A Regional Market analysis of the opportunities for Short Rotation Willow as a Biomass Crop

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Contents

Disclaimer:
The views and opinions expressed in this report do not necessarily reflect those of the European Commission or the Special EU Programmes Body (SEUPB).

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1. Introduction

Since about the 1970s, energy crops such as willow have been considered a viable option to provide some energy security in situations where native fossil fuel reserves are limited or non-existent. This is most certainly true for N. Ireland and the Republic of Ireland (The Island) but is also representative of some of the picture in Great Britain. The need for upscaling the production of these crops is arguably even more pronounced today considering the UK and Ireland requirements to reach 2020 and 2030 renewable energy targets and international commitments to achieving net zero carbon by 2050. It is unlikely that these targets can be made without the inclusion of bioenergy, and Perennial Energy Crops (PECs) are destined to play a significant role in this sector. In fact, the Committee of Climate Change's Sixth Carbon Budget states that Sustainable bioenergy is essential for reaching net zero[i]. Unfortunately, over the decades government policies to develop and grow this sector have largely failed[ii]. There are a number of possible reasons for this which include obstacles such as the strength of other agricultural sectors, the lack of biomass markets and processing infrastructure, embedded sectoral costs of producing biomass, short term incentivisation and scheme bureaucracy, failed large scale projects, competitiveness of large-scale biomass imports as well as low oil and other fossil fuel costs.

This long-term failure would suggest that there may be a need for a cross departmental approach to promote the development of this sector. Given the multi-benefits which biomass crops can deliver, departments controlling agricultural output, energy security & cost, environmental protection, business development and employment all have something to gain.

In this report we examine the uptake of SRC willow on the Island over the recent past and assess how this crop could become more prevalent into the future. It stands to reason that with current carbon targets, demands on carbon dioxide removal and the production of bioresources for multiple end uses, while considering environmental sustainability, crops like SRC willow provide a clear option to achieve all these demands going forward. Furthermore this report will examine …

- The different processes and costs
- Sector difficulties and past failures
- Best-practice guidance and advice
- Future policy hopes
- Benefits of SRC willow and what a thriving sector could bring.
- Supportive outcomes from the EU-CatchmnetCARE project
- Current activities in support of the sector which focus largely on the Biomass Feedstock Innovation strategy run and funded by UK DESNZ.

1.1. A future for Biomass

Biomass is predominantly domestically sourced in the EU and therefore is vital in our quest for energy security. However, it needs to be massively upscaled if our reliance on fossil fuel imports is to be drastically reduced, as required for the climate action agenda[iii]. Bioenergy offers diverse solutions and applications including space heating in buildings, renewable power production, grid stabilisation and decarbonisation of hard-to-decarbonise sectors such as transport, heating and industrial processes. In addition, technological developments in Bioenergy with Carbon Capture and Storage (BECCS), which combines power generation with permanent carbon sequestration, are gaining momentum globally.

Woody biomass from forestry thinnings, agri-residues and importantly from biomass crops, is projected to be vital in reducing the carbon emissions of many sectors. These include not just power generation but also heat, industry and transport. The latter includes sustainable aviation fuel which is estimated to increase to 40% of total aviation fuel use by 2050 according to the International Energy Agency. Europe's industrial and transportation sectors collectively emit more than half of its carbon emissions. However these sectors are much more difficult to decarbonise than power generation, which is being successfully decarbonised by power generation technologies such as wind turbines, solar photo-voltaic, wave, tidal and hydro technologies. If all these sectors are to be decarbonised, then the production of biomass feedstock must be massively upscaled. Furthermore, woody biomass is not just an energy resource, it is a carbon resource for societal displacement of products currently derived from fossil fuels which include plastics, ammonia/fertilisers, steel & cement/concrete. This is a circular bioeconomy in which the majority of energy and material needs are supplied by biomass and biomass derived products.

There have been, and still are, on-going debates about the role which biomass and bioenergy can play into the future (e.g. negative publicity regrading large scale destruction of forestry or negative reporting on large scale biomass use.[iv] [v]). These debates are often emotive. The potential downsides tend to be related to sustainability; of how and where it is grown and the overall lifecycle analysis (LCA) of its use and whether it is indeed advantageous in a long-term global warming potential context[vi]. Although calls continue to try to remove biomass from available renewable energy solutions for the EU, as of September 2022 the EU reaffirmed its position in recognising primary woody biomass as a renewable energy source; as classified under the Renewable Energy Directive (RED) as well as RED III[vii]. This confirms the EU standpoint that primary woody biomass is essential for reaching the target of 45% of energy to be produced from renewable sources by 2030 on its way to achieving Net Zero emissions by 2050.

If sensibly approached, biomass can be sustainably produced, for example, by engaging marginal, poor and degraded lands and choosing the right crops for the land and climate. In this way biomass crops can remediate these sites in terms of developing a number of ecosystems services such as biodiversity and improved soil carbon, but also, crops grown in this way do not compete with food crops. It is estimated that in the EU, this amounts to over 2 million individual sites[viii]. This potential for sustainable production was recently demonstrated by work in the EU-CatchmentCARE project illustrating that biomass crops can be targeted within an intensive livestock farm to improve a number of ecosystem services and as such improving the overall sustainability of the farming enterprise, in this case intensive dairy[ix x].

1.2. The Circular Bioeconomy

Currently we operate within a fossil-fuel based and very much a linear economy where energy and materials are simply extracted, used once and disposed of. In a circular bioeconomy (Fig. 1), the majority of carbon resources (biomass derived) are recycled and reused as far as possible (e.g. materials, chemicals and energy). This results in reduced waste, reduced GHG emissions and reduced environmental damage[xi].

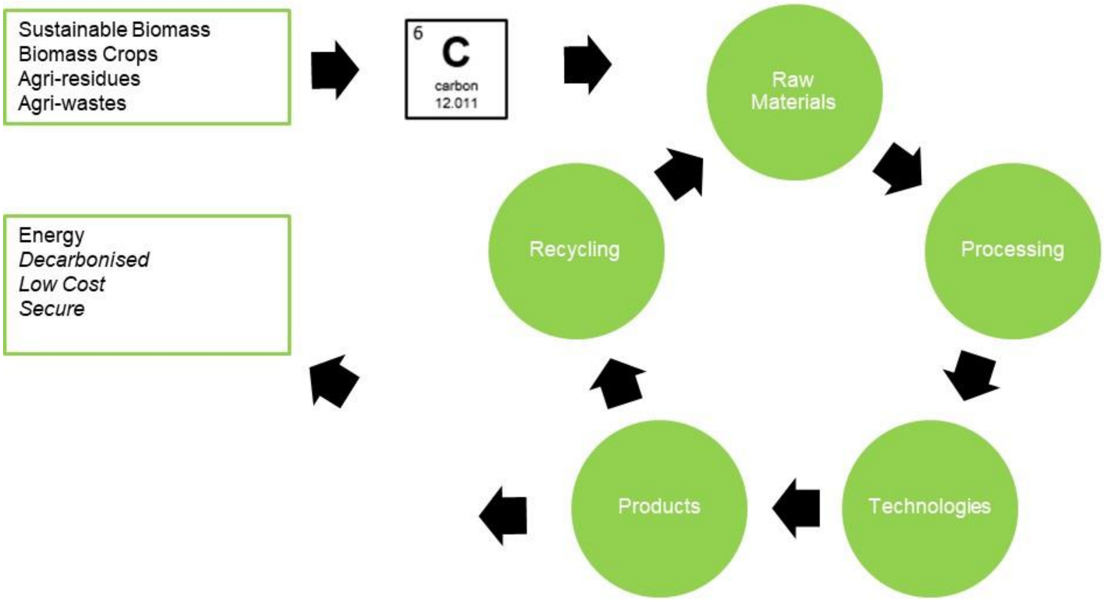


Fig 1. A circular Bioeconomy

This sustainable use and reutilisation must of course all be backed up by a full LCA but woody biomass is generally expected to play an increasingly important role in many different sectors which need to reduce and remove carbon from their activities[xii]. This can naturally come from utilising agricultural wastes and residues; however, the quantity of carbon resources required by society is such that purpose grown biomass is also a necessity.

1.3. Bioenergy Carbon Capture and Storage (BECCS)

The production of energy while also locking away carbon dioxide could be seen as a win-win for society and the climate. Not only does bioenergy supply energy, but the whole process of photosynthesis fixes atmospheric carbon dioxide thus removing it from the atmosphere. If all that carbon dioxide isn't directly released by complete combustion, then a permanent carbon removal solution can exist for the remainder. Thermo-chemical processes such as combustion, pyrolysis and gasification as well as gasification for hydrogen production (HyBECCS) can do exactly this whereby the resulting carbon dioxide can be locked away geologically or as biochar which can lock away carbon through product incorporation or land recycling. The potential of BECCS has been modelled and is estimated to deliver 20 to 70 million tonnes of carbon dioxide removal by 2050 in the UK[xiii]. Although much of the modelling has been utilising waste wood and agricultural residues such as straw, the incorporation of biomass crops into this sector would increase capacity and allow for energy production with carbon dioxide removal.

2. Heat Energy demand on the Island of Ireland

Thermal energy use is estimated to be about 40% of total energy use throughout the island. In N.Ireland, the heat demand has been estimated at 17.4 TWh, of which around 300 GWh, or 1.7%, is met from renewable sources, with a significant element of this existing renewable heat coming from biomass fuelled boilers. The requirements of the EU Renewable Energy Directive set out goals for the development of not only renewable electricity but also heat and transport. Back in 2011, in the Northern Ireland Programme for Government (PfG), the Executive set out targets for renewable energy. It anticipated that 4% of heat would come from renewable resources by 2015[xiv] with a further target of 10% of heat consumption by 2020. This was

proposed within the Strategic Energy Framework 2010 to 2020[xv]. In the Republic of Ireland there is an estimated 41 TWh of heat demand at a cost of €3billion and 65% of that is derived from fossil fuel imports[xvi]

3. Energy Crops in the Island of Ireland

3.1. Current position

Over the years, it has been recognised in N.Ireland that Bioenergy is one of a number of renewable energy sources available in Northern Ireland and that Its development will help to capitalise on the area's natural resources, contribute to the region's security of energy supply, create jobs, support businesses and reduce greenhouse gas emissions[xvii].

3.2. Past Plantation land areas

Table 1 - Republic of Ireland Bioenergy Scheme 2007 – 2013 (Willow)

Year	2007	2008	2009	2010	2011	2012	2013	Total
Carlow	0	43	0	0	0	0	0	43
Cavan	0	0	11	36	17	8	16	88
Clare	0	0	0	0	0	0	0	0
Cork	0	0	0	7	0	0	0	7
Donegal	2	3	9	7	0	0	18	38
Dublin	3	0	0	0	0	29	0	32
Galway	0	0	3	4	0	5	20	32
Kerry	0	0		0	0	0	0	0
Kildare	8	21	7	28	9	12	34	119
Kilkenny	0	0	0	0	0	0	11	11
Laois	0	0	0	0	0	6	47	53
Limerick	0	0	0		0	11	11	21
Longford	0	0	23	0	0	0	9	31
Louth	7	3	4	3	12	0	0	29
Mayo	0	8	0	0	8	0	3	20
Meath	28	29	38	31	28	33	35	222
Monaghan	0	4	50	17	0	4	0	75
Offaly	0	0	11	0	4	19	0	34
Roscommon	0	0	0	0	0	7	13	21
Sligo	0	0	0	0	0	0	0	0
Tipperary	5	0	0	34	21	0	0	60
Waterford	4	0	0	0	0	0	0	4
Westmeath	7	0	7	9	40	16	13	91
Wexford	0	15	0	10	7	0	0	33
Wicklow	0	0	4	0	0	0	0	4
Total	**63**	**128**	**165**	**186**	**146**	**149**	**231**	**1068**

Table 2 – N.Ireland willow planting

Year	Pre 2005	2005	2006	2007	2008	2009	Total
Tyrone	0	30	57	73	3	6	169
Fermanagh	0	0	0	62	27	5	94
L/Derry	73	121	35	40	0	18	287
Armagh / Down	0	52	83	134	0	15	284
Antrim	0	6	23	8	0	0	37
Total	**0**	**209**	**199**	**316**	**30**	**43**	**871**

At one point there were approximately 3,000 ha of SRC willow on the Island and the above current estimates may well be overestimates however it is fair to say that the area of land growing willow would have more than halved since the end of the planting and establishment grant periods.

3.3. SRC willow costs and economics

One of the main impediments to developing and expanding SRC willow as a viable agricultural diversification option relates to economics. This links primarily to the basic economic model of supply and demand and also to the financial hurdles involved in getting started (establishment costs and the need for a long term out-look). If the cost of fossil fuels is too low and the costs of bioenergy are considered as uncompetitive in comparison, then the economic incentive to establish SRC willow will not exist. Together with the almost non-existence of follow-on supply chains which include contractors for planting, harvesting, processing, storing and transporting, it is easy to see why the crop hasn't been widely established.

Willow can be grown either for self-supply or for sale to a contractor who will essentially buy the standing crop directly from the field, harvest it and take it away. In 2023 a contractor might buy the crop for around £10 to £15 per fresh tonne depending on factors such as the location, crop age and proximity to a customer. This return is unlikely to attract farmers to plant as it would amount to a return of around £200 to £300 / ha / year.

3.3.1. Establishment costs

When establishing willow, the costs of land preparation, planting material and the actual planting along with the necessary weed control pre- and post-planting and cut-back, must all be considered. There may be other costs to consider such as fencing for rabbits and unexpected weather effects (flood, drought) to contend with however it is generally considered that once the crop is well established in Ireland, there is every reason to expect on-going harvests for 25 to 30 years. The cost of establishment is currently considered to be in the region of €2,600 (£2,300) per ha.

To estimate this cost on a 'per tonne basis' the following assumptions have been made and calculated on a dry tonne basis. (N.B. A dry tonne is 0% moisture content (MC). In reality this will never exist in biomass production however for cost calculation purposes, it is valuable as a common denominator to keep all costs consistent).

- 25 year crop existence giving 8, 3-year harvests
- Average yield 10 dry tonnes / ha / y
- Dry tonnes produced over lifetime (7 harvests x 30 tonnes/ha) = 210 dry tonnes
- Establishment per dry tonne = £2,300/210 = £11 / tonne

For self-supply, other requirements must also be factored in include harvesting, drying, storage and miscellaneous costs such as loading floors and bays and management around the farm.

3.3.2. Harvesting costs

Although there are a number of harvesting methods, only chip harvesting exists in Ireland; Whole-stem, bale and billet harvesting do not currently exist as harvesting options. Harvesting costs can be applied in a number of ways; including by hectare harvested or by tonne of fresh chip harvested. The cost of harvesting can be in the region of £12.50/ fresh tonne or around £750/ha. This will depend on a number of factors such as area to be harvested, proximity to contractor, age and size of the plantation, land and weather conditions. This cost would equate to around £25 per dry tonne

3.3.3. Drying / processing costs

Following harvest, the chip must be processed which will entail drying and potentially grading. The requirement for this will depend on the needs of the final customer (chip quality standard) and whether the chip needs to be stored. The cost for this can add approximately a further £15/ dry tonne.

3.3.4. Haulage Costs

At the time of this report, haulage costs are around £20 per dry tonne within an approximate 70 mile distance. Normally this is done by moving floor trailer capable of carrying 15 to 20 dry tonnes however it can also be by farm trailer if distances make economic sense.

3.3.5. Summary costs

The above costs will therefore amount to:

Establishment	£11 / dry tonne
Harvesting	£25 / dry tonne
Processing / drying	£15 / dry tonne
Miscellaneous	£10 / dry tonne
Total (exc haulage)	**£61 / dry tonne**
Total (exc haulage)	***£76 / tonne (20% MC)***

At the time of writing this report, SRC willow woodchip is selling at around £150/tonne at 20% MC ex yard which would cover all supplier costs and make a profit, the size of which will depend on the set-up and activities of the contractor & processor. At this cost, heat from willow wood chip would be less than half the cost of oil or natural gas, even taking into consideration the efficiency losses from wood chip systems.

	kg wood chip	Litre of oil
Energy	5.1 kWh	10 kWh
Cost of fuel	(£150 / 1000) = £0.15 /kg	£1.00 / litre
Efficiency of boiler	85%	95%
Cost of kWh heat out	£0.034 / kWh	£0.105 kWh

Fig 2. Willow plantations at the height of the DARD Challenge fund and establishment grant period.

4. Difficulties with the Biomass Crops Sector

Despite historical financial support for planting (Biomass Crop Establishment Grants (NI and RoI) and Biomass Challenge Fund (NI)), the planting rates remained relatively low throughout the running of both schemes in N.Ireland (2004-2006 and 2007-2010). This was for several reasons, but primarily because of the immaturity of the biomass fuel market and the biomass energy sector in general. Previous schemes have therefore been deemed by many stakeholders, as having an overall minimal effect on the industry. To the best of our knowledge, there was little to no significant crop failure during the scheme. The schemes were less effective due to several industry and market drawbacks.

Several energy crop establishment schemes were implemented in both parts of the Island. In 2004, the N.Ireland Department of Agriculture and Rural Development (DARD) Forest Service introduced the ***Short Rotation Coppice Challenge Fund*** to aid the establishment of willow to be harvested as a renewable energy source. The initial response was in line with the aims set out in the scheme, with respect to the total area expected to be established. Between 2005 and 2010, approximately 818 hectares were approved for planting (Fig. 2). The first scheme planted 630 hectares. This received a support rate of 100%. During the second scheme, 188 hectares were planted and received a support rate of 40%.

The establishment grants reduced the potential spend to the farmer to the point at which planting biomass crops was a viable option. Without the long-term confidence supported by structured Government policy initiatives, farmers were reluctant to commit to a scheme that required at least a 5 year period of crop maintenance. Furthermore, the following concerns existed and continue to do so today:

- A number of farmers faced difficulties establishing productive crop from the outset due to unrealistic expectations with regards to the ability of very poor land and little maintenance producing acceptable biomass yields. Competition from other agricultural enterprises effectively made the concept of willow planting less appealing to the farmer.
- Many farmers faced a difficult route to market for the fuel and were challenged with a lack of specialist planting/harvesting equipment and processing facilities.
- Farmer mentality is a critical factor. Once the crop was planted, the commitment to the maintenance of the crop diminished.
- Furthermore, with so few farmers growing willow crops, there was little precedent on which to develop a groundswell of interest, working groups or cooperatives.
- Much of the economics of the financial return was predicated on the ability of the crop to perform a waste management function, specifically the recycling of sewage sludge (this was not specifically foreseen as a requirement by the establishment grant aid). This therefore had a value which proved relatively successful at supporting the income received by the willow farmer to a point where is at least compared with other more conventional agricultural pursuits. The economic viability of this activity however was becoming increasingly difficult due to Waste Management Regulation, in both parts of the Island. In essence, it was far simpler and less costly to recycle sewage sludge to food and fodder crops than it was to industrial crops.
- Low fossil fuel energy costs, along with no ambition or incentive for trying to move to sustainable heat production, enforced a low cost to biomass fuel ensuring little or no profit could be made on the sale of woodchip; especially if significant processing is required.
- Wood chip processing costs in Ireland will also require the removal of significant quantities of water from the wood chip and this is costly in term of infrastructure and energy requirements. Willow chip is harvested

at around 55% moisture and must be reduced to 20%-25% or less to ensure the chip is both stabilised (will not rot / compost during storage) and functions efficiently in the end use biomass combustion unit.

- The fall out of negative publicity surrounding the terminated Renewable Heat Incentive (RHI) scheme in N.Ireland has given biomass crops a tarnished reputation due to its association with biomass heating and pellet fuelled boilers[xviii]. Very little SRC willow, if any, was ultimately planted in NI to fuel biomass boilers. It is often considered that if larger sized boilers and district heating / heat networks (which would have demanded larger boilers) were incentivised, this would have increased the local demand for indigenous & sustainable biomass which would, in turn, have supported a local Biomass Crop sector and related economy.
- Lack of Infrastructure
- Lack of Processing
- Lack of Market
- Regulatory Issues with waste recycling to biomass crops such as SRC willow Crops

So far, all the SRC willow establishment schemes have not achieved the targets because there has not been enough market pull; the lack of market, demand and infrastructure available during the initial years of the schemes presented each stage with a restriction that effectively resulted in its poor uptake of crop establishment.

4.1. Past problems with schemes

There have been many and varied problems with recent biomass or energy crop support schemes and these have included the following…

- Finances have simply not been attractive due to many varied reasons which include returns on other farming exploits (dairy, cereals, beef, sheep).
- Linked to the above is the lack of a market 'pull' exacerbating the above. This has been seen on the Ireland of Ireland where really the main biomass crop customer for SRC willow has been the Edenderry Bord na Mona Power station. For a while there was some developing, smaller scale use for willow but this was essentially insignificant in comparison. A similar scenario existed in RoI for miscanthus. For both crops, logistics (proximity to Bord na Mona), influenced a drop-up of growers producing willow and miscanthus. Miscanthus growers also suffered from a further difficulty in acquiring customers as a result of Bord na Mona only being able co-fire a relatively small percentage of miscanthus along with peat and biomass crops such as SRC willow.
- The market in N.Ireland was less centralised however the market of SRC willow was slowly growing, partly supported by a heat support scheme which ultimately closed in 2016. Publicity around this scheme unfortunately gave rise to a negativity toward bioenergy, and bioenergy in

general. This still exists as of the end of 2022.

- The low price of energy and specifically the on-going low price of counterfactual fuels such as gas, oil and coal. In Ireland, the main counterfactual is oil and to a degree coal and increasingly gas. Fossil fuel prices have increased a lot during 2022 which is certainly increasing awareness of the potentials of bioenergy however, its incorporation in domestic or industrial use represents significant expense and many will take the view that cheaper oil and gas boilers are still the desired solution even though fossil energy costs will often exceed £0.10/kWh.
- The risk of moving to a new agricultural pursuit is often too much of a change for traditional farming communities and landowners. In combination with the above reasons, this also held back the development of a biomass crops sector along with the relatively long term commitment (25-30 years).
- There also exists risks and mistrust of schemes down to inherent complexity and past negative experience.

5. Energy Crops and biomass energy support schemes

Over the last 10 years, there has been much learning from the experiences developed in N.Ireland, largely from the implementation in 2013 of the Renewable Heat incentive (RHI). This was ultimately followed up by the Support Scheme for Renewable Heat (SSRH) in the Republic of Ireland. The use of biomass for energy production is seen by many countries across Europe as vital to meeting renewable energy obligations. Willow is the most common SRC species used in bioenergy plantations across Europe and is well suited to the temperate climate of northern Europe. Willow is fast growing and has high water use and nutrient retention rates. There has, however, been limited research to date into dedicated SRC willow riparian buffer strips and the associated environmental impacts. This information is needed to inform policy decisions regarding the widespread implementation of such systems in this way.

5.1. Renewable Heat Targets

With a backdrop of the European Union average of 22% of heat being supplied by renewable sources, the primary objective of the NI RHI, which was terminated in 2016, was to increase the uptake of renewable heat to 10% by 2020. The 10% target for renewable heat equates to 1,600 GWh (or an additional 1,300 GWh when considering existing levels). It was estimated at the time that approximately 4% of the heat target was reached however currently, it is unknown exactly the proportion of heat supplied by renewable sources.

In RoI, the heat target was set to deliver 12%[xix] of final heat demand from renewable energy sources by 2020 and the level currently estimated is 6.8%. The Support Scheme for Renewable heat has been making some inroads here however it is slow and as such, the RoI are introducing a Renewable Heat Obligation[xx] which will require that a proportion of the energy supplied to the Irish heat sector be from renewable sources. It is likely that the anaerobic digestion and biogas / biomethane sector will be an immediate beneficiary here however it is likely that solid biomass fuel will also be given a much-needed commercial boost.

5.2. Renewable Heat Incentive (N.Ireland)

During the lifetime of the Renewable Heat Incentive, approximately 2,200 biomass boilers were installed in Northern Ireland. Of this number, approximately 90% were pellet burners and had an average power of 90kW. Subsequent changes to the RHI (Renewable Heat Incentive) towards the end of its life did see the size limit of the boilers included under the RHI increase from 99kW to 199kW which could have increased the demand for wood chip given the fuel flexibility of larger biomass heat systems. However, the collapse of the scheme meant this was never to be realised for any useful duration. At one point it was recognised that N.Ireland was producing approximately 6% of its heat from biomass[xxi]. This amounts to 1000 GWh or approximately 200,000 dry tonnes biomass. This in turn would equate to about 20,000 ha biomass crops or about 2 to 3 % of the N.Ireland agricultural land area.

The market did mature during the period in which the RHI was in operation, and recent industry figures in 2023 reveal:

- 5 suppliers of planting material (compared to 1 in 2013)
- 4 planters
- 6 harvesting machines
- 15 drying facilities with over 40 individual drying floors, with current capacity to dry around 20,000 tonnes per annum; in excess of the requirement needed to serve the increased planting identified under this scheme.

Unfortunately, it is recognised that much of this has now gone and some of the leading development companies at the time have moved away from the industry and no longer plant, harvest, process nor indeed even grow SRC willow any longer.

5.3. Support Scheme for Renewable Heat (Republic of Ireland)

The Support Scheme for Renewable Heat is a government funded initiative designed to increase the energy generated from renewable sources in the heat sector. The scheme is open to commercial, industrial, agricultural, district heating, public sector and other non-domestic heat users. The primary objective of the support scheme for renewable heat is to increase the level of renewable energy in the heat sector. The expectation is that this will contribute to meeting Ireland's renewable energy targets whilst also reducing greenhouse gas emissions. Funding of €7 million was provided for the initial stage of this Scheme in 2018. As of early 2023 however, 30 heat projects had been completed with a further 70 or so in the pipeline. The SSRH as a result has been relaunched to try to accelerate this uptake[xxii].

6. Agricultural production of SRC willow for Biomass

There are many considerations for a farmer and/or landowner who might be thinking of diversifying into the agricultural production of biomass crops. These will include a consideration of the site, climate and soil as well as many other factors which will incorporate considerations of how biomass crops can be integrated into the current farming systems (environmental protection, biodiversity considerations) and of course economic considerations such as the presence of contractors, processors and markets.

6.1. Advice, Best practice Guidelines & upskilling

SRC willow Best Practice Guidelines[xxiii] have been produced by AFBI and Teagasc and have been the industry standard over the recent decades. There have however been many changes and updates since and this will form part of an on-line / digital application currently being developed with the recently funded programme of BEIS Biomass Feedstock Innovation Programme (2022)[xxiv]. This Advisory Tool will be called Envirocrops[xxv] and will take advice a whole lot further than ever before.

6.2. BEIS - EnviroCrops

The EnviroCrops web app will be a central source of impartial information in an easy to access, free or low-cost, user-friendly format, that will enable farmers, land managers and consultants to make an informed decision about planting biomass crops. Users will be able to provide simple information such as their postcode and find out

- what biomass crops are suitable for their land
- what yields are possible
- the best varieties or species
- the production timescales and costs
- the locality of contractors and markets, and
- the economic potential.

End users, be they a self-supplier, a local authority or a power station will be able to work out

- how much land is required to meet all or a proportion of their needs
- the production timescales, and
- the delivered costs.

Therefore, EnviroCrops will be able to provide users with a free or very affordable mini feasibility study so they can work out if a particular biomass crop such as willow, miscanthus, poplar or eucalyptus is

- right for their land
- their system
- their facilities, and
- their pocket.

EnviroCrops will provide direct access to updated best practice guidelines in a digital interactive way as well as deliver notifications on what activities are needed and when – an absolute must in the crucial establishment phase. The tool is intended to work with growers and contractors so that they can constantly update yield models with new information and keep the app outputs relevant to a changing climate. The intention is to also add elements to the design to facilitate the long-term financial sustainability of EnviroCrops beyond innovation funding from BEIS. This may include a biomass and carbon trading facility. Ultimately, the EnviroCrops tool will act as a trusted, independent price comparison website and an online marketplace.

6.3. Lead in times for energy crops biomass supply

Unlike forestry, energy crop supply can be implemented in a relatively quick time scale. These crops can be planted and managed for self-supply, for market trading or for individual customers and actively supply biomass within about3 years of planting. Forestry, on the other hand, can take 25 to 35 years before actively supply biomass fuel. It is also important to note that although there are currently strong initiatives and policy implementations to increase significantly the area of forestry on the island, the island is still one of the most under-forested area in the EU for a number of reasons.

Converting agricultural land to SRC willow maintains the land in “agricultural” use allowing for future flexibility of land use, whether to other biomass and non-food crops, or a return back to food and/or food/fodder. This is not the case with forestry as once it is changed, it cannot revery to agriculture. This is a strong benefit that SRC willow for biomass provides over a direct and total conversion to forestry. Currently (2020) RoI sits at 11.4% forestry, this is the lowest in the EU by a long way bar the Netherlands and Malta and significantly below the EU average of 38% [xxvi], NI is even lower than RoI with the UK in totality at about 13%.

7. Potential Biomass Crop Demand

The UK Government is considering a large expansion in the area of biomass crops in order to meet net zero commitments[xxvii]. A Biomass Strategy will be published around May 2023 which will build on previous work by the Committee on Climate Change (CCC) that proposed an area of between 0.2-1.4 million hectares (ha) by 2050. The UK Net Zero Strategy[xxviii] suggests annual planting areas of perennial energy crops and short rotation forestry (SRF) of 7,440 ha by 2025, 21,275 ha by 2030 and 26,350 ha by 2035. For this to be achieved the Biomass crops industry needs to take off quickly and to aid this, the UK Government has implemented the “Biomass Feedstocks Innovation Programme” for which £36 million in funding has been assigned to projects to support innovation in the production of sustainable domestic biomass. This represents possibly the biggest and most significant support step shown by either the UK or RoI Governments ever and as such, a dedicated part of this report will focus on this.

7.1. UK & proportional NI production

The National Farmer’s Union has modelled the yearly uptake of biomass crops required in order to meet these 2050 biomass crops targets. From a current UK wide area of biomass crops (Miscanthus & Willow) of 12,000 ha, this needs to grow significantly, year on year to achieve700,000 by 2050. This roadmap requires a growth rate of 100% per annum initially, declining to 10% by 2029, then 5% until 2040. The critical growth period in certainly in the early 2020s, doubling annually before settling into more modest growth in 2030s.

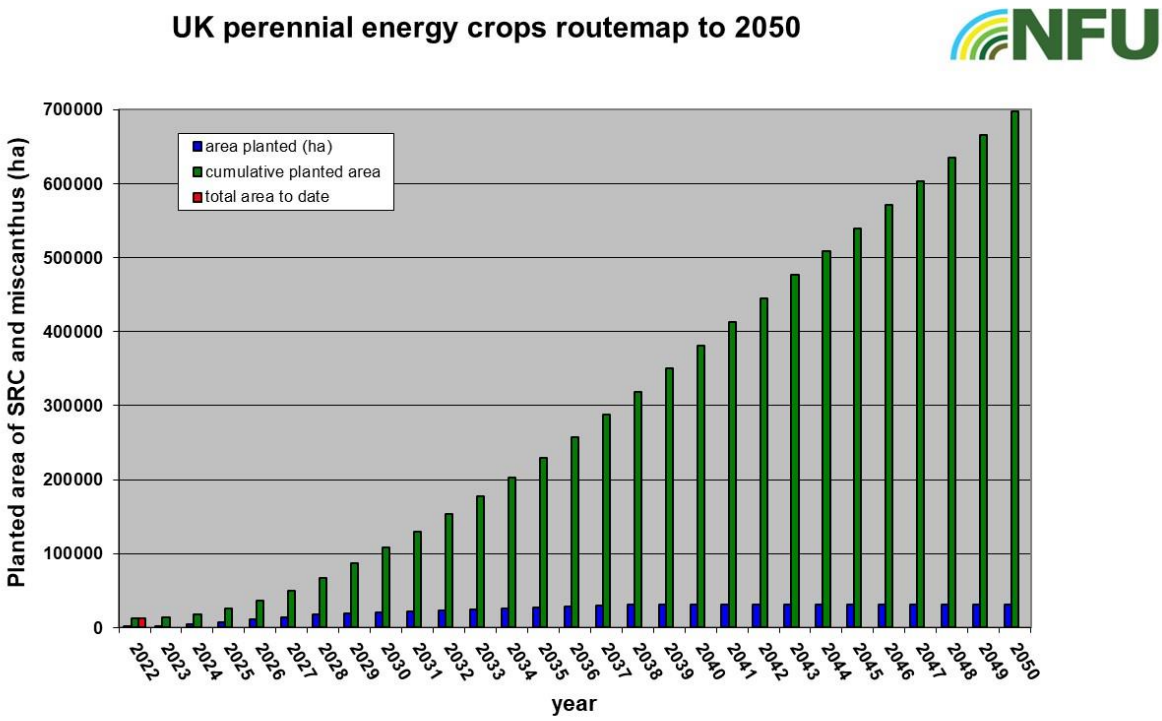


Fig 3. UK perennial energy crops route map to 2050

The Committee on Climate Change's recommendation that 260,000 hectares of farmland shifts to producing energy crops + other marginal areas – 700,000 ha is a significant undertaking and furthermore, the UK centre of Ecology & Hydrology has extrapolated this figure to 36,000[xxix] [xxx] ha of biomass / energy crop land by 2050. This would be the equivalent of 3% of the total agricultural land.

7.2. Sector Scale

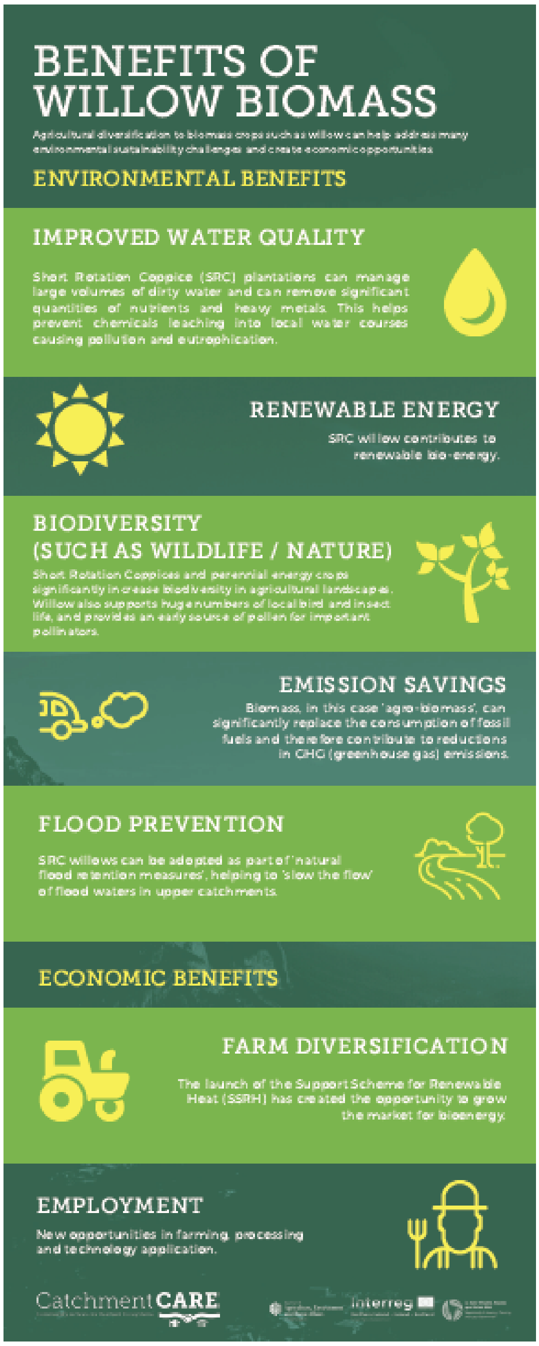
The current small-scale level of existing planting and crop management is sustainable with only a handful of contractors throughout the country however, the critical growth phase for planting contractors will be increasing from 1,000ha to 10,000ha per year at which point this sector is going to have to massively up-scale in terms of companies, machinery and efficiency if the 2050 target is going to be at all feasibly reached. There are two or three well-established large sized willow contractors in GB; however in Ireland, SRC willow contractors are rare, and this activity is peripheral to the other activities of these contractors as there is simply not the scale of industry to allow for this economically. This naturally reflects on efficiencies, costs, employment and accessibility throughout the year.

8. Multifunctional Benefits of Energy Crops

SRC willow is a fast growing perennial woody tree species currently grown for bio-resources (mainly for energy) however, the crop and how it is implemented, has a wide range of other functionality all relevant to current climate and environmental goals as well as UN sustainability goals 6,7,9,11,12 & 13.

8.1. Carbon & Emissions savings

The Irish Bioenergy Association(IrBEA) state that implementing the 40 by 30 strategy will reduce CO_2 emissions by 48% in the heat sector, which account for 20% of Ireland's total greenhouse gas emissions. It will reduce Ireland's dependency on total energy imports from 50% to 34%. The generation of feedstocks for renewable heat can contribute to the overall decarbonising of agriculture and provide alternatives for farmers. Perennial wood crops and short rotation forestry can help us reach net-zero by sequestering carbon, improving biodiversity, and supporting our power and fuel supply.



Biomass, in this case 'agro-biomass', can significantly replace the consumption of fossil fuels and therefore contribute to reductions in GHG (greenhouse gas) emissions

8.2. Jobs & Employment

New opportunities in farming, processing and technology opportunities. A 40% target for biomass would create approximately 23,000 jobs, many of which would be in rural Ireland producing fuel and feedstock to serve demand.

8.3. Benefits of Energy Crops for the landowner

Bioenergy has the potential to utilise existing farm-based wastes, residues and crops for the production of energy in the forms of electricity, heat and transport fuel. There is therefore a role for farmers to supply feedstock (fuel for burning) or generate energy themselves. Bioenergy is renewable, indigenous and can present opportunities for on-farm diversification and rural employment. Currently, the value of wood chip (approx. 20% MC) ex-processing yard is approximately £115/€130 per tonne. Standing crop (approx. 53% MC) however is worth in the region of £15/€17 per tonne. Biomass produced from perennial wood crops such as SRC willow is considered a renewable and sustainable way to contribute to the UK's climate targets and offers massive opportunities for farmers and landowners across the country to reduce their carbon footprint and help support the world's ambitions for a greener planet.

8.4. Biodiversity improvement and protection

Short Rotation Coppices and perennial energy crops significantly increase biodiversity in agricultural landscapes. Willow also supports huge numbers of local bird and insect life and provides an early source of pollen for important pollinators.

8.5. Flood Prevention

SRC willows can be adopted as part of 'natural flood retention measures', helping to 'slow the flow' of flood waters in upper catchments.

8.6. Farm Diversification

The launch of the Support Scheme for Renewable Heat (SSRH) as well as the upcoming Renewable Heat Obligation will hopefully create the opportunity to grow the market for bioenergy

8.7. Waste Management

The use of willows for waste management can aid in the management of point source discharges as well as contribute to the greening and cleaning up of contaminated sites. Willows can be used for the uptake of plant macronutrients, removal and bioaccumulation of heavy metals such as Cadmium, Nickel, Zinc and Copper. Willows have been shown to be effective in the ongoing sustainable management of discharges from industry, wastewater treatment and landfills which leading to reduced discharges and the utilisation of waste nutrient; a circular bioeconomy of biomass production from societal waste. Further wastewater biofiltration proof of concept facilities have been afforded by the EU-Catchment Care project.

8.8. Water Quality Protection - integrated livestock farming

- It has long been considered that SRC willow could serve a very functional and appropriate purpose in NI[xxxi] and RoI by integrating its establishment with livestock agriculture in a way that would provide an environmental protection and diversification opportunity as outlined in the previous paragraphs. The EU-CatchmentCare project has afforded the opportunity to explore this in a proof-of-concept way and help illustrate that ….SRC willow can be focused to areas of hydrological connectivity.
- SRC Willow can complement agricultural systems.
- Phosphorus exports to water can be permanently reduced
- Energy production can be greater that the energy demands for the entire life cycle.
- The crops can establish well, yield well and be managed on an-ongoing basis.
- Reductions in GHG emissions and fuel costs

9. EU-CatchmentCARE – SRC integrated with Livestock Agriculture

EU CatchmentCARE[xxxii] is an EU-funded project that aims to improve freshwater quality within the North Western and Neagh Bann international river basins. The project is focussed across three cross-border catchments, the Arney, Blackwater and Finn. The aims are being achieved through development of water quality improvement projects and installation of groundwater monitoring stations across the region. The project overall is grounded in the Water Framework Directive (WFD).

One part of the project was to develop a platform and demonstrate how the implementation of Biomass Crops in an intensive livestock setting could be used for agricultural diversification and environmental protection. This has led to much engagement and knowledge dissemination largely focussed on the implementation on one of the sub catchments within the AFBI Hillsborough farmed estate.

Fig 4. SRC willow biofiltration block (approx. 1.9 ha) within a 22ha sub-catchment.

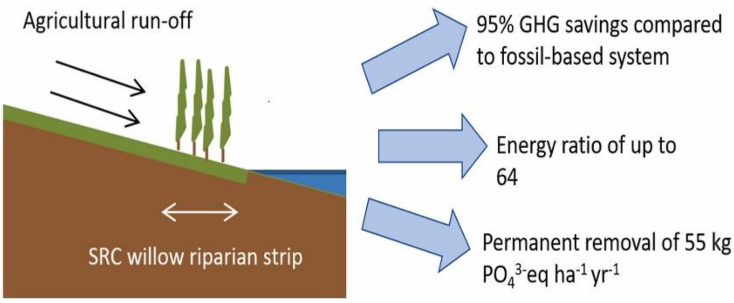


Fig 5. Methodology of environmental protection and GHG substitution[xxxiii]

Furthermore, given the concern than any diversification to biomass crops such as SRC willow could bring about a reduction in agricultural output (Dairy, Beef, Sheep, cereals), it is important that this platform is used to demonstrate as far as possible that such progressive environmental interventions can actually improve agriculture in terms of water quality, economics, carbon, biodiversity and improved Life-Cycle Analysis. Through the sister EU-Bryden Centre project, an LCA has been completed using an Irish dairy farm case study in exactly this way.

9.1. SRC Willow interventions in intensive livestock farming.

It has been modelled that on a typical dairy farm, SRC willow biofiltration blocks can reduce total phosphorus loss to water by 9% and total CO_2eq emissions could be reduced by 16.5% if energy from the willow displaces fossil fuels; along with minimal effect on milk production[xxxiv].

9.2. Water Quality & Buffer strips / biofiltration Blocks

Eutrophication of freshwater remains a significant environmental issue within Europe, with agriculture identified as a primary source of phosphorus (P) in many countries. In 2018 the EU average for surface water bodies achieving 'Good or Better' ecological status, as defined by the Water Framework Directive (WFD), was only 40%. Despite a significant investment in mitigation strategies, in many cases, the reduction in P export from agricultural systems have been insufficient to meet the targets of the EU Water Framework Directive. There remain significant challenges in balancing the often-competing objectives of agricultural intensification and environmental protection however one such measure could be the use of SRC willow planted in buffer strips or biofiltration blocks along at the edge of fields or in riparian areas.

9.3. Life Cycle Assessment

A life Cycle Assessment (LCA) or Life Cycle Analysis is a complete, 'cradle to grave' analysis of the sum of all the potential environmental impacts of products or services during the full life-cycle period. All environmental impacts must be considered to include production, manufacture, transportation, distribution, maintenance, operation and finally recycling, disposal or other end-of life activities. There is much in the literature about the environmental benefits of willow and its potential for GHG emissions savings as a fossil fuel displacement[xxxv] however these are almost fully based on plantations for carbon resource bioenergy instead of smaller targeted and purpose grown areas for integration within agriculture. As such the LCA calculations will be very different due to differences in harvesting, establishment, fertilisation, management and potentially even others.

9.4. A typical biomass buffer strip – Energy Flows

The Catchment Care SRC platform willow harvesting areas demonstrated a yield of 13.3 tonnes of dry matter/ha/year. These harvests are at the higher end of yield records and probably down to 1 of several reasons

- The willow varieties planted are more recent and higher yielding clones than those which would have been planted 20+ years ago.
- The willows are at the start of their yield phase (some other clones naturally reduce in survival or yield have a during of growth and harvesting[xxxvi].
- Willows in riparian biofiltration areas will, by definition, be continually fertilised with water and nutrient run-off from upslope farmland.

This harvest therefore equates to an energy production of 67,000 kWh/ha/y (@ 5,000 kWh / tonne). A number of indicators suggest that a 5% land conversion is possible and if this were the case with dairy farms, this would give an energy production equivalent of 3,300 kWh/ha/y. The processing requirements and energy conversion efficiencies used in

Bryden Centre LCA analysis, would suggest a resulting energy conversion of 90% (combined heat and power) or 3,000 kWh/ha/y which could be used for process heating & cooling and other uses such as pumping, lighting and space heating.

9.5. A typical biomass buffer strip – Nutrient Flows

Dairy farms in Ireland have a phosphorus surplus of 9.8 kg P /ha/y[xxxvii] and this is considered to be even higher in N.Ireland. Phosphorus residing within an agricultural system and in excess of agronomic needs will either bind to soil particles and remain in-situ or be lost to watercourses through surface runoff and leaching. In the Irish landscape a combination of poorly drained, impermeable soils and steep slopes mean that surface runoff during rainfall events is the primary pathway for phosphorus and sediment to be delivered to waterbodies. It is targeting these zones of hydrological connectivity where the most beneficial effect of the SRC willow interventions and be realised. There is much data on P removal rates however a value of 1.3 g P/kg dry matter was realised from the EU-CatchmentCare work which aligns well with previous data published by AFBI where P removal from different willow varies ranged from 1.08 to 1.51 and averaging 1.26 g P/kg dm[xxxviii]. at 13.3 tonnes/ha/year. Converting this to a SRC willow area results in approximately 9% of P taken up by the SRC willow and permanently prevented from leaching from the system. There is also a significant amount of Nitrogen leached from farms. Further work (unpublished) in indicating that up to 30% of P can be retained by the SRC willow intervention. Apart of P uptake by the crop itself, which is then removed at harvest, it is postulated that P is also managed by the increase in hydrological conductivity and permeability and reduction in volumetric flows. P is therefore retained by the soil / plant system and hindered from environmental discharge.

10. Recent Policy Development

10.1. Net Zero Strategy

The UK Net Zero Strategy sets out an ambitious plan to achieve its Net Zero targets by 2050. It proposes various policies for reducing greenhouse gas emissions and acknowledges the importance of perennial wood crops for achieving this, stating that biomass will be an important component of the pathway to net-zero. It also reiterates that the integration of "perennial energy crops (e.g., short rotation coppice (SRC)) into existing farm systems can increase the abundance and diversity of flora and fauna at a field scale".

Likewise, Renewable Energy Ireland and the Irish Bioenergy Association published "40by30", a roadmap to an Ireland where 40% of required heat can come from renewables by 2030. The launch was very clear that this trajectory is achievable and would reduce CO_2 emissions by 7% annually, in line with the Ireland Government climate action bill. The plan clearly shows that 40% of Ireland's heat can be provided by renewable sources, primarily from bioenergy, heat pumps, renewable gas and district heating networks and heat from bioenergy is particularly applicable for homes, farms, schools, hospitals and businesses using a combination of several different heating technologies. It is achievable and can create approximately 23,000 jobs given the right Government support and policies.

In the UK there is wide-spread acceptance that biomass, including bioenergy with Carbon Capture & Storage (CSS) has a key role to play in achieving net Zero. The question is essentially where and how biomass crops are best used to deliver on these targets – whether it is for generating, electricity, heat, biofuels or other unrelated energy purposes and carbon resources. The following policy document clearly demonstrated A systemic transformation across the UK economy, is required to achieve net zero by 2050. Act today. Protect tomorrow (Green Growth) and ensure we have an affordable, secure, and clean energy system for current and future generations (DfE). A Transformative Bioeconomy using renewable materials, organic, biological matter (DAERA) & A more competitive, inclusive and greener economy (DfE) – Green-Growth, Zero Carbon Technology (DfE).

2021 – International Energy Agency (IEA) - Net Zero by 2050 - A Roadmap for the Global Energy Sector

Much greater level of bioenergy crop prod uction, marginal lands, woody energy crop s can produce wice as much bioenergy per hectare as conventional bioenergy crops. Land & CO2 offsets integrity Certification, advanced feedstocks, wastes and residues and woody energy crops

2021 - UK 6th Carbon Budget – CCC – Key Recommendations.

Take up of low-carbon solutions. Expansion of low-carbon energy supplies. Reducing demand for carbon-intensive activities. 260,000 hectares of farmland shifts to producing energy crops….

2021 - BEIS consultation into how sustainably sourced biomass fuels can contribute towards our national net zero goals

Availability of sustainable biomass from domestic and international sources. Potential end uses to support our net zero target in the context of availability of sustainable biomass feedstocks. Sustainability of the supply chain and opportunities for strengthening existing criteria. Accounting of greenhouse gas emissions from biomass use. Bioenergy with carbon capture and storage technology and its potential applications to deliver negative emissions. Opportunities for innovation to support wider deployment of technologies with potential to support the net zero target

2021 – BEIS Biomass Feedstocks Innovation Programme

27 Phase 1 projects Incorporating 24 Organisations. AFBI in 2 of them.

2021 – BEIS Biomass Policy Statement

This document sets out the strategic aims for the role of biomass across the economy in the short, medium and long term to deliver towards net zero. There is less impetus and progress however in the

N.Ireland region however the following policy initiative exist in spirit.

2016 – N.Ireland Sustainable Agri-Land Management Strategy

Recommendation 3C - target water quality interventions on at least 4,000 ha (Point Source & Diffuse). The EU-CatchmentCARE has developed further the demonstration and evidence base of how SRC willow can play an important role the sustainability of agriculture however further data is required to aid and support future policy implementation.

2020 - DAERA Innovation Strategy (2020-2025)

A Transformative Bioeconomy, renewable resources and waste streams, bio-based products and bioenergy; using renewable materials that are made from organic, carbon-based biological matter. 2023 – BEIS Biomass Strategy.

2023 – BEIS Biomass Strategy

The UK Government plans to publish a Biomass Strategy in 2023 and to help to inform this strategy they are currently seeking input from stakeholders through a Call for Evidence on the Role of biomass in achieving net zero.

11. Going forward – opportunities for expansion

On the island of Ireland, government support and focused policy development is required in order to stimulate the biomass crops sector in terms of confidence and realised financial support. This must be from both a 'push' and 'pull' direction and develop both the solid biomass and anaerobically digestible biomass sector from an energy and furthermore, a 'carbon resources' direction to develop the non-fossil fuel based circular bioeconomy. Certain inroads of UK intention are becoming visible with the initiation of the Biomass Feedstocks Innovation Programme and it is felt that the upcoming, and somewhat delayed, UK Biomass strategy will very likely solidify further the UK policy to develop the biomass crops sector. This publication is now expected in the first half of 2023. Furthermore this may coincide with the UK "Environmental Land Management Scheme", which would seem to be a an ideal linkage if indeed biomass crops are to become part of the agricultural landscape as discussed in this report. Unfortunately, there are no mentions of biomass or energy crops in the N.Ireland Environmental Farming Scheme to date.

In the republic of Ireland, existing support schemes such as the Support Scheme for Renewable Heat (SSRH) need to be further streamlined to reduce the administrative burden and encourage further uptake particularly among pig, poultry, horticulture and mushroom sectors to decarbonise the heat generation within these enterprises.

11.1. Recommended policy recognition for upcoming support

On the Island of Ireland, any biomass developments should and must include recognition and support of the following to support and enable uptake. This also stands for when considering the inclusion of crops such as SRC willow as an agricultural landscape intervention as riparian protection or as biofiltration blocks,

- A market must develop in conjunction with the supply sector.
- A recognition of biodiversity (such agricultural diversification brings about many biodiversity benefits insects, invertebrates, birds, mammals) there is much literature evidencing this[xxxix].
- Mitigation of the effects of diffuse pollution reducing environmental water quality
- Targeted management of point source pollution. Sustainable and efficient agriculture and agrifood processing produces waste sludges and water. Such solutions can be implemented to benefit the environment as well as the agri-enterprise.
- There is a clear potential opportunity to link the current Northern Ireland Soil Nutrient Health Scheme (SNHS)[xl] with sound Environmental Farming scheme practices and utilise the LiDAR (light detection and ranging) derived digital terrain models (DTM) to accurately target appropriate areas of land to plant with biomass crop interventions for environmental benefit.
- Climate change mitigation through carbon dioxide emission reduction by replacing fossil fuels. In fact SRC willow can not only supplement farmer income but also improve the GHG balance of agricultural activities
- General protection of water quality e.g., legacy phosphorous erosion from long term agricultures giving rise to above optimum P indices
- Riparian plantations and targeted planting of SRC willow, on areas of marginal land or land areas more prone to being incorporated within hydrological pathways, to mitigate the effect on the levels of pollution entering waterways.

With all these benefits taken into consideration for policy makers, availability and access to knowledge, support, practitioners, researchers, contractors are paramount. The UK BEIS Biomass Feedstocks Innovation Programme clearly seems to be making notable headway into these initial needs.

12. The BEIS Biomass Feedstocks Innovation Programme

Discussions are continuing in the UK and in Ireland of how biomass crops and Bioenergy could best be employed to play their part in reaching the 2050 Net Zero Emissions goals. As explored in this report, the UK Committee on Climate Change has suggested a significant upscale of the sector. In N.Ireland, this could mean as expansion of Biomass crops from the current position of less than 400ha (estimated) up to 36,000 ha. If this same level of land conversion (less optimal land, brownfield land and planting for environmental service benefits as part of agricultural integration) were uniform across the Island, a conservatively estimated total biomass crop area of 100,000 ha by 2050 could be envisaged based on agricultural land area (The target area in the whole of the UK is 700,000 ha as a perspective). This area of biomass crop on the island would support a significant bioenergy industry as a result in terms of contractors for feedstock production, planting, harvesting, processing, transporting and general management. It is clear also that there would need to be a considerable support sector for this industry given the scale of personnel, machinery, equipment and infrastructure required.

For comparison, 100,000 ha of biomass would suggest a total energy production quantity of 5,000 GWh/y, a significant 17% of the 29TWh of 2021 heat use as published by the DfE Energy Strategy Path to Net Zero for N.Ireland.

If a biomass crops industry is to successfully develop to this scale in such a short time, the infrastructures and necessary innovations must be in existence. The UK Government therefore recently launched its "Biomass Feedstocks Innovation Programme"[xli] which is part of the UK Government's £1Bn Net Zero Innovation Portfolio. The projects funded are intended to aid the significant increase of sustainable biomass production in the UK and speed up the commercialisation of supported innovations.

Following an initial phase 1 project, 12 organisations were awarded a share of £32m phase 2 funding. This also includes a UK wide, 8 location, Biomass Crops demonstration platform (Biomass-Connect). An illustration of all these projects and how they interlink is seen in Fig 6.

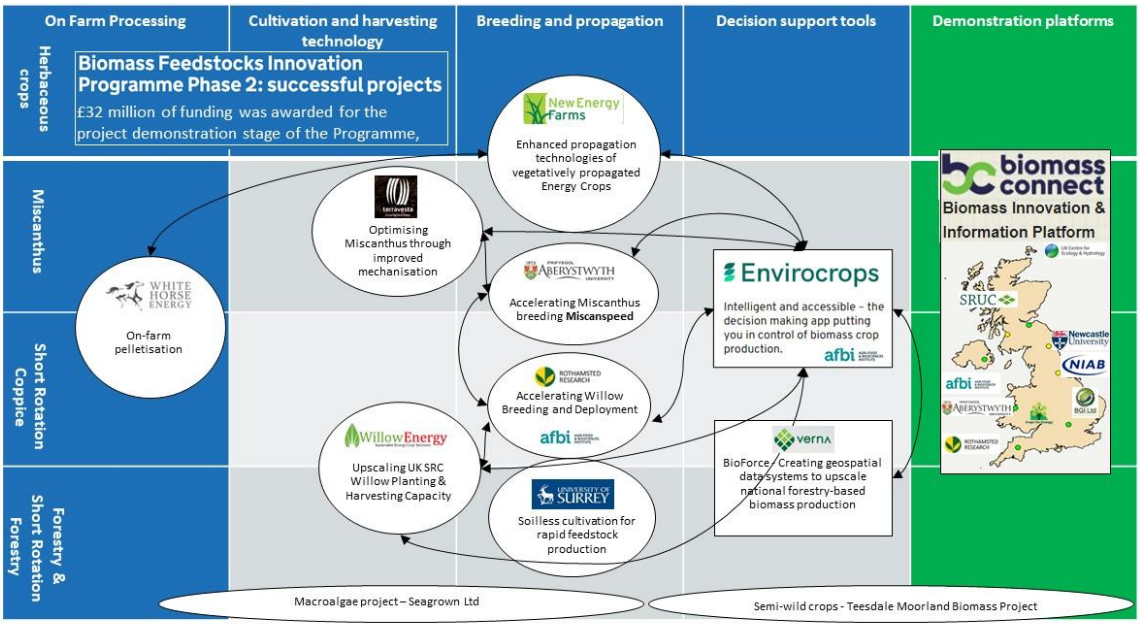


Fig 6. BEIS Biomass Feedstocks Innovation Programme Phase 2 Projects and demo platform

12.1. Biomass Connect: Biomass Innovation and Information Platform – Multi-site Feedstocks Demonstration

The Biomass Innovation and Information Platform is a demonstration and knowledge sharing initiative to showcase best practice and innovations in land-based biomass feedstock production. The platforms will be established at 8 different sites across the UK and will aim to build a cohesive and regionally based multi-actor community to contribute to the development, establishment and operation of the platforms. These platforms will become focal points of industry whereby varied and appropriate biomass crops can be up-scaled and developed to significantly contribute to Net Zero 2050 goal of upscaled planting.

The different locations (Fig 7.) will therefore contribute in terms of independent data, knowledge, robust evidence, variations and efficiencies.

Fig 7. BEIS Biomass Connect UK Platform Demonstration Sites

12.2. Project BIOFORCE (BIOmass FORestry CrEation):

This project will enable landowners, investors, and policymakers to assess sites throughout GB for forestry suitability, considering biophysical conditions, economic factors, local impacts, and regulations. The tools will cover Long Rotation and Short Rotation Forestry (including with fast-growing species such as eucalyptus and paulownia), Short

Rotation Coppice, and agroforestry. They will use improved climate modelling, to better assess species' suitability under future climate change.

12.3. EnviroCrops

The EnviroCrops web app will be a central source of impartial information in an easy to access, free or low-cost, user-friendly format, that will enable farmers, land managers and consultants to make an informed decision about planting biomass crops. Users will be able to provide simple information such as their postcode and find out. It will provide direct access to updated best practice guidelines in a digital interactive way as well as deliver notifications on what activities are needed and when – an absolute must in the crucial establishment phase. The tool is intended to work with growers and contractors so that they can constantly update yield models with new information and keep the app outputs relevant to a changing climate.

12.4. Miscanspeed - accelerating Miscanthus breeding using genomic selection

This project will demonstrate the application of genomic selection in accelerating the breeding of high yielding, resilient Miscanthus varieties. The current commercial clone Miscanthus x giganteus produces high annual biomass yields but has certain limitations. Breeding is underway to diversify the crop for resilient high yields across a range of environments, but this is limited by the 3 years that it takes to reach maturity. Genomic selection, which uses the information stored in the plant genome, has been demonstrated to increase the rate of genetic gain in commercial annual crops (e.g., maize, wheat), and this will now be implemented within the Miscanthus breeding programme.

12.5. Enhanced multiplication propagation and establishment technologies combined with new varietal introductions for vegetatively propagated Energy Crops

This project will increase the number of energy grass varieties that are available and increase yield. The majority of the UK energy grass crops are planted from one variety. The project will test varieties from existing global breeding projects in the UK. Over 40 new candidate energy crop varieties will be evaluated, with the aim to increase yield and provide between 5 to 10 new variety options for UK growers.

12.6. Optimising Miscanthus Establishment through improved mechanisation and data capture to meet Net Zero targets (OMENZ)

This project will recruit new growers to the Miscanthus biomass supply chain and help support the industry by raising awareness of Miscanthus of its many values across the sector. In doing so, it will also introduce various technologies, including automation, machine learning and biological treatments, to deliver a vastly improved Miscanthus establishment method.

12.7. Soilless cultivation for rapid biomass feedstock production

The project uses novel aeroponic technology to rapidly cultivate Short Rotation Coppice (SRC) willow cuttings which can be directly planted. Aeroponics is a way of cultivating crops by supplying the roots directly with water and nutrients without the use of any soil. The project will optimise the system so as much willow as possible can be grown, with minimal environmental harm and at least cost.

12.8. Net Zero Willow

This project is redeveloping the whole SRC willow production process right through from preparing propagation material, planting and harvesting. The innovations are being developed from the ground up to travel and operate on UK marginal land in the harshest of conditions.

12.9. Accelerating Willow Breeding and Deployment

This project will accelerate the breeding of SRC willow and generate information to guide the intelligent deployment of current varieties. Using genomic selection, it will improve selection for complex traits including yield. It will also improve confidence in selection, enabling the introduction of improved varieties to the market faster. This will greatly accelerate improved variety production and deployment, whilst lowering breeding costs for each new variety introduced.

13. Summary

Although the biomass crops sector is basically non-existent in N.Ireland and the Republic of Ireland at present, there exist urgent renewable energy and climate goals for which biomass crops are definitely part of the solution. There is ongoing investment and ambition in the UK to arm the biomass sector with innovation and knowledge, however biomass crops are still not a particularly enticing option for farmers, given the relatively high establishment costs, lack of infrastructure and of course, a limited market existence. Follow-on policy (agriculture and energy) is still required and must recognise all the benefits which biomass crops can bring to the environment while simultaneously facilitating the reaching of renewable energy and climate goals. With that in place, there is every likelihood the biomass sector will become self-supporting and can continue to grow for the wholesome benefit of the environment in every respect.

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