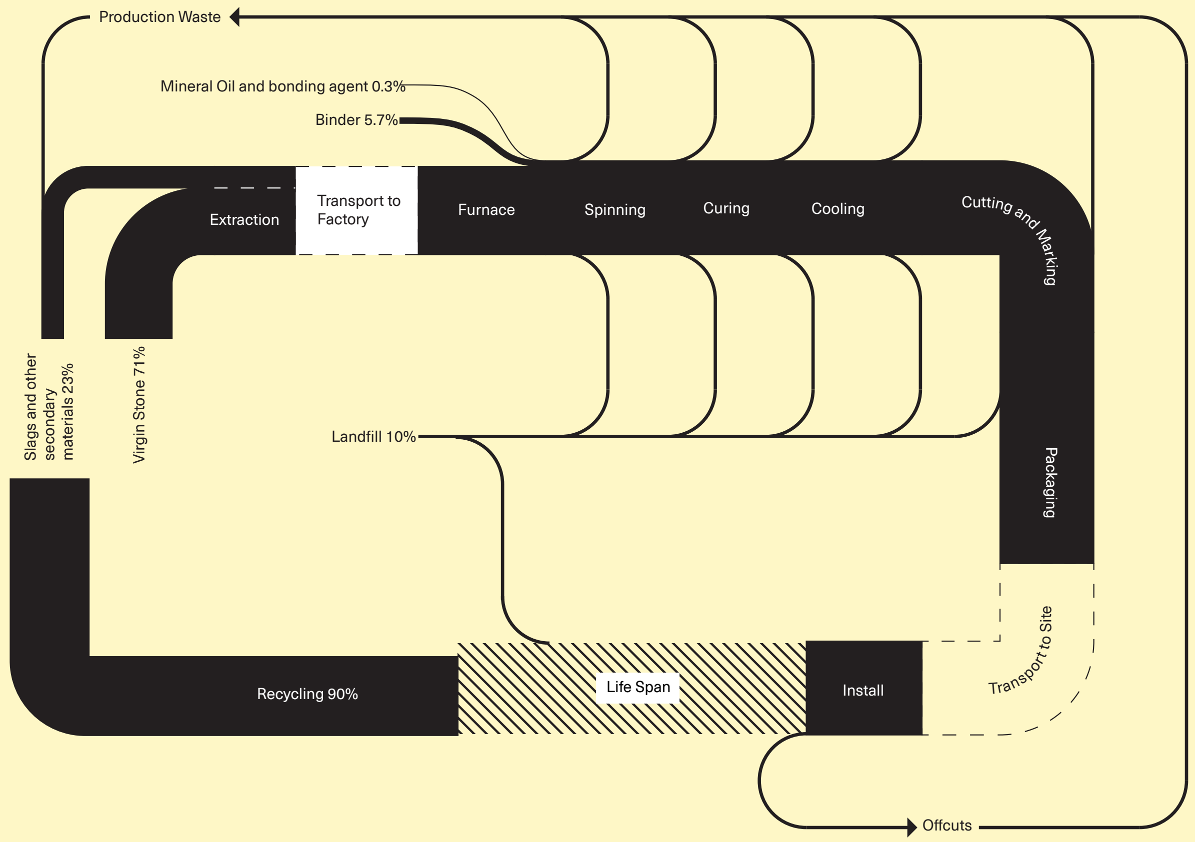
C. Lining supply chain

The material flow diagrams opposite illustrate the relative manufacturing processes, inputs and waste generated by the manufacture of Gypsum Plasterboard (Fig X) and a Hemp-Lime Board (Fig X), the two lining boards used in the analysis for business-as-usual and biobased houses, respectively.

Gypsum plasterboard can be recycled through the manufacturer, such as British Gypsum. If it is taken to landfill it must be deposited in a separate monocell. No recycling is recorded in the EPD. At the of its end-of-life hemp-lime board can be composted and used to fertilise soil. Apart from any non- recyclable packaging materials which can be used, zero waste is created from this process.

These diagrams are based on the information provided in Environmental Product Declarations (EPDs) that describe the journey of a material through a prescribed series of stages, A1-C4, known as “cradle-to-gate”. Stages A1-A3 relate to “Raw Material Supply”, “Transport” and “Manufacturing”. As with the other stages a series of metrics are used to describe how various materials perform. One clear metric is Global Warming Potential (GWP), for which gypsum plasterboard achieves a score of 1.89 and as yet hemp line board does not have a measured GWP. Looking at the “Raw Material Supply”, A1, gypsum plasterboard is formed from a slurry which is spread onto a paper liner on a moving conveyor to form an even layer. After a second layer of paper is applied to the top it is dried before being cut to size and packaged. While a fill EPD has not been published for Adaptavate, we know from the manufacturers of Breathaboard this is formed from a mix of hemp dust, binder, a small amount of natural additives, and water. This is laid onto recycled paper.

Rockwool



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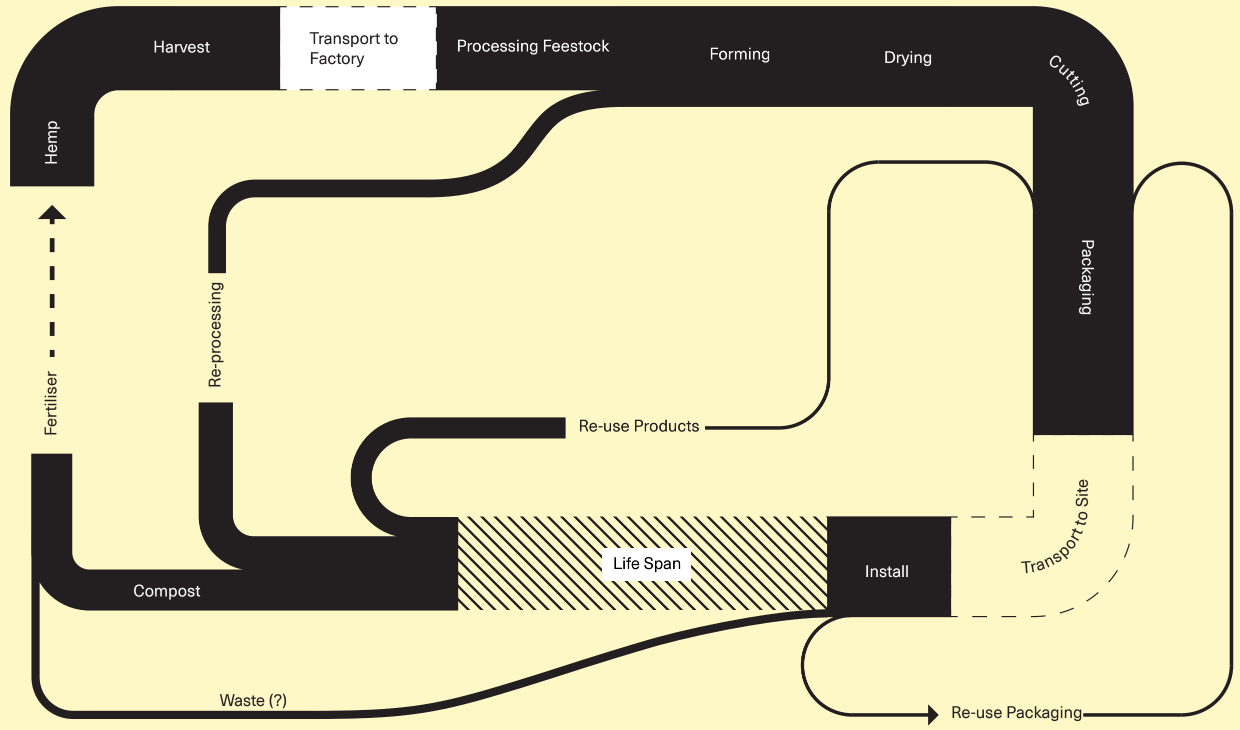


Figure 3.22 Conventional plasterboard supply chain diagram
Figure 3.23 Biobased adaptavate supply chain diagram

3.6 Market value

As explained in Section 3.1, 521,000 new homes need to be built in the NEY region over the next 17 years[60]. Depending on how successful efforts are to adopt biobased materials in the construction of new homes, the total value generated for the region could range from £0.5 billion to £1.9 billion per year by year 17. This equates to 10-36% of the total economic output of the region's housing sector.

The total value of the output generated for the region through the supply and installation of biobased materials over the whole 17 years could range from £4.3 billion to £14.8 billion.

This assumes the adoption and implementation of the bio-based construction materials considered in the carbon impact analysis in

Section 3.4 occurs to different extents. Three scenarios were considered: Ambitious, Progressive and Minimum

The bar chart shows the output of bio-based materials used in new residential buildings per year for each of the scenarios above, assuming 500,000 new homes are constructed over the 17 year period.

Initial uptake (0 - 5 years) is assumed to be slow to account for the risk-averse nature of the construction industry and the time needed to address outstanding research questions regarding biobased materials. The early-stage actions recommended in the roadmap, Section 7, aim to address these research questions and build confidence in these materials within the industry. The scenario assumes successful delivery of these actions is sufficient to allow adoption to accelerate in the second period (6–12 years). The actions must become more involved and more influential as you move up the adoption scenarios

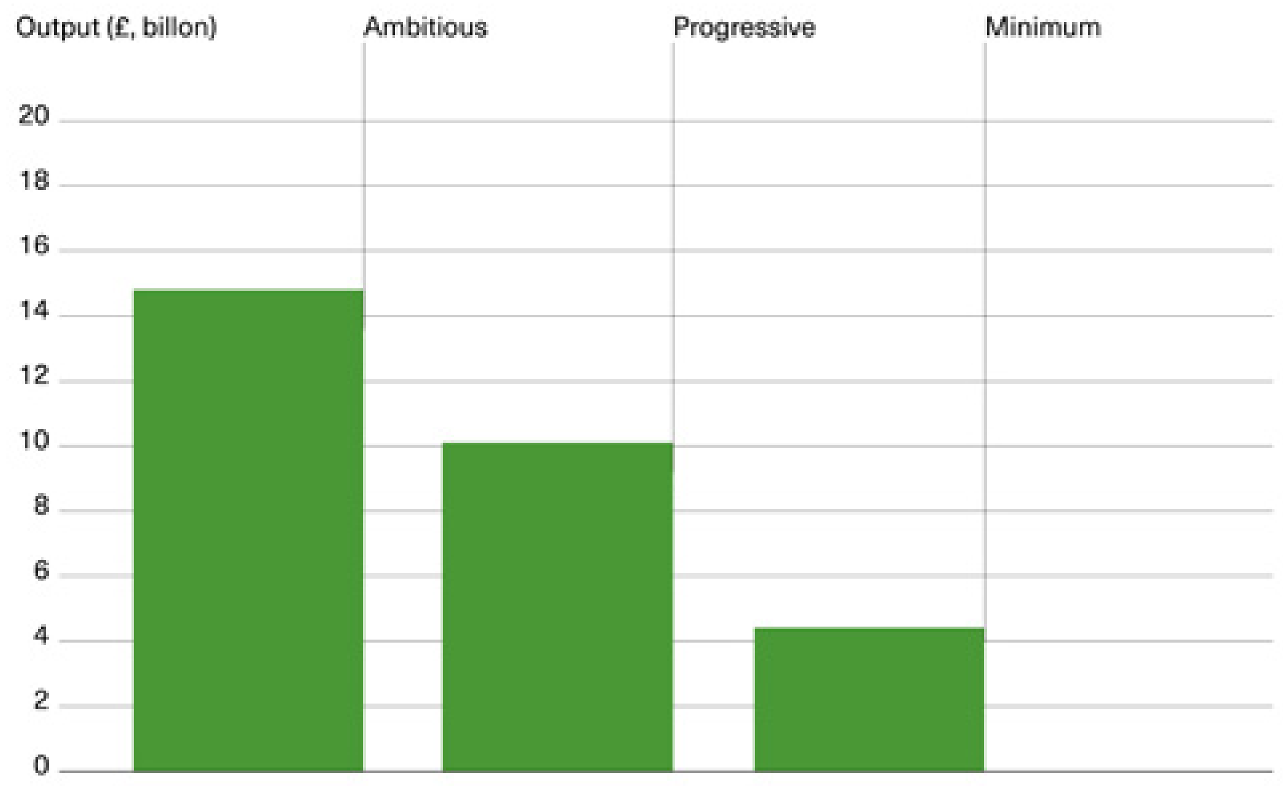
Ambitious – Growth to 41% of the market using bio-based materials after 10 years, then to 75% after 17 years.

Progressive – Growth to 28% of the market using bio-based materials after 10 years, then to 50% after 17 years.

Minimum – Growth to 12% of the market using bio-based materials after 10 years, then to 20% after 17 years.

60 See Appendix, Section 9.4 for Local Authority Housing Projections

For additional information on the methodology of this calculation see Section 8.2 (Appendix 2)



Total value of the output generated for the region through the supply and installation of biobased materials (£, million) per year

£5.5b

Lower estimate

30,700 homes need to built annually accross the region, or 520,000 homes over the next 17 years.

£14.8b

higher estimate

Using today's benchmarks this would generate more than 26 million tonnes of embodied carbon.

3.7 Strategic Plan

Using the comparative analysis above, and an understanding of the opportunities and limits of current land use and biobased manufacturing within the region today, this section proposes a model for the region's biobased industry growth. This growth is anticipated, as outlined in section 3.6, to be gradual, with uptake dependent on some external factors, such as regulation, as well as on the speed of a regional response to the climate crises. It is anticipated that the NEY could export biobased construction materials as well as to utilize them within regional construction. The maps to follow illustrate potential scenarios for the growth of the biobased industry across the region. These are based on the region's total housing need, which is estimated to be approximately 520,000 homes by 2038. The projected annual housing need, an estimated average of this figure, is approximately 31,000[61].

61 See Appendix, Section 9.4 for Local Authority Housing Projections.

Today

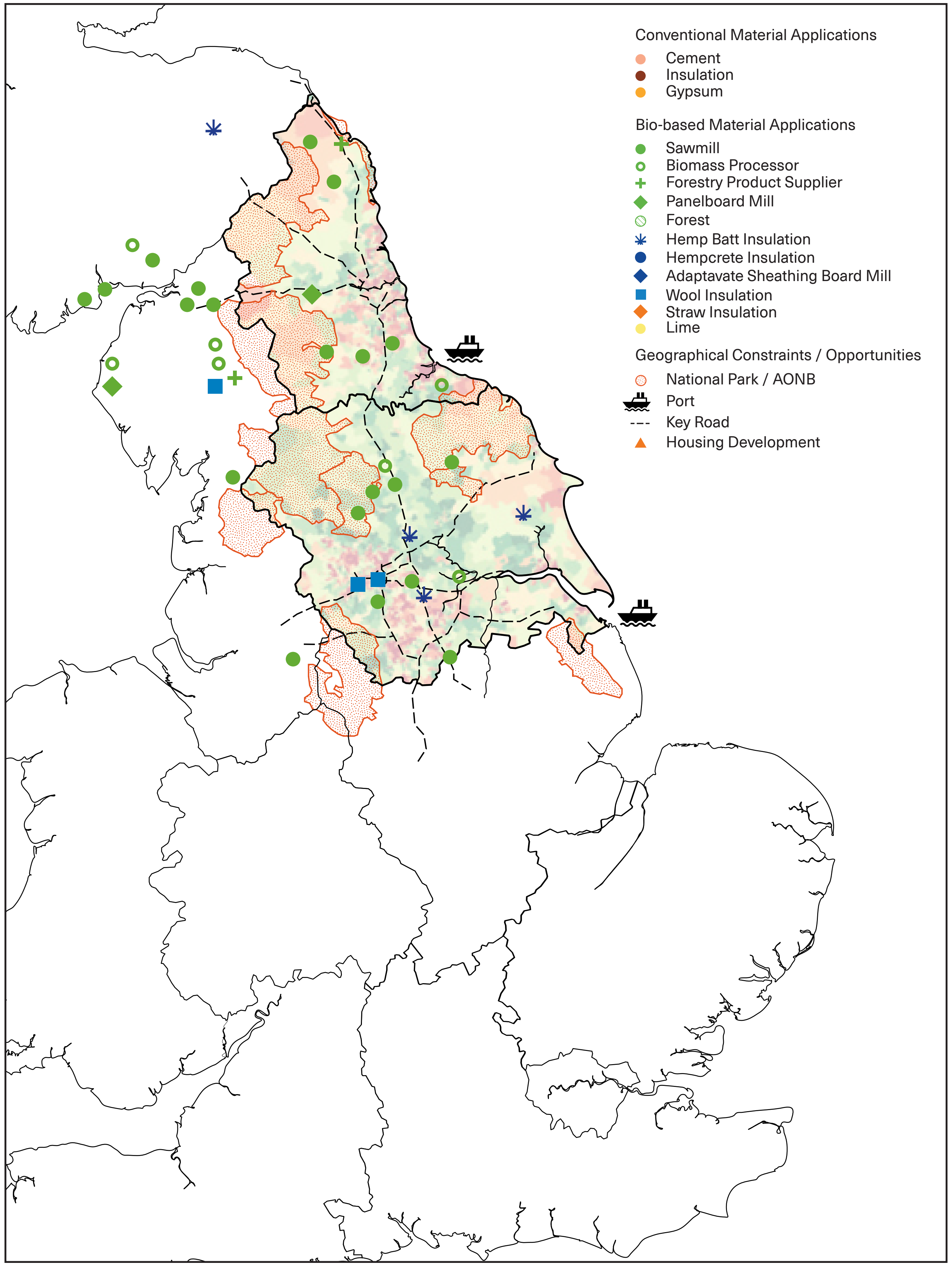
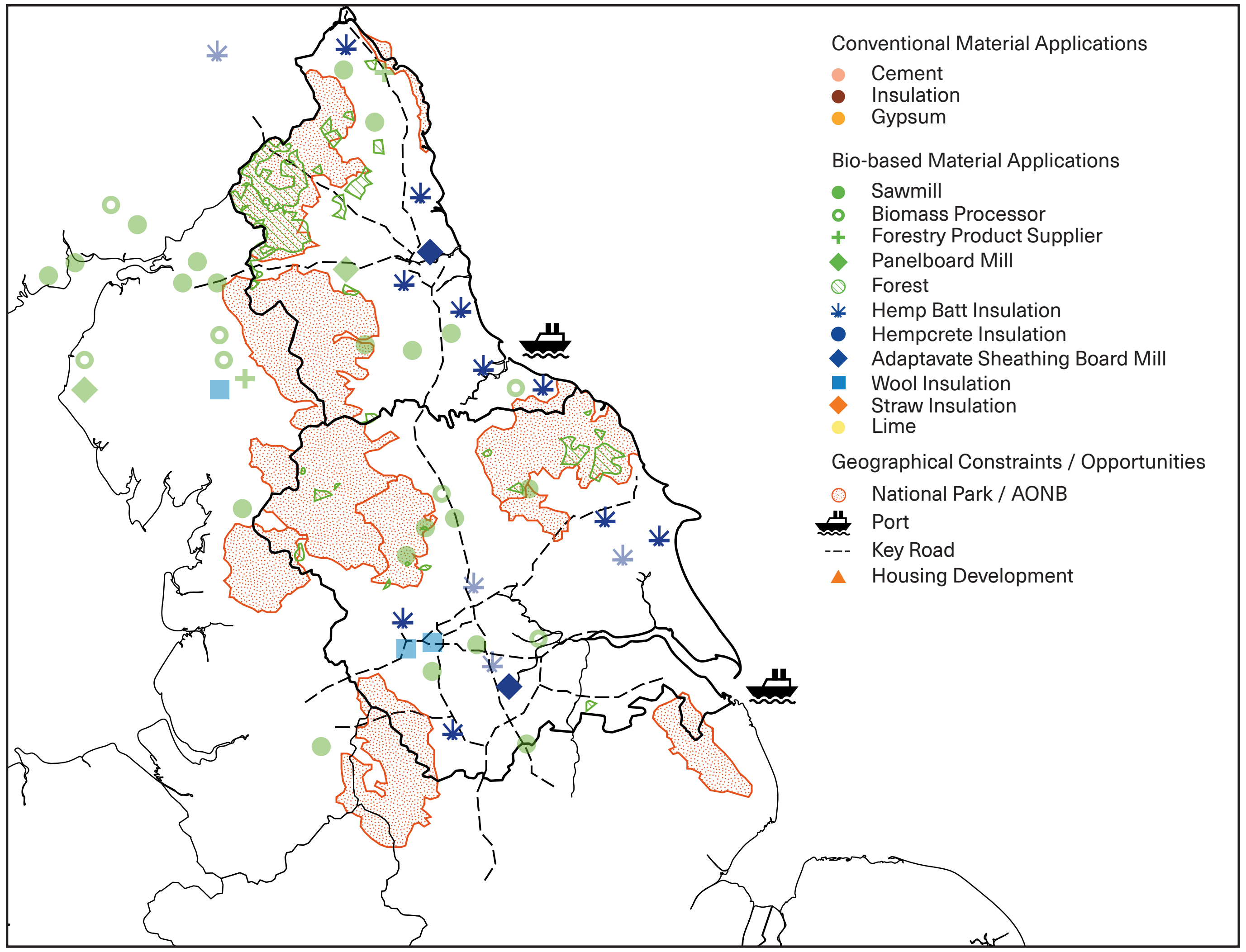


Figure 3.21 Hemp lining board proposed supply chain map



0-5 years (2021–2026)

+2.6% in ambitious scenario[66] = 800 homes

Regional growth

By 5 years,[62] to fulfill 2.6% of the housing need (or 800 homes) using proposed bio-based construction products (Timber, Hemp Batt Insulation and a hemp-lime lining board), the required increase in processing would be as follows:

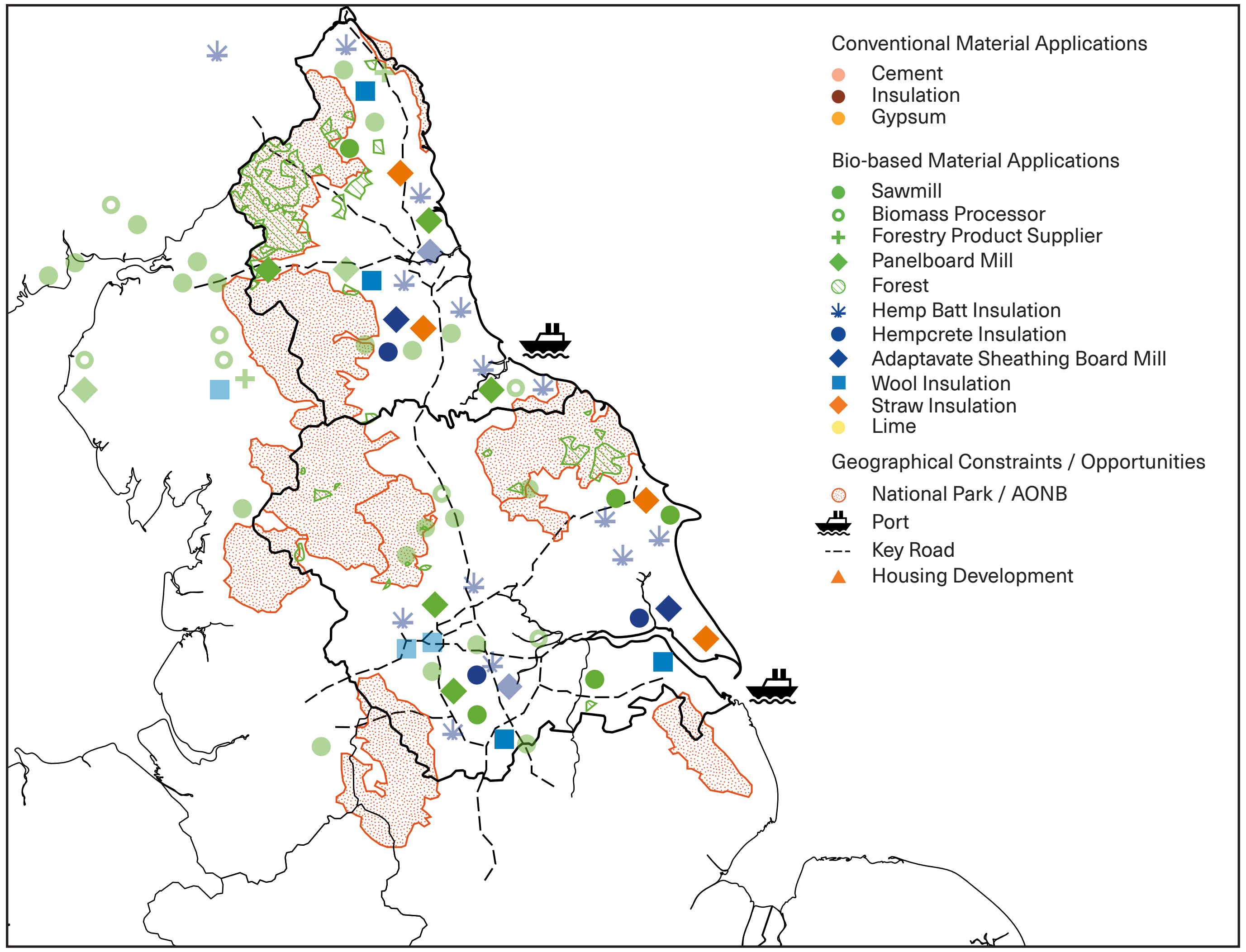
- **Timber:** To construct 800 homes in the fifth year this will require 42,000m3 of timber, well within the regions existing production[63]
- **Hemp Batt Insulation:** 1 additional primary processing facility would be required64, while demand could be met from their soon to open plant in the Scottish Borders, supplying around 1.5 million units to the NEY.
- **Hemp-lime boards:** Depending on the demand in the rest of the country, the existing facility in Gloucestershire could be relied upon to meet the need of NEY65.

National Growth

In addition to this capacity, additional capacity for domestic export is estimated at 5%, roughly 2.6% for the region of South-West England and the country of Scotland. This would therefore suggest additional processing capacity as follows:

- **Timber**: the existing capacity could produce exports to the rest of the country (at present around 35% of English timber stock is within the NEY)
- **Hemp Batt Insulation:** If a plant were constructed in the region it could serve the region's need with potential to export outside of the region.
- **Adaptavate boards:** If a plant were constructed in the region it could serve the region's need and provide exports to one other region such as Scotland based on a need of 800 homes per year.

62 Assuming full housing need for a single year is 31,000 homes
63 Existing timber production in the NEY amounts to 936,670.66m3 per year (softwood and hardwood, based on National Forest Inventory statistics). We know from analysis in this report 51.56m3 of timber are required for the structure of a single home.
64 The current yield of 0.32 kha would need to increase 16 times to 5.4 kha required to build 800 homes. East Yorkshire Hemp's current processing facility could handle hemp up to 500 h.
65 To be competitive a sheathing board mill must produce 1 million units per year (or around 2,880,000m2). Meeting the 2.6% of the housing need (or 800 homes) requires 576,800 m2 of Adaptavate, drawing hemp dust from 10.5 kha of land.
66 See Appendix, Section 9.3 for Economic Assessment Methodology; Adoption Projections.



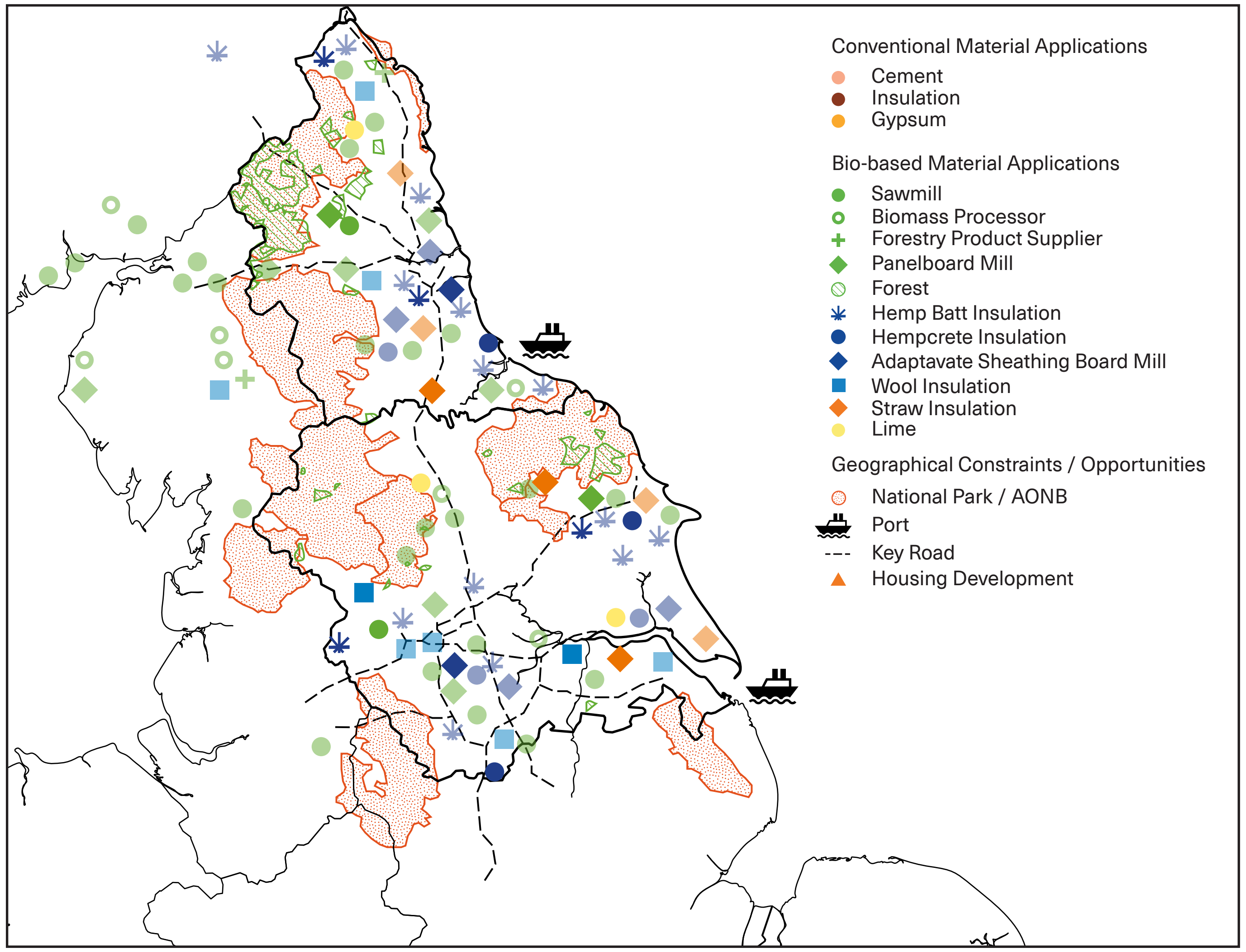
5-10 years (2026–2031)

+41.3% in ambitious scenario = 13,000 homes[69]

- **Timber**: If we are to construct 13,000 homes in the tenth year this will require 666,900m^3 of timber, well within the regions existing production, however additional felling would be required or imports as it is unrealistic to expect such a high proportion to be given over to structural uses.
- **Hemp Batt Insulation:** 11 additional facilities primary processing close to 100,00067 tonnes of hemp per year would be required to meet demand during this period. Either an expanded single plant, or around 10 smaller secondary processing plants would be required to produce the nearly 25 million hemp batts need to build 13,000 homes.
- **Hemp-lime boards:** Based on demand during this period[68] production could continue to be exported from the Gloucestershire plant if it grows to support such demand. However if sufficient demand is created so close to a ready supply of hemp and straw waste a business case could be mounted to open a new plant in NEY serving the region and beyond. Surplus demand could be used to export to other regions or internationally through the ports of the Humber, Tees, and Tyne.

67 98,865
68 Demand during this period rises to 3,250,000 units per year. This is considerably less than the capacity of the market leader plaster board facility of 300million units per year. However this could consist of a single facility, or 3 smaller facilities producing around 1 million units per year, the minimum figure suggested to permit commercially competitive operation.

69 12,660



10-15 years (2031-2036)

+74.6% in ambitious scenario = 23,000 homes[73]

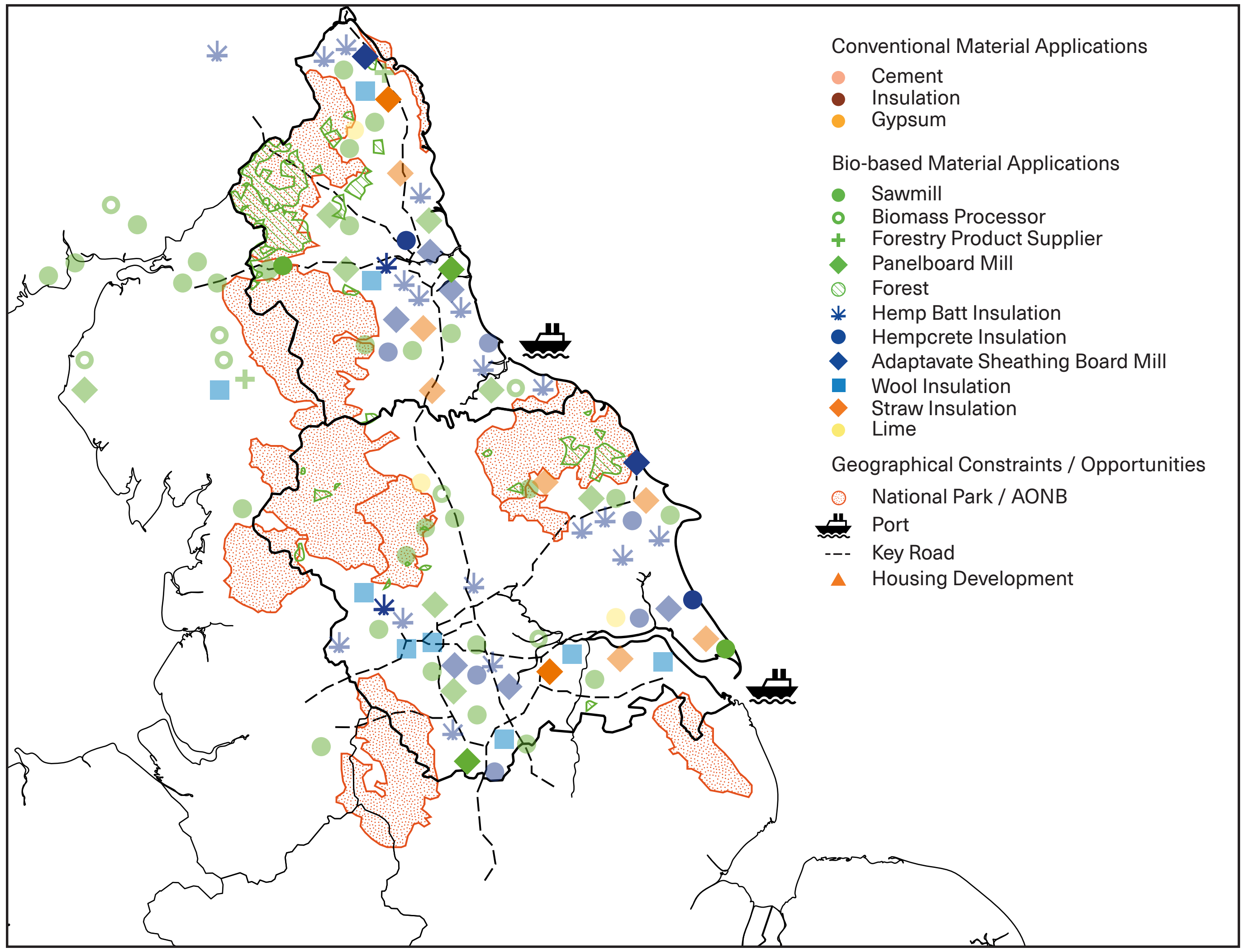
Timber: If we are to construct 23,000 homes in the fifteenth year this will require 1,187,490m3 of timber[70], in excess of the current timber yields within the region. This will therefore require importing timber from outside of the region to the amount of 250,819.34m3 annually, or significant additional felling if available.

Hemp Batt Insulation: Assuming a single processing facility can process 35,000 tonnes[71] of hemp per year this would require an additional 8 primary processing facilities to be established[72]. The existing secondary processing facility would need to be expanded significantly, or up to an additional 10 smaller plants could be established across the region.

Hemp-lime boards - Based on this demand during this period and conversations with a leading hemp-lime board manufacturer, if not already established in the previous period, a plant could be set up in the NEY during this period[74]. Dependent on size, up to 6 smaller manufacturers could be set up, though it would likely be the most commercially viable option to centralise this capacity in one location. Surplus demand could be used to export to other regions or internationally through the ports of the Humber, Tees, and Tyne.

70 Existing timber production in the NEY amounts to 936,670.66m3 per year (softwood and hardwood, based on National Forest Inventory statistics). We know from analysis in this report 51.56m3 of timber are required for the structure of a single home.
71 Figure of 35,040 tonnes/year taken from Tatham, manufacturers of hemp decortication machines which can process 4 tonnes/hour and operate 24/7, 365 days a year.
72 The projected yield at the end of the previous period of '26-'31 of 70.21ha, would need to increase to 126.82 kha/annum to build the required 23,000 homes.

73 22,868
74 According to evidence from Adaptavate, a market leading lining board manufacturer will produce up to 300 million units of board per year from a single facility, or 864 million units. In order to meet the projection of 23,000 homes per year, each using 720m2, by the end of this period 16,560,000 m2 of board would be required, or a facility producing 5,750,000 units. Hemp dust would need to be drawn from an area of 301 kha, or substituted with other agricultural waste such as hemp shiv, or straw.



15-17 years (2036-2038)

+74.9% after 17 years, at 2038 = 23,000 homes[77]

Timber: It is assumed that during the previous period of '31--'36 that the supply chain would have been adapted to meet this demand and therefore sustained planting and management of forests would be required to continue to meet this demand[75]
Hemp Batt Insulation: As during the previous period the same amount of homes continue to be produced during this period and therefore no additional facilities would need to established[76].

Hemp-lime boards: As the annual demand for hemp-lime board remains the same during this period as that between '31-'36 it is assumed that a plant(s) sufficient to supply the region has been established. Any surplus supply is available for export domestically or international through the ports of the NEY.

75 Existing timber production in the NEY amounts to 936,670.66m3 per year (softwood and hardwood, based on National Forest Inventory statistics). We know from analysis in this report 51.56m3 of timber are required for the structure of a single home. If we are to construct 23,000 homes in the seventeenth year this will require 1,187,490m3 of timber, in excess of the current timber yields within the region.

76 The land area required to grow sufficient hemp at the end of the previous period of '31-'36 of 87.88 kha, would need to increase to 155.48 kha/annum to build the required 23,000 homes.

77 22,960

4

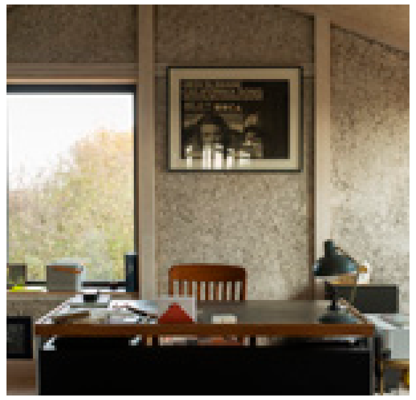
Why transition to a biobased and circular economy?

Transitioning to a biobased and circular economy

1 Could reduce the regions carbon footprint by 2.88 $MtCO_2e$

2 Provides landscape and biodiversity benefits

3 Could create healthier environments



4 Has the potential to stimulate growth by up to £14.8 billion

4.1 Growth of the biobased construction industry will reduce the region's carbon footprint

26% of the UK's carbon emissions come from buildings[1]. Transitioning to a construction industry that centres the use of biobased materials would significantly reduce these emissions, and therefore the region's total carbon footprint. Through the production and processing of materials in the region, the emissions associated with travel would also be reduced, further mitigating the environmental impact of the industry overall.

Over 2.8 million[2] homes in the NEY need to be retrofitted, with the additional need of approximately 520,000 new-build homes over the next 17 years. Use of biobased materials and circular construction methods in this construction will support the region in achieving its net zero targets. Building 500,000 homes with biobased materials instead of conventional ones could save a total of 2.88 $MtCO_2e$.[3] The potential emissions savings that would be made through the application of biobased construction in non-residential buildings would also provide a further opportunity for emissions reduction.

A building's total emissions can be split into its operational carbon (that is emissions associated with the running of the building, and its embodied carbon), the sum of all the greenhouse gas emissions (GHG) associated with the production, use and disposal of a material/product.[4] Some assessments suggest that embodied carbon accounts for up to 50% of a building's emissions over sixty years.[5] According to the Climate Change Committee's data (gathered from the past twenty years), the UK's buildings sector has seen the lowest CO2 reduction of any sector.[6] As a further compounding of this problem, the government's new targets for green building, published in January 2021[7] focus only on operational carbon.

At a regional level, the North and West Yorkshire Emissions Reductions Pathways report, and the Industrial Strategies of the North East, Tees Valley, York and North Yorkshire, and West Yorkshire focus only on gains to be made through reducing operational carbon.[8] There is an opportunity to make proportionately greater progress by improving the efforts to reduce the embodied carbon of the region's construction industry. Local authorities have the opportunity to set standards and targets for reducing embodied carbon that central government policy does not currently address.

There are examples in the UK and abroad of total carbon emissions being addressed through policy. The London Plan, published by the Mayor of London in 2021, sets out[9] full Life Cycle Analysis, including embodied carbon, is required for all new developments.[10] The French government recently announced that all new public buildings must be constructed from 50% timber or biobased materials, with biodynamic carbon measurement taking into account biobased materials' ability to lock up carbon for a specific length of time. This "biodynamic" measurement acknowledges that even in the worst case scenario in which the embodied carbon is released from the building in sixty years time, it will be released into an atmosphere with significantly reduced CO2 levels.[11] Finland similarly has ambitious plans to reduce building emissions through greater use of timber, recognising the material's ability to sequester carbon and reduce embodied carbon.[12]

1 The Committee on Climate Change puts it at 23% for energy-related emissions; material production & construction emissions would add approximately 2-3 %, so approximately 26% of UK emissions are from buildings, based on the 6th carbon budget sector report, refer to: Climate Change Committee. (2020). The Sixth Carbon Budget Buildings. page 6.
2 Data from MCLG open source data, SI to confirm , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
3 Based on the assessment carried out in section 3

4 BRE. (2018). BRE Global Methodology for the Environmental Assessment of Buildings using EN 15978:2011. (PN 326 Rev 0.0)
5 Architects Climate Action Network. (2021). The Carbon Footprint of Construction.
6 Climate Change Committee. (2021). Progress in reducing emissions 2021 Report to Parliament. Retrieved August 26, 2021, from https://www.theccc.org.uk/publication/2021-progress-report-to-parliament/
7 Ministry of Housing, Communities and Local Government and Pincher, C.(2021). Retrieved September 27, 2021, from https://www.gov.uk/government/news/rigorous-new-targets-for-green-building-revolution
8 Carbon Abatement Strategy Ref. , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

9 Refer to Section SI 2 and SI 9.2.11 in Mayor of London. (2021). The London Plan 2021. (ISBN 978-1-84781-739-6). London: Greater London Authority
10 Mayor of London. (2021). The London Plan 2021. (ISBN 978-1-84781-739-6). London: Greater London Authority
11 Errard, G. (2020). Wood and straw in more public buildings. Retrieved September 27, 2021, from https://immobilier.lefigaro.fr/article/d-ici-a-2022-tous-les-batiments-publics-devront-etre-batis-a-plus-de-50-en-bois_f5bae31c-47e9-11ea-b680-b87925275d6f/
12 Heino, P. Wood Building Programme. Retrieved September 21, 2021, from https://ym.fi/en/wood-building

4.2 Biobased material cultivation provides landscape and biodiversity benefits

Biobased construction materials will help the NEY to meet standards set out by local and national government in the coming decades, as well as to enable a transition towards more sustainable, regenerative farming. Developing biobased feedstocks engages with the goals set out in Carbon Abatement Pathways and the aims of Defra's new ELMS programme, facilitating greater biodiversity through the use of sustainable farming practices.

Sustainable crops like hemp help to rehabilitate soil, reducing the need for fertilisers, and removing the need for pesticides—with associated potential benefits to local water quality. The deep taproots of the hemp plant also aerate and open up the soil. Cultivating hemp can lead to greater yields in follow-on crops such as wheat. It also acts as an effective weed suppressant. In addition, hemp can be a part of fast and effective CO2 offset, growing up to 5 metres in only 3-4 months.[13] The absence of pesticides allows biodiversity to flourish. East Yorkshire Hemp grower Nick Voase notes dramatically improved biodiversity on his land as a consequence of hemp farming and limited pesticide use, with evidence of more lacewings, caterpillars, ladybirds, swallows and predatory wasps.[14]

There is also evidence that the hemp plant can draw out heavy metal impurities from the soil. In consultation with the authors of this report, Unyte Hemp suggest the use of hemp as a phytoremediator on brownfield sites. They propose the use of hemp for the improvement of soil quality on contaminated land, before processing the hemp plant into shiv and fibre for use in the construction of new homes on these brownfield sites, which are otherwise costly to rehabilitate.

Biobased feedstock crops will also enable farmers to address the requirements set out within the new Environmental Land Management Schemes (ELMS). It is anticipated that farmers will be remunerated for delivering enough clean water and clean air, as well as protecting land from environmental hazards, and ensuring the protection of plants and wildlife. In addition to these requirements, farmers will need to demonstrate the reduction of and adaptation to climate change in land management.[15] The region's carbon abatement strategies include proposals for afforestation as well as a reduction in meat consumption. These proposals can be facilitated through the increased cultivation of timber, and the expansion in the growth of new use crops as part of additional revenue streams for cattle farms and other farms adapting to reductions in demand.

Increased forestation helps to reduce flood risk, an increased risk within a changing climate. A varied approach to timber production, combining both large scale commercial forestry and smaller scale localised tree planting, can help to tackle climate change while also improving biodiversity.
Landscape impacts

13 British Hemp Alliance. The benefits of Growing Hemp. Retrieved September 16, 2021, from https://britishhempalliance.co.uk/about-hemp/
14 Reference Nick Voase interview, and hemp doc, Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

15 Environmental Land Management Schemes. (2021). Retrieved August 31, 2021, from https://www.gov.uk/government/publications/environmental-land-management-schemes-overview/environmental-land-management-scheme-overview

Figure 4.2

4.3 Biobased material manufacturing and processing is less polluting, and the environments they create are healthier

Conventional construction materials, such as concrete, synthetic insulations and lining boards, all require significant amounts of energy to produce and process. This releases a large amount of greenhouse gas emissions into the atmosphere, along with other harmful pollutants. As described in section 2, biobased materials sequester carbon dioxide while they are growing. They also often require less energy in their processing and product manufacturing such that their total embodied carbon is lower, as evidenced in the relative embodied carbon of the business-as-usual home relative to that of the biobased home, shown in Section 3.4.

Indoor Environments

With the UK population spending on average around 80-90% of their time inside buildings, and up to 60% of their time in their homes,[16] buildings are important modifiers[17] in population health.[18] Many of the factors influencing how we feel in the homes we live in are design-influenced. According to the UKGBC there are a broad range of factors that contribute to a home's health and wellbeing impact. The UKGBC defines a healthy home as one that is spacious, has good public transport links, access to outdoor amenity space, good daylight, year round thermal comfort, and good indoor air quality.

16 Dimitroulopoulou, S. Shrubsole, C. Foxall, K. Gadeberg, B and Doutsi, A. (2019). Indoor Air Quality Guidelines for selected Volatile Organic Compounds (VOCs) in the UK. London: Public Health England, page x - x
17 Thomson, H. Thomas, S. and Sellstrom, E. (2013). Housing improvements for health and associated socio-economic outcomes. (10.1002/14651858.CD008657)
18 Dimitroulopoulou, S. Shrubsole, C. Foxall, K. Gadeberg, B and Doutsi, A. (2019). Indoor Air Quality Guidelines for selected Volatile Organic Compounds (VOCs) in the UK. London: Public Health England, page x - x

As described in Section 2.2, a factor influencing Indoor Air Quality is contaminants introduced by materials and fittings in the home, these include volatile organic compounds (VOCs), Endocrine Disrupting Chemicals (EDCs), and mould. The presence of VOCs and the associated health risks in residential and public buildings are well reported.[19] They are widely used in construction and building products such as paints, varnishes, adhesives, solvents, and flame retardants. While these contaminants are not emitted from the palette of materials that this report analyses (namely: structure, insulation, lining boards), the use of paints, solvents and adhesives are commonly used alongside conventional construction materials.

Unlike conventional construction materials, biobased materials are naturally suited to moisture permeable wall build ups, a form of construction that reduces the likelihood of mould and also improves moisture and temperature regulation. Moisture is a problem indoors because it promotes mould growth and other biological contaminants, such as house dust mites.[20] Materials like hempcrete and timber pair best with breathable paints,[21] which are extremely low in Volatile Organic Compounds.

19 Vardoulakis, S. Giagloglou, E. Steinle, S. Davis, A. Sleeuwenhoek, A. Galea, S.K. Dixon, K. and Crawford, O.J. (2020). Indoor Exposure to Selected Air Pollutants in the Home Environment: A Systematic Review. International Journal of Environmental Research and Public Health, V17(8972), pages 2-24.
20 Holgate, S. Grigg, J. Arshad, H. Carslaw, N. Cullinan, P. Dimitroulopoulou, S. Greenough, A. Holland, M. Jones, B. Linden, P. Sharpe, T. Short, A. Turner, B. Ucci, M. Vardoulakis, S. Stacey, H. Rossiter, A. Arkell, E. Hunter, L. Sparrow, E and Orchard, E. (2020). The Inside Story: Health effects of indoor air quality on children and young people. London: Royal College of Physicians, page 75.
21 'Breathable' in this instance refers to moisture permeability

Figure 4.3

4.4 A transition has the potential to yield socio-economic benefits to local communities

Evidence suggests that biobased construction supply chains could provide jobs that are inherently safer than the traditional construction industry. This is due to a greater reliance on off-site jobs. In the report 'Offsite Construction: Sustainability Characteristic' (2013)[22], Building Intellect state that offsite jobs are up to 80% safer and also significantly improve working conditions. The agency report details how offsite jobs, as opposed to conventional construction sites, provide more stability for workers and create a permanent workforce. This capacity to produce a stable workforce allows for greater employee development. In recent decades, such a change has been seen in the consumer products industries. Across 2019/20, of the fatalities recorded in the construction industry 47% related to falls from height. An increase in offsite work would reduce the amount of work-at-height that needs to be carried out.

Growing the biobased material supply chain would create the opportunity to create jobs and improve skill sets where this is needed the most. The location of the proposed biobased industries coincides with some of the most deprived local authorities in the region. These local authorities would benefit both from the presence of larger scale employers as well as the training and apprenticeship opportunities associated with them. Scaling up the biobased industry will, however, require investment in assets, the forging of relationships across the supply chain, as well as education and training, in order to meet a growing demand for a specialised workforce. The gains of scaling up the biobased industry are clear. It would contribute to reaping greater benefits from the existing resources in the NEY, and ultimately increasing the competitive advantage and productivity of the region too.

At present, many mass house builders employ trades people from across the country, regardless of whether those skills exist within the region. Currently, there is no regulation to stop labour being brought in from outside the region. If the region remains a leader in biobased construction, it could embed the positive practice of local employment. By virtue of reduction in the travel of workers, and ensuring capital remains within the region, and environmentally friendlier supply chains, local employment would help the region to reach its zero net carbon targets faster.

22 Krug, D. Miles, J. (2013) Offsite Construction: Sustainability Characteristics

Figure 4.4

5

Barriers and opportunities

5.1 Regulatory frameworks

The Architects Climate Action Network (ACAN) propose that the Building Regulations are expanded to include requirements to assess, report, and reduce embodied carbon, within a new part: 'Part Z: Embodied Carbon Emissions'.

Without testing and data equivalent to that available for conventional building materials, biobased materials will not be able to break into the mass market. In order for construction materials to be more widely used, they must fulfill requirements laid out in Building Regulation Approved Documents A-R, and the national Building Standards.

Increasingly, EPD1 and LCA2 documentation is also sought by design teams and clients.3 This testing is often costly, creating a barrier to entry for material innovators working in the biobased sector. Current regulation relating to combustible materials may have significant effects on biobased materials; in the wake of the Grenfell Tower fire, the Building Regulations limit the use of 'combustible' cladding materials to buildings of approximately 5 storeys in height.4 At present, timber cladding and biobased insulation materials are considered to be 'combustible'.

The route to market

Over the last few years British biobased material innovator, Adaptavate, have developed a product called Breathaboard: an environmentally friendly alternative to plasterboard made using waste products from Yorkshire Hemp production. Adaptavate's development and testing of the Breathaboard was made possible due to a funding grant from InnovateUK.[5] This grant has enabled their collaboration with institutions such as Bath and York University, as well as the BRE. These detailed studies have helped to develop a product that can assure a consistent performance, necessary for the mass market, as well as supporting the development of a product specific EPD.[6]

1 EPD = Environmental Product Declaration, see glossary for explanation
2 LCA = Life Cycle Assessment, see glossary for explanation
3 For public work projects and programmes the government guidance Construction Playbook suggests the use of whole life carbon assessments
4 Ministry of Housing, Communities and Local Government. (2019). Guidance: Ban on combustible materials. Retrieved September 27, 2021, from https://www.gov.uk/guidance/ban-on-combustible-materials
5 citation of interview with Tom and Jeff from Adaptavate, Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
6 This EPD has not been published at the time of publishing, however it is anticipated by early October 2021

Barriers to market entry

Cecence, another biobased material innovator based in Hampshire, have developed a biobased rainscreen cladding product that has been used in celebrated live build projects, such as Flat House by Practice Architecture.[7] However, they have been unsuccessful in securing the funding required to conduct the required fire and accelerated weather testing. The undertaking of this testing process is a necessary requirement before large scale house builders and industry suppliers can be approached. In an interview, Cecence informed the authors of this report that accelerated weather machines cost more than £12K, with the test costing approximately £10K to outsource. Life cycle analysis is chargeable in the region of £20-60K. This shows how prohibitive the costs and risks associated with a route to market can be.

Collaboration with your market

The Construction Leadership Council has developed a series of metrics they suggest innovators use to provide reliable data on products in order to market them to the industry. However, this does not immediately unlock funding. Innovators are currently responsible for funding their own product testing. In the CLC's words, "If you can't get your product to market, you have a problem."

7 Refer to page number of case study, Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

Embodied Carbon

Building regulations do not currently limit the use of high embodied carbon building materials. Without this regulation in place, the industry relies on the individual responsibility of clients and homeowners towards the environment, and the costs and risk associated with low carbon material choice will continue to be placed on these individuals. The Architects Climate Action Network (ACAN) propose that building regulations are expanded to include requirements to assess, report, and reduce embodied carbon, within a new part: 'Part Z: Embodied Carbon Emissions'.

Relationship to Mortgages and Warranties

Testing, and the associated product data, is required to provide product warranties. It is through product warranties and guarantees that insurances can be arranged, which in turn permits mortgages to be offered on homes. See Section 5.4 for an expansion on this relationship.

5.2 Mortgages and insurance

Mortgaging and financing of biobased homes is considerably more difficult than those constructed with conventional building materials, discouraging their wider use.

There are considerably more barriers to the mortgaging and financing of biobased homes than those constructed with conventional building materials. This discourages the wider use of biobased materials and also limits demand.

How to obtain mortgages for a biobased home

Both the construction of new homes or renovation of existing homes typically require a mortgage. Mortgage lenders will provide financing for projects only when they know they are insurable, and for the large majority of insurers, biobased materials do not have the types of certification they require. There are a handful of mortgage providers offering products which are appropriate for sustainable, low carbon construction. The Ecology Building Society (EBS), and mortgage broker BuildStore, are both options—although BuildStore caters solely to the self-build market. The EBS will investigate individual projects with the small number of insurers with whom they work, to obtain the assurance they require that the design and build quality will meet the necessary standards. This process is both lengthy and costly. The responsibility lies with the property owner and is also passed on in the case of sale. These limitations make biobased construction less appealing than using conventional materials, further hindering its use within the NEY.

Further barriers to biobased design

In 20XX the architecture practice Outpost won RIBA Competition Great Places:Lakes and Dales for their design of a biobased housing development. At the time of writing, they are still awaiting approval for their planning application associated with the project, which is held up because of XX. The future of this partially biobased residential development hangs on whether the client will accept the risk associated with the mortgages of potential buyers. There are further examples of the barriers to biobased design. An additional proposal for the Home 2030 design competition ran by the RIBA and BRE on behalf of the Government "wouldn't be touched by a barge pole" by mortgage providers due to lacking accreditation of the proposed material palette from the BBA or NHBC.

The struggle with mortgages and insurance

Connect Housing in Leeds has a 3500 home portfolio, growing by 65 units per year. These are constructed in part by the organisation and they provide homes and support across West Yorkshire. However, as they finance future projects through mortgaging their existing housing stock, they are unable to use many biobased materials. If mortgages are not competitively available for biobased homes, then they will not be built despite the clear environmental interest in doing so.

Mortgaging biobased homes

The Ecology Building Society, established in 1981 and based in West Yorkshire, is the only lender specializing in mortgages on properties built with sustainability in mind. They accommodate the use of biobased materials and some non-standard construction methods. They are also interested in funding energy efficient housing, ecological renovations, and projects that inspire low-impact lifestyles. As the only company providing mortgages, these come at a premium. The prohibitive costs of borrowing for biobased projects limits access to homebuyers. As a consequence, biobased construction becomes a lifestyle choice rather than a means to build sustainability into the construction industry. Due to EBS's limited size, they are currently unable to provide mortgages for large scale developments. They limit loans to £3million to an individual client. As a consequence they aren't able to support community-led developments of more than 20-30 homes.

Insurance sector is slow to respond

The National House Building Council (NHBC) provides many of the structural warranties for new homes in the UK, as well as setting standards in consultation with the industry. Furthermore, change in environmental standards towards the encouragement of the use of biobased materials is slow. In conversation with the authors of this report, the NHBC suggests that one way to increase the speed at which Warranties and Standards change is through a change in national regulations.

Insurance of architects work with biobased materials

Architects require Professional Indemnity Insurance (PII) in order to protect themselves and their clients when working. The cost of PII insurance has risen in the aftermath of the Grenfell Tower Fire of 2017, this is proving a problem for architects wishing to design with innovative biobased materials. As outlined by Outpost, if insurers will not insure architects to use these materials, they will have no choice but to stop specifying and designing with them. Data and testing, as well as legislative support are necessary to ensure insurance is available to all designers. There needs to be greater incentives to work with low-embodied carbon construction materials.

5.3 Misconceptions and knowledge gaps

A variety of misconceptions and knowledge gaps exist in the general understanding of biobased materials. These range from concerns around their safety and durability, to more specific concerns such as the potential for vermin to nest within walls, as well as the threats from moths and other pests. While biobased materials are also combustible in nature, they are not exempt from building regulations: and when processed and treated correctly, they can be resistant to fire, moisture, and vermin. More work can be done to combat these misconceptions.

Moisture Regulation

A common misconception is that biobased materials create damp environments. However, when they are properly utilised in construction projects, these materials can facilitate the moisture regulation of indoor environments. They take on or give off moisture as required, creating stable environments through breathable[8] build ups. During interview, Indinature described how there is not enough data on vapour permeability in biobased construction projects for the area to be fully understood. Increased use of and research into these materials will provide a fuller picture.

Vermin

Many people believe biobased materials provide attractive homes for vermin. According to Building with Straw Bales[9] there is no evidence to prove this.

Poor construction techniques

The use of Calcium Cilicate blocks is currently uncommon as they are on the Deleterious Materials List. According to the RSA, they were used without sufficient expansion joints which lead to cracking. However, if they were used properly this defect would not have occurred. They remain on the deleterious materials list to this day and therefore considered unusable by insurers. This demonstrates that as use becomes more widespread, good practice in the installation of biobased materials is of vital consideration.

8 See glossary
9 'There is no greater risk of encouraging mice and rats into your straw-bale house than there is for any other types of building'. Refer to Jones, B. (2015). Building with Straw Bales. Cambridge: Green Books, page 205

> "(Conventional) construction materials need to be taxed for the carbon that they are emitting"
> —UK Hempcrete

Durability

Biobased materials are often considered to be old fashioned or to have a short lifespan. However, these misconceptions are often due to a lack of knowledge or outdated information. Importantly, there is a popular resurgence in the use of these materials by many architecture firms working on modern homes (See: Practice Architecture Flat House), and, furthermore, the durability of biobased materials is evidenced by the fact that buildings constructed this way have stood for several hundred years. Lady Row in York is an example of a timber frame building constructed in around 1316 that still stands today.

Fire resistance

While it is true that some constituent elements of biobased materials are combustible, both synthetic and biobased natural additives can be combined with these materials to offer a product that performs as well as conventional building products. Materials like Lime can be used to bind biobased materials together to improve their fire resistance. Adaptavate's bio based lining product, Breathaboard is fire retardant,[10] bound together by lime in order to produce an innovative alternative to gypsum plasterboard.

Cost

Biobased materials can be more expensive than their carbon-based counterparts. However, as use and consequent production increases, the costs will come down. Adaptavate claim that growing their production to a scale of 1 million units per year would allow them to bring a lining board product to market at £5.20/m2. This is in comparison to a market leader producing goods at around £3.75/m2 in facilities producing 300 million units per year.[11] Start up costs for housing systems, however, require proportionately smaller demand: the representative of modular straw housing system EcoCocon in the UK reported that demand for 30 homes or more per year would support a factory in the UK, removing the need to import and the cost of transport, which currently stands at around £3000 for a small home (with costs rising due to new import duties relating to Brexit).

The limited availability of experienced and skilled labour in the use of biobased materials and systems also increases the costs for contractors and developers. These costs are inevitably passed on to homeowners. As demand associated with production increases, the more economies of scale can be taken advantage of across the industry. From this combination, it is anticipated that material costs will decrease.

Competitive tendering processes also force contractors to push costs down in order to successfully win bids. And, in a labour market where costs are escalating and skills are in short supply, cutting costs on materials is the obvious first compromise to make. Until legislation and regulation encourages greater use of biobased and low carbon construction materials, contractors will not be able to take on the risk of the higher cost, lower carbon, local materials they may have otherwise chosen to work with.

10 Adaptavate Breathaboard. Retrieved September 22, 2021, from https://adaptavate.com/breathaboard-breathable-plasterboard/#

11 Based on interview with Adaptavate , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

5.4 Regenerative Farming

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In the wake of Brexit, recent changes in UK agricultural policy mean there is scope for greater funding for biobased feedstocks such as hemp and timber. Sustainable materials that can be grown and manufactured into biobased materials in this country have the ability to aid regenerative and sustainable farming practices.

Both the UK Agriculture Act of 2020[12] and the Environmental Land Management Scheme refer to farmers' capacity to provide public goods in the form of environmental improvements. Points 7 and 9 of the government's Ten Point Plan for a Green Industrial Revolution,[13] refer to 'Homes and public buildings' and 'Nature' respectively. This report suggests opportunities for the inclusion of biobased feedstocks as a tool to achieve these aims.

Agriculture within the region

Agriculture is a significant employer within the region, employing 32,000[14] in Yorkshire and 10,000[15] in the North East.[16] This represents 10%[17] and 3%[18] of the total UK Agricultural workforce. There is a strong case for investment in this sector within the region. Grow Yorkshire has a primary focus on 'ensuring farming is effective and money making'. They argue that if these two things are achieved carbon reduction will follow. This report outlines how the use of regenerative biobased feedstocks could also aid carbon reduction.

Changes to subsidies
ELMS and UK Agricultural Act 2020

In May 2021, the UK Agricultural Act 2020 became law. This policy addresses the role of UK agriculture post-Brexit and will have a significant impact on the provision of homegrown food and agricultural product supply chains. This system replaces the Basic Payments Scheme (BPS), which was previously part of the EU's Common Agricultural Policy (CAP). The BPS was criticised by the UK government as it "skews payments towards the largest landowners and that rewards ownership of land rather than sustainable practices or productivity." Both the UK Agricultural Act 2020 and the Environmental Land Management Schemes (ELMS) currently being piloted aim to redirect payments towards those farmers that can demonstrate public goods, such as sustainable or regenerative farming methods.[19] [20] Public goods are methods that can demonstrate practices that promote better air and water quality, thriving wildlife, soil health, or measures to reduce flooding and tackle the effects of climate change. Fast growing biobased feedstocks, such as hemp, can play a role in supporting diverse rotational farming methods, helping to rehabilitate intensively farmed soils.[21] Increasing the availability of timber from agricultural land can help to conserve native species and also promote tree planting and bio resilience in the forestry sector.

Local Carbon Action Plans

Biobased feedstocks can work alongside local carbon abatement strategies where they exist. At present the local authorities of West Yorkshire[22], Harrogate[23], Yorks & North Yorkshire[24], Northumberland[25] as well as Yorkshire Water[26] have developed such strategies. All share the aims to improve carbon sequestration via natural means, such as tree planting. The North and West Yorkshire Emissions Reduction Pathways report, published in February 2021,

12 Case, P. (2020). Landmark moment as Agriculture Bill passed into law. Retrieved September 17, 2021, from https://www.fwi.co.uk/news/eu-referendum/landmark-moment-as-agriculture-bill-passed-into-law
13 Johnson, B. and Prime Minister's Office. (2020). PM outlines his Ten Point Plan for a Green Industrial Revolution for 250,000 Jobs. Retrieved September, 21, 2021, from https://www.gov.uk/government/news/pm-outlines-his-ten-point-plan-for-a-green-industrial-revolution-for-250000-jobs
14 Can we source this 32,397 , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
15 Source this 10,610 , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
16 Defra Statistics: Agricultural Facts. England Regional Profiles. March 2021 , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
17 10.57%, Defra Statistics: Agricultural Facts. England Regional Profiles. March 2021 , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
18 3.46%, Defra Statistics: Agricultural Facts. England Regional Profiles. March 2021 , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
19 https://www.gov.uk/government/news/landmark-agriculture-bill-becomes-law , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
20 https://www.gov.uk/government/publications/environmental-land-management-schemes-overview/environmental-land-management-scheme-overview , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
21 Piotrowski, S., & Carus, M. 2011: Ecological benefits of hemp & flax. Hürth, DE: Nova Institute , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
22 https://www.westyorks-ca.gov.uk/media/4277/west-yorkshire-carbon-emission-reduction-pathways-technical-report-draft-v7-1.pdf , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
23 https://www.harrogate.gov.uk/downloads/file/1497/carbon-reduction-strategy , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
24 http://nycyerhousing.co.uk/data/documents/CAP-for-RHEs.pdf , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
25 https://www.yorkshirewater.com/news-media/news-articles/2021/yorkshire-water-reveals-carbon-strategy/ , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
26 https://www.yorkshirewater.com/news-media/news-articles/2021/yorkshire-water-reveals-carbon-strategy/ , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

proposed a maximum ambition scenario of aforestation and peatland restoration. This is suggested in accordance with monitoring forest management and putting some financial incentives in place where appropriate to support deforestation, agroforestry, lowland and upland peat restoration, farming practice changes and hedgerow planting. There is space for biobased feedstocks to be used within these frameworks. As at present, it is only operational carbon that is considered, the reduction in embodied carbon through the growth of biobased feedstocks provides an effective additional method to reduce the NEY's carbon emissions. This can be developed through the construction material supply chains (See: Section 3).

Reducing Flood Risk Through Aforestation

Within the NEY, tree planting can significantly reduce or remove flood risk in areas at high risk of flooding, as in the case of Pickering in North Yorkshire[27]. The Slowing the Flow at Pickering Report demonstrated conclusively that in the case of Pickering flood risk was reduced from 25% to 4% through the planting of 44ha of new forest while also improving forest management, among other tactics.[28] Targetted new forest planting and appropriate management could help to deliver not only carbon sequestration and a sustainable construction material source, but also help to tackle the growing threat of flooding within a changing regional and national climate.

27 https://www.theguardian.com/environment/2016/apr/13/500000-tree-planting-project-helped-yorkshire-town-miss-winter-floods , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

28 https://www.forestresearch.gov.uk/research/slowing-the-flow-at-pickering/ , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

Figure 5.1

5.5 Skills and jobs

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Biobased construction materials skills courses are currently uncommon in UK further education colleges. This is the case while biobased construction techniques are increasingly in demand. The unavailability of courses in biobased construction is due to a combination of a lack of funding as well as the absence of curriculums designed to focus on biobased materials and their use and methods in construction.

Demand for Biobased Construction Skills Courses

The CITB estimates that 350,000 new construction skills jobs need to be created by 2028 to meet the government's net zero targets for 2050.[29] As Chris Carr, Managing Director of Carr & Carr Builders, and Federation of Master Builders Board Member states, "A big part of [this challenge] will be upskilling the current workforce so that they understand what sustainable building is all about." Furthermore, the Ecology Building Society who provide loans on projects constructed with predominantly natural materials are experiencing significant growth at the moment, exceeding their annual targets by the end of August.[30] Hull College have described how the skills sector has lagged behind in providing the necessary courses to equip young practitioners.[31] This is in part due to a perceived, or apparent, lack of interest in such skills,[32] but additionally compounded by a lack of funding to provide experience and exposure with materials that are at present more expensive and less readily available.[33]

Hull College have made improvements to the way their courses are run by using more recycled and reclaimed materials, and removing the use of cement in training and demonstrations - opting for lime instead. However, they are still faced with the problem of using biobased materials such as wool insulation due to the significant increase in cost. Though some biobased construction methods are taught, there are no entirely biobased curriculums. As Jeffrey Hart, an experienced natural builder, has pointed out, this stands in the way of their broader adoption. By connecting construction colleges directly to real world building sites using biobased methods, a clear route for these skills could be set out, as is being tested between the Construction Skills Village and Sohoco in and around Scarborough, North Yorkshire at the time of writing.[34]

Training and development must go hand-in-hand

In an interview, UK Hempcrete stressed the need to establish jobs within the biobased construction industry in order to support the development and expansion of courses in the use of the materials. If a biobased construction material does not exist, neither can the courses that train how to use these skills. It is therefore imperative that the biobased material market is developed alongside the skills and jobs market. Todmorden Learning Centre describes how they will initially run 6 months courses with a view to run 5 year courses. Without enough students to enrol in courses they are unsustainable. Through growth in the biobased supply chain and creation of biobased construction jobs larger and longer courses would be possible.

Upskilling

Unlike plumbers and electricians, builders are not currently required to upskill when building regulations change. If builders were required to upskill, it would stimulate construction skills courses for the active working population and support the establishment of courses for new entrants into the sector.

According to a report by CITB, the NEY can expect a demand of 49,000 additional construction workers in the five years from 2018.[35] If this demand is not met, these skills will need to be imported from other regions of the UK or internationally. Construction Skills Village and SOHOCO of North Yorkshire state that this potential loss of employment opportunities in the region. It is one they are aiming to address by establishing more courses in the Scarborough area. With the expansion of the use of biobased materials in the NEY, it is vital that the labour is retained in the region too. This will require significant upskilling of the workforce and more investment in skills and educational courses.

Partnerships between manufacturers and skills colleges

Progress is clearly being made in partnering manufacturers and skills colleges in Yorkshire and the North East. However, the general lack of funding, and the elevated price of natural building materials is holding this progress back. Hull College have highlighted issues with obtaining funding to use biobased materials. This report suggests that partnerships between construction colleges and natural building material suppliers would mutually benefit both parties. If increased numbers of practitioners attain the skills, knowledge, and awareness about how to use these materials, the demand will also increase. Improved leadership in the prioritising of biobased materials from the course certifiers, such as the City and Guilds, would also assist and encourage construction colleges to focus more on biobased building materials within their curriculums.

29 https://www.citb.co.uk/about-citb/news-events-and-blogs/net-zero-350-000-new-construction-roles-to-be-created-by-2028/ , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

30 Comment recorded in Interview with Ecology Building Society, 20th Sept. 2021 , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

31 As mentioned in interview with Hull College by Material Cultures on 21st Aug 2021 , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

32 Cite Barabara Jones interview - cannot run courses if their isn't enough interest - therefore trying to run shorter courses to demonstrate interest and induce initial risk

33 Refer to ..? Research MC , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

34 Reference to Sohoco-Skills Village collaboration (website of press release)+ interview , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

35 https://www.citb.co.uk/media/unnpkyni/york-north-yorkshire-and-east-riding-june-18.pdf , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

5.6 Offsite Construction and Building Information Modelling

The design and build housing developer CITU, in Leeds, have shown that offsite construction methods provide opportunities for increasing efficiency while also improving health and safety[36] and expanding economies of scale. Working with Modern Methods of Construction and prefabricated building systems could provide a means to make biobased construction more accessible and affordable. It would do so by using crucial time-savings on site to drive down costs. Furthermore, advanced Building information Modelling (BIM) and Digital Twin models can also provide contractors on site with highly detailed data models. A BIM model is a digital model of the entire construction project prepared, coordinated and visualised by the entire project team prior to construction. By streamlining tasks for workers and through efficient monitoring of materials, projects using advanced BIM modelling have been proven to reduce construction waste, the quantity of materials ordered to site, and the labour time involved in coordinating the works on site.[37]

The increased uptake of digital modelling by architects, specifiers and contractors is a groundbreaking technological advancement in the conventional design process. It provides an exciting opportunity to use dynamic embodied carbon and energy modelling of projects in the design phase. Dynamic carbon modelling in the development stages of a project could contribute to an increased demand for biobased materials, reductions in construction waste and a better industry-wide understanding of the implications of different materials in construction on the carbon footprint of a building.

36 Comparison of Worker Safety Risks between Onsite and Offsite Construction Methods: A Site Management Perspective
Seungjun Ahn, A.M.ASCE; Luke Crouch; Tae Wan Kim; and Raufdeen Rameezdeen

37 Source?, Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

Figure 5.2

6

Risks

6.1 Risks relating to transitioning to a biobased economy

Risk category	Risk	Impact	Mitigation
Policy & regulatory	Biobased construction solutions are restricted to certain applications governed by legislation, e.g. in the external walls of designated buildings over 18m tall.	Growth impeded as consumer demand damped by concerns over regulatory compliance	Advocacy based on economic and environmental benefits Support testing to demonstrate compliance Targeted work with Building Control industry to upskill inspectors on safe installation practices
	High Street mortgage providers will not lend on homes comprising biobased materials in their structure and external envelope.	Growth impeded as mortgage lending limited to small specialists charging premium rates	Support new market entrants who will provide lending on these properties Advocacy substantiated by international experience of mature mortgage markets where biobased structure and envelope are prevalent, for example North America.
Technology	Biobased materials do not meet fire regulations or require toxic substances which reduce circular end-of life options to meet fire regulations.	For certain applications, e.g. high-rise residential properties, biobased construction will be challenged and/or restricted by existing fire regulations.	Technological solutions developed to address fire performance and legislation, e.g. development of low toxicity fire retardants Drive market acceptance through successful application to typologies which sit below the height threshold
	Due to inherent lower insulative performance of biobased insulation materials, greater wall depths are required to achieve U-values	Real estate market resists transition; requirement for cost of biobased construction to be low enough that it negates loss of revenue increased cost from reduced floor plate/ increased building footprint.	Support policy interventions which make biobased materials competitive, for example carbon pricing Support development of higher-performance biobased insulation
	Biobased material manufacturers cannot present warranties and/or technical data to ensure compliance with building codes and regulations, or other data such as environmental product declarations required by design teams.	Without confidence in the performance of such materials, designers will not be able to demonstrate compliance with codes	Support SMEs in accessing funding to carry out necessary testing to demonstrate compliance.

Transition risks are risks to businesses that arise from the transition to a low carbon economy.

Such risks are categorised as:

- policy and regulatory,
- technological,
- market, and
- reputational risks.

are exposed to transition risks. New market entrants and market incumbents alike are exposed to transition risks, to a degree dependent on the nature of their products and the speed with which individual businesses adapt to changing social and political expectations. . The table overleaf builds on the prior chapter on barriers and opportunities to identify some key transition risks that stakeholders across the supply chain may experience. The impact of such risks, and possible mitigating actions are also given.

All stakeholders in the construction supply chain

Risk category	Risk	Impact	Mitigation
Market	Consumer demand continues in an unsustainable direction.	Demand grows slower than anticipated in business plans for biobased/circular construction businesses. The potential impact of transitioning to biobased and circular construction practices (environmental and socioeconomic), is dependent on the scale of change.	Deliver campaign to raise awareness of the benefits of such a transition Address barriers discussed elsewhere in this document Introduce fiscal and policy incentives supporting adoption.
	Demonstrator and initial development projects may be more costly whilst the material supply chains are in their infancy and materials are scarcer.	Costly demonstrator projects could put off potential future investors and dampen demand.	Private finance follows public lead. Build cross-party consensus and support for a predictable supportive policy environment for biobased and circular construction. Direct national Industrial Strategy investment towards biobased construction materials.
	Large companies move into biobased industry and acquire specialized intellectual property, developed by SMEs.	Impact will depend on how such companies choose to develop their businesses. Risks could involve suppression of acquired businesses/technologies to reduce impact to established material markets; or offshoring of production. Alternatively, access to significant internal venture capital streams could support rapid addressing of such a transition.	Support local universities or other appropriate institutions to develop publicly-owned reservoir of IP and capability within the region. Use policy and procurement rules to incentivise local production.
	If policies are enacted locally but not nationally, national demand assumed when planning growth and scaling of local production might be insufficient.	Regional biobased/circular construction businesses over invest and grow faster than the national market can support.	Work with market leaders, universities and policy think tanks to advocate nationally for the adoption of biobased materials.
Reputation	Given the prevalence of misconceptions surrounding biobased circular construction, there is likely to be increased scrutiny on projects and any failings.	If an early project experiences a negative event, e.g. fire, lengthy/ expensive construction, poor technical performance, it may be that misconceptions and negative perceptions of such construction are reinforced/ exacerbated.	Mitigate commercial risks on pathfinder projects with Innovation funding. Mitigate technical risks with appropriate project programmes and appoint experienced design team. Publicly celebrate successful projects.

7

Actions to meet potential

7 Actions to meet growth

The plan for next steps outlined here has been developed based on our understanding of how sustainable change happens - through carefully managed ongoing processes that recruit allies and enable ambitious people and organizations to innovate towards a common aim. The shift to bio-based supply chain and construction will involve the active cooperation of a great number of partners across the private, public and academic / educational sectors, and across many sections of industry.

It is critical that existing businesses that are less agile or innovation ready are supported to experiment and develop ways to take part and grow through this transformation. Equally, it's important that space is made for new and challenger businesses to develop capacity to support new needs generated by the shift. However, to enable such a profound shift, the public sector has a critical role in creating conditions for change. There will need to be shifts in policy, financial support, education and innovation, all of which will need to be guided and enabled.

These actions are divided into three sections. In the first group of actions, we have mapped out a process that scales over-time, enabling all partners to gain knowledge and competence as the project scales. The second concerns itself with processes that may have a long gestation time, but that will create the conditions for longer term change. The third concerns itself with areas of work that are outside the scope of this report, and relate to adjacent areas of concern and work.

Direct Actions

7.1 Fund demonstrator project

7.2 Fund large scale biobased development to build confidence in supply chain capacity

7.3 Change planning policy in the NEY

7.4 Establish a collaborative Biobased Construction Materials Working Group

Enabling Factors

7.5 Support existing farmers, growers and processors

7.6 Construction Skills Curriculum Change

7.7 Encourage new entrants to the sector, support testing and innovation

7.8 Advocate for change with central government

7.9 Stimulate demand by educating homeowners and home-buyers

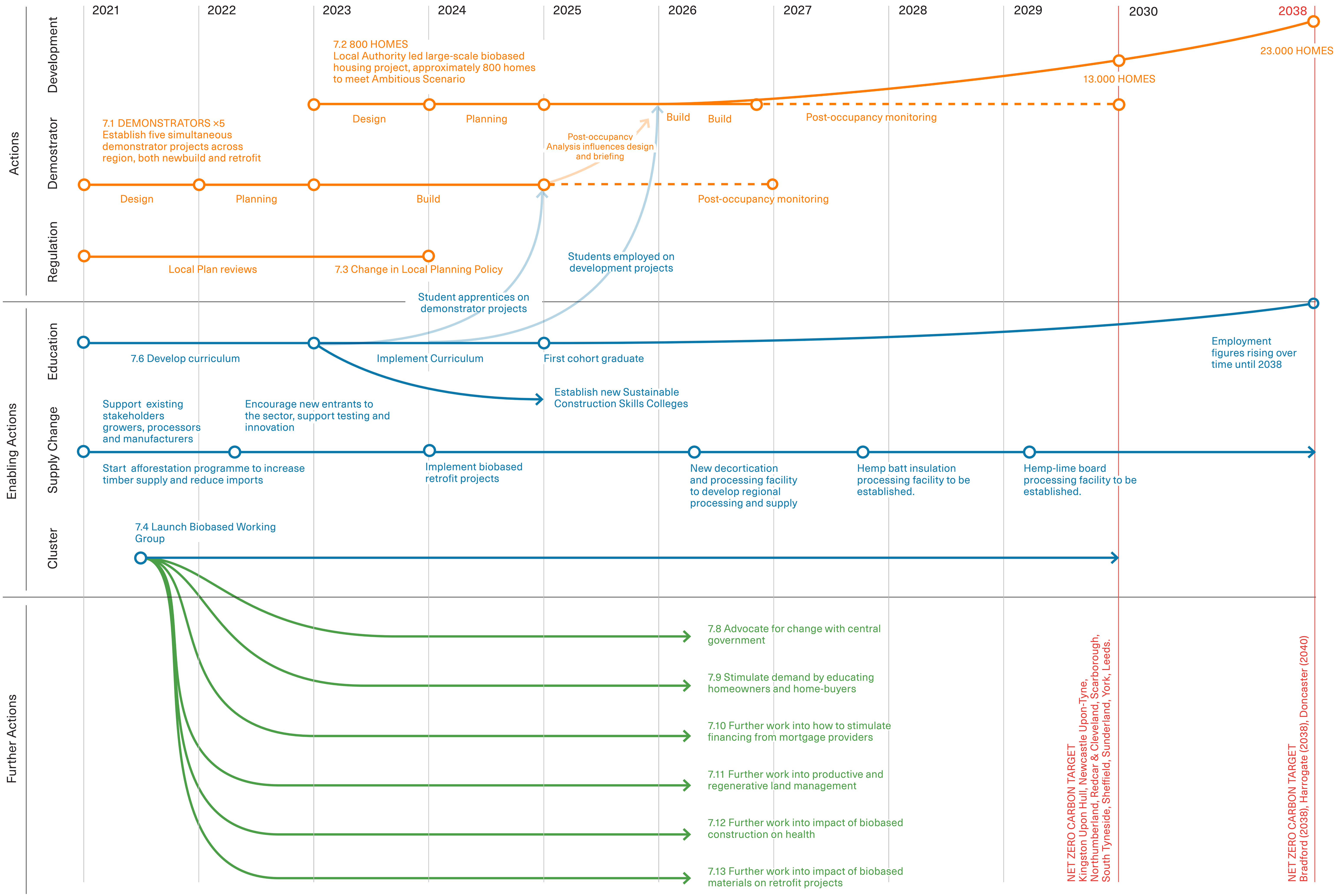
Simultaneous further work

7.10 Further work into how to stimulate financing from mortgage providers

7.11 Further work into productive and regenerative land management

7.12 Further work into impact of biobased construction on health and well being

7.13 Further work into the impact of biobased construction on retrofit projects



2021
2022
2023
2024
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2029
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2038
Actions
Development
Demonstrator
Regulation
7.2 800 HOMES
Local Authority led large-scale biobased housing project, approximately 800 homes to meet Ambitious Scenario
23.000 HOMES
13.000 HOMES
Design
Planning
Build
Build
Post-occupancy monitoring
7.1 DEMONSTRATORS ×5
Establish five simultaneous demonstrator projects across region, both newbuild and retrofit
Post-occupancy
Analysis influences design and briefing
Design
Planning
Build
Post-occupancy monitoring
Local Plan reviews
7.3 Change in Local Planning Policy
Students employed on development projects
Student apprentices on demonstrator projects
Enabling Actions
Education
Supply Change
Cluster
7.6 Develop curriculum
Implement Curriculum
First cohort graduate
Employment figures rising over time until 2038
Establish new Sustainable Construction Skills Colleges
Support existing stakeholders growers, processors and manufacturers
Encourage new entrants to the sector, support testing and innovation
Start afforestation programme to increase timber supply and reduce imports
Implement biobased retrofit projects
New decortication and processing facility to develop regional processing and supply
Hemp batt insulation processing facility to be established.
Hemp-lime board processing facility to be established.
7.4 Launch Biobased Working Group
Further Actions
7.8 Advocate for change with central government
7.9 Stimulate demand by educating homeowners and home-buyers
7.10 Further work into how to stimulate financing from mortgage providers
7.11 Further work into productive and regenerative land management
7.12 Further work into impact of biobased construction on health
7.13 Further work into impact of biobased materials on retrofit projects
NET ZERO CARBON TARGET
Kingston Upon Hull, Newcastle Upon-Tyne, Northumberland, Redcar & Cleveland, Scarborough, South Tyneside, Sheffield, Sunderland, York, Leeds.
NET ZERO CARBON TARGET
Bradford (2038), Harrogate (2038), Doncaster (2040)

7.1 Fund a demonstrator project

- Owned by - Public Bodies
- Partners: Construction skills colleges, product manufacturers, the NHBC, Building Societies, the BRE Innovation Park

A key element in fostering support and confidence in the biobased industry will be delivery of a number of successful demonstrator projects within the region. These projects can evidence best practice through the use of biobased materials while also showing the resilience of the local supply chain. The projects should be distributed throughout the region to evidence various local supply chain factors and build confidence and skills in different parts of the NEY. It's recommended that a minimum of three biobased residential new build typologies are built, alongside a series of retrofitted residential projects drawing on the skills and enthusiasm in projects like the Peacock and Verity Community Space in Masham, North Yorkshire. Three demonstrators distributed throughout the region will test the resilience and capabilities of different areas and local authorities within the region.

For the demonstrator projects to be a success, it is important that early partnerships with local research university clusters are established to ensure accurate monitoring of the demonstrator can take place in parallel. This will allow for the performance of the building to be recorded in terms of statutory requirements and in terms of best practice regarding embodied energy in the built fabric. A comprehensive Whole Life Cycle Carbon Assessment should be undertaken for each demonstrator in order to strengthen the case studies and demonstrate the value in transitioning to biobased circular construction in supporting the industry's net zero carbon ambition. These projects could also be used to further understanding of biobased construction by the mortgage and insurance industry: early partnerships with large scale structural warranty providers the NHBC would be groundbreaking - as would early engagement with large scale mortgage providers such as the Leeds Building Society.

The Home Builders Federation noted that Homes England[1] is actively seeking Pilot Innovation projects like this as part of their land disposal schemes. A partnership with Homes England could be one effective way of quickly identifying potential demonstrator projects. It's recommended that these projects are open design competitions, drawing on local and national design talent, with stringent criteria for the bidding process from architect to contractor.

A demonstrator project could:

- Test existing supply chains and local risk factors.
- Work with local material
- Partner the build project as an educational tool driving curriculum change with FE Colleges like the Construction Skills Village in Scarborough, amongst others.
- Illustrate a best practice use of biobased and circular materials.
- Partner with the BRE to ensure test data can be generated for all materials
- Show a scalable typology relevant to the mass market, such as the repetitious terraced house or semi-detached home, in addition to the retrofitted existing home.
- Celebrate local manufacturing and industry
- Work with agricultural cycles and material waste streams.
- Use advanced digital technology to limit construction waste on site.
- The NEY can look to the examples of successful demonstrator projects in Wales, Scotland2.
- 3 concurrent demonstrator projects are proposed in proximity to local feedstocks across the region, with a proposed budget for each of roughly £600,000 incl fees and post completion-monitoring, subject to land value and shifts in construction costs post-Brexit.

1 Homes England could prove a good partner. As land owners, they can take on the risk of the impact on land value of more stringent building requirements.

2 Reference demonstrators in scotland and wales here, Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

7.2 Fund large scale biobased developments

Direct Action

- **Owned by: Local Authorities**
- **Partners: Local contractors, Construction Skills Colleges, product manufacturers, the NHBC, Building Societies, the BRE Innovation Park .**

Building on the success of the Demonstrator projects, local authority housing developments within the region could be used as large scale demonstrations of the potential of the material supply chain and regional skills base. A fully biobased and circular housing development at scale would be unique in the context of the United Kingdom and demonstrate the potential of the North East and Yorkshire to become the first region of the UK to reach net zero carbon. In order to meet the 'Ambitious' scenario carbon targets and economic potential outline in section 3.6 approximately 800 biobased homes need to be built within the region over the next 5 years.

According to the Home Builders Federation, one of the primary factors inhibiting large scale homebuilders from taking up biobased and low embodied energy construction materials is a lack of confidence in the supply chain. The concern is as to whether these new material suppliers will be able to deliver the volumes necessary. A project at scale would enable the appropriate testing and monitoring of these supply chains in action. It would also form the basis for a regional plan to scale up newbuild residential biobased development from an uptake of approximately 2.5% after 5 years to 40% over the next ten years.[3]

3 See: Ambitious uptake scenario, Section 3.6

Programme

The longer timeframe for raising finance and securing planning in these larger scale developments would necessitate initiating these projects immediately, and in parallel to the development of the early Demonstrator projects. The establishment of a Special Development Vehicle that can seek funding beyond LA level is recommended. In order to practically reach the region's carbon targets, a series of ambitious projects will be needed to kickstart growth and inspire further developments. The region has the potential to instil confidence not only in local industry but in national construction. As a consequence, the larger scale development projects can take an active role in generating the market for the burgeoning material growers and processors within the NEY by demonstrating how sustainable construction components can be put into practice.

Potential future development sites

It is also recommended that Local Authorities explore the use of their brownfield sites to grow hemp, rehabilitate soil, and generate material for the construction of the new homes on these sites. This material could be used to sequester carbon, as well as store and extract pollutants from the soil before being used to build new homes on these otherwise expensive-to-rehabilitate lands; this is a business model currently being explored by Unyte Hemp.

The development of 800 biobased homes across the region could:

- Draw from learning and monitoring of the Demonstrator projects - see section 7.1
- Test supply chains and local risk factors at scale
- Provide a market for newly scaled biobased manufacturing
- Represent an employment opportunity for FE college students graduating from new Biobased construction skills courses - see section 7.3
- Show a scalable typology relevant to the mass market, such as the repetitious terraced house or semi-detached home, in addition to the retrofitted existing home.
- Be planned in advance to work with agricultural cycles and material waste streams.
- Use advanced digital technology to limit construction waste on site.

7.3 Change planning policy in the NEY

Direct Action

- Owned by: YNY LEP, NEY Energy Hub, Local Authorities across the region
- Collaborators: The Architects Climate Action Network (ACAN), the RIBA, Local Authority Planning Departments

Biobased construction is currently a small sector of the building industry. This is both caused by and the result of the industry's regulatory framework not favouring the widespread inclusion of these materials and techniques in mainstream construction projects. Whilst there is strong lobbying of central government to change the Building Regulations to regulate the embodied carbon of building materials in construction,[4] and for the new Future Homes Standards[5] to reflect this, it's anticipated that these changes will not be implemented at a national level in the immediate future.
The required changes to planning and building regulations would depend upon the existence of a national embodied and whole life carbon database. Such a database would support planning policies mandating embodied and whole life carbon assessment; this consistent and regulated data set would facilitate the implementation and control of such a policy.

4 See ACAN and Leti documents
5 Future Buildings Standard, which provides a pathway to highly efficient non-domestic buildings which are zero carbon ready, better for the environment and fit for the future.

At a regional level the adoption of the RICS Embodied Carbon Database and Whole Life Carbon Assessment process is recommended. This framework is already accepted across the industry as the gold standard LCA method.

One set of tools at hand for the NEY Region are the Local Plan, Local Planning Policy, and Supplementary Planning Documents, through which local authorities across the NEY can promote and favour the use of biobased and circular construction practice. Introducing policy in favour of low carbon construction in buildings across the region would encourage best practice assessment of embodied carbon by designers and client-developers. This could not only factor in the carbon expended in the production, as well as delivery and installation of materials, but also favour materials that actively sequester carbon, such as hemp, straw and timber.

This local planning policy change should draw on recommendations made by the London Energy Transformation Initiative (LETI) in their groundbreaking Climate Emergency Design Guide published in January 2020, which recommends that planning policy should:

Include requirements for embodied and whole life carbon in building planning and approval frameworks, with consent contingent on the subsequent reporting of performance against the design stage target.
Mandate a two-fold verification system at both the Design Stage and at Practical Completion Stage. This would build on planning policies that mandate embodied and whole life carbon assessment and adoption of target benchmarks.
Adopt planning policy that requires Environmental Performance Declaration (EPDs) for the majority of building parts forming substructure, frame, and upper floors.
It is further recommended that the procurement framework awarding criteria for public buildings and infrastructure within the region is reviewed. The framework could incorporate embodied and whole life carbon targets and wider social/economic responsibility in terms of life cycle costs within the scoring system.

Global examples of planning and building regulation reform to reflect the assessment of embodied carbon include the changes within France[6], Finland,[7] and the BioPreferred system in the US[8].

Regulating in favour of biobased materials within the NEY will:

- Demonstrate the impact Local Authorities across the country have to implement change in the context of the climate crisis, leading the way for other regions to follow suit and putting pressure on central government for a national change in the Building Regulations.
- Generate demand for these industries.
- Generate demand for more skills from the labour market, and therefore create more jobs.
- In time, drive down the costs of these materials to make them more cost competitive with their high-embodied energy competitors.

6 https://immobilier.lefigaro.fr/article/d-ici-a-2022-tous-les-batiments-publics-devront-etre-batis-a-plus-de-50-en-bois_f5bae31c-47e9-11ea-b680-b87925275d6f/ , Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
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7.4 Establish a collaborative Biobased Construction Materials Working Group

- Owned by: YNY LEP/ NEY Energy Hub/ Local Authorities
- Partners: The YNY Supply Chain Network, and Supply Chain North East

A biobased supply chain that develops and sustains connections between its various stakeholders is essential. There are two main benefits to a robust and sustainable supply chain. First of all there is the potential to make available knowledge and expertise to companies of all sizes who may not yet have the knowledge of what this means for their practices. A robust supply chain also offers the potential of improved circularity through the reuse of materials. In order to support the supply chain, a collaborative Biobased Materials Working Groups, which connects disparate strands of the industry together, will need to be established.

The Working Group described here would also be responsible for driving forward change and other actions proposed within this report: see 7.6- 7.13. To affect real change, the group should comprise a number of full time employed professionals with backgrounds in construction, natural materials and policy.

One of the roles of a working cluster would be to build a Focussed Biobased Supply Chain Website and Map. The Supply Chain Network (Yorkshire and the Humber) and the Supply Chain North East were both established to help share information regarding business developments and to assist in making opportunities visible. They share an Opportunities map and a Supplier Directory, two useful resources to build stronger networks and greater awareness of and between businesses in the region. A specialized website and map of biobased and circular construction businesses would be a useful tool for building both regional and national awareness of the strengths and potential in the NEY. It could be a resource for architects and specifiers, as well as local authorities, contractors and also those looking to enter the biobased industry as a career path. The service could signpost FE Colleges that offer specialized education programmes.

With strengthened connections created by working clusters, stakeholders within a biobased supply chain can grow and thrive by working together. The examples here demonstrate how this is enabled through funded organisations such as the Circular Economies at the West Yorkshire Combined Authority, who have begun to build and share this knowledge with a proven record of mutual success and prosperity.

Regional Case Study Examples:

The West Yorkshire Combined Local Authority (WYCLA) have a 5 stage plan9 to engage with local companies and find out what areas of their business can be improved. Proposals are put forward as to how and where improvements might be made. The authority then assesses their eligibility for grant funding to assist these transitions. Examples include door manufacturers seeking to increase the amount of recycled materials used in production, and companies looking to address supply chain issues regarding packaging that can be met through package return schemes and recycling. As simple as some of these measures seem, many companies, particularly SMEs, do not have the resources, knowledge, or awareness to find ways to implement such changes. A much larger and more sophisticated database would greatly benefit companies making the transition to more sustainable production. With regards to recycled materials, companies would be able to source certain materials in their end of life stages and reintegrate the materials into the manufacturing process. This is only possible through assistance from organisations such as the WYCLA funded by the European Regional Development Fund (ERDF). Funding by the UK government will need to be expanded once this lapses for this work to continue and grow.

9 Interview with Chidubem Nwabufo at the West Yorkshire Combined Local Authority, Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

7.5 Support existing farmers, growers and processors

- Owned by: YNY LEP, NEY Energy Hub, Grow Yorkshire, the National Farmers Union
- Partners: East Yorkshire Hemp, Unyte Hemp

Within the NEY there are strong foundations in feedstock supply and processing for the biobased construction industry. These businesses currently represent a small proportion of the construction industry. It is vital that they receive the right support to grow. While ineligible for innovation and R&D support, they represent a significant and crucial link in the supply chain. As the market and demand for these materials is still growing, they will also shoulder the greatest risk. This is due to the fact that their investments are made in advance of national regulation to support their produce.

A critical initial step is to lobby for changes to Industrial Hemp licensing. The hemp plant of Genus Cannabis is a controlled drug in Class B of The Misuse of Drugs Act 1971 (MDA and Schedule 1 of The Misuse of Drugs Regulations 2001). In other countries there has been a push to support the manufacturing of biobased materials such as hemp. In the UK, however, legal ambiguities and legislation still create roadblocks in the hemp supply chain, as set out in the recently published Yorkshire Hemp Supply Chain report. The timing of the assessment and approval process for licenses to grow hemp by central government is out of sync with agricultural crop growing cycles. This forces small growers to either apply for a license a full 18 months prior to sowing their crop or to take on the risk of the application process and order their hemp seed without a license in place. These risk factors are limiting the expansion of East Yorkshire Hemp's own hemp growing, one of the UK's main suppliers to the construction industry. East Yorkshire Hemp are a key figure in the supply chain of hemp batt insulation, hempcrete insulation, and hemp matting for use in cladding panels.

A secondary, parallel action is for the YNY LEP and NEY Energy Hub to partnering with the existing representatives of the agricultural industry in the NEY: Grow Yorkshire and the NFU, in order to develop a campaign to educate existing farmers and arable crop growers on the benefit of biobased construction crops to encourage more uptake of feedstocks like hemp as rotational crops. This uptake will be necessary for the region to grow the biobased construction industry and meet even the "Minimum" scenario set out in this report in Section 3.6.

The third step is to source funding. Where national funding can be sought to support regional farmers this could be used to facilitate this transition to biobased crops. The Farming in Protected Landscapes programme, part of Defra's Agricultural Transition Plan is one example. This programme will support projects which support nature recovery, mitigate the impacts of climate change, and support nature-friendly, sustainable farm businesses: all criteria met by the growth of biobased feedstock crops.

7.6 Construction Skills Curriculum Change

- Owned by: A new NEY Biobased Construction Skills Working Group
- Partners: Regional and national construction colleges, City and Guilds, in consultation with The Federation of Master Builders and the Chartered Institute of Building.

By 2023, Employment in the Construction industry is expected to grow to 2.75 million,[10] with an annual increase in construction output of 2.9% and employment growth of 1.4% (224,000+) over the next 5 years.

The construction and housebuilding industry faces a skills gap. In the wake of the pandemic and of Brexit these shortages have been exacerbated, as identified in areas such as Hull and East Yorkshire. In addition to the scarcity of skills in the conventional housebuilding market, the proposed transformational changes to both the supply chain and the culture of the construction industry will necessitate new and amended curricula for various jobs. This has been identified in conversations with Hull Construction College, and the Construction Skills Village, as well as by the Home Builders Federation. A new NEY Biobased Construction Skills Working Group should be established to drive this change forward. These changes are proposed at three levels:

In Schools

The skills and understanding that jobs in the construction industry necessitate are commonly undervalued. Misconceptions about the nature of work in the industry often deter students with strong skills in Maths and English from pursuing careers in construction. Therefore, recruitment into the industry needs significant improvement. The success of an education programme around the impact of the construction industry on the environment necessitates early school-level engagement with broader climate issues, as well as an accurate portrayal of the value and role of jobs in the construction industry to effect positive change. It's suggested that construction schools within the region partner with high schools to better inform and educate students about the career paths available to them. The potential impact these careers would have on positive climate change reforms within construction should be made explicit.

In Further Education and Construction Skills Colleges:

It's recommended that all entry level students are taught an environmental impact module as part of their college induction. The curriculum should be devised between the CITB and the relevant technical certificate awarding bodies, such as City and Guilds, in consultation with The Federation of Master Builders and the Chartered Institute of Building.

It is also recommended that funding to generate new courses and Technical Certificates for the skilled use of biobased materials in construction are created at Key Stages 2, 3, 4, and 5. It is important that these certificates are standardized and nationally recognised; courses currently exist across the UK, but uptake and interest is mostly from experienced builders looking to broaden their existing skills, self builders, or with mid-career professionals looking to change industry. Technical Certification bodies like City and Guilds currently offer Technical Qualifications in Bricklaying, Site Carpentry, Architectural Joinery, Painting and Decorating and Plastering. It is proposed that a Biobased Insulation and Lining module is created, covering the use and installation of materials such as hempcrete, hemp fibre, wood fibre and biobased lining boards. This module should focus on the use of biobased materials, teaching students how to install and detail airtight but vapour permeable construction materials in buildings.

It's also proposed that the existing curriculum of all Technical Certificates is reviewed to incorporate and acknowledge the impact of conventional materials in construction on the environment. The curriculum should focus on how to minimize waste in the application and use of these high-embodied carbon materials.

Subsidies for these courses should be initially offered to all Colleges and Further Education Institutions. A minimum of 18 students electing to undertake a course leading towards a Technical Certificate is necessary for most colleges like Hull to be able to offer a module, for which all existing staff members could be retrained to add to their skillset. Until greater voluntary uptake can be established it is proposed that subsidies to offer these modules to smaller groups of students are offered to all the construction skills colleges in the region. The HBF offers free training events touching on how to avoid common defects in construction. Similar workshops and training events for biobased materials could be organized by the new NEY Biobased Construction Skills Working Group, hosted within the construction skills colleges of the region.

In Senior Management roles within the construction industry

It is also proposed that Construction Management and supervisory courses offered by the National Construction College (NCC) expand to include environmental impact modules and training on the operation and supervision of low-embodied energy and circular construction sites.

The Home Building Skills Partnership (HBSP) was set up by the Home Builders Federation in 2016 (initially funded by CITB) and is a collaboration of home builders and supply chain organisations working together to attract and develop the workforce of the future. In partnership with the Home Building Skills partnership a Competence Framework specific to the installation of Biobased Materials should be developed.[11]

Information should be shared about the free resources and courses offered by the Supply Chain Sustainability school, like their Sustainable Procurement Modules on Building Information Modelling (BIM) and Delivering Energy and Carbon Efficient Buildings. This information should be targeted toward schools, colleges, recruitment centres and adult education programs.

Across industry consultants:

A Continued Professional Development (CPD) seminar should be developed for local Authority planners, architects and engineers in the region to educate all professional consultants within the industry of the benefits and urgency of a transition to biobased materials.

10 City and Guilds Technical Brochure, Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

11 https://www.hbf.co.uk/policy/home-building-skills-partnership/, Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

7.7 Encourage new entrants to the sector

- Owned by: Newly established 'Biobased Construction Materials Working Cluster' - See 7.5
- Potential Partners: The Biorenewables Development Centre, Innovate UK.

To meet the growing demand for biobased construction materials across the industry, the NEY region will need more growers, manufacturers and contractors with the necessary skills. As is outlined elsewhere in this report, the market and users do not always move as fast as they could, and as such funding is needed to allow innovators to access prospective markets. As the examples of Adaptavate and Indinature show, funding unlocks the necessary testing to bring their products to market, and attract investment to grow. This report suggests existing bodies, and perhaps new ones, can assist innovators in accessing the funding and support they need, as well as business advice. Actions to support new entrants to the market include:

Financial support for innovative R&D and material testing for SMEs. In most cases, biobased materials lack the data available for mainstream building products. Mainstream construction products have datasheets and Environmental Product Declarations that offer a wide range of assurances as to the performance of the product, clearly stating information such as compressive strength, thermal conductivity, reaction to fire, water absorption etc, all of which informs the nature of the warranty that also accompanies each product. Warranties rely on the provision of reliable information in a variety of applications, and are a requirement of home insurers and mortgage providers.

The properties of biobased materials such as hemp, flax, and straw, often lack this consistent and reliable data. There are also knowledge blackspots when it comes to their whole-life performance as part of an integrated buildup. With the current supply chain fragmented and undeveloped, small-scale actors often do not have the resources to invest in obtaining this information; testing new materials can cost hundreds of thousands of pounds.

In addition to standardized testing data, with sustainable and biobased products a Lifecycle Carbon Assessment is a necessary tool to evidence how a product, material or building system will perform and how its environmental performance might be improved. LCA data also supports BREEAM and Code for Sustainable Homes (CSH) assessments undertaken for new developments. The costs associated with this analysis vary but they are a significant investment for new businesses.

The success of the development of Adaptavate as a business model, and its range of products, demonstrates the potential impact of funding available within the region through the Biorenewable Development Centre in York. This has been European Regional Development Funding, and alternative sources of funding will need to be generated in future. The newly established 'Biobased Construction Materials Working Cluster' could partner with both the Biorenewable Development Centre and Innovate UK to support new SME's in the industry.

7.8 Advocate for change with central government

- Owned by: YNY LEP/ NEY Energy Hub/ Local Authorities
- Partners: ARB, RIBA, ACAN, LETI

Change to the Building Regulations and planning policy at national level will have immediate and dramatic impact. Lobbying for change with the central government would ensure a market for biobased construction feedstocks grown within the NEY, and reduce the first-mover risks the region will face as the frontrunner of change without national support.

7.9 Stimulate demand by educating homeowners and home-buyers

- Owned by: Newly established 'Biobased Construction Materials Working Cluster' - See 7.5
- Partners: HBF, the Home Owners Alliance

Demand for more circular, biobased construction will be generated by regulatory pressure from above and market demand from end-users. Work with the Home Builders Federation and the Home Owners Alliance on a campaign to promote biobased homes, explaining their benefits to the environment and end-user.

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7.10 Further work into how to stimulate financing from mortgage providers

- Owned by: Newly established 'Biobased Construction Materials Working Cluster' See 7.5
- Partners: Research consultants, the Ecology Building Society, the NHBC, Leeds Building Society, the Green Investment Group, the Yorkshire Building Society

Currently the Ecology Building Society is the only dedicated provider of mortgages to sustainably designed homes. By encouraging other providers to enter the market, with government backed loans, the mortgages offered will become more competitive and accessible. Further work should be funded to engage with the Ecology Building Society and other mortgage providers within the region, for example, working with the Yorkshire Building Society to expand their offering.

7.11 Further work into how to support productive and regenerative land management

- Owned by: YNY LEP, NEY Energy Hub, Grow Yorkshire
- Partners: Research consultants

Although out of scope of this study, a key factor in the success of a biobased industry will be the development of sustainable, productive and regenerative land management within the region. A project into the potential overlap between ELMs policies and productive, biodiverse biobased feedstock growth should be carried out.

In order to anticipate the potential impact of any monocultural biobased crops, further work into the ecological impact of biobased crops on the landscape should be carried out.

Further work into next steps towards effective afforestation within the region should also be carried out to meet the region's carbon abatement strategies.

7.12 Further work into the impact of biobased construction on health and wellbeing

- Owned by: YNY LEP, NEY Energy Hub
- Partners: Research consultants, Biovale, York University

The growth of the biobased industry would be bolstered by a strong evidence base around the positive health and wellbeing impacts of biobased construction materials on end users, contractors, buildings and manufacturers.

A research project with this specific focus should be initiated, drawing on existing built biobased buildings. This work should also involve monitoring of demonstrator projects (See 7.1 and 7.2), partnering with universities and research institutions within the region to develop further knowledge and data around the impact of biobased materials on indoor air quality and wellbeing.

7.13 Further work into the impact of biobased construction on health and wellbeing

- Owned by: YNY LEP, NEY Energy Hub
- Partners: Research consultants

The North East and Yorkshire (NEY) Energy Hub |has received a total of £53.2 million of Government funding as part of Phase 2 of the Local Authority Delivery scheme (LAD 2), which will run until 30 December 2021. Under this programme approximately 5000 homes will be retrofitted by March 2022.

There are however between 2.8 million and 3.7 million homes within the NEY which will still require upgrading and these represent a significant market for biobased construction materials. The potential economic and carbon benefits of working with biobased materials in these retrofit projects is a subject for further study and research to build a strong case for supporting their use in these projects across the region.

9.4 Local Authority housing

Month						April				May				June				July					Aug					Sep				Oct			
Week			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
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Client Meetings																																			
NEYH Energy Hub consultation																																			
YHSC Yorkshire Hemp Supply Chain Consultation																																			
Activity																																			
Map existing capacity																																			
Site visit to manufacturers, sources, stakeholders																																			
Literature review: Identify existing material sources and waste streams																																			
Literature review: Identify potential sites for development to generate market																																			
Stakeholder interviews																																			
Surveys and questionaires																																			
Consolidate findings into report																																			
Outline feasible potential																																			
Assess potential for material supply development																																			
Identify biobased material uses in construction systems																																			
Identify potential secondary waste streams generated																																			
Feasibility study designs, area schedules, outline bill of quantities																																			
Scope need for regional testing and certification infrastructure																																			
Assess local authority potential to support biobased material transition																																			
Propose monitoring and evaluation systems																																			
Consolidate findings into report																																			
Propose actions to meet potential																																			
Identify barriers to change																																			
Propose 5, 10, 20 year actions																																			
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Consolidate proposals into report text																																			
Identify Existing Knowledge Gaps																																			
Risk register documenting at regular intervals																																			
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Research Assistant	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0	5	5	0	0	0	0	0					