GROWING THE IRISH FOREST BIOECONOMY

COFORD

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CHAIRMAN'S FOREWORD

The COFORD Bioeconomy Working Group was set up in 2016 to explore the potential of the Irish forest sector in the emerging bioeconomy. The members of the Group are Gerard Murphy, Tony Quinn, Tom McDonald, Mark McCauley, Nuala Ni Fhlatharta, Jim McNamara, Donal Magner and Ciarán Fallon.

The gross output of the Irish forest sector is set to double by 2035 against a backdrop of increasing carbon constraint and this creates a tremendous opportunity. This report provides an exciting vision of a thriving, export led, forest bioeconomy which creates sustainable jobs in rural Ireland and supports national land-use carbon reduction and climate adaption objectives.

I would like to thank Chairperson Gerard Murphy and the members of the Working Group for their work in producing this report.

Michael Lynn
September 2017

12 PROPOSALS
FOR GROWING A VIBRANT FOREST BIOECONOMY IN IRELAND

1. Position forestry as a central pillar of Ireland's National Policy on the Bioeconomy
2. Embed the cascade use principle for wood resource management and planning in national policy
3. Develop an integrated carbon and land-use policy that recognises the significant sequestration and storage potential of the forest sector in Ireland
4. Ensure a long-term, consistent and growing supply of roundwood to the processing industry by supporting and investing in the national afforestation programme
5. Urgently address constraints on the productive capacity of the existing forest estate and barriers to wood mobilisation
6. Develop mechanisms to promote the use of low carbon building materials and adopt a strong 'wood first' public sector procurement policy
7. Review national building standards to support and promote the use of wood as a construction material
8. Support and promote the innovative use of wood products in construction such as cross laminated timber through research, training and professional development
9. Establish a well-resourced forest bioeconomy centre of excellence in Ireland and increase public and private investment in forest bioeconomy research
10. Develop and implement payment for ecosystem services (PES) forestry schemes to support the provision of green infrastructure
11. Develop and implement a plan to improve the overall resilience of the national forest estate and mitigate against the biotic and abiotic risks associated with climate change
12. Promote a deeper understanding of the economic, social and environmental benefits of the forest sector among the general public though a well-resourced and sustained communications campaign

THE BIOECONOMY

The concept of a bioeconomy has emerged in response to the challenges of food security, energy security, climate change and the depletion of non-renewable resources.

Virtually everything that can be made from fossil resources can also be made from biological resources. Substituting sustainably produced biomass for fossil resources facilitates decarbonisation and continued economic growth. A shift from fossil resources toward biomass also improves resilience and has strong potential for revitalising rural economies.

"IMPROVES RESILIENCE AND HAS STRONG POTENTIAL FOR REVITALISING RURAL ECONOMIES."

FORESTRY THE BIOECONOMY, THE CIRCULAR ECONOMY & CARBON SEQUESTRATION

The bioeconomy refers to economic activity derived from the use of biological resources to produce food, feed materials and energy. The circular economy refers to economic activity based on the use, reuse and recycling of resources and materials. In a circular economy the value of material is preserved for as long as possible with the overarching aim of minimising the use of non-renewable resources.

The bioeconomy and the circular economy can overlap as concepts with similar objectives. Sustainable forest management links these two concepts by providing renewable materials which continuously sequester carbon as they grow and storing this carbon while they are used, reused and recycled.

Forest biomass has a triple carbon benefit. Carbon is sequestered as forests grow. Forest biomass can be used to make products which displace materials with high embedded carbon such as steel, aluminium and concrete. At the end of its useful life sustainably sourced forest based biomass products can be converted into carbon neutral thermal energy and used for heating and/or electricity.

FORESTRY AND IRELAND'S CLIMATE CHALLENGE

Ireland has committed to a decarbonisation approach which involves carbon neutrality in the land-use sector without compromising food production. Afforestation is Ireland's most cost effective carbon action in the land-use sector. The rate of carbon sequestration peaks at a relatively early age in fast growing tree species and early action will contribute to carbon goals.

VISION

FORESTRY – LEADING THE DRIVE TOWARDS LAND-USE CARBON NEUTRALITY IN IRELAND

- **MEETING LAND USE CLIMATE CHANGE COMMITMENTS**
- **PROTECTING FOOD SECURITY**
- **CREATING SUSTAINABLE JOBS IN RURAL IRELAND**
- **PRODUCING LOW-CARBON, VALUE-ADDED PRODUCTS**
- **DRIVING A STRONG AND DIVERSIFIED EXPORT SECTOR**

IRELAND'S FOREST BIOECONOMY TODAY

The forest sector in Ireland comprises a range of industries that form a complete supply chain from farmers and forest owners, forest management to sawmills and processors and the manufacturers of forest products. The forest sector is long established in Ireland and its output is growing fast. The sector has diversified in recent years and developed significant export markets.

The forest sector is already making a sizeable and sustainable contribution to the national economy while at the same time providing important non-timber ecosystem services such as carbon sequestration, flood mitigation, wildlife habitat and a venue for outdoor recreation for our increasingly urbanised citizens.

Ireland's forest bioeconomy is thriving and the sector has the ambition and drive to grow further in the decades ahead. The gross output of the sector is set to double by 2035 against a backdrop of increasing carbon constraint and this creates a tremendous opportunity. Ireland's forest sector is ideally positioned to become one of Ireland's leading long-term sustainable industries.

"IRELAND'S FOREST BIOECONOMY IS THRIVING AND THE SECTOR HAS THE AMBITION AND DRIVE TO GROW FURTHER IN THE DECADES AHEAD."

THE VALUE OF IRELAND'S FOREST SECTOR (2015) – BY NUMBERS

10.7%
OF IRELAND IS UNDER FOREST

9,000
KILOMETRES OF FOREST ROAD INFRASTRUCTURE

FOREST PRODUCT EXPORTS WERE VALUED AT
€355
MILLION

78%
OF IRELAND'S FOREST PRODUCTS WERE EXPORTED

3.3M
CUBIC METRES OF ROUNDWOOD WAS HARVESTED FROM IRISH FORESTS

FOREST OWNERS NUMBERED 21,000

7.9
MILLION CUBIC METRES WILL BE HARVESTED IN 2023

750,000
HECTARES OF IRELAND ARE UNDER FOREST

201
MILLION DOORS
HAVE BEEN EXPORTED BY MASONITE IRELAND SINCE 1997

47%
OF IRISH FOREST ESTATE IS PRIVATELY OWNED

2,518
FELLING LICENCES WERE APPROVED

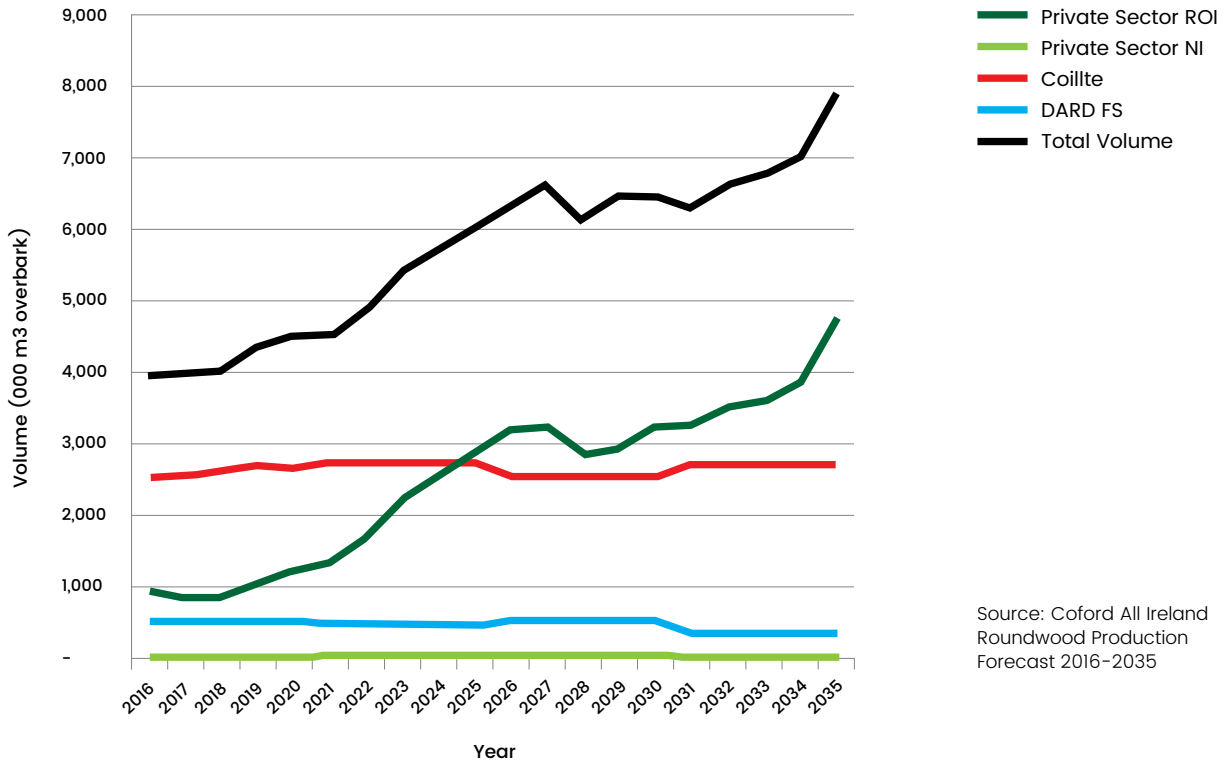
8
LARGE SAWMILLS
OPERATE IN IRELAND

Ireland has one of the best climates in Europe for growing trees and yet it is one of the least forested countries. Currently less than 11% of Ireland's land area is forested compared to the European average of 40%. However while the national forest estate is relatively small by European standards, the sector in Ireland is technologically highly advanced and the forest resource is optimised to current supply/demand requirements.

The Irish forest sector contributes €2.3 billion to the national economy, generates annual exports of over €350 million and employs over 12,000 people. The economic activity of the forest sector is spread through every region of the country and makes an important contribution to regional development and the rural economy.

Value of forest product exports	**€355 million**
Panel product production	**€240 million**
Biomass	**1.4 million m³**
Energy from forest-based biomass	**9 million Gj - valued at over €70m**
Value of forest-based leisure and tourism	**€400 million**
Carbon sequestered in Irish forests	**380 million tonnes**

The scale of the forest sector will increase significantly in the coming years as privately owned forests mature and reach harvesting age. This will significantly increase the supply of roundwood to the forest products industry. Ireland's sawmills are currently making large investments in line with this growth in the supply of their raw material. The new All Ireland Roundwood Production Forecast anticipates that production on the island will increase from 4 million m³ in 2016 to close to 8 million m³ by 2035.



Source: Coford All Ireland Roundwood Production Forecast 2016-2035

STRUCTURE OF IRELAND'S CURRENT BIOECONOMY

"THERE ARE 18 MILLION RECREATIONAL VISITS TO THE COILLTE ESTATE EACH YEAR."

ROUNDWOOD SUPPLY

- SAWN TIMBER **30%**
- PANELBOARD PRODUCTION **25%**
- ENERGY **35%**
  - USED AS FUEL BY PROCESSORS **64%**
  - FIREWOOD **19%**
  - WOODCHIP FUEL **9%**
  - PELLETS **7%**
- OTHER/NICHE PRODUCTS **10%**

i. Forestry

The cultivation of fast growing, commercial softwood species is at the heart of the forest sector. Currently, the bulk of timber being harvested is coming from Coillte forests but harvesting from private forests will ramp up rapidly in the coming decade.

ii. Wood processing and Forest products

The structure of the wood processing and forest sectors is oriented towards deriving the maximum value from the feedstock of roundwood from Irish forests. As such, the forest sector is first and foremost a producer of construction products – sawn timber and panel products.

There are three large panelboard plants in the country; two owned by Coillte which produce MDF and OSB and the Masonite plant near Carrick on Shannon producing MDF door skins.

These companies are innovative, large scale, capital intensive and export oriented. Their output is valued at €240 million per annum. In addition there are a number of large, medium and small sawmills all around the country. These are focussed on various market segments including all dimensions of sawn construction timber, cladding, fencing and wooden stakes.

The highest added value is derived from producing larger dimension sawn timber from larger, mature trees. An additional important market for Ireland's sawmills is the production of pallet and packaging materials, typically from smaller feedstock.

iii. Biomass

Wood biomass provides approximately 25% of Ireland's renewable energy and approximately 1.4 million m^3 is combusted to produce energy annually. The largest user is the wood processing industry which consumes almost 800,000 m^3. Most of this biomass is in the form of bark, sawdust, shavings and other by-products of the sawmilling industry.

The next largest user is the domestic firewood market with over 200,000 m^3 used each year. Installation of domestic wood stoves has increased demand for firewood in recent years but future growth prospects are constrained by building regulations which make the incorporation of wood stoves difficult.

The third largest use is in high efficiency combined heat and power plants (CHP) in large commercial installations such as pharmaceutical plants, food processing plants and leisure centres. This market is currently small at 124,000 m^3 per annum but has considerable potential to grow in a carbon constrained environment.

Finally, approximately 88,000 m^3 of sawdust, shavings and bark are used in the manufacture of wood pellets. Pellets consume large quantities of biomass feedstock with typically 3.5 tonnes being required to produce 1 tonne of pellets. This is due to the drying process and the heat energy required for this. There is currently one pellet manufacturer in Ireland and another in Northern Ireland. The market for pellets in Ireland is not growing as few pellet burners are being installed and the newer and larger installations tend to be more suited to wood chip.

iv. Non-Timber Ecosystem Services

In addition to wood products, the national forest estate produces many important non-timber ecosystem services. Coillte has a policy of open access and operates 260 recreation sites which includes 12 forest parks, over 3,000 km of hiking trails, 9 off-road cycling centres, 120 picnic sites, 8 children's playgrounds, 6 wild camping sites and 3 aerial trails courses. It is estimated that there are 18 million recreational visits to the Coillte estate each year, providing significant direct benefits in terms of health and wellbeing and generating economic benefits in local communities. For example the Ballyhoura Mountain Bike Centre attracts over 35,000 visitors each year and it is estimated that each visitor spends €48.80 in the local community. This center alone generates €1.7 million of tourism related economic activity in the Cork/Limerick border area.

As trees grow they are continuously absorbing carbon from the atmosphere. It is estimated that the national forest estate absorbs 4 million tonnes of carbon dioxide annually or about 6% of total national greenhouse gas emissions. As our climate changes it is predicted that we will experience more precipitation extremes. Forested uplands already slow the transmission of rainfall to streams and rivers and with coordination and planning they could play a greater role in flood mitigation in the future. Forests can also provide important benefits in terms of water purification and it is possible that the role of water protection forests will develop in the future reducing the requirement for expensive, hard engineering water management solutions. Finally, forests provide important habitat for a wide range of wildlife and support our international commitments to protect biodiversity.

Forest Management

Growing trees absorb carbon dioxide from the air and release carbon back into the atmosphere. As trees mature their rate of growth and their capacity to absorb and store carbon reduces. In an unmanaged forest trees die and decay releasing stored carbon back into the atmosphere. In a managed forest trees are felled as their growth rate subsides and they are replaced with new trees. This managed process of harvesting and replanting produces renewable feedstock for a bioeconomy and maximises carbon storage of forests.

Cellulose based food products

Japanese food company Omikenshi has produced a gluten free low carb noodle using a flour comprised of cellulose and konjac root. Since cellulose is indigestible by humans the flour contains sixty times less calories per kilo then wheat flour. Omikenshi plans further innovations within the booming diet food market and Japanese authorities have recently amended food labelling restrictions enabling companies such as Omikenshi to sell their products as functional foods.

Programmable Wood

Researchers at Massachusetts Institute of Technology (MIT) have developed wood products which predictably respond to sunlight, water, temperature and electric current. By controlling the wood grain through 3D printing they have developed flat forms which self fold and assume 3D shapes in response to a stimulus. Skylar Tibbits, Director of the MIT Self-Assembly Lab says "this technology allows us to produce more adaptive infrastructure in the future". The technology has potential for the development of self-transforming buildings or adaptive piping which expand or contract in response to water flow.

Cross Laminated Timber

A revolution in underway in the way we use timber for construction. Stadthaus is a nine-storey, high-rise building in Hackney, London comprising 29 private and affordable housing units. This pioneering building is constructed entirely in timber. It is the first building of this height to construct not only load-bearing walls and floor slabs, but also stairs and lift cores entirely from timber. By avoiding the use of high embedded carbon concrete and steel it is estimated 310 tonnes of carbon emissions were avoided.

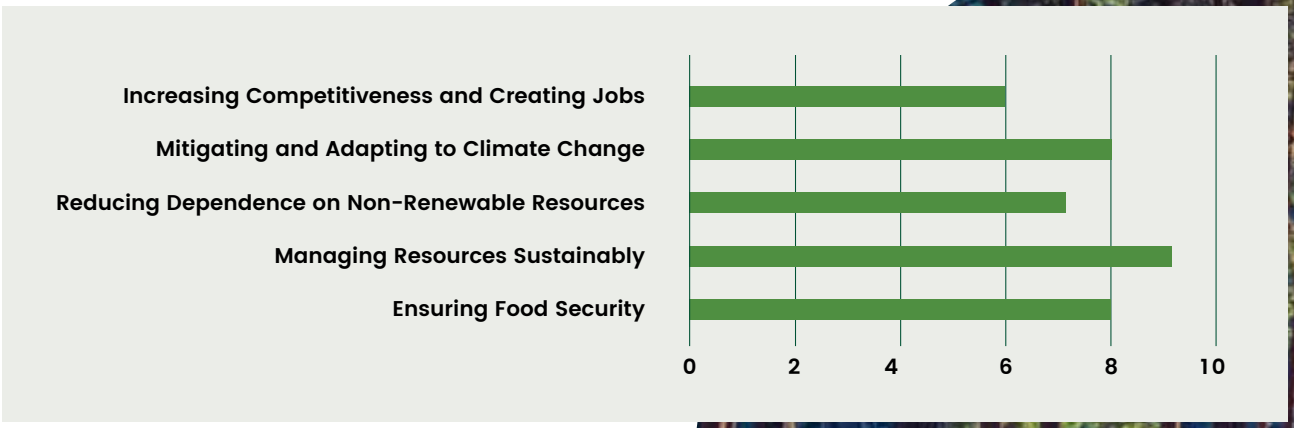
Photo credit: Programmable Wood Printed Products: Christophe Guberan + Self-Assembly Lab, MIT

TAKING THE PULSE - FOREST BIOECONOMY INDICATORS

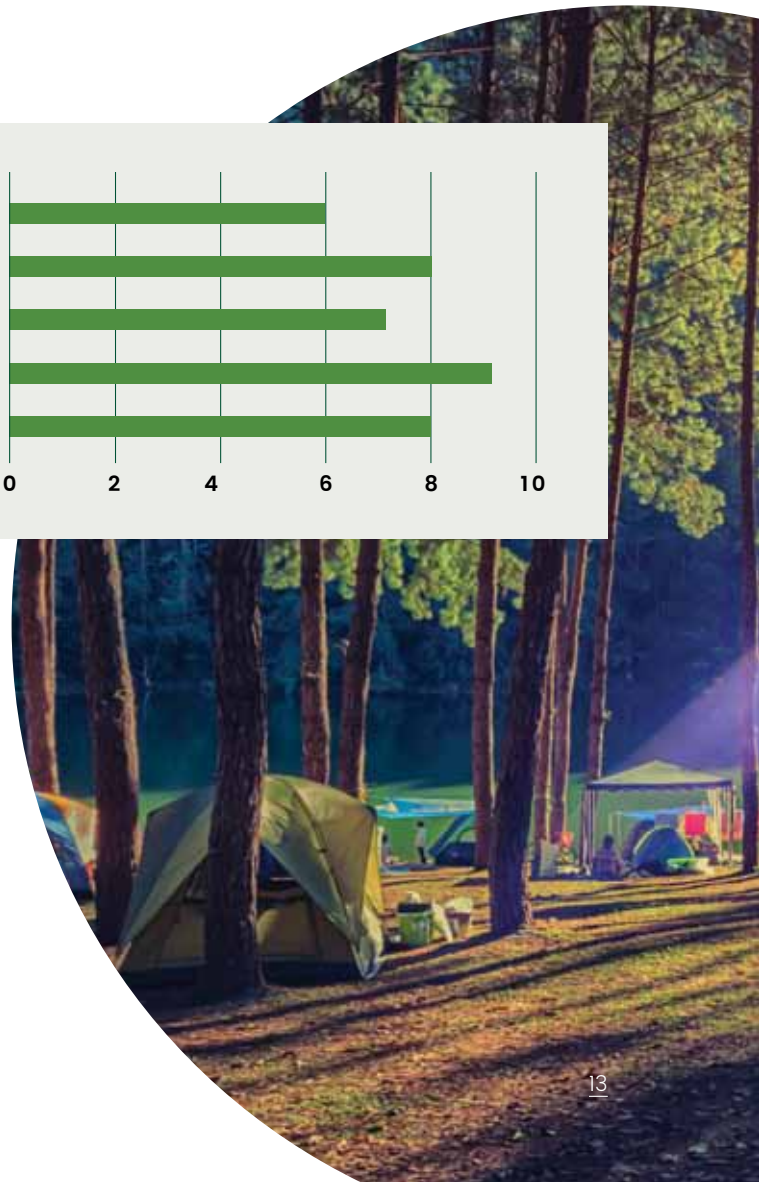
While a forest bioeconomy exists in Ireland today, is it possible to assess its current condition and state of development? The European Forest Institute has identified and analysed 203 potential indicators relevant for assessing the condition or state of a bioeconomy and narrowed this list down using the following criteria:

- European indicators for sustainable forest management,
- Relevance to the EU Bioeconomy Strategy,
- Adequacy for assessing direction of change,
- Data availability and quality.

From this list they have proposed a set of forest related bioeconomy key indicators complete with a comprehensive schedule of sub-indicators. The working group has adopted this system and through a series of workshops assessed the forest bioeconomy in Ireland today.



The national forest estate's excellent growth and carbon sequestration characteristics produced a high score for mitigating and adapting to climate change. A developed culture of sustainable forest management and structure and composition of our agriculture sector produced strong scores for managing resources sustainably and ensuring food security. Significant room for development was found in the areas of increasing competitiveness and creating jobs and reducing dependence on non-renewable resources and these are the areas where we see most potential in Ireland's future bioeconomy.



IRELAND'S FUTURE BIOECONOMY

Ireland's forests already make significant contribution to the economy and society but due to our relatively low forest cover, the age structure of our forest estate and the emergence of new scientific and technological developments, there is potential to substantially increase this contribution in the years to come. A growing forest bioeconomy will not only boost economic growth but will also help meet national commitments to aid in food production, reduce greenhouse gas emissions, manage natural resources and ecosystem services sustainably, reduce reliance on imports while promoting rural development and has the potential to deliver significant public benefits. The principles guiding development of a forest bioeconomy should be:

- maximisation of economic value,
- maximisation of carbon storage,
- adoption of a cascading use approach.

Cascading use means that as far as possible feed material is used and reused multiple times before its end of life. Cascading should be considered from the perspective of the whole wood cycle taking the overall efficiency of reuse and recycling into account.

These principles provide guidance for future development. They are not presented in a prioritised order and they are not suggested as hard and fast rules. It is foreseeable that instances may arise where principles are in conflict and trade-offs and balanced judgement will be necessary. They are however thought useful as general guides for development of an emerging sector.

By applying these principles in an Irish context it would appear that there are four significant areas for development in the medium term:

- Engineered eco-construction materials,
- High energy efficiency,
- New Innovative Products,
- Ecosystem Services.

ENGINEERED ECO-CONSTRUCTION MATERIALS

Irish forests produce 3.2 million m^3 of material each year and this is forecast to increase to 8 million m^3 by 2035. Maximising the value of this resource will be a major challenge for foresters, forest owners, timber processors and wood manufacturers over the coming decades. This complex challenge will need to be addressed across multiple government departments, local authorities and stakeholders.

The current breakdown of sawmill to panel board production is approximately 70:30 which means that the bulk of timber ends up as sawn timber for eco-construction, packaging and fencing with residue returning to panel board processing and wood energy. Ireland's panel board mills have shown that we can engineer wood products from residue to produce panels. However, Europe's timber processors are now engineering sawn timber to add value to the industry by building in wood.

If Ireland intends to maximise its timber resource to make a major impact in the bioeconomy, it needs to begin the process of engineering wood and composite materials for eco-construction. This will require new thinking by the timber industry, housing sector, engineering and architectural faculties in our third level colleges and State agencies and departments with responsibility for planning and the built environment.

Countries such as Austria, Norway, Sweden and Canada have been exploring engineered wood products for rapid multi-storey construction for decades and buildings 50m in height are attainable with much more ambitious programmes planned in cities such as Stockholm (34 storeys) and Vancouver (30 storeys).

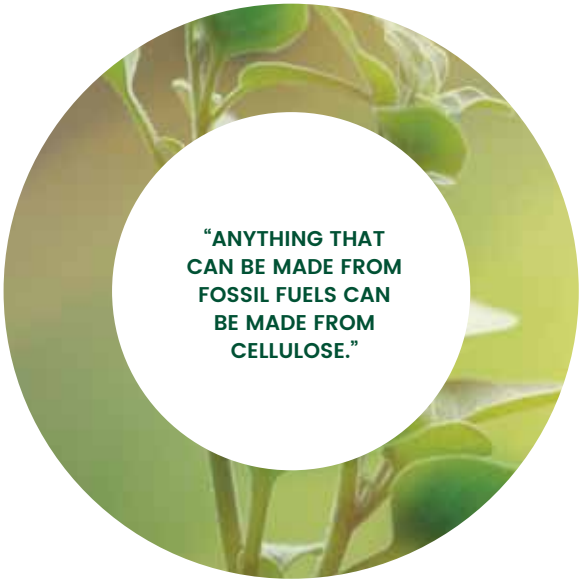
The most popular engineered construction wood is cross-laminated timber (CLT). This provides innovative building solutions for single-and multi-family residential houses, multi-storey residential and commercial buildings. The CLT species used in Austria and Sweden is Norway spruce. CLT research in Ireland is being carried out as part of the project 'Innovation In Irish Timber Usage' funded by the Department of Agriculture, Food and the Marine. Researchers at NUIG have demonstrated the viability of using Irish Sitka spruce for the manufacture of CLT.

HIGH EFFICIENCY ENERGY

Wood is an important part of our existing renewable energy mix and will continue to be so in the future. As carbon becomes more constrained in the coming decades and the value of carbon neutral fuels appreciates further, it is likely that we will see virgin wood fuel resources being deployed in increasingly higher efficiency applications such as combined heat and power installations. It may also be useful to deploy wood fuel in energy generation close to the point of origin and there may be an important role for wood in local power generation, particularly in areas remote to main energy distribution networks. Finally, as the circular economy matures, wood products which have reached the end of their useful lives and cannot be reused or recycled further, will be available for conversion into energy.

NOVEL PRODUCTS

Anything that can be made from fossil fuels can be made from cellulose and in a world of increasing carbon constraint we will see much more innovation in the use of wood. While Ireland has a relatively small forest estate in comparison with other European countries, we are one of the most innovative and technologically advanced. Scientific research is underway in a wide range of areas. One particular example is the Biobased Industries Joint Undertaking which is an EU research and innovation public-private partnership funding initiative. The funding programme is focussed on the development of feedstock supplies, biorefining technologies and biorefineries markets, products and policies.



The programme has funded circa 65 biobased industry related projects since 2014 and includes a focus on innovation concerning forestry management, forest based biomass and residues including the following 14 examples.

SMARTLI - Smart Technologies for the Conversion of Industrial Lignins into Sustainable Materials

EFFORTE - Efficient forestry by precision planning and management for sustainable environment and cost-competitive bio-based industry

PROVIDES - PROcesses for Value added fibres by Innovative Deep Eutectic Solvents

EUCLAVIA - EUCAlyptus LIgnin VAlorisation for Advanced Materials and Carbon Fibres

SYLFEED - From forest to feed: enable the wood industry to bridge the protein gap

LIGniOX - Lignin oxidation technology for versatile lignin dispersants

ZELCOR - Zero Waste Ligno-Cellulosic Biorefineries by Integrated Lignin Valorisation

LIBRE - Lignin Based Carbon Fibres for Composites

VALCHEM - ValChem - Value added Chemical building blocks and lignin from wood

EXILVA - Flagship demonstration of an integrated plant towards large scale supply and market assessment of MFC

GreenLight - Cost effective lignin-based carbon fibres for innovative light-weight applications

STARBBI - Standards and Regulations for the Bio-based Industry

BIOFOREVER - BIO-based products from FORestry via Economically Viable European Routes

TECH4EFFECT - Techniques and Technologies for Effective Wood Procurement

The Biobased Industries Programme provides an outlook on alternative processes, technologies and products that may improve value chains and provide alternative and innovative pathways for development for the future.

Ireland should actively participate in international research and innovation networks which have a strong commercialisation focus. We should also be prepared to lead research where international research is not addressing issues specific to our local context. Our advantage in this area will be our agility and capacity to respond quickly to emerging opportunities.

ECOSYSTEM SERVICES

In addition to wood products, the national forest estate produces many important non-timber ecosystem services. In the coming decades new forests and new approaches to managing existing forests may be able to create highly valuable green infrastructure. In some cases this infrastructure may be able to replace or reduce the requirement for traditional hard engineering. In other cases this infrastructure may provide services for new and emerging societal needs. A challenge will be designing and implementing schemes which provide financial recognition for services provided. There are significant developments in Payments for Ecosystem Services (PES) in flood risk management emerging in Southern Europe and it is expected that these will become more widespread and common.

ROADMAP

The gross output of the Irish forest sector is set to double by 2035 against a backdrop of increasing carbon constraint and this creates a tremendous opportunity. This report provides an exciting vision of a thriving, export led, forest bioeconomy which creates sustainable jobs in rural Ireland and supports national land-use carbon reduction and climate adaption objectives.

The Irish population is anticipated to increase by more than 750,000 by 2040 and will require a minimum of 500,000 new homes. This presents a massive opportunity for engineered timber construction and the development of district combined heat and power plants.

As our climate changes we will experience more weather extremes and we will experience flood risk and water quality challenges. Forests can play an important role as green infrastructure reducing the requirement for expensive and carbon intensive, hard engineering. Finally, as our population becomes increasingly urbanised, forests can provide important habitat for a wide range of wildlife and a venue for outdoor recreation activities.

As the bioeconomy develops new opportunities for wood product will develop and if we are primed and agile we will be in a position to commercialise these emerging opportunities.

Bio-packaging

Stockholm based premium ice cream manufacturer Fryst has replaced oil based plastic tubs with pulp based containers. The container is made from unbleached pulp which is thick enough to insulate the cold content and is strong enough to withstand filling and freezing. The packaging is cheaper than plastic and is recyclable and compostable. The company's founder Kim-Benjamin Falkarp says "in the future we will see more paper and plant based packaging materials with a greater flexibility in size and design".

Carbon Fibres

A team of researchers led by University of Limerick have begun a project to produce carbon fibre from forestry products. Carbon fibre is a reinforcement which when added to plastic improves its mechanical properties thereby forming a composite material. These new innovation materials are capable of lowering the cost of end products by 30% while cutting in half the carbon dioxide footprint of carbon fibre production.

Aviation Fuel

The transition from fossil fuels within the aviation industry presents real challenges. However, the LignoJet research project is now demonstrating that oil from forest raw materials could be a competitive alternative for production of bio-jet fuel. The project has now been chosen as a successful example of bioeconomy inititatives in the "Nordic bioeconomy – 25 cases for sustainable change" catalogue which was launched on 19 January by the Nordic Bioeconomy Panel.

Cellulose

$$(C_6H_{10}O_5)_n$$

Cellulose is produced in larger quantities and at a faster rate than anything else on our planet. Anything that can be made from oil can be made from cellulose.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THE FOREST BIOECONOMY
CIRCULAR BY NATURE

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