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1 Executive summary

- The RSPB manages 150,742 ha of land for the benefit of wildlife, including habitats of national and international importance. Frequently these habitats are dynamic systems which, left unchecked, change over time through the process of ecological succession. As a result, management interventions are required to maintain or restore these habitats. This places a huge demand on resources and can limit the extent and efficacy of habitat management. The RSPB is not alone in this issue, with other environmental organisations, statutory bodies (and other land owners/managers who have responsibility for sites containing these habitats) facing the same challenges.

- Bioenergy is a versatile energy source that can be low carbon, renewable and sustainable. However, there are risks and uncertainties associated with bioenergy production. The majority of biomass feedstocks are currently imported from outside the UK, although domestically sourced biomass is expected to play an increasingly important role in providing a sustainable and cost-effective supply of feedstocks for the emerging UK bioenergy sector. The primary source is anticipated to come from the agricultural sector; however, future sources could also be generated by the forestry sector, and from alternate land management practices that generate high volumes of biomass. The UK Bioenergy Strategy (DECC 2012) states that **Wastes**: use of end-of-life materials for energy can be an optimum use of biomass, where it maximises carbon and cost effectiveness, and where it is consistent with the waste hierarchy.

- Energy for Nature is one of several projects funded through the third round of Defra’s Payments for Ecosystem Services Pilot Scheme. The vision for the project is to develop a model that links biomass producers, through intermediaries and markets, to the buyers of their bioenergy products. In doing so, the aim is to create a sustainable funding stream that supports the continuation of essential conservation work whilst providing a reliable, and ecologically sustainable, source of energy to local communities.

- The provision of environmentally sustainable sources of fuel through Energy for Nature has the potential to deliver wider environmental benefits in relation to carbon, as well as enhancing habitats for biodiversity. The production of bioenergy from conservation biomass and the sale of bioenergy products locally could contribute to the resilience of rural communities to climate change, reducing their dependence on traditional fossil fuels for heat and power through the replacement of solid fuels, such as coal, with biomass briquettes or through the installation of biomass boilers – all powered by material from local nature reserves and the surrounding landscape. The creation and combustion of loose biomass/briquettes has a smaller carbon footprint than fossil fuels, therefore important carbon savings could be made through switching to bioenergy products. In addition, the production of biogas, and subsequently electricity, from anaerobic digestion of conservation biomass would increase the contribution to the amount of renewable energy within the National Grid, displacing the use of fossil fuels and providing further carbon savings.

- Working in the Somerset Levels and Moors as a case study area the pilot explored the opportunities available to develop the ‘conservation biomass to bioenergy’ concept as a PES style scheme.
• Energy for Nature is more complex than the typical PES model; however, the concept does make use of, and build on, the general PES principles outlined in Defra’s Best Practice Guide. Many initiatives are described as ‘PES-like’, and Energy for Nature would be no different. The scheme would conform to certain elements of PES more than others. However, whether truly a ‘PES scheme’ or not, it has the potential to generate a sustainable income stream to fund essential habitat management for conservation, or provide local ‘green’ energy for rural communities.

• Energy for Nature provides a dual solution to removing the biomass challenge and funding management faced by land managers. Within the case study area for the RSPB alone, this could enable the conversion of vegetation which costs c. £70,000 per year to harvest and remove via contractors, into bioenergy products worth £150,000 as wholesale loose biomass, or over £5 million if converted into biochar and sold retail. Our study shows that creating a profitable business is achievable; however, the extent to which is heavily dependent on the volumes and types of biomass, and bioenergy production processes used. The impacts for land managers, and therefore on landscape scale management for conservation (and potentially other ecosystem services), is significant from both a financial and an enhancement of areas for biodiversity perspective.

• Two models (Land Manager and Community) were developed which make Energy for Nature schemes accessible to a wider range of stakeholders within a landscape. The models identify opportunities for land and/or conservation managers to improve their habitat management, and the Community Model enables local communities to become involved, growing resilience and promoting rural development at the same time as improving their landscape. Whether the driver is land management or community development both models increase the potential opportunities for delivering biodiversity at the landscape scale, and help contribute to a low carbon, more sustainable economy through providing communities with greener, locally sourced alternatives to fossil fuels.

• The Land Manager Model can be applied across similar landscapes in the UK and across Europe where surplus biomass is an issue, and sustainable funding streams are required to continue habitat management. The development of the Conservation Biomass Calculator will facilitate the scheme to also be used in heathland, and drier habitats, as well as wetlands. The calculator is an electronic tool designed to help land managers explore the potential of converting their biomass into bioenergy. Woodland management also generates large volumes of biomass that could be converted to bioenergy, and are another habitat of interest to both the RSPB and others.

• The Community Model would be transferable across the UK; however, with different socio-economic structures in other areas of Europe we have not looked at how this would operate outside the UK as yet, but have partners who are keen to explore this area further.

• A range of challenges were identified in developing such a scheme, from variability in the quantity and quality in the supply of feedstock, to the length of contracts between sellers and processors, and transaction costs. These are all important considerations and, provided all relevant stakeholders are involved from the beginning of the development process, may be addressed and potentially mitigated for.
• The classification of some of the biomass by the Environment Agency (EA) as a ‘waste’ material currently results in the material being subject to waste rules. This could have serious consequences in relation to acquiring the necessary permissions for developing a conservation biomass to bioenergy scheme. Currently all the material that has been processed from reserves has been seen as a low risk material and, where necessary, is operating under an exemption. However, it could easily be argued that the material harvested from reserves has a use as a biofuel, and is therefore not a ‘waste’ material and should not be subject to the same restrictions.

• Another important potential barrier to scheme success for a combustion set-up is that the burning wetland biomass products is not yet approved for the Renewable Heat Incentive (RHI) scheme. Satisfying the emissions standards and attaining this approval would make biomass to bioenergy via combustion much more profitable and facilitate scheme development and delivery.

• For any scheme to succeed transaction costs would need to be addressed – both those that were real and those that are perceived. For example, identifying and liaising with individual site managers would have significant time, labour and financial implications for businesses (i.e. harvesters/processors) involved in a scheme, whilst the sellers (i.e. land managers) typically have little resource available to identify suitable processors/harvesters. There may also be logistical challenges associated with moving machinery and equipment between sites in an economically viable way. In addition, most land managers currently consider biomass to be a problematic ‘waste’ product of habitat management – the opportunities available are not appreciated or fully understood. Consequently, a cultural shift in how land managers view this ‘problem’ is required in order to help them realise this opportunity. To address this both sellers and processors suggested that there was a need for some form of intermediary to act as a link between actors, linking each together and negotiating contracts. We have suggested the Energy for Nature Coordinator as a role that would fulfil this requirement. The coordinator could be independent or from an organisation (e.g. RSPB, Natural England, etc.); however, they should be local to the landscape in which they are working, and ideally be known and trusted by at least some of the stakeholders.

• Choosing the correct methods for converting biomass to bioenergy is crucial for Energy for Nature to operate successfully. Depending on the conversion methods chosen to produce bioenergy a significant investment in the installation of infrastructure to enable delivery may be required. This could be a barrier for some community schemes where it may be difficult for community groups or co-operatives to secure the necessary level of investment. In addition, failure of land managers or communities to understand the characteristics of the biomass they have available to them, or consider the variability in quality and/or supply could easily compromise the business case and result in scheme failure. The Energy for Nature Coordinator is essential here: with knowledge of the conversion processes, the characteristics of the different forms of biomass and the availability within the landscape, the coordinator can help prevent the use of inappropriate conversion techniques and promote scheme success.

• There are still many uncertainties surrounding conservation biomass to bioenergy therefore the payment pathways (or business model) chosen may need to be flexible, enabling actors to adapt to changing conditions over time. For example, in the short term it may be more prudent for land
managers to pay processors to harvest and convert the biomass into bioenergy, but retain ownership of the biomass whereas in the long term greater profits and business resilience may be achieved by grouping all the actors into a co-operative.

- Further work is also required to identify and quantify the additional ecosystem services delivered through Energy for Nature and how these change through habitat creation, restoration and management. Once this data has been gathered we can assess how best to adapt Energy for Nature, and move from piggy-backing to a more cost effective payment structure, such as layering or bundling.¹

- This study has brought together interested parties in developing and testing an Energy for Nature PES-like scheme in the Somerset Levels and Moors. Having generated interest and worked through the first two phases of the PES development guide the next stage is to negotiate contracts (i.e. Phase 3) and pilot the scheme in the study area. The two aspects that we are particularly interested in developing in the next stages of any follow on research relate to how the Community Model could work, and how the intermediary would operate within a scheme. The role of the intermediary, in particular, is crucial and the only way to fully understand the requirements of this role, and how it may be resourced, is to test it through piloting a scheme on the ground. We are keen to build on the work we have done in Somerset and trial Energy for Nature scheme(s) in this area. The RSPB, in partnership with others, are continually looking and applying for funding to take this work forward.

---

¹ *Piggy-backing:* Not all ecosystem services produced by a habitat area sold to buyers; one service may act as an ‘umbrella’ and whilst other services are provided to the buyer free of charge (Defra, 2013).

*Layering:* Multiple buyers pay for the separate ecosystem services provided by a single habitat (Defra, 2013).

*Bundling:* A single buyer or group of buyers pays for the full package of services that are derived from the same habitat (Defra, 2013).
2 Introduction

2.1 The conservation problem

The RSPB manages 150,742 ha of land for the benefit of wildlife across a network of 212 nature reserves throughout the UK. Within our nature reserves we are responsible for the conservation of a variety of species and habitats, many of which are of national and international importance, e.g. blanket bogs and lowland heathlands. Frequently these habitats are dynamic systems which left unchecked, change over time through the process of ecological succession. Heathlands are a prime example of this, with invasive species such as bracken and scrub dominating the vegetation and reducing areas of open space. This transition leads to habitat loss and the displacement of much of the wildlife associated with the original habitat. As a result, conservation management interventions are required to maintain or restore these habitats. This places a huge demand on the RSPB’s resources (in terms of labour, equipment and time) and can limit the extent and efficacy of the habitat management that we are able to deliver across our reserve network. The RSPB is not alone in this issue, with other environmental organisations, statutory bodies (e.g. Natural England, Environment Agency), and other land owners/managers who have responsibility for sites containing these habitats facing the same challenges.

Managing wetlands for wildlife

The importance of wetland habitats for wildlife and people is recognised worldwide and reflected by the global designation of 2,186 Ramsar Sites (Ramsar, 2014). The term ‘wetlands’ encompasses a range of different habitats, and in the UK this ranges from blanket bogs, swamps and fens, to reedbeds, grazing marsh and wet woodlands. Reedbeds are particularly important habitats for biodiversity, supporting uncommon birds and invertebrates, such as the bittern and the reed leopard moth. Generally, the larger the reedbed the better able it is to support species, such as the marsh harrier, that require more extensive areas of habitat. Their value to biodiversity increases further when they are present within a mosaic of other wetland habitats, including swamp, marsh or open water. However, reedbeds are a nationally scarce habitat with only 7,700 ha in the UK (BARS, 2011).

A significant proportion of the UK’s reedbeds (1,297 ha) are located within RSPB nature reserves, and so they form one of the RSPB’s priority habitats for conservation action. Reedbeds are a prime example of a dynamic system that requires high levels of management intervention to maintain their ecological integrity, evolving into scrub and woodland if left unmanaged. Reed cutting and the removal of cut material and litter is the principal management tool for halting succession and improving habitat quality for biodiversity. In most cases management is carried out by hand, using brush cutters and pedestrian mowers to cut the reed, which is then raked into piles and burned on a suitable site nearby. These current (business as usual – BAU) methods are laborious and costly, averaging c. £1,304/ha for the two cutting methods alone (Table 2.1). This nearly doubles, reaching c. £2,550/ha, when the disposal of the cut reed generated as a by-product of management is taken into account (Table 2.1). The volume of cut material (biomass) produced is vast and, as it currently has no useful function under BAU conditions, creates practical issues around its removal. Standard practice is to burn the biomass as described above; however, disposal may also consist of paying for its removal, or leaving to decompose naturally on
site. As a result, the costs and practical issues encountered in current reedbed management limit the extent and quality of management that the RSPB is able to undertake, both at a site level and when extrapolated across the 1,287 ha of reedbeds that it is responsible for.

Table 2.1 Average costs incurred by the RSPB for reedbed management based on BAU techniques.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time taken (hrs)</th>
<th>Labour cost (£/hr)</th>
<th>Other variable costs (£)</th>
<th>Total cost per operation (£/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting - brushcutter</td>
<td>4</td>
<td>16</td>
<td>50</td>
<td>114</td>
</tr>
<tr>
<td>Cutting – pedestrian mower</td>
<td>35</td>
<td>16</td>
<td>630</td>
<td>1190</td>
</tr>
<tr>
<td>Raking &amp; burning cuttings</td>
<td>199</td>
<td>6.25</td>
<td>0</td>
<td>1243</td>
</tr>
<tr>
<td>Transporting machinery/ labour</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total cost (£/ha)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>2550</strong></td>
</tr>
</tbody>
</table>

Photos 2.1a,b. Well managed reedbeds at RSPB Strumpshaw Fen (1a) and RSPB Ham (1b). Scrub is evident in the background of both pictures. ©RSPB.
2.2 Ecosystem services and Payments for Ecosystem Services (PES)

2.2.1 What are ecosystem services?

A healthy natural environment provides us with a wide variety of benefits that support and enrich our everyday lives. These benefits are known as ecosystem services, and encompass both the tangible and non-tangible benefits that we receive from nature - ranging from the essential and complex biological processes that create soils and clean water, to the provision of inspiring landscapes or amazing wildlife spectacles. Consequently, ecosystem services are often defined as ‘the benefits provided by ecosystems that contribute to making human life both possible and worth living’ (UK NEA, 2011). These benefits can be received either directly or indirectly, and are sometimes separated into ecosystem ‘goods’ and ‘services’: goods refers to the material benefits produced by ecosystems, such as timber, fuel or food, whilst services includes aspects such as water supply, pollination and soil formation.

Ecosystem services are often divided into four functional groups, reflecting the benefits that they provide us with (MA, 2005; UK NEA, 2011; Table 2.2).

Biodiversity plays a fundamental role in providing ecosystem services. The large number of visitors to national parks and nature reserves shows that biodiversity provides us with a variety of cultural services that contribute to our wellbeing. However, less talked about elements of biodiversity, such as earthworms and soil microbes, are instrumental in shaping nature's structure and processes, and therefore underpin
service provision. As such, conserving biodiversity is integral to maintaining the essential ecosystem services that our natural environment provides.

Table 2.2 Classification of ecosystem services according to the Millennium Ecosystem Assessment (MA) and the UK’s National Ecosystem Assessment (UK NEA).

<table>
<thead>
<tr>
<th>Provisioning services</th>
<th>Regulating services</th>
<th>Cultural services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products obtained from ecosystems, e.g.</td>
<td>Benefits from the regulation of natural processes, e.g.</td>
<td>The non-material benefits obtained from ecosystems, e.g.</td>
</tr>
<tr>
<td>Food</td>
<td>Climate regulation</td>
<td>Spiritual and religious</td>
</tr>
<tr>
<td>Fresh water</td>
<td>Disease regulation</td>
<td>Recreation</td>
</tr>
<tr>
<td>Fuel</td>
<td>Water regulation</td>
<td>Aesthetic</td>
</tr>
<tr>
<td>Fibre</td>
<td>Water purification</td>
<td>Inspirational</td>
</tr>
<tr>
<td>Biochemicals</td>
<td>Pollination</td>
<td>Educational</td>
</tr>
<tr>
<td>Genetic resources</td>
<td></td>
<td>Sense of place</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cultural heritage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supporting services</th>
</tr>
</thead>
<tbody>
<tr>
<td>The services necessary for the production of all other ecosystem services, e.g.</td>
</tr>
<tr>
<td>Nutrient cycling</td>
</tr>
<tr>
<td>Soil formation</td>
</tr>
<tr>
<td>Primary production</td>
</tr>
</tbody>
</table>

2.2.2 What are Payment for Ecosystem Services (PES)?

Payments for Ecosystem Services (PES) schemes are a form of market based instrument used to help deliver the provision of ecosystem services over and above what would be delivered in the absence of a payment. In contrast to the 'polluter pays principle' the PES framework is based on the idea of the 'beneficiary pays principle', whereby the ecosystem service user (i.e. the beneficiary) pays the service provider to secure the continuation of its supply (Defra, 2013). Much research has been undertaken into the development of PES schemes around the world and Wunder (2005) provides the most widely recognised definition. This states that PES schemes are:

1. A voluntary transaction where
2. A well defined ecosystem service, or land use likely to secure that service
3. Is being ‘bought’ by a minimum of one ecosystem service buyer
4. From a minimum of one ecosystem services provider
5. If, and only if, the ecosystem service provider secures the provision of the service (conditionality)
PES schemes can be varied, operating across a range of spatial scales, involving a variety of stakeholders who are linked together in a variety of different ways\(^2\). However, the key actors in any PES scheme are:

- **Buyers**: the beneficiaries of the ecosystem services who are willing to pay to secure service provision
- **Sellers**: the land or resource managers who are able to supply the service through their management
- **Intermediaries**: people or organisations who can link together the buyers and sellers and aid with scheme design
- **Knowledge providers**: people or organisations who are able to provide expert advice essential to the development of a scheme (e.g. regarding land management, valuation, legal matters, etc.)

### 2.2.3 Policy relevance

The findings of the Millennium Assessment (MA, 2005) demonstrated that the changes humans have made to ecosystems in the past 50 years have resulted in the increasing degradation of ecosystem services globally, and this negative trend could continue well into this century. Similar messaging came out of the subsequent UK National Ecosystem Assessment (UK NEA, 2011), which found that roughly 30% of the ecosystem services provided by the eight broad habitat types found in the UK are declining or in a degraded state. This is often linked to long term declines in habitat quality or extent which, in turn, reflect the post-war emphasis on food production, water and energy supply. Although the provision of some services has improved in recent years, many are still degraded or in decline.

In the National Environment White Paper (NEWP): The Natural Choice (Defra, 2011), the UK Government recognises that a healthy environment and the ecosystem services this provides underpins all aspects of our life, including economic prosperity, and our health and wellbeing. Indeed, a properly functioning natural environment provides us with value for money. For example, properly functioning peatlands help filter material and debris from water in upland catchments, reducing discoloration, and consequently reducing the end-of-pipe processing costs of water companies, saving them and the consumer money. Similarly, when functioning properly these upland habitats may help reduce run-off in peak rain events, ‘slowing the flow’ in the upper reaches of the catchment and reduce the impact of downstream flooding. Water companies in the UK have recognised these cost saving benefits and are now investing in initiatives to restore moorlands in their catchments\(^3\). However, this is not always the case. Nature is often undervalued and the benefits it provides us with are not taken into account through the decision making processes. Through the NEWP the Government calls for the economic and social benefits of nature to be properly valued and integrated into all levels of decision making, from

\(^2\) For further detailed information on the range of actors, types of scheme and scheme development please refer to Defra’s Payments for Ecosystem Services: Best Practice Guide (2013)

\(^3\) Examples in the UK include:

- South West Water’s [Upstream Thinking Initiative](#)
- United Utilities [Sustainable Catchment Management Programme (SCaMP)](#)
- Northern Ireland Water’s [Sustainable Catchment Management Programme (SCaMP)](#)
Government though to business and communities. One of the proposed ways of achieving this is through the growth of a ‘green economy’. This requires the creation of markets in which ecosystem goods and services can be sustainably traded. Although beyond the scope of the Government to achieve on its own, it has committed to a range of actions, from the creation of the Natural Capital Committee and the Ecosystem Markets Task Force, to investigating the options around PES. This last action sits within Defra’s remit and has resulted in the production of their Payments for Ecosystem Services: Best Practice Guide (2013), and funding being made available for research into scoping out and developing PES schemes in England.

2.3 Biomass to bioenergy – a potential solution for conservation?

2.3.1 Policy relevance

The Climate Change Act 2008 sets out a mandate for the reduction in the UK’s greenhouse gas and carbon emissions, climate change adaptation and incentivising actions which reduce emissions and waste. As such, it provides the backdrop for much of the UK’s current energy policy. A key element is the Government’s aim to reduce targeted greenhouse gas emissions by a minimum of 80% by 2050 compared to the 1990 baseline. This will be achieved through national policy and strategy, accompanied by a series of actions to help reduce reliance on fossil fuels and promote a more energy efficient, low carbon economy. Increasing the use of low carbon technologies is a key policy driving activities to reduce emissions through several actions, including the investment in low carbon innovation and exploiting renewable resources.

At the European level the Renewable Energy Directive presents the Commission’s policy on the production of energy from renewable resources in the EU. The Directive requires the EU to meet a minimum of 20% of its energy needs via renewable energy sources by 2020, with individual targets set for member states. Under this Directive the UK Government has a commitment to sourcing 15% (up from 3% in 2010) of the nation’s energy from renewable resources, including bioenergy. Sustainably sourced bioenergy has the potential to contribute up to 30% of this target, and estimates also suggest that it could contribute 8 - 11% to the UK’s total energy demand by 2020, and 12% by 2050 (range 8 - 21%)\(^4\).

Bioenergy is a versatile energy source that can be low carbon, renewable and sustainable. It links into heat, electricity and transport, and may be generated from a range of biomass feedstocks, making it an important component of the UK’s energy mix. However, despite this potential there are risks and uncertainties associated with bioenergy production, particularly surrounding the level of contribution biomass can actually make to a low carbon economy, and the cost and availability of sustainability sourced biomass. To address these issues the UK Bioenergy Strategy was produced by the Department for Energy and Climate Change (DECC) in 2012. Based on four underpinning principles the strategy provides a framework of guidance for the development of future policy supporting bioenergy produced from sustainably sourced biomass, which doesn’t impact on food production, and that makes a genuine contribution to carbon reductions.

\(^4\) UK Bioenergy Strategy, DECC 2012
The principle methods of bioenergy generation outlined by DECC required to meet the UK’s energy needs are: biofuels, biorefineries, and energy recovered through biomass used in anaerobic digestion. The majority of biomass feedstocks are currently imported from outside the UK (DECC, 2012). However, domestically sourced biomass is expected to play an increasingly important role in providing a sustainable and cost-effective supply of feedstocks for the emerging UK bioenergy sector in the lead up to 2020 and beyond (DECC, 2012). The primary source of biomass is anticipated to come from the agricultural sector, through agricultural residues and an increase in the production of energy crops (e.g. miscanthus or switchgrass). Future sources could also be generated by the forestry sector through areas that are currently being harvested, and by bringing unmanaged woodland back into production for woodfuel (e.g. Bioregional and the Sylva Foundation’s Good Woods Initiative; Bioregional, 2013). Interestingly, this latter approach highlights the potential contribution that habitat management (for land uses other than agriculture) may make towards meeting the country’s bioenergy targets.

2.3.2 Bioenergy and the RSPB

The recognition of the opportunities presented by sustainably sourced biomass in the UK Bioenergy Strategy comes at a time when the RSPB is looking to develop new ways of sustaining conservation work in economically and ecologically sound ways. The biomass generated through our management operations has the potential to form a sustainable means of financing the ongoing management of key habitats for biodiversity through the creation and sale of bioenergy products, whilst also providing an environmentally sound energy source for local communities located near to our reserves. This idea of ‘conservation biomass to bioenergy’ could also provide the RSPB and other land managers with the opportunity to carry out more, and better quality, conservation management across larger areas, in line with Lawton’s principles of ‘bigger, better, and more joined up’ (Lawton et al., 2010).

Building on the UK Bioenergy Strategy DECC have seized the initiative in developing the concept of conservation biomass to bioenergy by funding the Wetland Biomass to Bioenergy Project (see Box 2.1 for details). Launched in 2012, the project is developing the end-to-end processes necessary to remove biomass from environmentally sensitive sites and turn it into a marketable bioenergy product, such as briquettes or bio-methane via anaerobic digestion. The RSPB are leading the project, working in partnership with three small-medium enterprises (SMEs), consultants and academics to develop the technologies capable of delivering the concept in an ecologically sympathetic yet economically viable, and carbon efficient manner. The technologies developed through the project will aid the move to mechanisation of habitat management for land managers, such as the RSPB. However, the project does not consider the ways in which the bioenergy generated can be used or distributed, or establish what the associated administrative pathways required to link together biomass suppliers, SMEs processing the material, or the buyers of the bioenergy are. The theoretical framework provided by PES could provide a useful basis for determining how best to bridge this knowledge gap, and offer insights into how to develop schemes which turn the concept into reality.
Box 2.1 DECC Wetland Biomass to Bioenergy Project

Following on from RSPB trials examining ways of developing briquettes for domestic heating using surplus biomass from conservation management activities, and in response to the Bioenergy Strategy and the Technology Advancement Needs Assessment (DECC 2012), DECC launched the Wetland Biomass to Bioenergy Project in October 2012. An innovation competition for industry and academia, the aim of the project was to develop the end-to-end processes required to create bioenergy, from harvesting wetland biomass through to energy production, subject to the following sustainability criteria:

According to the UK Bioenergy Strategy the production of biomass for bioenergy must not:

a) Pose a threat to food security, either in the UK or internationally; or,
b) Present risks for biodiversity or ecosystems through loss of semi-natural and natural habitats, intensification of agricultural production, or the potential introduction of non-native invasive species; or
c) Pose competition for housing, or encourage indirect land use changes.

The aim for the end of the project in March 2015 is to have developed a portfolio of processes which enables land managers to harvest wetlands in a way which is economically viable yet also allows habitat quality to be improved for wildlife and create opportunities to increase the area managed for conservation. In addition, it will produce bioenergy which could fund future habitat work, and generate carbon savings.

The RSPB worked closely with DECC’s Science and Innovation Team to develop the project, and engaged a project manager to coordinate and facilitate delivery. Sites for trials and demonstrations were chosen in the Somerset Levels and Moors in southwest England, eastern England and the Strathspey Wetlands in Inverness-shire. Consortiums of wetland managers were established in each of these areas.

The project was formed of three phases:

- Phase 1: System design and life cycle analysis (Oct 2012 – Mar 2013)
  Fourteen applications were received from a variety of disciplines. Seven were selected to continue.
- Phase 2: Preliminary demonstration and trials (May 2013 – Mar 2014)
  At the completion of Phase 1, three of the applicants were selected to go forward.
- Phase 3: Final development, demonstration and trials (April 2014 – Mar 2015)
  The competition element was removed from the project and all three successfully continued into the final phase.

Each of the three projects offered a slightly different approach to the end-to-end process:

1. **AB Systems Ltd.** Biomass briquetting for bioenergy – Somerset Levels and Moors, Suffolk Coast
   New and innovatively modified harvesting machinery for cutting and collecting biomass, coupled with AgBag storage and drying of cut material. Briquetting via a mobile briquetter and use of loose biomass.

2. **AMW-IBERS:** Project Kade – Northern and eastern Scotland
   Harvesting via Softrak (i.e. a low ground pressure tracked vehicle). Biomass separated into liquid and solid fractions through screw pressing. Liquor used to pass through an anaerobic digestion (AD) unit to heat and power the system. Solid fraction combined with bio-charred biomass and wood and converted into briquettes.

3. **Natural Synergies Ltd.** Sustainable utilisation of wetland biomass for energy generation – Somerset Levels and Moors
   Harvesting via methods developed by AB Systems, then using wetland reed and rush as biomass source (i.e. a feedstock) for a medium sized AD unit.
Energy for Nature

Energy for Nature is one of several projects funded through the third round of Defra’s Payments for Ecosystem Services Pilot Scheme. At the RSPB we are interested in how economic mechanisms, such as PES, can help us further our conservation work and, as such, we have taken the opportunity to build on our research with DECC by leading the Energy for Nature project. Our vision is to develop a model that links biomass producers (e.g. RSPB, Natural England, local farmers), through intermediaries and markets, to the buyers of their bioenergy products (e.g. local communities, the National Grid). In doing so, we aim to create a sustainable funding stream that supports the continuation of essential conservation work whilst providing a reliable, and ecologically sustainable, source of energy to local communities.

We are exploring the opportunities that Energy for Nature could provide us, and other land managers, with on the Somerset Levels and Moors in southwest England (Map 2.1). This area is one of the RSPB’s focal Futurescape areas, due to the important species and habitats within the region. We have a long history of working in the area, with several important nature reserves located in the Somerset Levels and Moors. We have also been working with local land managers in this area through the DECC Wetland Biomass to Bioenergy Project. The landscape is also distinct, providing a natural boundary area to focus on. As a result, we have chosen this region to form our case study area so that we can build on the relationships, knowledge and experience already gained here.

The Somerset Levels and Moors is a complex landscape in which wetland habitats are a key feature, the area is of national interest for its biodiversity and holds a particular additional interest for the RSPB as our three principal wetland reserves in the area currently contribute approximately 2,800 dried tonnes of biomass per year. We are aware that we are not the only ones in this situation, with local land and nature reserve managers expressing their interest in generating new income streams through the diversification of their activities within our DECC research. Indeed, the land neighbouring our reserves generates an additional estimated 12,800 dried tonnes per year, creating a huge potential for biomass to bioenergy locally.

By using PES as the basis for this work we are provided with a framework that helps us to identify the linkages between the service providers (i.e. RSPB and other land managers) and the beneficiaries (e.g. local communities), establish the role of intermediaries and SMEs, and develop a model of how payments and service provision are related via the processing pathways developed through the DECC research project. In the following sections of this report we outline the processing options available to land managers, provide indications of the costs involved, and put forward models which link these options together.

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5 Defra are interested in developing ways to support practical and innovative PES projects on the ground, which may also contribute to learning around ‘proof of concept’ for PES schemes. As such, Defra funded 11 pilot projects over two funding rounds between 2011 - 2013. A further round of pilots was funded in 2014 to continue to develop the knowledge base around the practical applications and ‘proof of concept’ for PES. This project was funded through this latest round of the PES Pilot Scheme.
Map 2.1. Map showing the Somerset Levels and Moors case study area. The case study boundary includes land in the north and south areas of the region, and covers protected areas (SPA, SSSIs, Ramsar sites and nature reserves, and sites within the RSPB’s Somerset Levels Futurescape area.
3 Energy for Nature

This chapter examines the possibilities afforded to conservation organisations, other land managers and local communities through conservation biomass to bioenergy concept. ‘Energy for Nature’ is a PES based concept that could potentially deliver biomass to bioenergy using PES based approaches. Through the chapter we explore how Energy for Nature relates to the PES framework and the five stages of PES development outlined in Defra’s best practice guide, and propose two new models for delivering Energy for Nature for wetland biomass at the landscape scale.

3.1 Energy for Nature and the PES framework

The PES framework provides a good basis to start developing a payment model for Energy for Nature. For example, within our case study area we have a range of stakeholders who can act as buyers and sellers of ecosystem services, organisations or individuals who could act as intermediaries, and several potential knowledge providers (Table 3.1). Energy is the primary ecosystem service being delivered to the buyers. ‘Payments’ would fund enhanced conservation management within the buyers’ locality as a co-benefit, creating a landscape scale, input-based, private payment scheme.

This provides a simplistic overview of how an Energy for Nature scheme could operate. The need to process the biomass from its raw state into a more financially valuable bioenergy product which can then be sold in markets (and therefore provide the income for enhanced ecosystem service provision by the seller) means that an Energy for Nature scheme would be more complex than a traditional PES model. For example, there are a number of ways in which the buyers and sellers can be configured within a PES scheme (Fig 3.1). Our requirement to include ‘processors’ in the PES chain adds another actor into the model and therefore an additional layer of complexity. As a result this presents us with the following scenarios for how payments could move between the buyers and the sellers:

Scenario 1 (Fig. 3.2)

1a) The seller pays the processor to harvest the biomass and process into briquettes and/or biochar. The seller retains the ownership of the biomass, and therefore the subsequent bioenergy products, and then sells direct to the buyers.

1b) The seller pays a contractor to harvest the biomass. The seller retains the ownership of the biomass and sells the unprocessed (chopped) biomass direct to the buyers as a feedstock for biomass boilers. The contractor may also be paid to deliver the biomass to the buyer as part of the contract.

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6 ‘Input based’ payments are made for the implementation of specified land or resource management practices which are likely to secure ecosystem service provision. This is in contrast to ‘output based’ payments which are made in relation to the ecosystem service itself, e.g. paying for a specified increase in biodiversity. ‘Private’ payment schemes are self organised schemes in which the beneficiaries are in contract directly with the service providers and don’t involve the use of government/public funds for service delivery (Defra, 2013).

7 N.B. this doesn’t consider the mechanism of how the payments are transferred between actors or the role of the intermediary at this stage.
Table 3.1 Summary of the possible actors who could participate in an Energy for Nature PES scheme and their motivations for becoming involved in the scheme. Based on data gathered through the DECC Wetland Biomass to Bioenergy project and local stakeholder meetings held through the Energy for Nature project.

<table>
<thead>
<tr>
<th>Actor</th>
<th>Organisation/individual</th>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seller</td>
<td>• Conservation land managers, e.g. RSPB, Natural England, Somerset Wildlife Trust</td>
<td>• Biomass is generated as a by product of conservation management</td>
</tr>
<tr>
<td></td>
<td>• Farmers</td>
<td>• Removing problematic rush from wet grassland pastures</td>
</tr>
<tr>
<td></td>
<td>• Other land managers, e.g. Environment Agency</td>
<td>• Removal of vegetation generated through management or material for AD</td>
</tr>
<tr>
<td>Buyer</td>
<td>• Households</td>
<td>• Cheap source of residential heating</td>
</tr>
<tr>
<td></td>
<td>• Wholesalers</td>
<td>• Bulk purchase of locally produced briquettes</td>
</tr>
<tr>
<td></td>
<td>• Community groups, e.g. parish council, schools</td>
<td>• Generate income/benefits for the group/local community</td>
</tr>
<tr>
<td></td>
<td>• National Grid</td>
<td>• Renewable energy feeding into the national energy mix</td>
</tr>
<tr>
<td>Processor</td>
<td>• SMEs with harvesting or briquetting equipment, or operators of medium or large sized AD units (e.g. the SMEs indentified through the DECC project)</td>
<td>• Generate a profit from the harvest and/or sale of bioenergy products</td>
</tr>
<tr>
<td>Intermediary</td>
<td>• Trusted local organisation or independent Energy for Nature scheme coordinator</td>
<td>• Investing in the social and environmental aspects of the local community</td>
</tr>
<tr>
<td>Knowledge provider</td>
<td>• Energy experts, e.g. consultants or universities</td>
<td></td>
</tr>
</tbody>
</table>

Scenario 2 (Fig. 3.3)

The seller pays a contractor to harvest the biomass and deliver to the processor as a feedstock for an AD unit. The processor pays the seller for the unprocessed (chopped) biomass, and sells the electricity to the National Grid.

Scenario 3 (Fig. 3.4a-d)

The processor pays the seller to harvest; they then keep the biomass to convert into bioenergy products. There are then several options for the sale of bioenergy to the buyers:

a) Briquettes and/or biochar: The processor pays the seller to harvest the land and the ownership of the biomass. They then process the biomass into briquettes or biochar which they then sell direct to the buyers.
b) AD: Processor 1 pays the seller to harvest the land and the ownership of the biomass. Processor 2 buys the biomass from Processor 1 as a feedstock for an AD unit, and sells the electricity generated to the National Grid.

c) Briquettes, biochar and AD: Processor 1 pays the seller to harvest the land and the ownership of the biomass. They sell green/wet material to Processor 2 as a feedstock for AD, and retain the dry material to produce briquettes and/or biochar.

d) Biomass boiler feedstock: The processor pays the seller for the rights to harvest the land and ownership of the biomass. They then sell the cut, but unprocessed, biomass to consumers with biomass boilers that are able to use loose material.

**Scenario 4**

Processor 1 harvests the sellers’ land free of charge and takes ownership of the cut material. They then either:

- a) Sell the cut material to Processor 2 as a feedstock for an AD unit
- b) Sell direct to a buyer with a biomass boiler that can take the unprocessed material
- c) Process into briquettes and/or biochar

Processor 1 then pays a percentage of the profits from the sale of the bioenergy products back to the seller. The payment pathway looks similar to that illustrated in Fig. 3.4.d.

**Scenario 5**

The sellers, processors, and potentially also the final beneficiaries, belong to a co-operative grouping (e.g. a formal co-op, Community Interest Group (CIC), community energy group, etc.). Each individual or organisation pays a membership fee to belong to the group and receives a share of the profits from the sale of the products.

Of all the scenarios presented above, scenarios 1a and 1b provide the best fit to the recognised PES framework outlined in Defra’s guidance. For example, a direct payment is made from buyer to seller for the service (i.e. energy), and all stakeholders enter into the agreement voluntarily. The payment would enable the sellers land managers (primarily nature reserve site managers) to reinvest in the enhancement and expansion of habitat management which would meet the additionality and conditionality criteria set out in the guidance.

Scenarios 2, 3 and 4 could be considered to fit loosely within the general PES framework. For instance, although not received directly from the buyer as set out in the guidance, the seller does receive a direct payment for bioenergy provision – either from the sale of the biomass to the processor, or as a percentage of the processors’ profits. This payment ensures that habitat management for biodiversity (i.e. secondary service provision) can continue and these benefits are still received by the buyer. As with
Scenario 1, the payment would enable land managers to invest in delivering biodiversity to meet the conditionality and additionality criteria.

Figure 3.1 The four possible configurations of buyers and sellers within PES schemes, taken from Defra (2013).
Figure 3.2 Payment pathways associated with scenarios 1a and 1b. Sellers retain the ownership of the biomass and a direct payment is made from the buyer to seller. Bioenergy products could be briquettes, biochar or raw (chopped) biomass.

Figure 3.3 Payment pathways associated with Scenario 2. This is a two staged pathway with payments moving from buyer to processor, then processor to seller.

The payment pathways outlined in Fig 3.3 and Fig 3.4 for these scenarios suggest that an Energy for Nature PES scheme based on scenarios 2 and 3 would require a two phased payment between the buyers and sellers:

1. Many-to-one for the payment transferring from the buyers to the processors
2. One-to-many for the payment transferring from the processors to the sellers

This adopts two of the buyer – seller configurations found within traditional PES model (see ‘many-to-one’ and ‘one-to-many’ in Fig. 3.1). However, a two staged scheme would see these combined, with the processor in the centre of the payment pathway (Fig. 3.5).
Figure 3.4 a-d. Payment pathways associated with Scenario 3. These are two staged pathways that require the payment to move from buyer to processor, then processor to seller. The bioenergy products in Fig. 3.4a,c could be either briquettes or biochar.
Scenario 5 is more complex, with all actors paying to belong to a form of co-operative grouping and all receiving a share of surplus revenue. In its loosest sense this idea could fit with the definition of PES as a voluntary transaction in which a minimum of one buyer pays a minimum of one service provider for a specified ecosystem service (Wunder, 2005), i.e. group membership would be voluntary, the beneficiaries would be paying for the service through membership and the sellers would benefit from the share of the surplus revenue as their ‘payment’. Again, this doesn’t fulfil the direct payment criteria within the guidelines; however, subject to membership caveats relating to the sustainability of production of the biomass by the sellers joining the group, conditionality and additionality may potentially be met.

All scenarios see the beneficiary paying for the ecosystem service although, with the exception of Scenario 1, this would necessitate a two phased payment (i.e. moving from buyer to processor, then processor to seller). All scenarios presented would see stakeholders enter the agreement voluntarily, therefore meeting the first two key principles laid out in the PES guidance (Defra, 2013).

For additionality to be achieved from a conservation perspective, an Energy for Nature scheme promoting better quality habitat management would be required, as well as creating new areas of wetland habitat. In the case of wetlands, this would most likely result in the conversion of land from agricultural uses, and so may create the potential for increased pressure on land use (i.e. ‘leakage’) to occur elsewhere in the wider landscape. However, farming in the case study area is a marginal system and the opportunity...
costs incurred are likely to positively favour the diversification of agricultural activities into conservation biomass to bioenergy, and so not compete with food production or increase agricultural pressures elsewhere.

Ensuring permanence of service provision through an Energy for Nature PES would be a more complex challenge for non-conservation based land managers. For the RSPB our charitable remit is to conserve wildlife, therefore actions undertaken through a scheme would not be reversed, even if the market for bioenergy were to decline. This is likely to be the same for other land managers who have a similar conservation mandate to follow. However, ensuring permanence would be harder to guarantee for private sellers, such as farmers, whose land management decisions are guided by different drivers. In a co-operative setting this may be addressed through caveats on membership, outlining a minimum length of time land must be managed in an environmentally sensitive manner. For situations in which land managers contribute biomass on an ad hoc or one-off basis, this would remain a challenge.

Establishing a baseline and the subsequent monitoring of service delivery once a scheme has been established is an important aspect in PES scheme design. In Energy for Nature the primary service being delivered is energy, with biodiversity as a co-benefit. This makes the baseline and monitoring elements more simple. In the case study area no bioenergy is currently being produced from biomass, therefore the baseline would be formed from BAU conditions in terms of energy production. With respect to biodiversity, much of the land that would enter a potential scheme is currently under conservation management, either directly by the local conservation organisations, or indirectly through agri-environmental schemes (AES) or advisory work administered by conservation organisations (e.g. RSPB or FWAG Southwest). As such, data is already available for establishing baselines for biodiversity, and suitable monitoring methods are either in place or obtainable. The involvement of nature conservation organisations also means that the impacts of changes in land management on biodiversity are well understood, which would aid the monitoring and evaluation of scheme success.

Initially, an Energy for Nature PES scheme would focus on the delivery of energy and biodiversity as the primary ecosystem services. However, wetlands are complex ecosystems and it is likely that a range of other services would be provided to the buyers through better management and the expansion of these habitats. For example, reedbeds may act as water purifiers, removing pollutants and consequently improving water quality. Similarly, they may store and sequester carbon, mitigating the damaging effects of climate change. Other habitats within the wetland system may help mitigate flood risk, slowing the flow through the catchment, or by providing flood storage areas. This is particularly relevant in the Somerset Levels and Moors where flooding has become an increasingly serious problem. Wetlands also provide a range of potentially valuable cultural services, including wildlife watching, recreation, and eco-tourism. At present, these additional benefits have not been assessed in the case study area which is why we would

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8 Opportunity costs: A measure of the benefit foregone by using a scare resource for one purpose instead of for its next best alternative use (e.g. the income foregone if a parcel of agricultural land is taken out of production and set aside to provide habitat for biodiversity). Definition taken from Defra (2013).
restrict the scheme to energy biodiversity in the first instance. Further research is required to identify and quantify which, if any, additional ecosystem services are being provided in conjunction with biodiversity, and also identify any potential trade-offs. Until this research is carried out it is seems likely that there will be some degree of free-riding occurring through the payment scheme, with buyers paying directly for energy (and indirectly for biodiversity) but receiving additional benefits for free. In the longer term, with more data available, we would anticipate a move from this ‘piggy backing’ payment to either bundling or layering of ecosystem services within the scheme.

3.2 Energy for Nature and PES development

Defra (2013) suggest that there are five stages involved in the design and development of a PES scheme:

1. Identify a saleable ecosystem service and prospective buyers and sellers
2. Establish the PES scheme principles and resolve technical issues
3. Negotiate and implement agreements
4. Monitor, evaluate and review implementation
5. Consider opportunities for multiple-benefit PES

Phase 1 covers the initial scoping and background research into the opportunities available for those interested in developing a scheme. For this pilot we chose the Somerset Levels and Moors as our case study area because we already have good links to local stakeholders through our existing conservation work and DECC’s Wetland Biomass to Bioenergy project. As a result, much of the information required for Phase 1 was already available or obtainable at the outset of the study. Through the DECC work we already knew that there was an appetite for some form of biomass to bioenergy PES style scheme in the area. For example, several land managers involved in the DECC project had also identified themselves as potential sellers of biomass. Similarly, the consultants conducting the life cycle analysis (LCA) for each of the SMEs are involved in this pilot project and would act as one of the knowledge providers in any future scheme. We also know that it is the local conservation organisations, statutory agencies and farmers who are the key actors in securing service provision through their land management activities, and that buyers would predominantly be from within the local communities.

Having initial data relating to potential buyers, sellers and knowledge providers available at the outset of this project was extremely useful. By following through the elements of Phase 1 we were able to identify where remaining knowledge gaps were and address these prior to moving forward to consider scheme development. For example, we had uncertainties regarding the potential level of supply of biomass from

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9 Piggy-backing: Not all ecosystem services produced by a habitat area sold to buyers; one service may act as an ‘umbrella’ and whilst other services are provided to the buyer free of charge (Defra, 2013).
Layering: Multiple buyers pay for the separate ecosystem services provided by a single habitat (Defra, 2013).
Bundling: A single buyer or group of buyers pays for the full package of services that are derived from the same habitat (Defra, 2013).
the study area and around the prospects for trade, particularly relating to the business case, as the scheme would involve the use of emerging technologies. These queries were addressed through market and economics analyses, and by working with the SMEs and local farmer involved in the DECC project. The remainder of the project focused on Phase 2 of PES development.

Defining scheme principles and resolving technical issues forms the basis of Phase 2. We used stakeholder workshops to gauge the wider interest in an Energy for Nature PES based scheme and establish what some of the basic principles would need to include. Some elements are still uncertain, as they relate to which payment pathway is selected as the foundation of the scheme. Also, as the market for bioenergy products is still at a very nascent stage, the payment pathways chosen may change over time, so a degree of flexibility would need to be retained. The key actors who would be involved in a possible Energy for Nature scheme are outlined in Table 3.1 in the previous section, and Table 3.2 provides a summary of the additional principles that would be necessary to underpin a scheme.

We also used the stakeholder meetings to help us identify potential issues relating to the development and implementation of a scheme, and as an opportunity to investigate ways in which we could resolve them. Several potential challenges and barriers to scheme delivery were raised during the meetings. However, the following three were the most significant and commonly raised:

1. Variability of supply
2. Economic viability for the SMEs
3. Transaction costs

Variability in supply, both in terms of quantity and quality of the biomass, is an unavoidable issue when working in a natural system. For example, the volume and quality of reeds harvested from a site may vary on an annual basis and are determined by a range of factors, such as: previous management, the age of the material, and the time and conditions at harvest which then, in turn, affect the moisture content and weight of the biomass. In addition, the management of nature reserves often changes year on year, with different areas of the wetland harvested at different times, which may also affect volume, quality of supply and harvesting costs. This presents a challenge to both the seller and the processor of the biomass. For the seller there is a risk in signing up to a contract requiring a specific tonnage of biomass to be supplied and then not being able to deliver. Also, reserve management plans tend to be on a five year basis; therefore signing up to longer term agreements could also risk failure to deliver. Failure of the seller to meet their contract is also a significant concern for the processor who, under scenarios 2-4, would take ownership of the biomass and base their business models on the purchase of a minimum volume per annum. The characteristics of the material is also relevant in terms of its end use – briquetting material for combustion requires the material of a lower moisture content to enable the briquetting process and maximise its calorific value for burning. In contrast, AD units call for greener (non woody) material which is low in lignin, and therefore more easily broken down through the digestion

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10 For further details please refer to analyses in Chapter 3 and the Energy for Nature Interim Report
process. In addition to the moisture content both conversion processes require the biomass to be in a specific condition. This primarily relates to the size of the material once harvested (i.e. chop size), but also that the material has been valued after harvesting and stored in an appropriate way.

Variability of supply is critical to understanding the economic opportunities biomass to bioenergy can present. The SMEs involved in a scheme may make significant investments in developing the technologies required to process biomass, and they need to see a return on this investment. To achieve this a minimum volume of biomass would need to be harvested annually and security in long term contracts would be desirable, if not essential\(^1\).

Transaction costs were raised by both sellers and processors, and the issues here relate to the administrative challenges of linking the two actors together. For example, in our study area the processors expressed reluctance at the need to identify and liaise with individual site managers themselves as this would have significant time, labour and financial implications for their businesses. Similarly, the sellers typically have little resource available to them to identify processors who are able to harvest and/or process material, and so incur opportunity costs in diverting resource to this activity. Also, as the study area presents a fragmented, predominantly wet, landscape there are logistical challenges associated with moving machinery and equipment between sites in an economically viable way, getting the equipment on site and, where necessary, finding suitable adjacent sites to bag material for storage or process into briquettes in situ. In addition to these ‘real’ costs, there are ‘perceived’ opportunity costs associated with biomass to bioenergy for the sellers. At present, most land managers consider biomass to be a problematic ‘waste’ product of habitat management (predominantly for conservation, but also agriculture), and reallocating resources away from ‘profitable’ activities to deal with biomass is seen as costly – the opportunities available are not appreciated or fully understood. As such, paying for contractors to harvest and remove the material is still seen as the preferable option as it is the easiest, although not most cost-efficient, model. Consequently, a cultural shift in how land managers view this ‘problem’ is required in order to help them realise this opportunity.

Other challenges that stakeholders raised included landownership, the risk of creating perverse incentives and subsequent trade-offs in service provision. In the study area land ownership is highly fragmented which relates back to the concerns of the processors regarding the administrative burden of locating and working with sellers. This is where an intermediary role played by an Energy for Nature Coordinator would be beneficial. A scheme coordinator would act as the link between the sellers, processor and/or buyers, aggregating sellers and therefore reducing the transaction costs incurred by all parties.

Producing trade-offs in service provision is a risk stakeholders in our study area identified in relation to agriculture, rather than the provision of other ecosystem services from the landscape. Their concern was the creation of perverse incentives, with biomass becoming more profitable than agriculture resulting in

\(^1\) From discussions in stakeholder meetings the suggested optimal contract length a SME would want to enter in to with a seller was 10 years.
land being turned over to the production of energy crops (e.g. Miscanthus). In landscapes other than the Somerset Levels and Moors this could be more of a risk, but excluding energy crops from being accepted within Energy for Nature schemes could help reduce the risk of driving energy crop production in this scheme context. In our case study area the farming system is marginal, and the area consists of several small farming communities with a rich cultural heritage associated with managing the land. Therefore it is unlikely that the creation of a biomass to bioenergy payment scheme would compete with food production in this instance. Interestingly, this form of diversification could have the potential to bolster farm income and enable farmers to continue to rear livestock in the area, depending on how profitable wetland biomass becomes. This would help continue the strong farming heritage associated with this landscape in which livestock, particularly cattle, are instrumental in shaping.

Table 3.2. Underpinning principles that would form the basis of an Energy for Nature PES scheme.

<table>
<thead>
<tr>
<th>Ecosystem service(s)</th>
<th>Energy (directly) and biodiversity (indirectly) in the first instance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographical scale</td>
<td>Landscape, such as catchment, or similar geographic scale, e.g. Avalon Marshes area of the Somerset Levels and Moors</td>
</tr>
<tr>
<td>Contractual period</td>
<td>TBC – this depends on the processing methods used and the returns on investment required by the processor. Where substantial infrastructure required this is likely to be over several years as processors require a minimum guaranteed level of supply each year. Where possible this could be tied into reserve/site management plans.</td>
</tr>
<tr>
<td>Agreed interventions</td>
<td>Reedbed and wetland expansion and creation</td>
</tr>
<tr>
<td>Measures to minimise trade-offs</td>
<td>Monitoring of impacts of equipment on sites(^{12})</td>
</tr>
<tr>
<td></td>
<td>Ecological sustainability caveats for biomass production imposed on sellers</td>
</tr>
<tr>
<td></td>
<td>Exclude energy crops from inclusion in the scheme</td>
</tr>
<tr>
<td>Any ‘packaging’ of ecosystem services</td>
<td>Piggy-backing in the first instance</td>
</tr>
<tr>
<td></td>
<td>Move to bundling or layering based on future data</td>
</tr>
<tr>
<td>Type of payment approach</td>
<td>Input based, possibly front loaded during scheme set-up</td>
</tr>
<tr>
<td></td>
<td>Payments would be set £/t for raw biomass bought from the sellers</td>
</tr>
<tr>
<td></td>
<td>Price paid by buyers for bioenergy products determined by the market</td>
</tr>
</tbody>
</table>

In this project we are focusing on biomass derived from wetlands, habitats which are often located in discrete parcels within the wider landscape. Spatial targeting helps identify key production sites within an area whilst the maximum geographic scale at which a scheme could operate would be determined by the LCA. In our Somerset study this identifies the Avalon Marshes in the northern area of the Levels and Moors as one scheme ‘catchment’, i.e. a discrete geographic area in which biomass is sourced,

\(^{12}\) For more details about the ecological monitoring please refer to Box 3.1.
processed and sold as bioenergy. Other ‘catchments’ could be identified within the wider study area (e.g. Langport and surrounding area in the southern moors). This would create a regional Somerset Levels and Moors Energy for Nature umbrella scheme containing several sub-schemes in smaller ‘catchments’. Within each ‘catchment’ core production sites would be identified through the spatial targeting process. In this instance these would be the nature reserves within the northern area of the region (including the RSPB’s Ham Wall, Somerset Wildlife Trust’s Catcott Lows, and Natural England’s Shapwick Heath reserves). Secondary production sites would be formed from smaller or more distant sites, and adjacent agricultural land. Identifying these potential production sites (and therefore sellers) would enable scheme designers (or the intermediary) to assess the potential of both the individual sites, and the catchment as a whole, for producing wetland biomass.

Interestingly, as a scheme would operate at a local level a direct connection can be made between the buyers and the landscape from which they are benefitting. For example, for a scheme based in the Avalon Marshes in Somerset, the local people of Meare and Westhay would be able to visit their local nature reserves where the biomass is sourced, see the harvesting and habitat work taking place, and enjoy the wildlife associated with the habitats where their energy has come from.

Establishing the baselines for an Energy for Nature scheme would be relatively simple within our study area. The baseline would be the amount of additional energy generated from biomass not currently turned into energy, and the level of biodiversity provision in the absence of additional habitat management (i.e. BAU). It is likely that conservation bodies would be key stakeholders in schemes in other landscapes, both within the UK and Europe, as these organisations are often those that generate the greatest volumes of biomass via their habitat management. The expertise within the stakeholder community regarding land management for biodiversity means that the interventions required to deliver increased biodiversity are well understood, as are the monitoring techniques to do this. Establishing baselines for additional ecosystem services, such as flood mitigation or carbon sequestration, could require more work depending on the available data for the chosen landscape and stakeholder expertise. For our Somerset based Energy for Nature scheme to develop into a multiple-benefit PES (i.e. Phase 5) we would require additional research and investment in determining the additional services provided and the current level of service delivery.

Through this Defra study we have worked our way through phases 1 and 2 of the PES development pathway. Further details of what an Energy for Nature model could look like are outlined in Section 3.3 below.
Box 3.1 Environmental monitoring

New land management techniques involving the use of different harvesting and processing machinery forms the basis of Energy for Nature. Therefore the impacts of these operations on sites needs to be monitored. As part of this project the RSPB Reserves Ecology Team developed a monitoring programme which allows site managers to monitor impacts on vegetation structure and substrate composition. It also considers the possible effect of managing larger areas of wetlands on specialist target species. Three main areas are considered in the monitoring programme:

1. Mechanical harvesting and vegetation
   - Quadrats were used pre- and post-harvest, and data was collected on vegetation structure, density and type, vegetation abundance, percent of bare ground
   - Fixed point photos were taken pre- and post-harvest on managed and unmanaged (i.e. control) sites. Photos were taken of representative vegetation on both sites, and of planned access points and haulage routes on the harvested sites.
   - All locations monitored were recorded to enable replication in subsequent years
   - Conclusions can be made once the vegetation has recovered from harvesting operations
   - Comparisons need to be made within the context of the management objectives, e.g. if reducing rush cover is desirable then recording less rush dominance post harvesting would be a positive outcome. In contrast, damage to reed rhizomes may reduce growth and be a negative impact if dense reed cover was the objective.
   - This was the first year of monitoring therefore no comparisons can yet be drawn.

2. Mechanical harvesting and soil structure
   - Substrate compaction was measured through a visual structural assessment of the soil and by measuring the soil infiltration rate at three randomly located points across harvested and control sites.
   - Soils samples were used to assess soil structure at the control and harvested sites. A Visual Soil Structure Quality Assessment was then completed using guidance produced by the Danish Industry of Agricultural Sciences.
   - All samples from harvested sites showed no indications of compaction, the soil structure stayed intact, and no visual differences were recorded between the control and harvested sites.
   - Soil infiltration rates were measured using a metal infiltrometer ring in the harvested and control sites. Water was added to the ring, allowed to fall to a specified level and then refilled to the original level. The time interval between was recorded, and the process repeated until the timings were constant. The infiltration rate was then calculated using the following equation:
     \[
     \text{Infiltration rate (m/day)} = \frac{\text{distance of water level drop (cm)} \times 864}{\text{time taken for water level drop (s)}}
     \]
   - This test was repeated three times and the average taken for each sample to account for variability between soils and the small sample size.
   - Some difficulties were experienced measuring infiltration rates in very wet areas where the water table was too high. However, no noticeable differences were identified through comparisons between the controls and cit sites.

3. Harvesting patterns and biomass use
   - ‘Rejuvenation’ is a new approach to reedbed management and is being trialled at the RSPB’s Ham Wall reserve in Somerset since 2006/07.
   - Larger areas are managed for a five year period through water level control, cutting and intensive grazing, to reduce reed dominance in an attempt to introduce dynamics back in to the system.
   - As larger areas are managed this form of approach lends itself biomass to bioenergy. Economies of scale mean that with less machinery movements and less resource demanding methods this could be a cost effective means of managing wetlands.
   - Impacts of this management have been monitored through the breeding success of key wetland birds, including the bittern and bearded tit, which have diverse habitat requirements.
   - Populations of both these species have increased during the trial management period. The results also suggest that this is a management regime that will provide the necessary habitats for biodiversity in a more cost effective way.
3.3 Energy for Nature – the model

It was clear from the feedback we gathered through this pilot study that there are two distinct motivations behind stakeholders wishing to develop an Energy for Nature scheme:

a) Land management

b) Community energy and rural development

Improved land management, be it for conservation or agriculture, was the principle driver for the majority of stakeholders. This is unsurprising as the majority were representatives from organisations responsible for managing wetlands for wildlife, and who are struggling both to remove biomass from their reserves and generate income to support further conservation management. Consequently, biomass to bioenergy is an interesting means of solving their ‘conservation problem’, and a potential way of funding further habitat work. Similarly, local farmers are interested in looking for ways to diversify their income streams, and generating a profit from bales of rush removed from their wet grassland pastures could be an option for them. Consequently, the basis of an Energy for Nature scheme in this instance is removing a land management problem and turning it into a funding opportunity.

For some of our stakeholders the main driver was rural development through community energy, rather than a land management based issue. By creating a local ‘bioenergy hub’ biomass to bioenergy could provide a means of generating cheaper energy for local people, and contribute to rural development through creating more environmentally sustainable and resilient communities.

Consequently, we suggest that there are two possible forms of an Energy for Nature scheme:

a) Land Manager Model

b) Community Model

Both possible schemes are outlined in more detail below in sections 3.3.2 and 3.3.3. However, despite there being different motivations driving scheme development, there are several elements that would remain constant within each:

Scale

Both schemes would:

- Operate at the landscape scale
- Be based around core and secondary biomass production sites
- Have sites located in ‘catchments’ within the landscape, based on the area determined by the LCA
- Potentially have multiple ‘catchments’, and therefore sub-schemes, operating within a larger umbrella Energy for Nature scheme
Actors

Both schemes would:

- Contain the same sellers and processors
- Have the local community act as the principal buyers
- Require the same knowledge providers
- Require an intermediary to link the processors and sellers, and potentially buyers, together

Payments

In both schemes payments would remain:

- Focused on energy and biodiversity as the primary ecosystem service being delivered (in the first instance\(^{13}\))
- Input based, paying for habitat management as a proxy for biodiversity delivery
- Spatially targeted
- Based on the market price of raw biomass or briquettes, depending on which payment pathway is followed
- Linked to caveats in the ecological sustainability of biomass production and exclude energy crops

Baselines and monitoring

Both schemes would:

- Use the same baselines to measure service delivery
- Use the same methods to monitor service delivery

3.3.1 The Energy for Nature intermediary

Feedback from all of the stakeholder engagement activities carried out during this project point towards the need for an ‘Energy for Nature Coordinator’ to act as an intermediary in any form of scheme that is developed. Sellers and processors are both time and resource limited; therefore the intermediary is required to act as a link between the two actors, identifying suitable sellers and linking them to the relevant processors. Who carries out the role is likely to vary from scheme to scheme, but most likely it would be an individual from an organisation interested in developing biomass to bioenergy and working locally in the area in which the scheme is developed. For example, in our Somerset study the role could be fulfilled by a member of local staff from any of the stakeholder organisations involved in the project (e.g. RSPB, Natural England, etc.). The coordinator would operate across several ‘catchments’ within the landscape that the scheme operates (e.g. the Avalon Marshes would be just one ‘catchment’ administered within a wider Somerset Levels and Moors Energy for Nature scheme).

\(^{13}\) This is explained further in Section 4.1
The role of the Energy for Nature Coordinator would be similar for both conservation or community led schemes, and assumes that there is an initial interested party/stakeholder group leading the idea and who the coordinator would work with. The steps involved in the role are outlined in Fig 4.6. and described in more detail below.

**Figure 3.6** Five keys steps required in the Energy for Nature Coordinator (i.e. intermediary) role.

1. **Identify sites**

   For a given landscape the coordinator would work with the initial scheme interest group to scope out what opportunities exist for biomass to bioenergy. The first stages would be to use GIS, and local knowledge, to identify specific habitats and sites which could form the core production sites and then the wider area for secondary sites. The coordinator would work with the knowledge providers to use the LCA to determine the full extent of the ‘catchment’ that a scheme could feasibly operate in (e.g. the Avalon Marshes in the northern regions of the wider landscape of the Somerset Levels and Moors would be one ‘catchment’).
2. Identify sellers

Once core and secondary production sites are identified the coordinator would work with local stakeholders (e.g. community groups or eNGOs) to identify the land owners/land managers and contact them regarding their interest in participating in a scheme.

3. Identify the biomass to bioenergy potential of sites

Working with the individual land managers the coordinator would use the Conservation Biomass Calculator (see Box 3.2) to assess the potential of each site for producing biomass suitable for bioenergy production, establish estimates of costs, and identify the most appropriate processing option for the material.

4. Link to processors

Negotiate contracts with processors for the sellers. Sellers would be aggregated and bilateral contracts formed in order to spread the risk of not delivering. Share experience, knowledge of contracts and ways of working.

5. Links to buyers

This is an optional aspect of the role, and will depend on the payment pathways chosen by the sellers and the level of knowledge or connections to existing buyers and markets.

The coordinator role would vary subtly within and between schemes depending on the level of existing stakeholder knowledge and engagement. Consequently, there are multiple entry points for intermediaries to join in with a scheme. For example, in a conservation driven scheme it is likely that some form of grouping of the key land managers will already exist, will know where the majority of potential core production sites are located, and also who owns/manages them. In this instance input from the scheme coordinator may start at stage 2 or 3 outlined above. Conversely, in a community led scheme there may be little prior knowledge of suitable sites and the coordinator would need start at the very beginning of the process.

Funding the role of the coordinator needs to be considered in more detail. It is possible that the form of co-operative structure adopted by the members of the Community Model provides a simple administrative structure for paying the coordinator from the revenues generated through bioenergy sales. This may also work in the Land Manager Model, although the administrative structure required to pass payment on to the coordinator would be different and would need to be established early on in the process.
3.3.2 Energy for Nature – Land Manager Model

This model is based on generating an income to fund land management, particularly for land managers who need to deliver more, and enhanced, habitat management for the benefit of wildlife. As such, the model assumes that sellers are predominantly site managers from conservation organisations, statutory bodies (e.g. Natural England), or private companies (e.g. water companies). The model may also apply to private individuals, such as farmers. As the level of payment relates to the market value of the bioenergy product being sold, the economically most optimal option would be for sellers to retain ownership of their biomass and sell briquettes, biochar or raw (chopped) biomass direct to the buyers (i.e. scenarios 1a,b, Fig. 3.2.). This pathway presents the most similar framework to the typical PES model. However, this may not always be the most viable or practical option for sellers (for example, in the initial stages of the scheme where uncertainties may remain about the quality or quantity of supply, or local markets may not be well developed), therefore this framework also outlines the pathways for sale of biomass from the seller to AD operators (Scenario 2, Fig. 3.3) and the option to sell the biomass outright to the processor (scenario 3a-d, Fig. 3.4.a-d).

Box 3.2. Conservation Biomass Calculator

The calculator is a tool that will help land managers assess the potential of their biomass for producing bioenergy products, and help change biomass from being considered a land management problem to a bioenergy solution.

The calculator is a software based tool that can be run on a normal PC. The calculator requires land managers to input site specific data which it will then use to generate options for which processing methods are most suitable, based on a range of variables (e.g. material composition, moisture content). The energy balance sheet generated through this process is then compared to BAU conditions to show the GHG gas savings, costs and benefits of converting to bioenergy, and assess the feasibility of the proposed processes.

The calculator also has the capability to generate the monetary cost of the processes and any associated investment needed. The economic evaluation of alternative processing options could be performed in different ways depending on specific circumstances and requirements.

The calculator performs a simplified LCA to identify where improvements to the process could be made, and where the carbon and economic expenditure is being generated. The software is an evolving system, designed with the capacity to build in new conversion technologies as they are developed and habitat requirements as they arise.

The calculator is structured the following basic elements:

- **Guidance Section**: summarises the purpose and use of the software for the assistance of general users
- **Basic Input/Output Section**: provides a user-friendly means of entering the key values for prominent parameters for general users. Also summarises the overall results in terms of the economic costs and net GHG emissions of current land management practice, and alternative options involving biomass for bioenergy production.
- **Assumptions Section**: houses all the baseline information (e.g. monetary and carbon cost of fuel, staff time, contractor cost, number of working hours in a day, calorific value of fuels, etc.). This data is controlled by the ‘owner’ of the software so that it could be changed as necessary to ensure it is up to date. This data would form the basis for all calculations, from which the final information would be generated.

The calculator results can be taken by the user to inform future management decisions and entry into a biomass to bioenergy scheme.
By providing the option to sell direct to the buyers the framework enables sellers to receive the added value of converting their biomass into a more valuable product. It also presents the opportunity to add a ‘nature friendly’ premium to briquettes, reflecting the links to conservation, and increasing their returns. For example, briquettes or biochar produced from RSPB reserves would be branded in line with the organisation’s brand guidelines and sold in local reserve visitor centres, or through other local outlets, at a premium. This premium would reflect the ‘nature friendly’ production of the product and how its sale funds further conservation work. Marketing these products in this way would also work for other charitable organisations, such as the Wildlife Trusts. Buyers in this model would range from householders purchasing briquettes and/or biochar from nature reserve outlets, to local wholesalers, or businesses/organisations (such as schools), who require material to power biomass boilers (for briquettes only).

The Land Manager Model could also provide the seller with the option of participating in any nationally branded schemes, such as Bioregional’s former HomeGrown® scheme. Although a national scheme, it successfully linked small scale producers producing ecologically sustainable charcoal with their local B&Q stores, thus maintaining local supply chains. This was achieved through the creation of a company to provide infrastructure for the supply and marketing of charcoal, including the provision of branded and barcoded bags for suppliers (Desai et al., 1996). The company’s role in coordinating contracts between B&Q and the supplier would be similar to what we would envisage the Energy for Nature Coordinator fulfilling under any future nationally branded briquette scheme.

Fig. 3.7 provides a general framework for land managers considering entry into an Energy for Nature scheme and the possible payment pathways associated with different bioenergy products. There are two entry points for land managers:

a) Contacted by the regional Energy for Nature Coordinator following a landscape assessment (stages 1 and 2 of the intermediary role)

b) Directly approach the regional Energy for Nature Coordinator for an assessment

In both instances the potential of the site for entry into a scheme will be assessed using the Conservation Biomass Calculator. For those land mangers contacted by the coordinator this will automatically be carried out for them if they are interested in joining the scheme. For those who independently express an interest in Energy for Nature they can either contact their local Energy for Nature Coordinator for an assessment, or use the calculator independently and then contact the coordinator should the results be favourable. If the calculator output is favourable the coordinator would then start the process of linking the seller to the harvesters/processors and/or buyers. This model assumes that sellers do not join a formal co-operative or community energy group – if they wish to do this the model would follow that is outlined in the next section. The model assumes that the sellers retain ownership of the biomass but pay

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14 At present the Conservation Biomass Calculator is only available to RSPB staff involved in this pilot and the DECC Wetland Biomass to Bioenergy project. The aim is for the calculator to be made available to all RSPB staff in the first instance, and then as a web based tool available to all land managers.
for the processors and/or contractors to harvest/process/deliver biomass as determined by the calculator. Although this would suggest an individual contract between seller and processor, the need to reduce transaction costs would necessitate unilateral contracts between the harvester/processor and a number of locally based sellers, even if just for harvesting operations, in order to make the operations financially viable. The contract would set out a minimum volume of biomass required per annum by the harvester/processor that needs to be met by the local sellers. Contracts would be administered by the Energy for Nature Coordinator who would be responsible for assessing the biomass potential of each seller for that year, and matching them into the contract. This spreads the risk of sellers not producing sufficient biomass to justify the processors harvesting and/or producing bioenergy products from their land, and reduces the transaction costs incurred by both parties.

15 If the seller sells the biomass to the processor, or sells to an AD operator then the payment does not come direct from the buyer (i.e. scenarios 2 and 3a).
Figure 3.7 Flow diagram illustrating the general framework of the Land Manager Energy for Nature model. ★ indicates points at which the Energy for Nature Coordinator can enter the process to provide help and advice to the land manager on the viability and their options for biomass to bioenergy.
3.3.3 Energy for Nature – Community Model

This model is based on developing resilience in rural communities through community energy initiatives, such as districting heating\(^\text{16}\). This model assumes that a community group (e.g. parish council or community energy group) is driving the process to deliver cheaper and more sustainable energy for the benefit of the local community through biomass to bioenergy (rather than via solar or other energy options). As such, the model follows Scenario 5 in Section 3.1, whereby the buyers, sellers and processors pay for membership of some form of co-operative organisation and receive a share of the profits from the sale of bioenergy or receive cheaper energy. As in the previous model, land managers (either conservation or statutory agencies, or private companies/individuals) act as the sellers of the biomass, and the local community (through the community group) act as the buyers of bioenergy. Processors are required to act as the harvesters and/or producers of the bioenergy products. An Energy for Nature Coordinator would still be required to coordinate contracts between the actors, as the same challenges in terms of variability in quality and supply remain relevant in this model.

As the model is driven by the creation of low carbon, cheap, community energy it is more complex than the Land Manager Model. Although the actors remain the same, in this instance they all have a stake in the energy initiative through membership of the co-operative\(^\text{17}\). This ensures benefits are felt by the community, and not just the land managers/SMEs involved in producing/processing the biomass. This structure also enables caveats to be placed on membership to ensure that environmentally sensitive practices are used to harvest the biomass and in the management of land for service delivery.

As with the Land Manager Model there are two ways in which community groups could become involved in an Energy for Nature scheme, via an Energy for Nature coordinator (who would need to be in place):

a) Contacted by the regional Energy for Nature Coordinator following a landscape assessment (stages 1 and 2 of the intermediary role)

b) Directly approach the regional Energy for Nature Coordinator for more information

If a landscape has been identified as potentially suitable for biomass to bioenergy a community group would be approached by their local Energy for Nature Coordinator. In this instance the coordinator would take the group through the steps outlined in Fig. 3.8 from the beginning, helping the group to identify land managers, assess sites, establish the viability of options and then bring the actors together. Community groups who would contact the coordinator independently would possibly require help at various stages of the framework presented in Fig. 3.8. For example, they might have land managers within their group who produce biomass and know where the key production sites may be within the landscape, and therefore require help at later stages of the process, such as with contacting processors. On the other hand, a

\(^{16}\) District heating is the term used to describe a network of insulated pipes used to deliver heat, in the form of hot water or steam, from one or more sources to an end user.

\(^{17}\) This does not have to be a formal co-operative but could take the form of a Community Interest Company (CIC), a local Land Trust, or similar. The Forestry Commission have recently published guidance on developing community woodfuel bioenergy schemes (Forestry Commission, 2015). The guidance provides useful information on how to set up a suitable community group structure for this type of project.
group may know which bioenergy option they’re interested in investing in (e.g. a biomass boiler), but have no knowledge of the potential of the local landscape to provide them with biomass as a feedstock. The coordinator would step in at this point to help the group identify possible sites, and use the Conservation Biomass Calculator to assess whether biomass to bioenergy is feasible for their community energy project.

The model assumes that the community want to invest in one of the processing options (i.e. purchase an AD unit or biomass boiler); however, the level of detail available in the Conservation Biomass Calculator is not sufficient to assess the full financial feasibility of a community energy project. Therefore, a full feasibility study is recommended as the final step in the process to achieve this and determine the most appropriate form of co-operative grouping (e.g. formal co-operative or CIC, etc.) required to take the project forward.

The Energy for Nature Coordinator role is crucial in this model as they would be more involved in the development and operationalising of a scheme. In addition to the core work elements highlighted in Section 3.3.1, they would be required to coordinate membership of the co-operative structure created to administer the energy initiative, as well as help the community group develop funding applications for feasibility studies to be conducted. As mentioned in Section 3.3.1., funding of this role would need to be carefully considered at the beginning of any scheme development to ensure that the role is viable.
Figure 3.8 Flow diagram illustrating the general framework of the Community Energy for Nature model.
4 Business case and structure

This chapter examines the current understanding of the products, costs of production and potential markets and revenue available for the conservation biomass to bioenergy concept. By quantitatively illustrating the economics of potential supply and supply costs along with expected demand and willingness to pay for these products we present the business case of “Energy for Nature”.

4.1 Business case

We should start by considering the supply chain we are trying to build in its simplest and most general form. From there we can try to add the complexities which a business will have to deal with in order to operate effectively.

The raw product is a surplus material from habitat management for biodiversity. However it is one which must be actively harvested and transported. Although this material can be utilised as an energy product in its raw form, to maximise its value and its versatility it is better for it to be processed into something which can be utilised by a wider consumer base as heat or power. Once processed this final product can be sold wholesale or retail by the group of stakeholders involved. The business in simplest terms requires us to:

- Let the vegetation grow
- Cut and collect it
- Convert it into consumable energy
- Sell it to homes and businesses

The complications around biomass to bioenergy are driven by the variety of plant matter produced, who owns/manages it, variation in its qualities and its management requirements. These initial complications lead to a complex set of processing methods and final products which help to deal with that variety. These processing methods then require a set of business agreements to be developed allowing all actors to receive greater financial rewards than they otherwise would. These complexities must be accommodated under four constraints:

- The business must be profitable or reduce costs from the status quo
- The business must lead to a net reduction in carbon emissions
- Habitat quality for biodiversity must be improved or maintained
- Intensive production of specialist energy crops must not be incentivised

This project aimed to better understand these complexities and how they might be overcome in a working biomass to bioenergy business. The easiest way to begin to untangle this is to start by setting out to 'Measure what can be measured, and make measurable what cannot be measured'. These
measurements enable us to better understand the constraints. We can break that task up into the four sections:

- Vegetation
- Manufacturing
- Markets and Business Models
- Constraints

We explore these tasks further in the following sections, and describe the quantification process for each stage, with accompanying models.

4.1.1 Supply

First we give an overview of the approximate costs in the production processes in context of the total available land and vegetation within the pilot area of the Somerset Levels and Moors.

Land

We begin by mapping out the areas by habitat type (Table 4.1). These areas are not the total area of the habitat under ownership but the physical area which would be cut for management purposes. None of the material itemised is currently used for other purposes but rather burned on site or disposed of rather than utilised. Hay crops are sometimes used but the hay identified in this section is of low quality and unlikely to be saleable. The area described as ‘Potential’ refers to land not currently under ownership as a nature reserve but which is cropped and could be included in the medium term. There are larger resources that might be available beyond these as climate change and wetter weather further alters ground conditions and vegetation composition.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Currently cut/year (ha)</th>
<th>Potential for cutting/year (ha)</th>
<th>Total/year (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fen</td>
<td>22</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td>Grassland</td>
<td>40</td>
<td>230</td>
<td>270</td>
</tr>
<tr>
<td>Grassland/Fen</td>
<td>10</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Reedbed</td>
<td>19</td>
<td>30</td>
<td>49</td>
</tr>
<tr>
<td>Wet grassland</td>
<td>40</td>
<td>-</td>
<td>40</td>
</tr>
<tr>
<td>Wet grassland – hay</td>
<td>277</td>
<td>500</td>
<td>777</td>
</tr>
<tr>
<td>Wet grassland – rush</td>
<td>292</td>
<td>4500</td>
<td>4792</td>
</tr>
<tr>
<td>Willow pollards</td>
<td>25</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Willow Scrub</td>
<td>1.5</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Woodland Thinning / coppicing</td>
<td>0.4</td>
<td>-</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Grand Total (ha)</strong></td>
<td><strong>727</strong></td>
<td><strong>5260</strong></td>
<td><strong>5987</strong></td>
</tr>
</tbody>
</table>

| Non-area based totals         |                         |                                 |                 |
| Hedgerow (metres)             | 200                     |                                 | 200             |
| Willow pollards (pollards)    | 25                      |                                 | 25              |

Table 4.1 Habitat areas available for cutting in the Somerset Levels and Moors case study area. In this section we are presenting very rough estimates to work through the issues. ‘Cut Now’ refers to areas which are currently...
managed by Natural England, Somerset Wildlife Trust or the RSPB. ‘Potential’ is based on previous mapping work describing other landholdings in the area which might be considered lower value and so likely to wish to have vegetation removed.

**Box 4.1. Biomass potential of roadside verges**

We had considered the converting arisings from roadside verges into energy products. Mapping had suggested that somewhere between 1,000 and 10,000 tonnes might be available from that source. Unfortunately contact with the local council revealed that soft vegetation is merely blown back onto the verge rather than collected. To collect cuttings would require a second vehicle running alongside the cutter covering a significant distance – slowing the process and therefore costing significantly more.

To overcome collection costs the income from the energy crop would have to be significant as collection along roads cannot be as efficient as collection in a field. Estimating the cost of that work requires some complex assumptions regarding the number of trips which a collecting vehicle would need to take from the depot to the site and back. The total distance covered is likely to be considerable and outweigh the benefits gained from converting the crop into fuel.

There may be reasons to collect these crops which have not been fully explored. The first might arise if we better understood urban contamination of watercourses. 49% of UK freshwater fails to meet environmental limits because of diffuse pollution. Nationally only 14% of failures are due to diffuse pollution from urban runoff but in certain areas such as the Thames runoff from roads specifically is the biggest cause of failures.

Roadside verges attenuate some of the pollutants washing off of the roads. Though we have seen no study on this the cutting and blowing back onto the verge of that vegetation may return those pollutants to the soil. Once in the soil the pollutants may wash into water tables or streams. Further research would be required and it may only provide marginal improvements but it is worth considering the possibility that removing cut vegetation from roadsides might further reduce water pollution.

There is also evidence from a COMBINE project: Converting Organic Matters from European urban and natural areas into storable bio-Energy that contaminants from runoff can be dealt with when converting the crop into energy products. The Combine program’s French partners have been washing roadside verge crops in warm water before pressing. At that stage some mineral contaminants, which can cause problems in boilers, are washed out in the liquid collected. That liquid can be used in the anaerobic digestion process whilst the solid matter can be dried and converted into briquettes (Rachel Smith – Severn Wye Energy, pers comm.).

There have also been calls to alter management in order to encourage wild flowers in verges. One way to achieve this might be to cut and bale and so remove them and trials have been considered in Dorset. In so doing the fertility of the soil would reduce improving circumstances for wild flowers and reducing the need to cut regularly. This would in the short term provide more vegetation but the long term goal would be to reduce it and so sustainability of supply may be an issue.

Both of these ideas keep the possibility of the use of roadside vegetation alive but would require significantly more thought and research.

2) [https://repository.abertay.ac.uk/spui/bitstream/10373/1043/2/JefferiesEviTraPolConSoiSUDS11thFinal.pdf](https://repository.abertay.ac.uk/spui/bitstream/10373/1043/2/JefferiesEviTraPolConSoiSUDS11thFinal.pdf)
3) [https://www.dorsetforyou.com/conservation-verge-trials](https://www.dorsetforyou.com/conservation-verge-trials)
Crop

We now need to understand how large a crop the areas identified would produce. Table 4.2 links the areas described in Table 4.1 to vegetation types and the amount of vegetation that can be cropped. The total crop varies significantly but given our use of these sites we have reasonable estimates for yearly yield\(^\text{18}\).

Table 4.3., which presents total arisings, is now much simpler than our original mapping table with fewer products. We would conservatively estimate that we can produce 2,800 tonnes of vegetation currently and add a further 12,800 tonnes in the future from other land owners.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Vegetation type</th>
<th>Dry yield (tonnes/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fen</td>
<td>Rush/sedge dominated</td>
<td>2.2</td>
</tr>
<tr>
<td>Grassland</td>
<td>Poor hay</td>
<td>5</td>
</tr>
<tr>
<td>Grassland/Fen</td>
<td>Poor hay</td>
<td>5</td>
</tr>
<tr>
<td>Reedbed</td>
<td>Reed</td>
<td>7</td>
</tr>
<tr>
<td>Wet grassland</td>
<td>Poor hay</td>
<td>5</td>
</tr>
<tr>
<td>Wet grassland – hay</td>
<td>Poor hay</td>
<td>5</td>
</tr>
<tr>
<td>Wet grassland – rush</td>
<td>Rush</td>
<td>2</td>
</tr>
<tr>
<td>Willow pollards</td>
<td>Woody biomass</td>
<td>8</td>
</tr>
<tr>
<td>Willow Scrub</td>
<td>Woody biomass</td>
<td>8</td>
</tr>
<tr>
<td>Woodland Thinning / coppicing</td>
<td>Woody biomass</td>
<td>8</td>
</tr>
<tr>
<td>Hedgerow</td>
<td>Woody biomass</td>
<td>Unknown</td>
</tr>
<tr>
<td>Willow pollards</td>
<td>Woody biomass</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

Table 4.3 Dry vegetation yields from areas managed by current and potential partners in the case study area.

<table>
<thead>
<tr>
<th>Vegetation</th>
<th>Currently cut (tonnes/year)</th>
<th>Potential for cutting (tonnes/year)</th>
<th>Total (tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fen</td>
<td>48.40</td>
<td>-</td>
<td>48.40</td>
</tr>
<tr>
<td>Grassland</td>
<td>1,835.00</td>
<td>3,650.00</td>
<td>5,485.00</td>
</tr>
<tr>
<td>Rush</td>
<td>584.00</td>
<td>9,000.00</td>
<td>9,584.00</td>
</tr>
<tr>
<td>Reed</td>
<td>133.00</td>
<td>210.00</td>
<td>343.00</td>
</tr>
<tr>
<td>Willow/Scrub</td>
<td>215.20</td>
<td>-</td>
<td>215.20</td>
</tr>
<tr>
<td>Total</td>
<td>2,815.60</td>
<td>12,860.00</td>
<td>15,675.60</td>
</tr>
</tbody>
</table>

\(^{18}\) For more details please refer to the following INTERREG report: Utilisation of Biomass as Payment for Ecosystem Services Schemes in the Somerset Levels and Moors.
Harvesting uniform dry fields of wheat can be achieved quickly and efficiently with modern agricultural vehicles. Harvesting a crop of varying density through boggy land is a greater challenge. A range of different vehicles can be brought in to deal with this challenge. At some sites water levels can be controlled to allow vehicles to move better, and there is also the option to wait for the weather to break to improve conditions on the ground. Despite the development of new technologies none of these options prevent harvesting on wetlands from being a challenge. The challenge is not simply that the work is slower and more expensive, but also that varying conditions make it more difficult to predict how much effort will be required for a given area or how wet the product will be. For these reasons the Conservation Biomass Calculator developed by North Energy Associates Ltd allows for a range of variables regarding moisture and crop density to be tweaked. Playing with aspects such as the time of year cut and the vehicle used can further alter harvesting costs. We can start by simply presenting variation by habitat with the easiest fields with the shortest transit and the densest crop compared with the hardest fields and the longest distances with the sparsest crops.

The Conservation Biomass Calculator was developed for wetlands. It therefore does not cover wood crops such as willow or dry crops such as hay. For these we can rely on traditional farm data books such as The John Nix Farm Management Pocketbook (Redman, 2012). Table 4.4 begins by simply showing the cost of harvesting per hectare based on figures from the Conservation Biomass Calculator. The calculator allows us to alter the coverage density, terrain difficulty and transit distance on a three point scale e.g. “dense”, “medium” and “sparse” for density. By setting terrain difficulty to “hard” and transit distance to “long” we can consider the toughest fields. Dense crops slow down harvests and increase costs but also reduce cost per unit harvested. For that reason for the “Hard” setting in the tables we set density to “Sparse”, terrain to “hard” and distance to “long”. “Medium” and “Easy” were based on the “medium” settings and the opposite settings to “Hard” respectively.

We can see that cost can vary by around £150 per hectare on wetlands. This table was produced by using the wetland calculator through adjustment of the harvesting variables to either ‘hard’, ‘medium’ or ‘easy’. The John Nix handbook provides estimated harvesting costs for willow and hay crops at £205/ha and just under £150/ha respectively.

This impact of price on wetlands is exacerbated for some habitats when we have easy to harvest sites providing the densest crops. These values are high and based on specialist equipment. At some sites these costs will be reduced where more traditional equipment can be used. Table 4.5 shows that the high costs of harvesting reed per hectare drops considerably when we consider that it comes in higher densities than other vegetation types. We can also see that where the cost differential was amongst the highest for reed it is now by far the lowest. Harvesting sparse amounts of soft rush on difficult ground is over four times more expensive than dense rush on easy ground. To some degree this variation will be predictable. Difficult fields will always be difficult and as such it is likely that sparse rush in difficult fields

19 See Box 3.2
would not be harvested. In our Somerset case study we can simplify the vegetation types listed in Table 4.5 down to just a few types and add the non-wetland costings (Table 4.6).

**Table 4.4** The cost of harvesting one hectare of wetland, by wetland habitat type base on the Conservation Biomass Calculator.

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Hard (£/ha)</th>
<th>Medium (£/ha)</th>
<th>Easy (£/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Rush</td>
<td>251.16</td>
<td>205.58</td>
<td>181.63</td>
</tr>
<tr>
<td>Common Reed</td>
<td>517.38</td>
<td>423.50</td>
<td>374.15</td>
</tr>
<tr>
<td>Fen - not dominated</td>
<td>517.38</td>
<td>423.50</td>
<td>374.15</td>
</tr>
<tr>
<td>Fen - Rush and Sedge</td>
<td>507.24</td>
<td>415.20</td>
<td>366.82</td>
</tr>
<tr>
<td>Fen - Reed</td>
<td>523.26</td>
<td>428.32</td>
<td>378.40</td>
</tr>
<tr>
<td>Scrub</td>
<td>498.34</td>
<td>407.92</td>
<td>360.38</td>
</tr>
</tbody>
</table>

**Table 4.5** The cost of harvesting one dry tonne of wetland, by wetland vegetation type base on the Conservation Biomass Calculator.

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Hard (£/dry tonne)</th>
<th>Medium (£/dry tonne)</th>
<th>Easy (£/dry tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Rush</td>
<td>251.16</td>
<td>107.03</td>
<td>46.06</td>
</tr>
<tr>
<td>Common Reed</td>
<td>82.57</td>
<td>60.50</td>
<td>42.71</td>
</tr>
<tr>
<td>Fen - not dominated</td>
<td>470.35</td>
<td>352.92</td>
<td>267.25</td>
</tr>
<tr>
<td>Fen - Rush and Sedge</td>
<td>422.70</td>
<td>272.21</td>
<td>170.99</td>
</tr>
<tr>
<td>Fen - Reed</td>
<td>373.76</td>
<td>215.88</td>
<td>250.27</td>
</tr>
<tr>
<td>Scrub</td>
<td>355.96</td>
<td>254.95</td>
<td>200.21</td>
</tr>
</tbody>
</table>

**Table 4.6** Harvesting costs of wetlands specifically relevant to the Somerset Levels and Moors case study area.

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Hard (£/ha)</th>
<th>Medium (£/ha)</th>
<th>Easy (£/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fen</td>
<td>517.38</td>
<td>423.50</td>
<td>374.15</td>
</tr>
<tr>
<td>Grassland</td>
<td>-</td>
<td>150.00</td>
<td>-</td>
</tr>
<tr>
<td>Rush</td>
<td>-</td>
<td>150.00</td>
<td>-</td>
</tr>
<tr>
<td>Reed</td>
<td>517.38</td>
<td>423.50</td>
<td>374.15</td>
</tr>
<tr>
<td>Willow/Scrub</td>
<td>-</td>
<td>205.00</td>
<td>-</td>
</tr>
</tbody>
</table>

Having rationalised the table we need only multiply Table 4.6 by the areas identified by Table 4.1 and mapped by Table 4.2. This gives us the annual costs in Table 4.7.
Table 4.7 Estimated total costs of harvesting wetland biomass in the Somerset case study area, now and in the future.

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Currently cut (£/year)</th>
<th>Potential for cutting (£/year)</th>
<th>Total (£/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fen</td>
<td>9,317.00</td>
<td>-</td>
<td>9,317.00</td>
</tr>
<tr>
<td>Grassland</td>
<td>55,050.00</td>
<td>109,500.00</td>
<td>164,550.00</td>
</tr>
<tr>
<td>Rush</td>
<td>43,800.00</td>
<td>675,000.00</td>
<td>718,800.00</td>
</tr>
<tr>
<td>Reed</td>
<td>8,046.50</td>
<td>12,705.00</td>
<td>20,751.50</td>
</tr>
<tr>
<td>Willow/Scrub</td>
<td>5,514.50</td>
<td>-</td>
<td>5,514.50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>121,728.00</strong></td>
<td><strong>797,205.00</strong></td>
<td><strong>918,933.00</strong></td>
</tr>
</tbody>
</table>

Combustion and pyrolysis processing

To maximise its value and utilisation the basic vegetation needs to be prepared before it is converted into useable energy. For biomass boilers or AD this processing requires only that the moisture content is regulated to an appropriate level. To use the vegetation in domestic fires or wood burners the vegetation must be dried and then compressed into useable briquettes. However, a higher value product can be created if the vegetation is converted into biochar, where pyrolysis removes all of the water content to produce a ‘smokeless’, highly flammable substance which can either be burned or added to briquettes to improve their calorific value.

The cost of carrying out this work varies considerably as can be seen in Table 4.8. Loose biomass taken by tractor to a site costs only £5/tonne of dry matter. If the loose biomass needs to be transported longer distances on a truck before being stored in an AgBag the price increases to £10/tonne of dry matter. Briquettes can be of varying quality and can even be encased in wax to improve the look, feel and combustion qualities. The main variation is in how crumbly the briquettes are with wetter vegetation creating more friable material. However, this does not present significant differences in processing costs at the moment as costs hover around £75/tonne of dry matter and the intention is not to use material with a moisture content over 30% for briquetting. Costs at this point are based upon processing the briquettes in the field and if we were to move the vegetation to a more efficient factory these prices might reduce considerably. Biocharring costs closer to £100 per tonne, requires significant energy and time for the burn, and labour to monitor the process. However, it can provide a product with a much higher retail price.

Adding these figures together we can see that processing cheaply harvestable soft rush or reed into loose biomass for boilers can be achieved for less than £50/tonne. At the other end of the scale, if harvesting is difficult and the intention is to create biochar, total production costs might rise to well in excess of £500 per tonne in the worst case scenario. It is therefore clearly important to harvest and process appropriately.

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20 There remains uncertainty regarding the cost of charring – these remain estimates provided by North Energy Associates Ltd.
Table 4.8 The cost of processing one tonne of dry biomass for conversion into heat, gas or electricity.

<table>
<thead>
<tr>
<th>Product</th>
<th>Cost of processing (£/tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Loose Biomass</td>
<td>5</td>
</tr>
<tr>
<td>Briquettes</td>
<td>75</td>
</tr>
<tr>
<td>Biochar</td>
<td>100</td>
</tr>
</tbody>
</table>

Up to this stage the various vegetation types (at medium cost) would cost in total between £33 and £297 per tonne (Table 4.9)

Table 4.9 Cumulative costs of harvesting and processing one tonne of dry biomass for each wetland vegetation type.

<table>
<thead>
<tr>
<th>Vegetation</th>
<th>Loose Biomass (£/dry tonne)</th>
<th>Briquettes (£/dry tonne)</th>
<th>Biochar (£/dry tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fen</td>
<td>200.00</td>
<td>267.50</td>
<td>297.50</td>
</tr>
<tr>
<td>Grassland</td>
<td>37.50</td>
<td>105.00</td>
<td>135.00</td>
</tr>
<tr>
<td>Rush</td>
<td>82.50</td>
<td>150.00</td>
<td>180.00</td>
</tr>
<tr>
<td>Reed</td>
<td>68.00</td>
<td>135.50</td>
<td>165.50</td>
</tr>
<tr>
<td>Willow/Scrub</td>
<td>33.13</td>
<td>100.63</td>
<td>130.63</td>
</tr>
</tbody>
</table>

Costs of cutting fen habitats are higher than in other vegetation types. Furthermore, for combustion this would require significant amounts of drying which would add further cost and it is likely that it would be reserved for AD. If this were a strictly profit making business it would be likely that fen would simply be ignored to keep costs low. Since the purpose of the business is to facilitate better management of the site it is possible to cross subsidise, and since fen takes up a relatively small proportion of the total area it does not adversely affect overall costs and so could be included. Average harvesting costs come to approximately £45/tonne with current land holdings, rising to around £60/tonne if all potential land is included. It should be noted that this change is driven by the change in the kinds of vegetation cut rather than any losses from scale. In fact, we would be likely to receive some reduced costs from scaling up which might mitigate this increase in average costs.

Concentrating on the overall averages creates a simpler set of prices (Table 4.10), but also underlines the need to interlink the businesses and landowners in order to cross subsidise land management rather than incentivise farming for biomass.
Table 4.10 Average cost of producing different bioenergy products.

<table>
<thead>
<tr>
<th></th>
<th>Loose Biomass (£/tonne)</th>
<th>Briquettes (£/tonne)</th>
<th>Biochar (£/tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>52</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>Future</td>
<td>67</td>
<td>134</td>
<td>164</td>
</tr>
</tbody>
</table>

**Anaerobic Digestion**

Anaerobic digestion (AD) brings with it significant further costs, the majority of which are related to the capital costs of commissioning and building the unit. The Nix Farm management book (Redman, 2012) suggests that these costs would typically be between £1.5 and £2 million for a 450 kW plant. One of the DECC project participants have concentrated on a smaller plant at £100 kW, and with a capital cost of around £820,000 to provide proof of concept for smaller systems.

There are clear economies of scale for Anaerobic Digestion plants since capital costs increase slower than potential power output. Getting the balance between required levels of vegetation from reserves and reducing the capital cost to income ratio is a key decision. Using a larger system improves income as a proportion of capital costs but might require more vegetation or storage than is readily available. Using a smaller system puts greater pressure on the business to keep costs low, but it also means that lower amounts of vegetation are needed to fuel the digester. Approximately 2,300 tonnes of non-woody vegetation would be needed each year. Harvesting would make up most of the running costs of the unit which would only require 0.5 FTE staff to run it.

There are a range of opportunities for low interest finance for low carbon energy projects including: The Green Investment Bank and the European Investment Bank’s Natural Capital Financing Facility. As such, it is be possible to find funding although this may be difficult for small community initiatives. The economics of even standard AD projects are, as with all aspects of this project, finely balanced. The extra technical and capital costs of AD tend to make the simpler products more desirable. However, within a wetland system the AD ability to deal well with very wet vegetation adds much needed flexibility to the system.
Box 4.2. Carbon savings as a product

Carbon emissions are a tradable product either informally through voluntary markets or formally through mandatory emissions trading schemes such as the EU ETS. Where switching from fossil fuels towards low or zero emission fuels can be cheaper than buying carbon credits this can be a lower cost route to decarbonisation.

To estimate the potential cost of reducing carbon emissions we estimated values to feed into the following calculation.

\[
\text{Cost / tonne CO2e reduced} = \frac{[\text{Cost fossil fuel/kWh} - \text{Cost bioenergy product/kWh}]}{[\text{CO2e fossil fuel/kWh} - \text{CO2e bioenergy product/kWh}]}
\]

The calculations here are all based on retail fuel costs. These are very rough approximations based on the values we currently have and could change in different circumstances. In particular they consider only the fuel costs and do not include the varying capital costs involved in using different materials.

The calculation assumes that the only qualitative difference between the products is the amount of carbon produced. For briquettes & coal this is not the case since briquettes are a cleaner and tidier fuel source for the home and so sell at a premium. For loose biomass we have included an estimate for the increased cost of the boiler over oil or gas systems.

The table below shows that whilst briquettes cost more than fossil fuel alternatives and can yield a significant cost per tonne of carbon reduced the loose biomass yields a net saving per tonne of carbon.

<table>
<thead>
<tr>
<th>Bioenergy products</th>
<th>Fossil Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coal</td>
</tr>
<tr>
<td>Briquettes</td>
<td>-£40.42</td>
</tr>
<tr>
<td>Loose chopped</td>
<td>£58.07</td>
</tr>
</tbody>
</table>

Constraints

A normal business creates a product subject to the costs of production and the demand and given prices as well as basic technical limitations. For our business we add to those constraints environmental requirements which do not technically prevent production. If the product created more climate change emissions than it saved or damaged more habitat than it managed it would be a failure and the only way to know if we are breaching these constraints is to measure them.

a) Carbon emissions

This is dealt through conducting Life Cycle Analyses\(^{21}\) which showed an 85% - 92% reduction in climate change emissions over the use of natural gas or coal for heat respectively and including harvesting

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\(^{21}\) The Life Cycle Analysis (LCA) balances the carbon and greenhouse gas costs and savings associated with the conversion of conservation biomass to bioenergy for each of the processing techniques. Consequently, it is able to identify the upper threshold of where material can be sourced and transported to/from before the processes become unsustainable from an emissions point of view.
emissions. Sensitivity analysis of production and energy density led to only small changes in this overall emissions estimate. We can be assured that our system is greener than wood pellets produced from virgin forests. As such there should be ample opportunity to develop a brand which can displace some of these from the current UK energy mix.

b) Maintain habitat quality

In some respects this is not a constraint but a benefit of the system. By re-couping some or all of the costs of management we can better manage the land we have. Reserve managers often lack the money or capacity to manage reserves to the degree they would prefer. By being able to pay for the costs of removal we automatically increase capacity for habitat management. In doing so the concern should always be that reserve managers are not incentivised to cut more, or to cut inappropriately. This is not likely to be a significant problem since reserve manager’s aim is not to turn a profit but to manage a reserve. However, it may still at times be tempting to gain extra funds in one area to spend in another. Land managers must also consider the impacts of the harvesting work on soil structure and manage the impacts of heavy machinery. This may only marginal but being aware of the possibility might be enough to preclude it.

c) Prevent production of energy crops for the system

Outside of this particular scheme there is little that can be done to prevent landowners producing energy crops to convert into briquettes or AD. However, these technologies are widely used and known of, and so not a consequence of this project. Whilst incentives in the UK have not led to the explosion of productive land converted for biogas crops seen in Germany, it does not mean we should be complacent. In Somerset the aim would be to set standards for those working with us and, if and when a co-operative is set up, to have standards on land management built into the governance of the company.

d) To be profitable or save money

In section 4.1.3 we consider in detail the basic economics of the business. The constraint here is not necessarily that the business makes a profit but that money is saved from business as usual. Section 4.1.3 indicates that a profit is possible but care must be taken in interpretation since profit depends upon careful management.

There is always a concern when presenting averages or snapshot values from models and estimates that the reader might take the wrong impression. Reading the harvesting costs on fen land alone might easily give the impression that this work is hugely expensive and cannot be profitable. Equally, when looking at the average figures for the production of biochar for retail one might believe that the business is bound to be hugely profitable. In the case of biomass the truth is more uncertain. The economics are reasonably finely balanced. It would be easy to make poor decisions on which fields to harvest and be left with a large amount of overly wet product which cannot be briquetted. Alternatively, if large quantities of biochar are produced but buyers cannot be found, money will be lost. In wet years harvesting will be harder and the product will be of less use in the more profitable supply chains of briquetting or char.
which should be taken is that it is feasible to take these products and sell them profitably. However it may
be necessary to find financiers willing to accept long repayment periods for relatively low interest rates
which can then be repaid, still allowing a modest profit. All of these points rely on the skills of those co-
ordinating the biomass to make best use of it and develop supply chains able to consume everything
produced as the project, hopefully, grows.

4.1.2 Demand
Here we consider the potential demand for each bioenergy product including income from government for
the public benefits of these products.

Anaerobic Digestion
In 2011 DECC and Defra co-produced an AD strategy describing the government's interest in AD given
its potential to reduce waste destined for landfill and control the greenhouse gas emissions associated
with disposing of biological waste at landfill sites. The renewable energy potential of AD is of interest
given its potential to be produced at all times and more consistently than other renewable sources.
Finally, the government noted the production of fertilisers for improving the sustainability of farming
practices.

For small scale energy production the two revenue support streams which are of interest would be the
Feed in Tariffs (FiTs) and Renewable Heat Incentive (RHI). FiTs relate to the electricity production and
RHI to the heat produced. FiTs is paid as a generation tariff for all electricity and a flat export tariff of 4.7
pence for each kWh not used on site but fed into the grid. The generation tariff varies by technology and
over time. Currently the government plans to progressively reduce the feed in tariff for AD.

Within AD plants the tariff also varies depending upon the size of the plant with smaller plants receiving
higher payments. From the 31st of March 2015 AD plants under 250 kWh, such as the one suggested for
this project, would be paid 10.13 pence per kWh down from 15.82 pence before March 2014 when work
on this project began. It is clear from the timescales involved in developing projects such as this one how
government changes in rules and incentives act to dissuade investors from taking risks in these areas.

The RHI again varies by plant type and size. For small biomass it pays 8.6 pence per kWth of heat for
the first 1,314 hours each year and 2.2 pence for the remainder22. That heat cannot be used all year
around so restricting to 7 hours per day in winter and 3 hours per day in summer leaves 511 hours at rate
2. The simplest way to present this is therefore to think of it as £124/kW of heat produced by the system.
However, wetland biomass is not yet approved for RHI.

An AD plant may sell electricity into the National Grid and, as such, has access to a national market. For
that reason the local context is of less relevance. However, there is likely to be some competition (or
potentially collaboration) over the supply of feedstocks. Competition may exist if accessible feedstocks

22 http://www.rhincentive.co.uk/eligible/levels/
were to run short (though we see no evidence of that). Collaboration may be useful since the addition of drier feedstock to wet digestate (such as slurry) can improve the efficiency of the process. It is, therefore, possible that local AD plants might wish to share access to different feedstocks to find an optimum blend. In this context it is worth noting that there are two AD plants on either side of the study area for this work and six relatively close to the study area\textsuperscript{23}. However, all of these plants currently take slurry and food wastes. It may improve the efficiency of all of the AD plants to have some percentage of drier feedstock (i.e. a little fibre); we should therefore remain open to a broader, more collaborative, approach to bioenergy production through AD.

The AD plant is able to produce heat for use by local homes or businesses, and the intended capacity of the unit at Lilac Farm would allow it to provide heat for 30 homes. With household heating oil bills in the UK at around £33 per week for households using heating oil\textsuperscript{24} this could replace up to £51,000 of high carbon energy with cheap low carbon heat for the local community across the 30 households.

**Key Findings**

- The UK requires significant increases in renewable electricity production leaving significant room for expansion.
- Highly useful characteristics since it can use wet vegetation and the need for a variety of feedstocks might create demand for wetland vegetation.
- Though small in relation to the national picture the industry as a whole will be subject to the wider market forces for electricity prices.
- Government support exists which can provide a great deal of certainty needed for the investment.
- It is important to note the technical need to experiment and that full operational capacity might not be achieved immediately.

\textsuperscript{23} [http://www.biogas-info.co.uk/maps/index2.htm](http://www.biogas-info.co.uk/maps/index2.htm)

Solid fuel - domestic

The forestry commission showed that in 1997 9% of UK homes had wood heating and, of those, only 36% (3%) used it regularly and 8% (0.7%) used it as the main source of heating. This is changing, though slowly, due to changing preferences, energy prices and government policy (University of Strathclyde, 2013).

Prices for solid fuel products are highly variable since they come from a range of private suppliers; there is significant variation in quality and low consumer information. Table 4.11 presents a subset of the comparable prices found for the Somerset area.

The premium for kiln dry logs perhaps underlies the uncertainty consumers have regarding whether logs have genuinely been seasoned for the periods stated. Otherwise it may simply suggest that buyers are
not well informed regarding local prices. It may therefore be worth considering accreditation from a third party to support the quality of the product and obtain a higher premium.

We have found similarly variable prices for briquettes and expect to be producing a range of different quality products. However, prices have been seen as high as £270/tonne and they do not get as low as for wood. The Forestry Commission Woodfuel Scoping Study (Forest Research, 2008) investigation found prices for wood pellets between £114 and £300 per tonne but only £26 to £90 per tonne for woodchip, and £24 to £120 for firewood). We would expect briquettes to receive prices closer to those for pellets. The same study made estimates for the costs of production for woodchip and firewood and we include them here for reference.

This price variation is of interest: a proportion of the briquettes produced will be well packed and of very high quality; however, where the moisture content is higher or where the vegetation used has less binding qualities the compaction process could be less successful. The product in these cases will still burn well but will be more vulnerable to fragmentation. We imagine that we would price differentiate based upon that quality.

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Bulk price</th>
<th>Product</th>
<th>Price (£/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSM Firewood</td>
<td>No</td>
<td>Hardwood Logs</td>
<td>96.67</td>
</tr>
<tr>
<td>MSM Firewood</td>
<td>Yes</td>
<td>Hardwood Logs</td>
<td>91.67</td>
</tr>
<tr>
<td>West End Tree Services</td>
<td>-</td>
<td>Hardwood Logs</td>
<td>96.02</td>
</tr>
<tr>
<td>Minehead Sawmills</td>
<td>Yes</td>
<td>Hardwood Logs</td>
<td>38.00</td>
</tr>
<tr>
<td>Minehead Sawmills</td>
<td>No</td>
<td>Hardwood Logs</td>
<td>48.39</td>
</tr>
<tr>
<td>Barle Firewood</td>
<td>No</td>
<td>Kiln dry hardwood logs</td>
<td>97.50</td>
</tr>
<tr>
<td>Barle Firewood</td>
<td>Yes</td>
<td>Kiln dry hardwood logs</td>
<td>105.00</td>
</tr>
<tr>
<td>MSM Firewood</td>
<td>No</td>
<td>Softwood Logs</td>
<td>73.33</td>
</tr>
<tr>
<td>MSM Firewood</td>
<td>Yes</td>
<td>Softwood Logs</td>
<td>65.00</td>
</tr>
<tr>
<td>West End Tree Services</td>
<td>-</td>
<td>Softwood Logs</td>
<td>68.59</td>
</tr>
</tbody>
</table>

**Key Findings**

- Significant room for expansion as demand for woodburning stoves continues to grow
- It remains a largely informal market with data on quantities sold and prices piecemeal and uncertain
- There are huge variations in price likely driven by customer uncertainty regarding quality
- Good opportunity for low capital intensive direct sales to homeowners and businesses in bulk
4.1.3 Business Case

The development in Somerset can evolve from the capital infrastructure which has been put in place through the DECC project. This means the biomass boiler at the RSPB’s Dewlands Farm office, and the AD plant in Westhay. The remaining arisings (i.e. cut vegetation) can be converted into loose biomass, briquettes or biochar for wholesale or retail. In each case the costs associated with harvesting are theoretically incurred with or without the business. However, they are included here to give a better idea of the capacity of the project to offset these costs.

Biomass boiler

The installed boiler requires approximately 13 tonnes of woodchip per year containing 41.6 MWh of energy. This approximates to around 10 – 13 dry tonnes of vegetation from the surrounding nature reserves. Given the uncertainty in predicting off take this amount is small enough to be within the margin of error and so easily deliverable. 13 tonnes of woodchip would cost between £30 and £90 per tonne as quoted by the Forestry Commission. However, locally in the case study area it has been found to be nearer £100/tonne. Where lower prices are quoted, it may be related to the bulk production of whole trees from Southern US forestlands.

Production from the reserves costs approximately £50 - £60 per tonne. Much of that cost would be incurred from harvesting anyway, and the capital cost of the biomass boiler is equally offset by the need for the site to maintain some form of heating system. In addition, it could claim funding from the RHI, although wetland material is not yet registered. If wetland material were registered for RHI then as a small non-domestic system it would qualify for the same rates as the AD system which approximates to £2,300 per year for a site using 35,000 kWth as is currently estimated.

Table 4.12 The annual business case for biomass to bioenergy in the Somerset Levels, starting with the biomass boiler.

<table>
<thead>
<tr>
<th>Conversion system</th>
<th>Biomass boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass required</td>
<td>10-13 tonnes</td>
</tr>
<tr>
<td>Cost (£)</td>
<td>500 - 780</td>
</tr>
<tr>
<td>Incentives income (£)</td>
<td>0</td>
</tr>
<tr>
<td>Sales income (£)</td>
<td>500 - 780²⁵</td>
</tr>
<tr>
<td>Net income</td>
<td>0</td>
</tr>
</tbody>
</table>

Anaerobic Digester (AD)

The initial plans had been for a 100 kW plant which would require approximately 2,300 tonnes of wet biomass assuming 65% moisture content. The 100 kW plant therefore requires around 800 tonnes of dry mass. The capital costs increase the complexity of the business case for this technology. With FiTs at

²⁵ For the boiler we are assuming that we are selling the fuel back to ourselves at cost.
15 pence per kWh, the rate when the wider project started, with an AD plant costing approximately £800,000 could pay off the capital at 6% interest within 8-10 years. It would, with a 100kW plant, be difficult to recoup the full cost of harvest whilst paying off the loan. Once the loan is repaid the AD plant would have earned just over £90,000 per year whilst paying full costs for harvesting.

At current FiTs levels of 10 pence/kWh it would take closer to 15 years to repay the loan with interest and whilst paying only a nominal payment of £15 per tonne. Once the loan is paid off the site could pay for the full cost of harvesting and preparation, and still provide approximately £56,000 per year in profit. It is worth noting again that shifting government policy on FiTs levels makes it very difficult to plan long term to explore novel methods such as these. A lack of clear and stable government policy undermines innovation and investment.

The returns for AD improve significantly with a larger plant. A 250 kW or 450 kW system does not cost double, or quadruple, the initial capital costs and may therefore be able to make the system more viable. The Nix handbook (Redman, 2012) suggests a capital cost of £1.5 - £2 million for a 450kW AD unit. The pilot work undertaken through DECC project currently suggests that a 250 kW system may be the most economically viable. With a larger plant (250kW or 450 kW) it should be possible to recoup the full cost of harvesting whilst also repaying the loan. The initial landholdings would not be able to fully supply a 450 kW system, but a 250 kW system would require around 2,000 dry tonnes equivalent and could be supplied from current cuttings. For a 450 kW system it would be entirely possible to consider the vegetation as a supplement in the initial years to alternative, more common, waste fuel sources such as slurry. However, a system of this size might need to be placed near to higher capacity cables and require other capital investment.

Table 4.13 presents approximate values for different scale systems. Note, again, that we include the full cost of harvesting and, as such, the losses in the early years are less concerning given that they are costs which would already be incurred. The purpose of the table is to present an approximate picture of the impact from scaling up the plant size.

It is difficult to separate out what would be considered sales income from ‘incentives’ and so all income is presented as ‘incentives’. The losses in the initial years can be more than overturned by accepting a nominal fee for vegetation or waiving payment until the capital is repaid. For larger systems the biomass might be supplemented by other waste streams further reducing costs to the partners, though this may not be necessary or desirable. Decisions such as these, based on the realities on the ground, will make the difference between a profitable and non-profitable business.
Table 4.13 Approximate yearly budgets for AD systems before and after repaying the capital loan

<table>
<thead>
<tr>
<th>Plant Size</th>
<th>100 kW</th>
<th>250 kW</th>
<th>450 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass required (tonnes)</td>
<td>805</td>
<td>2,000</td>
<td>3,600</td>
</tr>
<tr>
<td>Capital Cost (£)</td>
<td>800,000</td>
<td>1,200,000</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Cost during repayment (£)</td>
<td>180,000</td>
<td>290,000</td>
<td>450,000</td>
</tr>
<tr>
<td>Cost following repayment (£)</td>
<td>60,000</td>
<td>120,000</td>
<td>210,000</td>
</tr>
<tr>
<td>Fuel Costs (included in costs) (£) (if all reserve biomass) (£)</td>
<td>40,000</td>
<td>100,000</td>
<td>180,000</td>
</tr>
<tr>
<td>Incentives income (£)</td>
<td>116,000</td>
<td>295,000</td>
<td>530,000</td>
</tr>
<tr>
<td>Sales income (£)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net income (During repayment) (£)</td>
<td>-64,000</td>
<td>5,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Net income (Following repayment) (£)</td>
<td>56,000</td>
<td>175,000</td>
<td>320,000</td>
</tr>
</tbody>
</table>

For the rolling business case we present the original 100 kW plan only. However, as can be seen, net income can increase significantly by increasing to a 450 kW system. It is, therefore, likely that a larger system would be installed especially since total harvesting costs could then be met. We therefore present approximate figures for a 250 kW system assuming capital costs of £1.2 million. Higher capital costs might preclude full harvesting costs being recouped in early years.

Table 4.14 The approximate annual business case for biomass to bioenergy in the Somerset Levels: the biomass boiler and an AD unit.

<table>
<thead>
<tr>
<th>Conversion System</th>
<th>Biomass boiler</th>
<th>AD 250 kW AD First 10 years</th>
<th>AD 250 kW AD After 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass required</td>
<td>10-13 tonnes</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Cost</td>
<td>500 - 780</td>
<td>290,000</td>
<td>120,000</td>
</tr>
<tr>
<td>Incentives income (£)</td>
<td>295,000</td>
<td>295,000</td>
<td></td>
</tr>
<tr>
<td>Sales income (£)</td>
<td>500 - 78026</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Net income (£)</td>
<td>0</td>
<td>5,000</td>
<td>175,000</td>
</tr>
</tbody>
</table>

Biomass, briquettes or biochar

These fuel products could be sold wholesale directly to be stored in homes, or for businesses, or else sold retail. Retail income is significantly higher for some products as char can be sold at £3/kg. £3000/tonne is 10 times higher than even the retail price of briquettes (at a maximum of around £3000/tonne)

For the boiler we are assuming that we are selling the fuel back to ourselves at cost.
Biochar wholesale prices are thought to be closer to £1,000/tonne delivered, or £850/tonne undelivered to larger businesses. Lower quality briquettes have been assumed to be worth closer to £180/tonne when sold for use in biomass boilers.27

Table 4.15 describes the costs for production of: loose biomass, briquettes and biochar; but does not include the extra cost of retail sale which may scoop up some of the profitability. Costs are based on a contractor carrying out the work with their own equipment and so include no capital costs. For instance, biochar might appear to be a highly profitable channel but the biomass business will not be able to claim all of that income once retailing costs are included. However, there would be scope to sell some of these products directly to homes or through the reserves.

These figures yield useful profits, but since we are dealing with averages it is important to ground them a little since we cannot simply turn every tonne of biomass into a £2,850 profit. To begin with the figures would suggest that no biomass should be wasted in the complex and costly AD system. However, it should be remembered that some of the biomass produced on wetlands will be very wet and unsuitable for these briquetting processes without significant and costly drying. As such, an AD plant is likely to form an important anchor in a system such as this one to deal with matter too wet for burning.

It should also be remembered that these figures do not fully account for some sites which will be more costly to harvest. If the land is dominated by fen the average cost of production will increase significantly, further underlying the need for partners to work together to ensure that all habitats benefit from the system rather than being ignored for more profitable land.

The income the business can yield depends upon what vegetation is used where. Careful decisions about where vegetation will yield the greatest income will make significant differences for this business. If dry matter is sent to the AD system and wet matter accidentally held back for briquetting it could turn a large profit into a loss very quickly. Whilst it might be tempting to convert everything possible into biochar, we may not be able to sell it all through existing channels. In the early years there would be approximately 800 tonnes of dry biomass remaining after the boiler and AD system has been fed.

The ranges in Table 4.16 are pulled up significantly by the high retail price of biochar and there is no reasonable way in which these can be achieved, particularly in the short term. They are gained from multiplying the figures in Table 4.15 by 800. However, a small business delivering loose biomass or briquettes to homes in the same model as current firewood sales is achievable in the short term. That business might reasonably be expected to make of the order of £36,000 to £100,000 per year before delivery costs, depending upon the price achieved and the total production of biomass.

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27 The concern over the friability of briquettes will ultimately come down to consumers and may not be as large a concern as currently thought. Sawdust briquettes can be very friable but are still sold in garden centres for wood burning stove use.
Table 4.15  Approximate average costs and income per dry tonne of storable energy products

<table>
<thead>
<tr>
<th></th>
<th>Loose Biomass</th>
<th>Briquettes</th>
<th>Biochar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost (£/tonne)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>52</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>Future</td>
<td>67</td>
<td>134</td>
<td>164</td>
</tr>
<tr>
<td><strong>Price (£/tonne)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>120</td>
<td>250</td>
<td>3,000</td>
</tr>
<tr>
<td>Wholesale</td>
<td>85</td>
<td>180</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Net Income (£/tonne)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>18</td>
<td>46</td>
<td>836</td>
</tr>
<tr>
<td>Maximum</td>
<td>68</td>
<td>130</td>
<td>2,850</td>
</tr>
</tbody>
</table>

Table 4.16  The annual business case for biomass to bioenergy in the Somerset Levels: the biomass boiler, an AD unit and storable bioenergy products.

<table>
<thead>
<tr>
<th>Conversion System</th>
<th>250 kW AD</th>
<th>250 kW AD</th>
<th>Loose, Briquettes or Biochar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First 10 years</td>
<td>After 10 years</td>
<td></td>
</tr>
<tr>
<td><strong>Biomass boiler</strong></td>
<td>10-13 tonnes</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td><strong>Cost (£)</strong></td>
<td>500 - 780</td>
<td>290,000</td>
<td>120,000</td>
</tr>
<tr>
<td><strong>Incentives income (£)</strong></td>
<td>2,300</td>
<td>295,000</td>
<td>295,000</td>
</tr>
<tr>
<td><strong>Sales income (£)</strong></td>
<td>500 - 780$^28$</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Net income (£)</strong></td>
<td>2,300</td>
<td>5,000</td>
<td>175,000</td>
</tr>
</tbody>
</table>

Scaling up

As described earlier there is significant opportunity to manage more land in the Somerset Levels and Moors. In scaling up the business the opportunity to sell biochar at scale to the retailer increases, the resilience of the business to wet and dry years increases, and the ability to differentiate the crop for that best used in AD and that best directly burned increases. Clearly, this further complicates the business model (as described in the next section), but the ability to place the business on a firmer footing, as well as more sensitively manage some areas of the case study area.

The land we have identified would increase the yield by more than five times up to approximately 15,600 tonnes per year. Even a 450 kW AD unit would be likely to use up approximately one fifth of that total, leaving 12,000 tonnes which could be sold wholesale for £220,000 profit as biomass, or £10 million as biochar. This would require significant scaling up of the logistics, which would bring further costs (as well

$^28$ For the boiler we are assuming that we are selling the fuel back to ourselves at cost.
as further savings), but these figures give some indication of the scale of the potential business. At these scales the business can easily cross subsidise the vegetation production for the AD unit in early years. These figures must always, however, be accompanied by the warning that with cost overruns, or particularly wet vegetation, that potential profits can quickly turn into a loss and that decision making and management of the vegetation is likely to be key.

### 4.2 Business structures

In order to harvest, process and sell wetland biomass as economically (as well as ecologically) sustainable bioenergy products we must bring together multiple actors. With such a wide array of landowners, processing technologies and companies, retailers, products and customers, and working within strict parameters relating to carbon emissions and biodiversity, there are many different options for combining all the variables together.

Through our research thus far it has become clear that both small, simple business models, and larger more complex ones, are viable. Unilateral agreements to sell biomass from land managers to contractors are a simple solution which could be used in the initial years of a scheme. However, this limits expansion, makes it harder to manage for years of poor supply, or to be certain that private land managers are not cutting too much and damaging habitat quality.

Another option is to establish some form of cooperative in which all members share in the profits. Significant interest in a cooperative based framework has been expressed by the local stakeholders in the case study area. This is a complex arrangement which would need to be established at the same time as the complex technical aspects of production are resolved; however, the benefits would be an ability to scale up production, maintain standards of habitat management for biodiversity manage stores for years of poor production and develop a trusted brand. Following the significant flooding events experienced within the study area in recent years work is being carried out to develop a Land Trust to try to manage the landscape for the benefit of local people. This Land Trust might eventually provide a suitable governance structure, if not a home, for a broader cooperative movement. To date no decisions have been made on business structure issues amongst stakeholders but there is a broad understanding of the pros and cons of these approaches, and there are no barriers to beginning with a simpler management system which could then evolve into a cooperative grouping.

#### 4.2.1 Potential business structure

Consideration must be given to how the different landowners, contractors and an AD unit are brought together to produce a range of bioenergy products. Figure 4.1 describes a simplified version of the flow diagrams used by the LCA process. Different shapes are used where a new company is required. The circle represents land managers, and would begin with three organisations split across several reserves.
There are two extremes which the business structure might take. These range from all the organisations working independently without formal agreements beyond individual trades of products or services. At the other extreme is an entirely co-ordinated cooperative where all members share risk and profits reducing the former and stabilising the latter.

In the scenario where the different organisations remain independent all interactions with other parts of the supply chain are simply transactions between companies. For instance, a contractor might pay (or be paid less than it would normally cost) to harvest and remove biomass. At this point they would then own the material. The contractor might then sell that biomass on to an AD plant or briquette it for sale. At this extreme all sales are a one off and there is no certainty of future sales. Fuel dependent capital, such as an AD plant or boiler at a site, would be dependent on continually agreeing terms each year with other parts of this complex chain. If they failed they would have to find fuel from elsewhere and, whilst slurry or wood pellets might be available, this model provides little certainty. In one year a land manager might pay a contractor to remove biomass, which would be owned by the contractor, but in the next decide to retain the biomass after cutting, or expect to be paid for the contractor to access the land.
It is possible to improve on this by creating longer term supply contracts between organisations. For instance Estover, a small renewable energy company\(^{29}\), are considering multiple year contracts to guarantee access to coppiced materials from nature reserves. Such contracts can include clauses to prevent the need to cut in years in which quality of the site as habitat for wildlife might be damaged by harvesting. On the other hand, it helps to ensure that fuel sensitive capital will have access to material for a number of years, and precludes continually negotiating a new contract each year. Such a solution removes some of the cost and risk of the independent model but does not require complex governance structures.

Combining these loosely organised companies and eNGOs into a single co-operative lies at the other end of the spectrum. There are clear difficulties in putting together a management structure, deciding on proportions of ownership or access to profits. It may be that as the technical details of moving from

\(^{29}\) http://www.estoverenergy.co.uk/about/
experimental production to actual supply are determined, this extra layer of complexity may be too much. Furthermore, before some of the technical aspects of supply are known it might be difficult to develop a workable constitution for such a cooperative. Nevertheless, there are significant advantages presented by such a group regarding:

- Supply Risk
- Harnessing the range of abilities in different organisations
- Ensuring environmental and product standards
- Enabling Expansion

Supply risk

Variation in vegetation production or the accessibility of sites for harvesting between years is likely. By linking all land managers together it may be easier to deal with years when harvesting produces less material due to their capacity to store arising’s on their land, and/or because some sites might be less badly affected than others. There is also the improved capacity of a coordinated business being able to negotiate spot sales from private landowners in lean years in order to meet minimum requirements for AD units and any boilers.

Abilities

By creating a cooperative structure, each member can bring different skills and knowledge to the group that can be used to drive the biomass to bioenergy model forward. For example peat producers will slowly cease mining activities in these areas leaving land which might be best used for wildlife conservation and bioenergy production. Peat producers have existing retail supply chains an infrastructure for their current compost products. Including the peat producers as land owners in a co-operative may bring different retail and logistical contacts or experience that the eNGOs or contractors do not have. Similarly, the environmental organisations are able to provide land management expertise that enables biomass to be produced without impacting negatively on biodiversity.

Standards & expansion

The LCA is necessary to ensure that the bioenergy products yield genuine savings in greenhouse gasses. With respect to biodiversity we are carrying out monitoring, but given that the primary purpose of Somerset Wildlife Trust, the RSPB and Natural England is the protection of the natural environment we are not concerned that desire for funds from energy production will damage habitats. However, if the project expands to include private landowners with different incentives it is less certain that land which might otherwise be used for food or biodiversity might not be used for energy crops. This has been a significant issue in countries such as Germany where demand for energy in AD plants has led to a significant expansion of bioenergy production.
Scaling up the business model to the national scale

Bioregional provide a model for how local producers could scale up to a degree required for national retailers (Desai et al., 1996). Through their experiences with B&Q they found that sustainable small scale charcoal producers were struggling to access national retailers because they could not produce in large enough volumes. To overcome this they provided centralised standards and provided barcoded bags to regional producers who could then deliver direct to their local stores. In this way they combined 32 small scale charcoal producers into a single brand. This model might be useful both in Somerset but also for expanding this business model across the nation.

If reserves across the country were to begin to produce char in relatively small amounts we might attempt a similar model. The far higher returns from char would provide a significant incentive to find some way to make it a significant part of the business.

4.2.2 Suggested business structure

Short term – small & simple

The cost of harvesting vegetation can vary significantly between high density easily accessed areas and low density quagmires. Variation in moisture significantly affects the calorific value for combustion materials and the ability to briquette biomass. At the other extreme material which is too dry and high in lignin will affect its use in AD. We can estimate these impacts but we cannot create a model able to predict perfectly which areas should be harvested at what time, and how they should be used in each year. Decisions such as these will develop over time and as such it is reasonable to begin cautiously whilst managers get to grips with the system.

The second reason to start small is that we do not yet have channels through which to supply large quantities of biomass. The initial years will involve working to establish a customer base, be that direct retail sales or wholesale through existing fuel merchants.

In starting small the business might lose some flexibility in the management of the land. The larger the system the better able we might be to grade the biomass into: wet, medium and dry, and send it to the AD plant, loose biomass/low quality briquettes, high quality briquettes and biochar respectively. In a larger business mistakes or simply necessary harvesting decisions in individual areas on difficult land have proportionally lower negative repercussions. A larger business might also find it easier to negotiate larger contracts for high value biochar products and spend less time trying to find buyers. However, these impacts are likely to be outweighed by the reduced possibility of being left with large quantities of unsellable products harvested at too high an expense. The business should therefore not aim to expand beyond the partnership reserves in the first years.

Longer term the companies providing harvesting and storage services might be brought into a more integrated business. To begin with the preferred option is that they be hired as contractors to carry out harvesting, chopping and briquetting work with the vegetation remaining the property of the landowners.
The aim in the first years should be to grade this vegetation by moisture content and sell it wholesale to the AD owners and current wood fuel suppliers, or direct to homes and businesses in bulk. The extra value associated with biochar is a significant incentive but until clear channels are found to buyers it would be difficult to be certain we could sell it all.

If a 250 kW or 450 kW AD plant were commissioned this would be able to consume a significant proportion of the feedstock available which is of a wetter nature. A 250 kW system would take up around 2,000 tonnes of biomass leaving roughly one third for use in briquettes. This would be beneficial if it is found that large proportions of the biomass is too wet for briquetting, or that it is too costly to process such large quantities in the simple manufacturing systems available. The 450 kW system brings with it significant increases in profit margins. However, the size of the plant depends upon financing and technical feasibility on site.

To sell the remaining biomass as briquettes will require significant effort in developing a customer base. Firewood provision in the UK is largely through local businesses delivering in bulk and advertising through the internet, local businesses and classified adverts. The capital costs of setting up such a venture would not be prohibitive large, requiring only a truck and a driver. It may take some time to build up a customer base able to buy up the entire stock produced. Aiming to supply in bulk to businesses with biomass boilers, promoting the improved environmental credentials (over pellets), might reduce that risk.

An alternative to direct sale would be to offer the briquettes to existing firewood businesses at wholesale prices which would reduce total profits. It would also create a dependency on these companies long term, as the direct customer base would never be built. However, it would, if achieved, provide a quicker and more dependable source of demand.

It might be wise in the beginning not to try to convert and sell all 800 tonnes of biomass remaining. A proportion could be created and expansion of sales could follow as the consumer base grows. Profits may be, at best, modest in the early years as costs may be higher, and the prices offered for the novel product lower than we might hope. However, with careful management this section does show that it should be possible to fully recoup the costs of habitat management which are normally a burden to land managers. A prudent and cautious start should still leave scope for a more ambitious development as technical management issues are worked through, and technical capacity and a customer base is built.

It is possible that a cautious approach would struggle to overcome financing, supply chain and technical problems which might be resolved by a bolder start. However, it seems unlikely that much would be lost from a prudent slow start which could be accelerated if indications were that this would be the less risky approach.
Long term - co-operative working

As those developing the project build the skills to efficiently manage the biomass and grow their consumer base it will be time to bring in more land owners with more biomass. At this point, rather than having to duplicate work across a range of landowners, it would make sense to band them together into some form of co-operative. Furthermore, because of the need to flexibly move biomass between production chains, depending upon quantities and moisture content, it would also be useful to include the processing businesses in the co-operative. The benefits are clear and include:

- Supply at scale to larger retailers
- Reducing the possibility of not selling everything
- And opening the possibility of providing higher value products such as char
- Share costs of marketing and administration across the partners
- Develop a brand
- Reduce uncertainty of supply
- Shift vegetation between product paths to ensure the driest biomass is reserved for briquetting
- Maintain production standards
- Set and maintain high biodiversity protection standards

The benefits are not unique to this biomass system. The Scottish Forestry Commission has provided recommendations for foresters to form cooperatives for woodfuel production (Forestry Commission Scotland, 2011). In that system they suggest co-operatives between forest owners which might also include forestry contractors, chipping contractors and hauliers.

The concept of a co-operative can be loosely defined as any member owned business. In the case study area, there are a range of possible options for developing some form of co-operative grouping for biomass to bioenergy. Other organisations provide information on how to set up community groups/co-operatives for this purpose (e.g. Forestry Commission Scotland, 2011; Forestry Commission, 2015), but key points include:

- Appointing an honest broker
- Carrying out a feasibility study
- Choosing an organisational structure
- Adopting a legal structure

The honest broker can be found through a range of co-operative development groups. Partners in this project currently work well together already but an experienced broker could still provide advice and ensure that all parties feel fairly treated through the process. This role could be carried out be an intermediary, such as the Energy for Nature Coordinator role, outlined in Chapter 4.
A feasibility study would be a sensible step at this stage. It would gauge how the businesses are doing and where they would sell the increased production. For a co-operative group it would also describe the shared vision and ensure that all parties are agreed on the direction.

Organisational structure defines the kind of members and how they are integrated. If the various stakeholder organisations were brought together to share their products and services it would be a consortium co-operative. Alternatively, there is the possibility that a Land Trust will be developed in the case study area to deal with future challenges that could arise from flooding. If such a Trust is developed it might provide the perfect vehicle to support a biomass to bioenergy co-operative and simplify the process for having done much of the work already.

A range of legal business structures are available. With the mixture of private, charitable, public, and community members, and given the wider aims of the project for community benefit, there is one structure which may be of future interest: Community Interest Company (CIC). The defining feature of a CIC is that it benefits the community. Such a company can still be a public or private company limited by shares or limited by guarantee. It would also still be registered with Companies House. However, the assets and profits from the company would be restricted in use and size respectively to ensure that the primary focus of the company is the public good. These restrictions could provide desirable guarantees for the charitable and public members of the co-operative.
5 Evaluation

Energy for Nature is a concept that could help conservation organisations generate an ecologically sustainable income stream to fund essential habitat management for the benefit of wildlife and people through the sale of bioenergy. It is an interesting idea that takes PES and its guiding principles but develops it in a new direction. The scope of Energy for Nature is great, with opportunities for local communities to become involved as well as land managers.

Below we evaluate the project against key questions set by Defra in order to inform the growing literature around the opportunities and application of PES in the UK.

a) Has proof of concept been demonstrated? Are there show-stoppers?

Energy for Nature is more complex than the typical PES model; however, the concept does make use of, and build on, the general PES principles outlined in Defra’s Best Practice Guide (Defra, 2013) whilst successfully delivering benefits to nature. In its simplest form both Energy for Nature models presented meet the five basic elements of a PES scheme as put forward by Wunder (2005) and Defra (2013):

1. A voluntary transaction where
2. A well defined ecosystem service, or land use likely to secure that service
3. Is being ‘bought’ by a minimum of one ecosystem service buyer
4. From a minimum of one ecosystem services provider
5. If, and only if, the ecosystem service provider secures the provision of the service (conditionality)

In meeting this overarching criteria Energy for Nature allows all actors the choice to enter into a scheme, and energy biodiversity and in some scenarios carbon benefits, (Box 4.2) are the ecosystem services delivered (in the first instance) by defined management interventions. Through purchasing bioenergy products the buyers are indirectly paying for habitat management to ensure biodiversity is conserved. In addition, there will be multiple sellers (service providers) within a given landscape and, similarly, multiple buyers. In both of the models presented the actors are the same as in a typical scheme, i.e. sellers, buyers, intermediaries and knowledge providers, and in the Land Manager Model payments can move directly from buyer to seller when the bioenergy products being sold are briquettes, biochar or raw biomass. The PES ideas of scale, additionality, conditionality and permanence of service delivery are all addressed within both Energy for Nature models, as are the modes of payment. The biggest departure from a typical PES scheme is the two staged payment pathway in which the payment moves from buyer to seller via a processor who is required to convert raw biomass into saleable bioenergy products. However, in the long term this pathway is unlikely to be followed in the Land Manager Model as it is least profitable compared to the land managers selling bioenergy products directly to the buyers other than where sellers are selling biomass direct to AD operators. The Community Model would use this more complicated payment pathway as it would be based on a form of co-operative structure where members pay a membership fee and receive a share of the surplus revenue.
Using these principles, whether the approach adopted is that of the straightforward Land Manager Model or the more complex Community Model, this study has demonstrated that the PES model provides the basic foundations on which to build a successful Energy for Nature scheme. It presents the ability to embrace different scales of operation, from a simple, direct payment structure between single parties to a wider landscape/community delivery which may incorporate a range of payment pathways. This ability enables the principles of Energy for Nature to be applied to a range of diverse locations at a relevant scale which in turn will be determined by area specific factors such as biomass characteristics, stakeholders and market.

A range of challenges were identified through the stakeholder workshops, from variability in the quantity and quality in the supply of feedstock, to the length of contracts between sellers and processors, and transaction costs. These are all important considerations for the development of any Energy for Nature scheme and, provided all relevant stakeholders are involved from the beginning of the development process, these challenges may be addressed and potentially mitigated for. They have the potential to be show-stoppers if not fully considered; however, with proper planning and risk analysis the likelihood of any of these factors preventing a scheme from being developed is much reduced. The employment of an energy for Nature Coordinator to act as an intermediary will also help address these challenges. For example, the coordinator would have an overview of the biomass supply and demand requirements within a landscape, and ensure that biomass was appropriately stored to provide continuity in the supply of feedstock.

One additional barrier highlighted was the classification of some of the biomass by the Environment Agency (EA) as a ‘waste’ material, and therefore subject to waste rules. This could have serious consequences in relation to acquiring the necessary permissions for developing a conservation biomass to bioenergy scheme. However, this classification is still open to interpretation and, following conservations between Defra and the EA, it has been concluded that each situation needs to be assessed on a case by case basis. Currently all the material that has been processed from reserves has been seen as a low risk material and, where necessary, is operating under an exemption. Using the legal definition of ‘waste’ from Defra, which is ‘any substance or object which the holder discards or intends or is required to discard’, it could easily be argued that the material harvested from reserves has a use as a biofuel, and is therefore not a ‘waste’ material and should not be subject to the same restrictions.

Depending on the conversion methods chosen to produce bioenergy a significant investment in the installation of infrastructure to enable delivery may be required. For example, this may well be the case for the use of medium scale (i.e. 100 to 200 kW) AD systems. This could be a barrier for some community schemes where it may be difficult for community groups or co-operatives to secure the necessary level of investment. This issue was raised through both expert talks and participatory workshops at the recent DECC sponsored Community Heat Conference and in the UK Community Energy Strategy (DECC, 2014). Scoping and feasibility studies may be funded through initiatives such as

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http://www.regensw.co.uk/event/decc-community-heat-conference/
the Rural Community Energy Fund (RCEF) and Urban Community Energy Fund (UCEF) through WRAP. For anaerobic digestion income streams can be generated through either the Domestic or Non-Domestic Renewable Heat Incentive (RHI) but this is only triggered post-installation. This could be mitigated against if the UK Government could establish funding streams which utilise existing feedstocks to help support the growth of the biomass to bioenergy approach within local communities.

Choosing the correct methods for converting biomass to bioenergy is crucial for Energy for Nature to operate successfully. Failure of land managers or communities to understand the characteristics of the biomass they have available to them, or consider the variability in quality and/or supply could easily compromise the business case and result in scheme failure. This is where the role of the Energy for Nature Coordinator is essential. With knowledge of the conversion processes, the characteristics of the different forms of biomass and the availability within the landscape, the coordinator can help prevent the use of inappropriate conversion techniques and promote scheme success. The importance of having an intermediary role in Energy for Nature reflects the findings of the previous Defra PES pilot projects (Dunn et al., 2014).

b) What is the ‘prize’, or opportunity for PES, and can this be quantified?

Conservation organisations, such as the RSPB, are finding it increasingly difficult to secure funding to deliver conservation management for the benefits of wildlife and people. In dynamic habitats the quality and area that can be managed is limited by the vast quantities of surplus biomass generated through operations. For habitat management to continue, and improve, in key habitats, such as wetlands, this problem needs to be addressed, and conservation biomass to bioenergy through Energy for Nature provides a dual solution to removing the biomass challenge and funding management. For the RSPB alone, this could enable us to convert vegetation which costs c. £70,000 per year to harvest and remove via contractors, into bioenergy products worth £150,000 as wholesale loose biomass, or over £5 million if converted into biochar and sold retail. The business models rely on biomass being used in the correct process, and suitable biomass for the most profitable conversion techniques (i.e. biochar) may not always be available, therefore it may not be possible to achieve such high profits. However, creating a profitable business is. The impacts for land managers, and therefore on landscape scale management for conservation (and potentially other ecosystem services) is significant.

Although a more complex idea, the fact that many of the PES concepts laid out by Defra can be followed, or to some extent incorporated, within Energy for Nature suggests that this type of scheme is the next step up from the typical PES model, such as Environmental Stewardship. For example, by having the two models available within the scheme Energy for Nature becomes accessible to a wider range of stakeholders within a landscape. This format provides opportunities for land and/or conservation managers to improve their habitat management, and also enables local communities to become involved, growing resilience and promoting rural development at the same time as improving their landscape. Whether the driver is land management or community development both models increase the potential opportunities for delivering biodiversity at the landscape scale, following Lawton’s ‘bigger, better, more
joined up’ principles (Lawton et al., 2010). Also, from a climate point of view Energy for Nature could help contribute to a low carbon, more sustainable economy.

The Community Model has interesting potential surrounding rural development and raising awareness of sustainability issues, in addition to wildlife conservation. In this instance Energy for Nature could help build stronger, more resilient and environmentally sustainable rural communities. Conservation biomass to bioenergy has the potential to reduce the carbon footprint of the communities through providing communities with alternative, green, sources of energy in place of fossil fuels, bolster the local economy through the sale of bioenergy products and, potentially, create local jobs through the creation of a Community Energy Hub. Children’s disconnection from nature was highlighted in The Natural Choice (Defra, 2011) as an issue that needs addressing, and a community based Energy for Nature scheme could prove to be a great way of reconnecting children and adults with the natural environment. For example, taking local school children to visit sites during harvesting operations, to see briquettes being made from the harvested material and then take a sample home is a simple way to convey the message that nature needs looking after and it provides us with benefits if we do.

More research is required to fully understand the benefits of Energy for Nature, particularly in relation to the delivery of additional ecosystem services across a given landscape. However, at least for wetland habitats, it is likely that there would be some important additional benefits linked to carbon sequestration and water management.

c) What has been achieved through the pilot?

This project was developed in parallel with the final year of DECC’s Wetland Biomass to Bioenergy project. The DECC project focused primarily on the practicalities of removing biomass from sensitive sites and turning the material into bioenergy. However, how this work could be operationalised was outside of the scope of the project, and through this Defra funded pilot we have been able to start addressing this knowledge gap. Through the project we have:

- Established the level of interest in a PES style scheme in the Somerset Levels and Moors case study area.
- Identified the key motivations behind the interest in Energy for Nature and established the need for two models: the Land Manager Model and the Community Model.
- Energy for Nature schemes in larger landscapes could contain several sub-schemes within smaller ‘catchments’. Schemes could be a mix of both models.
- Identified the key actors required in an Energy for Nature scheme, including the essential role of an intermediary in the form of an Energy for Nature Coordinator.

31 During the DECC funded Biomass to Bioenergy project the average net GHG emissions saving achieved compared to the counterfactual situation of traditional wetland management and the burning of fossil fuels to provide energy was from 85% for natural gas rising up to 92% for coal.
- Identified transaction costs (both real and perceived) as being potential barriers to scheme uptake.
- Built on old relationships and engaged with new stakeholders, building trust amongst interested parties in the case study area.
- Developed the Conservation Biomass Calculator, a tool for assessing the biomass potential and bioenergy options for land managers.
- Developed an environmental monitoring strategy to assess the impacts of machinery and operations on sites.
- Used Defra's PES guidance to work through phases 1 and 2 of PES scheme development.
- Got to a position where we have sufficient knowledge to enter Phase 3 of PES development (i.e. negotiate contracts) for the Land Manager Model and trial delivery within the landscape area of the Somerset Levels and Moors if the necessary resource can be secured.

In relation to adding to PES schemes more generally we have:
- Established that Energy for Nature can be considered as a PES-like scheme, conforming to, and incorporating, a range of broad PES principles.
- Energy for Nature would operate in landscape areas, which contain smaller ‘catchments’ for the delivery of bioenergy schemes, for which the boundaries are defined by life cycle analysis.
- Whatever approach is adopted, whether payments are direct from buyer to seller, or via the processor/co-operative, all are input based. One of the key principles is that payments are only made for products sourced from sites adhering to environmentally sensitive management practices which are undertaken to enhance areas for biodiversity.

d) What is the legacy of the project? What can we say about the prospects for PES going forward?

This pilot study has brought together interested parties in developing and testing an Energy for Nature PES-like scheme in the Somerset Levels and Moors. Having generated interested and worked through the first two phases of the PES development guide the next stage is to negotiate contracts (i.e. Phase 3) and pilot the scheme in the study area. The RSPB, in partnership with others, are continually looking and applying for funding to take this work forward.

There are two aspects that we are particularly interested in developing in the next stages of any follow on research: how would the community model work; and, how would the intermediary operate within a scheme. For the Community Model we are interested in how this could operate on the ground as a Community Energy Hub and are currently looking for funding to explore this further in the Avalon Marshes in the northern area of the Somerset Levels and Moors.

The role of the intermediary is crucial and the only way to fully understand the requirements of this role, and how it may be resourced, is to test it through piloting a scheme on the ground. We are keen to build
on the work we have done in Somerset and trial Energy for Nature scheme(s) in this area. We are currently in a position to move forward with this work, subject to future funding being made available.

Further work is required to identify and quantify the additional ecosystem services within the case study area and how these change through the creation, restoration and management of region’s wetlands. Once this data has been gathered we can assess how best to adapt Energy for Nature, and move from piggy-backing to a more cost effective payment structure, such as layering or bundling.

e) What are the lessons from the project?

Dunn et al. (2014) acknowledge that most of the pilot schemes funded by Defra thus far can be more accurately be described as ‘PES-like’, and Energy for Nature would be no different. The scheme would conform to certain elements of PES more than others. However, whether truly a ‘PES scheme’ or not, Energy for Nature has the potential to generate a sustainable income stream to fund essential habitat management for conservation, or provide local ‘green’ energy for rural communities.

This project was developed to compliment work already underway by DECC. As such, our study area was chosen to be in a landscape where we already had good working relationships with, and knowledge of, local stakeholders, the landscape and the related landscape issues (in terms of both biomass and wider issues, such as flooding, etc.). For a project operating over such short timescales this was essential, and proved extremely useful when engaging with the local stakeholders. We found that many of the questions raised in Phase 1 of the PES development guidance were already addressed through other projects in the area, making working with local colleagues essential. If Energy for Nature were to be developed in landscapes outside of this case study area we would strongly advise the development team (whether a land manager or community group) to make use of local networks or staff members of local environmental and community organisations to get stakeholders involved in the very beginning of the process.

It became clear during the very early stages of the project that for any scheme to succeed transaction costs would need to be addressed – both those that were real (e.g. time for land managers to assess biomass to bioenergy potential of their land) and those that are perceived (e.g. biomass to bioenergy is too complicated/too much work/not worth investigating). Both sellers and processors suggested that there was a need for some form of intermediary to act as a link between actors, linking each together and negotiating contracts. We have suggested the Energy for Nature Coordinator as a role that would fulfilled this requirement. The coordinator could be independent or from an organisation; however, they should be local to the landscape in which they are working, and ideally be known and trusted by at least some of the stakeholders.

There are still many uncertainties surrounding conservation biomass to bioenergy. This means that the payment pathways (or business model) chosen may need to be flexible, enabling actors to adapt to changing conditions over time. For example, in the short term, to help initiate the culture shift, it may be
more prudent for land managers to pay processors to harvest and convert the biomass into bioenergy, but retain ownership of the biomass. In this situation it would be straightforward to use this biomass for AD whilst a base of wholesale or bulk business and residential customers is built along with technical capacity to organise the biomass to enable other opportunities to be exploited. Long term, greater profits and business resilience may be gained by grouping contractors, landowners, the local community and the AD business in a consortium co-operative. The co-operative would spread costs from more costly harvesting areas, enable better grading of biomass quality into appropriate products, and develop enough scale to potentially provide the much higher value biochar to national retailers to achieve greater profits. However, adding this level of business complexity to the technical and business development issues of the early years might overcomplicate the early development unnecessarily.

f) How transferable is this to other parts of the country? Are there particular actions the Government could be doing to facilitate or remove barriers?

Energy for Nature has been designed around landscape scale wetland management for biodiversity. The Land Manager Model is based on solving a conservation/land management problem through the sale of biomass; this can, therefore, be applied across similar landscapes in the UK and across Europe where surplus biomass is an issue, and sustainable funding streams are required to continue habitat management. The Community Model would be transferable across the UK. With different socio-economic structures in other areas of Europe we have not looked at how this would operate outside the UK as yet, but have partners in Poland, Lithuania and Belgium who are keen to explore this area further.

Energy for Nature is adaptable for other habitat types. For example, heathland management also present conservation/land managers with similar difficulties to wetland managers, and a version of the Conservation Biomass Calculator is being developed to facilitate the use of heathland materials for biomass to bioenergy. Woodland management also generates large volumes of biomass that could be converted to bioenergy, and are another habitat of interest to both the RSPB and others. The Forestry Commission have recently published guidance on how to develop community based woodfuel schemes (Forestry Commission, 2015), and this guidance could provide a useful starting point for a community Energy for Nature scheme based on woodland biomass.

We are aiming to make the Conservation Biomass Calculator available as an online tool accessible to all land managers, available to people within and outside of the RSPB. Specialists within the RSPB’s web team have confirmed that this is technically feasible and only a moderately complex piece of work for us to undertake. Consequently, we will progress this subject to successfully finding funding.

Within the RSPB we are developing a long term strategy which will enable us to roll out Energy for Nature across our reserve network. In order to develop this, a landscape scale approach will be used to identify key habitats (and therefore reserves) where biomass is problematic and affecting our conservation management, and where there is potential within the wider landscape surrounding the reserves. Using the Conservation Biomass Calculator the types and quantities of biomass can then be assessed for our
reserves, and then the wider landscape, and either the Land Manager or Community Energy for Nature models can then be applied as necessary. For us to be able to do this effectively more information about how these potential Energy for Nature schemes could work needs to be gathered through trials on the ground.

Through this Defra project we have established our models as a basis for delivery. We now need to test them to be able to demonstrate true proof of concept, identify any barriers, challenges or opportunities that occur through the implementation process, and establish how best to mitigate these and other issues. As such, we propose to build on the work carried out in Somerset and use the Somerset Levels and Moors as an initial pilot area, with the aim of trailing within the Avalon Marshes in the north and then new ‘catchments’ in the south of the region. Ideally we would then like to trial in other landscapes to test landscape transferability, preferably where the DECC work has also taken place and we have stakeholders who are interested, or at least knowledgeable about the biomass to bioenergy concept. This will be captured within the wider long term RSPB strategy and will form the basis on which we look to progress this work forward in the future.

Although the RSPB are extremely keen to develop this research, any future work is subject to further funding, which is difficult to secure. Further investment by the Government through Defra and DECC would be a great help in driving this work area forward and help organisations to get over the hurdle of moving from scoping and developing the concept to applying it in practice and testing it.
References


