Short Rotation Coppice for Energy Production

Good Practice Guidelines

Photo: Forest Research

Photo: Steve Wright

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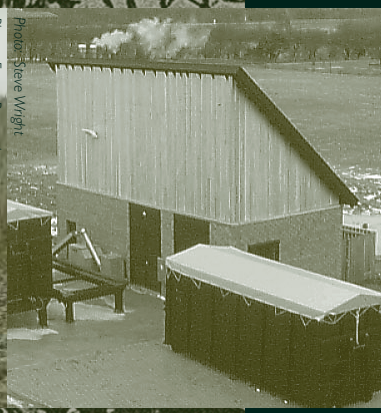

Photo: Steve Wright

The development of an economically and environmentally sustainable industry

Photo: BG Energy

These guidelines were designed in partnership with the following organisations:

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Town Planners Landscape Architects Architects
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The guidelines were produced using a consensus building process which was designed and guided by a steering group made up of British Biogen, Friends of the Earth, ETSU and Environmental Resolve (an undertaking of the Environment Council). The process brought together the industry, environmentalists, planners and government agencies in order to address potential stakeholder concerns and support the development of the industry in a sensitive manner. Full details of the process and participants are given in Appendix 1.

Funded by the Department of Trade and Industry through British Biogen

First published November 1996, reprinted May 1999

Short Rotation Coppice for Energy Production

Photo: B9 Energy

The development of an economically and environmentally sustainable industry

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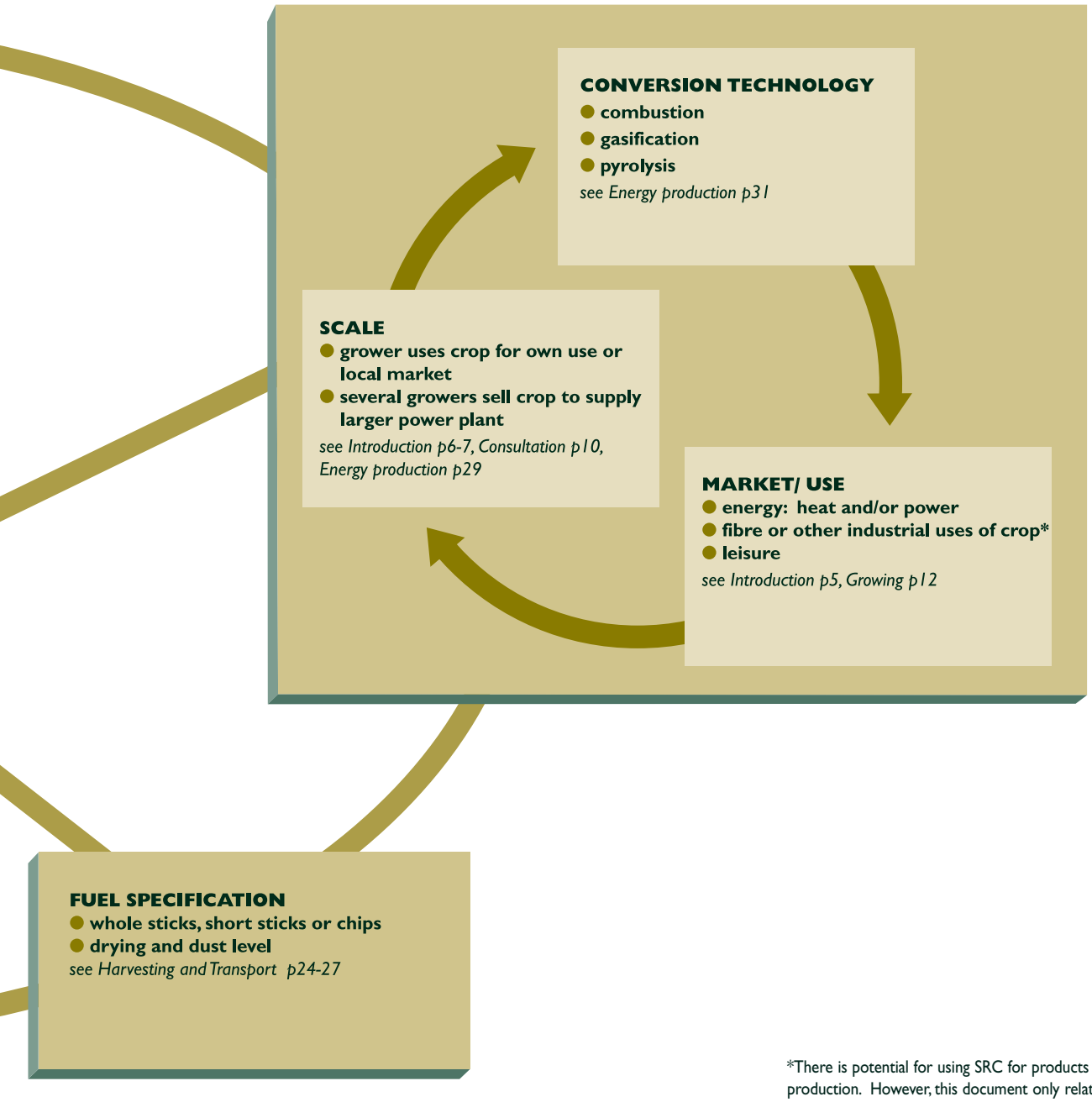
Contents

Summary of the relationships between all aspects of developing SRC for energy production.

This chart shows the close relationship between all the elements of any development of SRC for energy production. In many cases, one element will determine another: for example, the fuel specification will determine the harvesting methods, which will in turn determine the crop layout.



*There is potential for using SRC for products other than energy production. However, this document only relates to SRC used for energy production.

Introduction

Photo: British Biogen

SRC Willow, an energy crop.

What is SRC energy production?

Short Rotation Coppice (SRC) is an energy crop, usually willow or poplar, which is used to produce either heat or electricity or both. It is known generally as biomass and is a type of renewable energy.

Renewable energy developments are generally considered to be environmentally beneficial, by providing clean energy from resources that are continually replaced. However, as with any development, Short Rotation Coppice energy production projects can have local impacts. Therefore, it is the responsibility of developers to consider the environmental impact, economic viability and acceptability to local communities of each scheme.

These good practice guidelines aim to help new projects to proceed in an appropriate and sensitive manner so that the industry as a whole can continue to expand with a responsible reputation. They have been developed by a whole range of organisations and individuals with extensive experience as developers, environmental bodies, farmers and planners of Short Rotation Coppice developments for energy production.

Benefits of SRC development

The development of SRC for renewable energy production is a new industry with potential for considerable expansion, offering benefits for growers, developers, consumers, local communities and the environment. It is a form of renewable energy which has great potential to help meet

current and future demands for energy.

Any development of renewable energy must be seen in the context of UK and EU policy on sustainable development: that is, development which meets the needs of the present without compromising the ability of future generations to meet their own needs. Energy production is a vital element of such a future. Pollution problems, current rates of consumption of fossil fuels (such as coal and oil), and dependence on imported fuels associated with conventional methods of energy production are generally seen as unsustainable.

Energy crops offer one of the greatest potential sources of renewable energy for electricity, heat, and combined heat and power generation. If energy crops such as SRC are included in the general mix of agricultural crops in a considered and informed way, there could be significant environmental and ecological benefits alongside the development of a fully sustainable energy resource.

The benefits from a well-run SRC energy production industry include:

Environmental benefits:

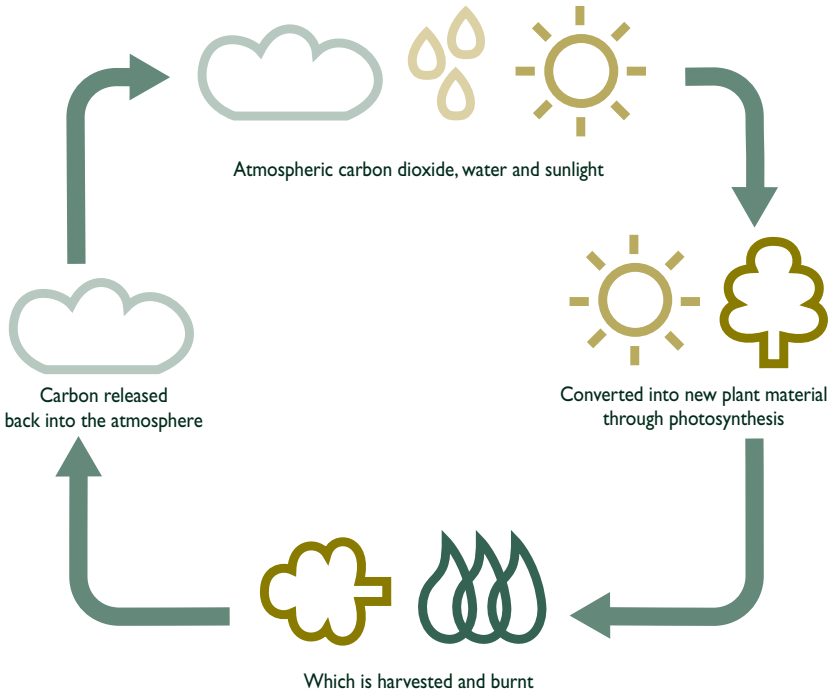
- SRC can produce energy with no net increase in atmospheric carbon.
- Fuel can be used close to the area of its production, which reduces the need for long distance haulage.
- Local power generation reduces transmission losses and can strengthen the electricity grid by providing additional and alternative sources.
- As a rotation crop, SRC is harvested at specific intervals, to provide a regular and constantly renewable supply of fuel.
- SRC plantations, usually of willow or poplar, can provide landscape variety, and a habitat for many species of plants, birds and other wildlife. Blocks are planted over a two to five year period (usually three), and then harvested in rotation, so fields within the growing area will always represent all age classes.
- Converting existing arable land to SRC will reduce the amount of agricultural chemicals required as SRC is a low-input crop: once established it requires a very much lower input of chemicals than conventional arable crops.

Carbon Cycle

Carbon dioxide (CO_2) is an important greenhouse gas contributing to global warming. One of the principal sources of man-made carbon emissions is fossil fuel combustion. As a renewable energy resource, SRC may offer significant opportunities to reduce carbon emissions from fossil fuel combustion and thereby reduce the risk of future climate change.

Plants constitute a living reservoir of stored carbon. There is a natural carbon cycle: when plants are burned or decompose, the carbon is released to the atmosphere. If energy crops are managed sustainably, the fuel cycle contributes little or no net carbon to the earth's atmosphere: ie it is carbon neutral.

The net carbon benefits of a particular biomass energy system will depend on the carbon emissions associated with the energy system it replaces, the efficiency of biomass conversion techniques, and the energy balance associated with growing and transporting the fuel prior to combustion.



Derived from: *Principles and Guidelines for the Development of Biomass Energy Systems.* US National Biofuels Round Table.

Economic benefits:

- SRC can contribute to farm diversification and may attract various grants and other payments.
- It can utilise under-used agricultural land.
- It can provide employment both for agricultural workers (especially in winter, when harvesting is done and other agricultural work is scarce), and at the power production plant for both skilled and unskilled workers.
- It is a robust and durable crop, making it especially suitable for urban fringe and similar areas; sporting and recreational facilities (such as walking or bird-watching) can be provided in SRC crop areas. Both the plantations and the power plants may also be promoted as visitor attractions, to provide educational opportunities as well as additional income and grant aid.

Scale of SRC schemes

Currently, the emerging SRC energy production industry is developing in two ways:

- Schemes are being developed at a very local level, supplying heat and/or electricity to buildings such as hospitals and schools. Alternatively, farmers may be developing a heat only scheme to heat farm buildings enabling them to reduce energy bills and use spare land on the farm to grow the SRC. These on-farm schemes may also use forestry residues from woodland on the farm as a source of fuel, to supplement specially grown SRC.
- Larger scale schemes are being developed to produce electricity for the national grid, using SRC in purpose-built power generating plants, usually producing between 5 and 10MW. These developments have obtained contracts under the Government's Non-Fossil Fuel Obligation (NFFO), which seeks to stimulate clean energy production by guaranteeing both a price and a market for the electricity produced. However, it should be noted that even the largest SRC power generating plants will only be a fraction of the size of conventional power stations (a coal-fired power station will generate in excess of 300MW of electricity).

Using these guidelines

These guidelines are designed to cover all the issues which may affect projects of any scale. However, given the wide variety in the scale of SRC energy production developments, readers should be aware that not all the issues raised will be equally relevant to all schemes. While most of the principles of good practice will need to be considered even by the developer of a small on-farm scheme, some of the issues which are raised, and actions recommended, will only be appropriate for larger schemes.

The guidelines follow SRC energy production chronologically through steps from growing, to harvesting, to energy production. However, in reality, the steps do not follow this sequence. All the pieces of the jigsaw must be in place for a successful scheme to get off the ground, and they may need to happen concurrently. For example, a grower will not embark on growing SRC without a definite use or market and the potential for

Table 1
Scale of SRC Biomass Schemes

	Generating Capacity	Equivalent Number of Houses Served	Number of Vehicle Movements at Plant	Amount of Fuel Required
				HEAT
Small	<250kW$_{th}$	up to 50	10-30 per year	up to 130 odt[1] per year
Large	250kW$_{th}$-1MW$_{th}$	up to 200	40-120 per year	up to 515 odt per year
				POWER
Small (heat and power schemes)	<250kW$_e$	up to 125[2]	88-175 per year	up to 876 odt per year
Medium	<250kW$_e$-1MW$_e$	up to 800	1-5 per day	up to 5600 odt per year
Large	1MW$_e$-35MW$_e$	up to 31,500	2-75 per day	up to 234,800 odt per year

Notes:

These figures are based on a series of comparisons relevant for the scale of plant quoted and current market conditions. The figures do not compare between different scales. This table should only be used as a very rough guide.

[1] odt = oven dried tonne

[2] Based on average house consumption of 1kW$_e$

alternative sources of income and uses for the crop. Equally a developer will want a guaranteed fuel supply, a market for the power (the grid or a local outlet) and a site for the power plant.

The developer of the power plant will usually take overall responsibility for any larger scale SRC energy production projects. They will specify to growers the form in which the fuel is required for the power plant, and may have significant input into the ways in which the crop will be managed, harvested, stored and transported; they may even undertake the harvesting themselves. The developer will wish to have confidence in all aspects of the project since the power plant is likely to require a substantial financial commitment. The power plant will also be subject to strict regulation and require formal permission from planning and other authorities. The chapter on Energy Production covers many of these issues. The grower will have concerns about the economic viability and practical aspects of growing SRC as a crop, as well as being sensitive to environmental and local concerns. The chapter on Growing aims particularly to cover issues of concern to growers. The chapter on Harvesting and Transport will be of interest to both growers and developers.

The following chapters are designed to cover all the issues that may be relevant to the different elements of a project. Clearly, local circumstances will mean that each development is different and different issues will have priority. This guide is therefore not a step-by-step set of procedures, but rather aims to cover the full range of issues that may need to be addressed and to provide some basic principles to aid local decision-making. Further detailed information is available in a range of technical publications and official regulations, which are listed in Appendix 5.

	Hectares of land for crop	Potential for Development in UK	Technology	Physical Size Comparison	Licence
S C H E M E S					
	13ha[3] *1.6% 1 mile radius*[4]	100,000 - 500,000	hot water boiler	car	none - except in smokeless zone
	52ha *6.4% 1 mile radius*	1000 - 5000	hot water boiler	garden shed	Environmental Health Officer
S C H E M E S					
	88ha *0.4% 5 mile radius*	currently determined by the NFFO	gasifier and engine	small barn + fuel store	Environment Agency
	560ha *2.75% 5 mile radius*	currently determined by the NFFO	gasifier and engine	medium barn + fuel store	Environment Agency
	23,480ha *3% 30 mile radius*	not permitted under the NFFO	steam cycle	medium barn to large factory	Environment Agency

Table devised by ETSU

[3] A hectare of land (ha) is equivalent to about 2 football pitches

[4] Percentage of land likely to be taken up by SRC planting within the given radius of a generating plant eg 1.6% of land would be taken up with SRC within a 1 mile radius of a plant.

Photo British Biogen

Visitors to an established SRC plantation

Consultation

Community interests

Local communities are likely to be affected by SRC energy production projects as a result of, for example:

- transporting the crop to the power plant
- the construction and operation of the plant itself
- changes to the landscape created by the coppice plantations
- the potential for increased local employment both in growing the crop and in energy production.

The extent to which communities are affected depends on the nature and scale of the planned project. However, even small on-farm schemes will have an effect on neighbours and will require some consultation. In all cases, well-planned consultation undertaken at an early stage will improve the quality of the final scheme, as well as help to avoid later conflict.

Timing

Early consultation is particularly important in SRC energy production projects as they are relatively new in the UK. Most people will know little about the visual appearance of a project or the impact it may have on local people and the environment. Early information to local people on coppice plantations, transport routes and power generation, as well as quick responses to particular concerns, will help people feel confident about this new industry in their area. Local people will understand if details have not yet been finalised, and will welcome the opportunity to comment at an early stage.

Early consultation with statutory conservation agencies over locations for planting and growing SRC may also be helpful. These statutory agencies are government bodies and are used to dealing with informal consultations in confidence.

Consultation should continue throughout the development stages of a scheme, and will need to cover all aspects including the design and management of the plantation, the harvesting, storage and transportation of the crop, and the

construction and operation of the power plant itself.

To some extent, consultation can be structured alongside the process for gaining formal planning permission for the power plant, but may need to be extended. For example, the growing, harvesting and storage elements of an SRC energy production project will usually fall outside formal planning requirements, although some grant schemes for growers require consultation as a condition of grant aid.

Who to consult?

People who live and work in the immediate vicinity of the proposed scheme, specific local interest groups and statutory agencies are all likely to have an interest in the development of an SRC energy production project. A sample list of statutory and non-statutory consultees is given in Appendix 2.

The project leaders for the development will need to identify all the likely areas of concern and involve interested groups at the most appropriate stages. Different stakeholders will have concerns about different aspects of the project. Those living near the power plant may have concerns about its visual impact, noise from construction or emissions from the plant. Some people will want information on traffic movements through their community, while others will be concerned about the impact of SRC on the landscape or the local ecology.

Whose responsibility?

For large scale developments, the developer will usually have overall responsibility for managing the consultation process as they will be responsible for the development of the power plant, as well as influencing the growing, harvesting, storage and transportation of the crop. However, the grower will also want to manage their activities in a manner which is sensitive to the environment and to local concerns, and may contribute substantially to the consultation process.

The development may be a community project, run by local people. However, this does not eliminate the need for wide consultation and involvement.

Preparing for consultation

Consultation needs to be planned and integrated into the overall development process. The following steps may help to maximise the effectiveness of consultation and enable the developer to address any concerns that arise:

- Developers should analyse the community, or communities, that might have an interest in the development (stakeholder analysis). Information will also be needed on local issues that may be relevant. This will enable developers to prepare their consultation and communications strategy.
- SRC energy production is a new industry and it may be appropriate to produce information for local people about the nature of the industry and the specific local development, what it will look like and the impact and benefits it will have.
- Consultation needs to start as early as possible in the planning and design stage. It needs to be planned, but also flexible enough to meet the needs of changing circumstances.
- Honesty, openness and commitment to consultation are essential. Although developers would not be expected to resolve all concerns expressed, they should always respond to concerns. If something cannot be altered, a clear explanation of the reasons should be provided.

Consultation methods

A number of consultation methods may be used, depending on local circumstances such as the particular needs of the community and other interested organisations and the scale of the project. These might include:

- exhibitions
- open days, and visits to similar sites already in existence
- public meetings
- questionnaires
- special meetings for key local organisations (such as parish councils)

- workshops for mixed groups of stakeholders to consider particular issues.

Liaison should continue after plant construction is completed. For example:

- Visitors to the power generating plant or SRC plantations: local groups and others may be interested in touring the plant. Some coppice could be developed on the site of the plant so that the whole process could be shown to visitors.
- Links may be made to the environmental programmes of local schools.
- A liaison forum could be established between the developer, the local authority and local communities, building on contacts made during the development stages. This could be linked to formal and informal monitoring, which may be required in any case by conditions of the planning permission.

In Mid-Suffolk, a community liaison committee was established through the Environmental Health Officer for regular monitoring of public opinion about the plant; HMIP were responsible for most of the technical monitoring. This committee has provided a degree of visible local accountability by the plant operators, and has been seen as a valuable means of communication for all parties concerned.

Issues for consultation

The key issues on which the developer consults are likely to include:

- timing of construction of the power generating plant
- design and layout of power plant (including size of plume and chimney, plans for screening etc)
- traffic routes (for building, supplying and operating the plant)
- monitoring air emissions from the plant
- impact of the SRC plantation
- public access through the plantation.

These issues, and many others, are covered in detail throughout these guidelines.

Photo: British Biogen

Two year old willow SRC with wide headland

Growing

This chapter covers the full range of issues relating to establishing and managing SRC plantations. The degree to which the guidelines will apply to any specific circumstance will depend on the scale of the scheme. Each grower will decide on the relevance of the issues and recommended actions to their own operations. For smaller scale operations, many of the impacts may be less and the issues easily dealt with. More careful consideration may be required for larger schemes which may have a greater impact on the local area.

Short Rotation Coppice (SRC) can be a financially profitable new crop for growers, given the existence of a market, especially on set-aside land and with current support schemes. It can also provide an opportunity to develop a number of additional, profitable uses. Once established, SRC is a low-input crop, which can have considerable environmental benefits, especially where land has previously been farmed intensively. Indeed, SRC has great potential to encourage wildlife diversity.

There is considerable mutual benefit in the balance between commercial viability and the environmental benefits of SRC as a crop. Practices which may enhance the conservation benefits may also help to reduce pest and disease problems and maximise yield.

Some of the principles of good practice for growing SRC are well-established, and form the basis of this chapter. However, practice will continue to evolve as commercial growing develops. Clearly, the wide diversity of land in the UK will mean that growers will have to take a range of issues into consideration and, therefore, these guidelines cannot be prescriptive.

This chapter covers the three essential elements that should be considered in growing SRC:

- whether the crop would be economic in the specific circumstances of the potential grower
- selecting an appropriate site
- establishing and managing an SRC plantation to maximise environmental benefits and reduce negative impacts.

Economic viability

The decision to grow SRC needs to be based on whether it would be economically viable. In assessing the level of income the crop may produce, a grower will want to consider the following options:

- **Can the crop be used on the farm?**
  Using the crop as fuel on the farm to produce heat can reduce heating bills, make use of under-used land, and generate additional income through the sale of surplus production.
- **Is there a local developer?**
  If growers want to be part of a supply chain for energy production, they need to be within range of a developer who will buy the fuel. Current practice indicates that developers usually prefer to obtain fuel within a radius of 48-64 km (30-40 miles).
- **Is there an opportunity to form a co-operative?**
  Several growers may be able to form a co-operative and sell in bulk to a developer.
- **Is there an opportunity to create a local market?**
  Growers could create their own market through a local heat plant or by collaborating on the joint development of a power generating plant.

Funding

Grants and other payments are available for growing SRC from a number of sources. For example:

- There are grants for equipment, machinery, advice, associated woodland management and establishment under schemes such as the Farm and Conservation Grant Scheme (MAFF), Countryside Stewardship (Countryside Commission), and the Woodland Grants Scheme (see below).
- The Woodland Grants Scheme (WGS) has its own guidelines. Details from the Forestry Authority (Conservancy Office or the Grants and Licences Division).
- Arable producers who have land eligible for the Arable Area Payments Scheme can grow SRC on set-aside land. Details from MAFF local offices, Scottish Office Agriculture, Environment and Fisheries Department, Welsh Office Agriculture Department (WOAD), or the Department of Agriculture for Northern Ireland.
- Specific incentives may be available in designated areas such as National and Community Forests. Details from the Countryside Commission.

Additional income

SRC can also provide additional income to the grower through the following:

- SRC can provide good cover for pheasants. The Game Conservancy Trust has done research into opportunities for the development of game on farmland. They and other organisations can give detailed advice to growers.
- The establishment of SRC may enable growers to use or sell wood residue from existing woodland, thus creating extra income from an under-used resource.
- Some growers have found that there is a high level of public interest in SRC as it is a relatively new crop. Farms with an existing visitors centre may find that SRC provides new interest for visitors. Even without a formal visitors centre, a public access agreement can be established and can offer educational and recreational opportunities for visitors.

Site assessment & selection

As with any crop, only when a grower has identified a reliable market, and confirmed the economic viability of the crop, will site assessment and selection take place. Then a range of practical issues will influence the decision on whether, and how, to go ahead on a particular site. Special consideration will be given to the following, all of which are covered in more detail below:

- Landscape and visibility
- Soil type
- Water use
- Vehicle access
- Nature conservation
- Archaeology
- Pests and disease
- Public access.

Landscape and visibility

As a row crop, SRC will be a new and visible feature of the countryside. It can have either a beneficial or negative impact on the landscape, depending on where and how it is grown. The actual impact will depend upon the character and quality of the recipient landscape, the extent of physical change involved, and the ability of the landscape to accommodate this change. For example, if all the fuel for a large-scale power station is to be grown within a concentrated area, the change in character of the landscape could be considerable.

Certain types of landscape will be more suitable for growing SRC than others. To assess the likely impact of large-scale SRC production it is recommended that developers undertake a landscape assessment in order to understand the landscape in which it is intended to grow the crop.

Special consideration should be given to the impact of SRC plantations within National Parks and Areas of Outstanding Natural Beauty (AONBs). These are areas which have been designated nationally for the quality of their landscape, and to which specific protection policies apply. There may also be relevant regional or local landscape designations, as well as areas designated as being of special conservation value: see Nature conservation below.

As SRC typically grows taller than other crops, the visibility of the scheme, and its impact on people's visual amenity needs to be considered when selecting a site. An SRC plantation may contribute positively to variation in landscape types and enhance views; alternatively there may be issues of reduced visibility from paths or favourite views. If the plantation is likely to obscure locally important views at certain times in its life cycle, it may be appropriate to select alternative sites, although any negative impact may be reduced through careful design.

Photo: British Biogen

SRC in the landscape, six months after planting

Soil type

A variety of soil types are suitable for growing SRC, although particularly shallow or dry soils may give poor yields. The grower needs to consider that the crop will be harvested in winter and that machinery may damage wet soil. Therefore, it will not be suited to floodlands, boggy areas or sensitive wetland areas.

Water use

SRC's water demand will vary depending on the choice of species (poplar or willow) and on the varieties selected. Research shows that poplar has a high water use when water is available; the situation with willow is less clear although a similar response should be anticipated. As with any crop, growers should consider the possible impacts on water demand and use when choosing a site:

- The yield of SRC is likely to be affected by water availability, although the exact relationship between water and yield is yet to be determined. It is likely that yields will be better in wetter parts of the country.
- If a substantial area within a water catchment is to be given over to SRC production, then consideration of the impact on ground water should be given a high priority. However, where the crop forms merely one of a wide range of differing land uses the water impact should be negligible.
- SRC may have benefits in buffer zones or surrounding high-input crops. The root mat which forms under an SRC plantation is an effective mechanism for soaking up nutrients, so SRC may have a positive role to play in limiting nutrient loss to waterways.
- The roots of SRC can be damaging to field drains. Where a drainage system is new, the grower may wish to choose a different location for the crop. However, the life of a drain system should be considered in relation to the expected life of the SRC plantation.

Vehicle access

Vehicle choice will be determined by maximum payload, vehicle size and access to the farm. For very small schemes, it is possible that a farm tractor and trailer may be the best option.

Vehicle access to the plantation will mostly be in winter (when the crop is harvested), so identifying a site close to, and with easy access from, existing routes and hard roads will be a priority.

Nature conservation

SRC has greater potential to encourage wildlife diversity than any other row crop currently grown by UK farmers. It can provide habitats for insects, birds and wildflowers, some of which may be considered pests in other crops. There are a number of conservation issues which growers need to consider when looking for a site:

- The intrinsic ecological value of the site should always be taken into account. In areas where ecological value has been recognised by local, national or European designation, such as a Site of Special Scientific Interest (SSSI) or National Nature Reserve (NNR), careful investigation should always be undertaken of the potential impact of growing SRC. There are likely to be legal consequences of national or European level designations which need to be taken into account. Advice should always be sought on the ecological and other implications of particular designations. Examples of habitats which may prove especially sensitive include ancient woodland, linear features such as hedgerows, wetlands, heathlands, unimproved grassland, peatlands and lowland wet grassland.
- Growers should consider planting SRC in areas that are currently of low conservation value, where it will be of most benefit to wildlife. Advice should be sought from local conservation agencies.
- SRC is most likely to be grown on three types of land:
  - Pasture.
  - Land currently under arable production. In this case, SRC is likely to be of more benefit to nature conservation than the previous crop.
  - Set-aside land, in which case growers will be subject to the normal set-aside regulations which require the maintenance of any existing environmental features on the land (such as trees, hedgerows and ponds).
- The type and proximity of adjacent habitats should also be taken into consideration. SRC can help to provide habitat links between areas of existing woodlands. The high insect load of an SRC plantation will benefit birds nesting in nearby woodlands. Alternatively, an area of existing conservation interest may be adversely

affected by the creation of an SRC plantation, especially if it is a wetland or marshy grassland.

Archaeology

As with any crop, when identifying potential sites for SRC plantations, growers should avoid known archaeological sites. Sites of archaeological interest have survived in a variety of forms including earthworks, ruined structures and cropmarks. Cropmarks can be seen from aerial photographs and show the presence of features in arable areas. Many of the better archaeological sites can be found on marginal land in the uplands but some are also in areas of undisturbed pasture.

Some of these sites may be found marked on maps but, as many sites have not been properly surveyed or recorded, most will not be. In most areas there will be a register of sites of archaeological interest held by the county archaeologist. To find out more about the area in which the SRC will be grown, contact the local planning authority, who will refer you to the relevant organisation. It is worth noting that the Woodland Grants Scheme asks for information from professional archaeologists for every application for new planting that it receives.

Pests and diseases

Some steps to reduce pest and disease attack can be taken at the site selection stage. For example, identifying sites where leatherjackets, slugs and snails are not in abundance, or where there are few deer, rabbits and hares, will reduce the initial preparations required.

Public access

Public access to, or through, the plantation will need to be taken into account in the choice of site. If public access is required to the plantation then a site should be selected which allows this. If there are public rights of way across the selected site, these must be maintained and taken into consideration in the planning and establishment of the plantation. If SRC is grown near urban areas it could stimulate plenty of public interest - so public access may be beneficial.

Public access arrangements can be agreed with local councils, local residents and rights of way users through consultation at an early stage.

Plantation design and planting

The detailed design of plantations needs to maximise the benefits of SRC in terms of productivity and the environment, whilst avoiding detrimental effects on the landscape and conservation value. This section outlines the issues which need to be considered, and offers guidance where possible. It covers:

- Landscape
- Designing for harvesting
- Public access
- Water use
- Pest and disease control
- Nature conservation
- Site preparation and weed control
- Choice of planting material
- Planting and first year
- Storage.

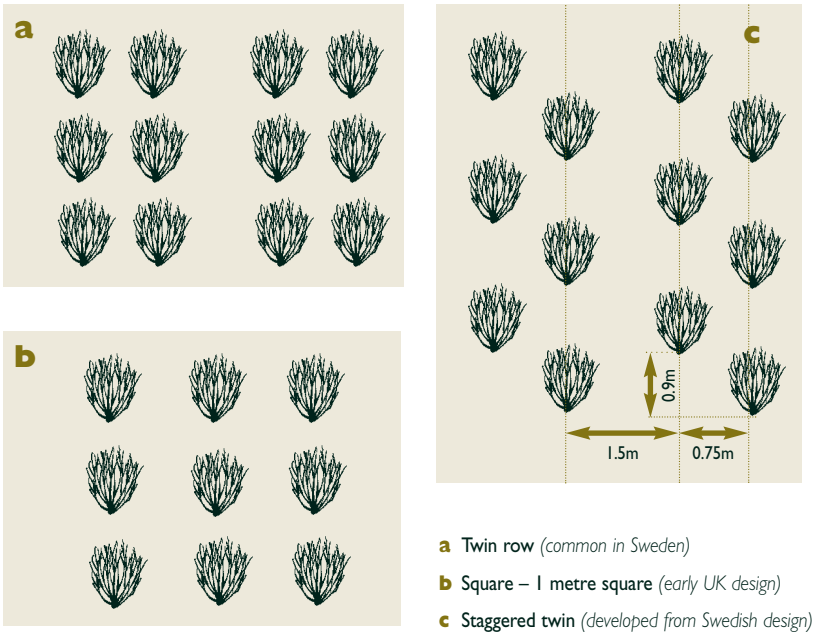
Landscape

SRC is essentially a row crop. However, it is important to ensure that the crop fits into the landscape as much as possible. For example:

- The proposed SRC plantation should be in scale with the landscape and shaped to follow the landform. In areas of weak landform, such as flat or gently rolling country, hedgerows or belts of trees can make a strong pattern. Small woods can be used to extend or strengthen this and regular shapes may be easier to fit in.
- Edges of woodland are important as landscape features. The edges of the SRC plantations should be made to look as natural as possible, graded and varied in scale with the landscape. Link where possible with new and existing

woodland features such as hedgerows and small woodlands, and consider planting hedges on the edge of the plantation. Consideration should also be given to the management of edges. Annual cutting will help 'round off' the straight edges, and a border crop could be planted for alternative uses.

Figure 1
Planting Design



a Twin row *(common in Sweden)*
b Square – 1 metre square *(early UK design)*
c Staggered twin *(developed from Swedish design)*

Based on Agriculture and Forestry Fact Sheet. Short Rotation Coppice No 1. *Establishment.* Published by ETSU for the DTI.

Designing for harvesting

SRC is harvested after two to five years' growth. The average harvesting of SRC, using a chipper or mechanical harvester, is around three hectares a day, depending on the type of harvester used and the size and layout of the plantation. With this in mind, it might be possible to have three different age-classes of SRC in one 10-hectare field (see Fig 2).

Plantation layout needs to be planned for ease of harvesting: in accordance with the planned harvesting regime and the equipment available. Fig 1 shows three examples of how a typical plantation may be designed (although growers have used other methods and different spacing of planting in different circumstances):

- A typical plot might be from 10,000 to 20,000 cuttings per hectare.
- Planting in twin rows allows harvesting of two rows at a time, usually using direct cut and chip methods (see Harvesting and Transport chapter for details). There would usually be about 1.50 metres between double rows of cuttings so that the side walls of the tyres of the tractor are not damaged by the cut crop.
- 90cm spacing between rows of cuttings and 75cm spacing between cuttings in a double row will allow for tractor access.

Research is continuing into the optimum spacing between varieties. It is one of the factors, together with better pest management, which may lead to increased productivity. Spacing of the varieties can affect the end-product: by changing the spacing, the grower may end up with smaller or larger pieces of wood at harvesting.

From a harvesting point of view, varieties need not necessarily be planted in straight lines. It is possible, depending on the harvesting method chosen, to plant cuttings in different row directions and curved rows which may benefit the landscape and wildlife (see Fig 2), adding to the visual diversity of the plantation and reducing exposure to penetrating winds.

Public access

SRC can have a negative impact if it reduces access to, or enjoyment of, rights of way, important or popular views, common land or valued amenity areas or facilities. Careful design will be needed to minimise obstruction to statutory rights of way or other routes which, while not having legal status, do have a history of public use and enjoyment. The impacts of plantations can be reduced by careful planning for public access which respects these features and consults with the relevant groups and interests.

If the grower wishes to increase access, care must be taken to ensure visitors to the plantation can enter with ease and that there are no barriers such as steps and stiles which might make visits by some people difficult. Information on SRC as a renewable energy form can be displayed on information boards so that it can be promoted and explained to visitors. Paths, signs and other countryside furniture should be constructed from materials and colours which fit in with the surroundings.

Water use

Where water management is a priority, measures can be taken to design and manage the plantation to maximise positive benefits and minimise negative impacts. For example:

- A few large blocks of SRC plantation will use less water than many small blocks due to the increased evaporation from crop edges. However, a balance needs to be struck in each specific circumstance between the issue of water loss and the benefits for wildlife of smaller blocks with more edge habitats.
- The location of important bore holes should be taken into account when planting. For example, if there is concern that the crop will reduce water availability, then the area around the bore hole should be avoided. However, if the crop can be used to reduce pollutants entering the bore hole, the crop may be an advantage.
- Water use by SRC is related to the age of the crop. In some areas, harvesting of the whole crop at the same time may have a negative impact on recharge and run off. Cutting in rotation should reduce this by ensuring a mix of stand ages in any one water catchment area.
- Where there is a possibility for waste waters to be used as fertilisers or irrigation for the crop, consideration should be given to the impact on local water courses and loadings managed to ensure that run off and leaching is minimal.

Pest and disease control

SRC is likely to require minimal chemical inputs. With good design and management, the grower can reduce the impact of pests and diseases and establish a system where pesticides are used very infrequently or not at all: use of pesticides will severely reduce the conservation benefits of the plantation. Growers need to plan for pesticide applications when designing the plantation by spacing the planting to allow access by tractors and to reduce damage to adjacent crops, watercourses and habitats.

Photo: B9 Energy

inspecting a willow leaf for signs of rust

Willow and poplar rusts

Willow and poplar rusts are fungal diseases, resulting in premature leaf loss. Severe rust infestion may lead to yield loss. A mixture of varieties increases diversity and reduces the impact of rust. An approved cuttings supplier should have up to date information on appropriate varieties.

Insect infestation

Insect infestation is less likely to appear if the trees are on an appropriate site and not under stress. Research is continuing into an integrated pest management system which includes resistance, diversity, and chemical and biological control through the selection of varieties. Once established, SRC is a low input crop and it should not be necessary to use insecticide as the crop tolerates high loads of insects and disease.

The risk of pest damage needs to be minimised. A wide variety of insect species will live in SRC plantations, although only a few will attack and cause damage to young SRC, particularly willow. Some can reduce crop growth and vigour through loss of leaf area; others may cause breakages and infection sites. Impact can be reduced through mixing varieties, and also by encouraging natural control mechanisms such as parasitic wasps. Birds, insectivorous mammals and insects from neighbouring woodlands and hedgerows can also assist in keeping insect pest numbers down.

Rabbits, hares and deer

Rabbit, hare and deer damage can be severe when the shoots are young, and precautionary measures may be necessary. A large plantation block may help to reduce animal pest damage. Plantations in isolated areas have been shown to be more likely to suffer from deer damage; public access may be a benefit in this case as it may discourage extensive deer grazing.

Photo: Rufus Sage, Game Conservancy Trust

Two year old willow SRC

Nature conservation

As SRC is a rotation crop, it will always provide a mix of habitat types. There are many ways of encouraging wildlife diversity without reducing the production yield of an SRC plantation; indeed, many of these activities will improve the management of the plantation, resulting in mutual benefits. Fig 2 shows one example of how conservation issues could be incorporated during the design stage. In addition, SRC can be managed to provide the following benefits:

Wildlife

Wildlife diversity should be encouraged by mixing varieties and age-classes in SRC plantations appropriately. Effective mixing of varieties also has benefits for controlling pest and disease damage and maximising yield.

Birds

SRC has been shown to attract a wide range of woodland and other birds. In spring, newly-cut SRC is used by skylarks, pipits and wagtails. Young coppice growth attracts migrant warbler species as well as reed buntings, while third or fourth year SRC is preferred by other resident species such as thrushes, tits and finches. Resident songbird species are also often seen feeding in SRC stands during the winter, while snipe are often found resting-up in plantations. Pheasants will use SRC all year round. SRC plantations may also provide insects as a food source for other birds nesting in any nearby woodland. See Fig 2 for an example of design which will benefit birds.

Wild plants

Headlands and rides provide access to the crop for harvesting, crop inspections and other operations. Headlands and rides which are more than six metres wide should be used wherever possible, as they support more grasses and herbs than those which are narrow. This will improve soil stability during mechanical operations and provide valuable habitats for wild plants, butterflies and other insects, some of which may help to control insect pests in the crop. The grower could consider sowing a special hard-wearing mix of grasses and herbs into the access headlands and rides. Once established, this would be cut once or twice a year. Areas of tussocky grass will be particularly valuable to predatory beetles and spiders which may help control pests in SRC and in adjacent cereal crops. In addition, certain flowering plants (for example, cow parsley) attract pest-controlling parasitic flies and wasps.

Mature hedgerows

Mature hedgerows along the perimeter of a plantation provide shelter for the crop and may lead to increased yields, while also providing valuable nesting habitat for songbirds and game, as well as for wildflowers and insects.

Edge habitats

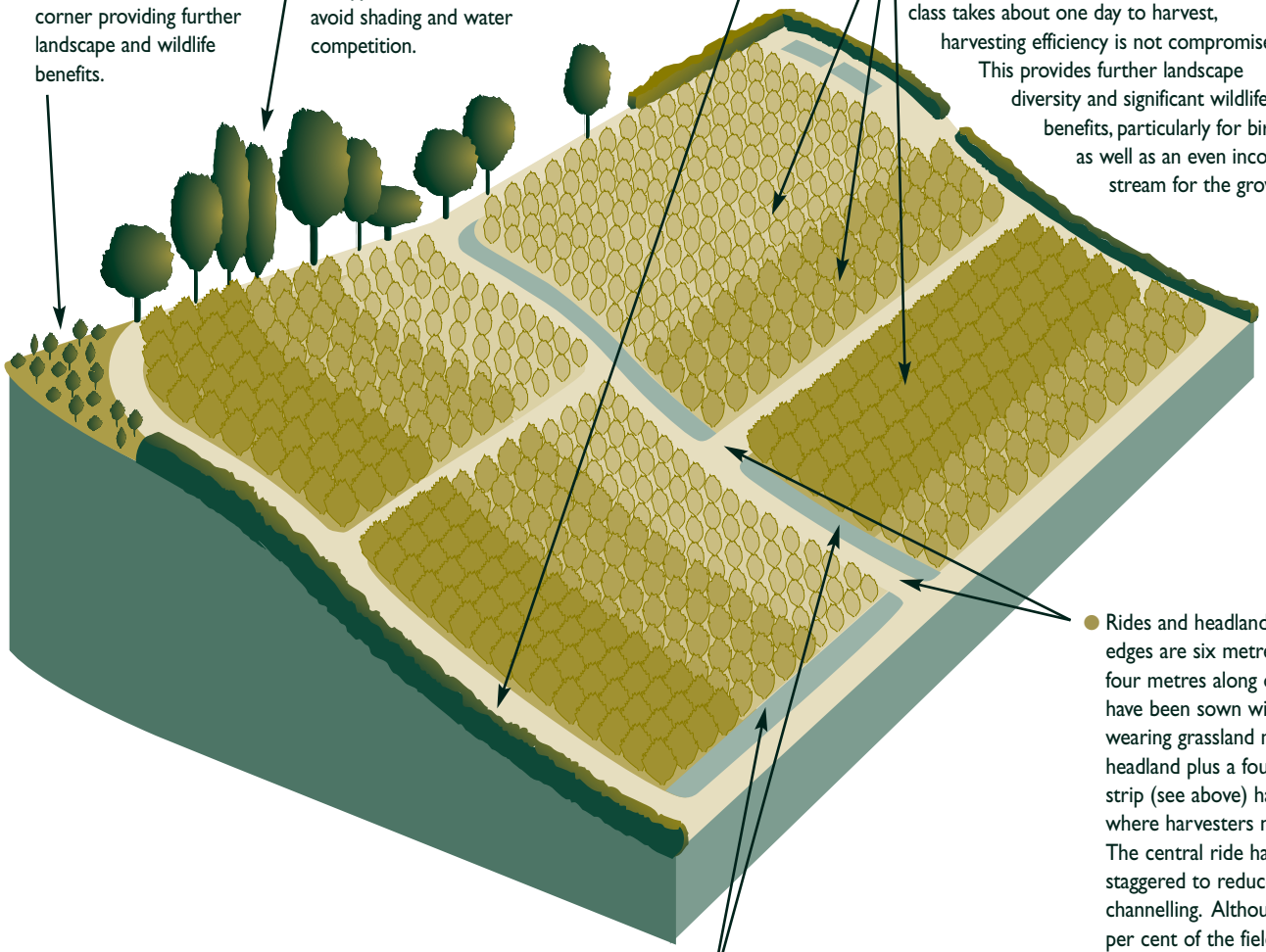
Edge habitats are important for wildlife. Where possible, the grower should avoid shading the side of a hedgerow by planting too close to it, because of the impact this could have on ground flora and wildlife. To reduce shading, headlands can be positioned near hedgerows as they require wider space anyway.

Figure 2

An example of Short Rotation Coppice plantation design

Figure 2 shows a 20 hectare planting containing three age classes of SRC (indicated by the three colours) and a range of different varieties. The layout is designed to maximise production and harvesting efficiency, as well as potential environmental benefits.

Each variety is planted in strips of between two and ten rows within each age class block. This may help reduce the impact of some potential pests and diseases. Alternative ways of mixing varieties can also be used.



- Hedgerows along the west and east edges shelter the crop and provide nesting habitat for songbirds and game. Hedges are trimmed once every three years to encourage flowering shrubs, and are allowed to grow in scale with mature SRC.
- **First year regrowth coppice**
- **Second year regrowth coppice**
- **Third year regrowth coppice**
- The three colours represent a mix of different aged coppice regrowth which has been developed by cutting sections of the crop in rotation over successive years. If each age class takes about one day to harvest, harvesting efficiency is not compromised. This provides further landscape diversity and significant wildlife benefits, particularly for birds, as well as an even income stream for the grower.
- A small area of woodland has been planted in the awkward north-west corner providing further landscape and wildlife benefits.
- Along the north edge the coppice edge is beyond the canopy of mature trees to avoid shading and water competition.
- Rides and headlands along closed edges are six metres wide, and four metres along open edges, and have been sown with a hard-wearing grassland mix. A six metre headland plus a four metre edge strip (see above) has been used where harvesters need to turn. The central ride has been staggered to reduce wind channelling. Although about eight per cent of the field area is taken up by headlands and rides, the edge effects such as shading and water competition mean that the production 'loss', compared with wall-to-wall planting, will be less than this.
- These close-spaced SRC edge strips are cut every year, and increase access at the end of rows for large harvesters without compromising the planted area. They also provide shelter along exposed edges during the growing season.

Devised by Rufus Sage, Game Conservancy Trust

Edge strips, containing SRC planted at half the main crop spacing and cut every year, can be planted along exposed edges and across the ends of rows (see Fig 2). Once cut, they increase access for large harvesters, without compromising the planted area. During the growing season, the first-year regrowth will provide shelter within older, taller SRC, and improve conditions, for certain wildlife species and for game birds.

Site preparation and weed control

Ideally, site preparation should start in the autumn prior to planting. Thorough preparation of the planting bed will ensure that the crop, which can have a life of some 25 years, will have the best possible conditions for good establishment. The management of SRC is most intensive during the first 12 months, and careful attention to weed control is required during this phase to ensure less remedial work is needed later. The extent of these activities will depend on the previous uses of the site.

Before ploughing the grower may need to apply appropriate herbicides for controlling perennial weeds. There may be opportunities to control weeds such as couch grass by applying an appropriate herbicide before harvesting some arable crops, or on land in set-aside. The site then needs to be ploughed and cultivated to give a fine planting bed.

Although herbicide application is likely to be required prior to planting and in the first year, it should drop to minimal or nil use after that. Herbicide use is therefore low in comparison with other crops. The following steps should be taken to control weeds and so reduce herbicide use by making what is used more effective:

- Ensure the site is free of perennial weeds.
- Use effective pre-planting techniques for perennial weed control.
- Plant more vigorous varieties closer together, although this may result in competition (see Choice of planting material below).

Photo: ETSU

One and two year old poplar SRC

Choice of planting material

Growers will select varieties of willow and poplar to give the best yield for a particular site. In general, monoclonal blocks should be avoided. A great deal of research has gone into the most effective way of mixing different plant varieties and species in the plantation, to maximise yield, minimise pest and disease and reduce competition.

Advice should be taken when mixing different varieties of planting material to ensure that they are appropriate to the region and most likely to resist pest and disease. Mixtures may be planted in rows, blocks or by simply mixing certain varieties before planting. Fig 2 shows one example of mixing varieties.

Advice is available from the Forestry Commission, and in ETSU Fact Sheet No 2: *Clone Selection* (see Appendix 5).

Planting and first year

The grower can plant early in the year or, using cold-stored planting material, as late as April or May. Before planting, it is important to ensure any weed growth is controlled by further cultivation or spraying. Slug control, and leatherjacket control on

former pasture land, may also be required. Within one week, or after rain has consolidated the soil, an appropriate residual herbicide mix should be applied.

Planting can be carried out in a variety of ways using a range of planting machinery or by hand. Moving planting material to and on the site requires considerable care. Advice on planting and material handling should be sought from material suppliers.

Weed control

Weed control is especially important during the first year of SRC management. Weeds tend to develop quickly where there is damage from pests and disease because of loss of leaf canopy. It is normally necessary, following planting, to apply herbicides to maintain weed-free conditions throughout the first and possibly the second year. These may be overall selective herbicides or directed sprays of contact herbicides. The crop is cut back in the first winter and normally a herbicide mix is applied in March or April before bud growth. If there is significant weed growth following the first harvest, it may be necessary to apply further herbicides at this stage.

Allowing some weed growth within established SRC plantations may not have a significant effect on yields (when compared to the cost of spraying) and will have considerable wildlife benefits in terms of insects and other animals. However, it should be acknowledged that chemical weed control is likely to be essential when first establishing SRC, as unrooted willow and poplar cuttings are extremely sensitive to competition for moisture. Over time, less competitive shade-tolerant herbs and grasses may colonise the plantation from nearby shady habitats without detriment to the crop. In general, growers should seek to reduce the chemical weed control to the minimum as soon as possible after the initial preparation of the site.

Fertiliser

Research has shown that the benefits of any fertilisers on SRC are marginal. However, there may be an opportunity to make use of treated waste sewage sludge as an organic fertiliser. Sewage sludge should be applied as if growing food crops. From an ecological point of view, growers should avoid applying it on headlands and edges and only use it on the crop itself, targeting specific areas of the plantation. There is a Code of Practice for the Agricultural Use of Sewage Sludge, and guidance for farmers and landowners in other published material. See Appendix 5 for details.

If the SRC plantation is in a Nitrate-Sensitive Area or Nitrate-Vulnerable Zone the grower has to pay attention to the amount of nitrate that is applied to the land. Contact MAFF for the locations of these areas.

Storage

Crop storage could be on the SRC plantation itself, elsewhere on the farm, at an intermediate location or at the power generating plant. If on site, consideration will have to be given to the space required for the quantity and the particular type of storage required (indoors or outdoors) as well as the access required by commercial vehicles. Harvested sticks could be stored loose or in bundles on headlands, while chips will require some form of containment or protection. See Harvesting and Transport chapter for more details.

Photo: Picture House Ltd

The storage of woodchips in a closed barn

Photo: Forest Research

One pass harvesting to cut and chip

Harvesting and transport

The system used to harvest, store and transport the SRC crop depends on the scale of the operation, the specification of the end user and a host of local factors such as access and road size. This section covers all the issues which are likely to affect larger scale growers supplying SRC as a fuel to a power plant, although the principles will be applicable equally to smaller-scale projects including on-farm heat schemes.

As with many crops, there will be both positive and negative environmental impacts. For example, as a perennial crop, SRC avoids the vehicle movements associated with the planting, harvesting and management cycle of annual crops. This reduces the total energy input over the SRC life cycle. The environmental impact of harvesting, storing and transporting SRC is likely to be similar to, or better than, that of any other agricultural crop.

Harvesting

The impacts of harvesting SRC are similar to those of harvesting other arable crops, except that:

- SRC is harvested in 2-5 year (normally three year) cycles so it is unlikely that there will ever be complete site clearance. This means

that there is always a variety of age classes in the landscape which has benefits for the countryside and provides a variety of habitats for wildlife.

- Harvesting SRC is not detrimental to wildlife. As it is done in winter, it is well outside any breeding seasons, and summer migrants will not be present.
- Winter harvesting also allows for the deployment of agricultural workers and equipment at a quiet time of year.

Storage

Facilities for storing SRC will usually blend in with typical farm environments. Even if the harvested crop requires some form of weather protection, this is likely to be simple and unobtrusive or even provided by an existing building.

Transport

Emissions, fuel use and traffic flow will play an important role in the overall impact of any project. Where the SRC is grown and used on the farm, transport impacts overall can be reduced as there should be less transport of other fuels onto the farm to meet energy needs. Where the crop is transported to an external power generating plant, lorries similar to those used to transport existing agricultural products are likely to be required. The effects of increased traffic flow will be felt most around the power plant. It is likely that the plant will be supplied by growers within a maximum of a 48-64 km (30-40 mile) radius. However, although increased traffic flow is a frequently cited issue around any new development, the impacts of traffic at even the largest SRC power generating plant will be comparable to other agricultural industries.

The variety of local circumstances means that it is not possible to specify which methods of harvesting, storage and transport any individual scheme should use. Table 3 (at the end of this chapter) summarises the advantages and disadvantages of the main harvesting, storage and transport options.

Harvesting

Decisions about harvesting techniques will be determined largely by the size of the plantation and the fuel specification given by the user (see Table 3). Indeed, the primary concern for the grower will be the need to provide a product that meets the requirements of the user (the power generator, where that is the market). These will vary according to the size and nature of the project. Some developers will wish growers to harvest and store whole sticks so that they can then be chipped to the required size on the site of the power generating plant. Other developers will expect growers to provide a ready chipped product. Growers will need to understand the requirements of the users so they can plan for harvesting and storage accordingly. Where a farmer is growing SRC for their own use, they will have total control of harvesting techniques.

There are a number of general considerations that growers should take into account in planning and carrying out harvesting, all of which are dealt with in more detail below:

- **Timing**
- **Noise**
- **Mechanised harvesting**
- **Safety.**

Timing

SRC harvesting occurs during the winter, from November to March, after 'leaf fall' and before 'leaf set' or 'bud burst', as this is when the moisture content of the wood is at its lowest. Harvesting during the growing season would damage the plants. Winter harvesting offers a useful opportunity to deploy labour and equipment at a quiet time of year for farms. However, harvesting must always be undertaken with care because the ground is vulnerable in wet conditions, and heavy harvesting equipment on wet ground can compact soil and damage its structure. Wet ground may not prevent harvesting if wide-tyred or tracked vehicles are used. Growers can also reduce the likelihood of

damage to the soil through plantation design (see Growing chapter). In addition, willow roots form a dense mat which help to support heavy equipment.

Noise

SRC is grown on agricultural land and is cut using adapted conventional harvesting equipment or specialist machinery (see below). Noise levels will be similar to those experienced through the harvesting of other arable crops. However some noise levels, for example from chipping operations, could be a concern for neighbours and local communities. It would be good practice to inform local residents about harvesting operations before they commence, including providing details of how long they are likely to last. In addition, efforts should be made to minimise disturbance through careful design such as screening with hedges.

Photo: Forest Research

Mechanised harvesting

Mechanised harvesting

At some point in the supply systems chipping must take place. This can be done during harvest, at the farmstead prior to use or transport, at an intermediate storage facility or at a centralised chipping facility at the power generating plant. The choice of harvesting machinery and system will depend on the scale of the operation, the design of the crop layout and, for example, whether a contractor or grower will harvest the crop. Equipment may also be pooled by a group of growers, or provided by a developer, as well as provided by an individual contractor or grower. When harvesting, SRC should be worked in blocks, to avoid going over the same ground more than once, to minimise soil damage and maximise efficiency.

There are two main systems for harvesting SRC: Direct cut and chip systems and Stick harvesting systems.

Direct cut systems

These are based on principles used for other agricultural crops, where the whole crop is cut and chipped or billeted in one operation. This system is most likely to be operated by contractors or grower co-operatives because of the initial high investment in machinery. Less expensive tractor mounted versions are also available and may be feasible for smaller operations. In this system, the chipped material is blown into a trailer alongside as the machine moves through the crop. The chips can then be stored on the farm or, if being used elsewhere, be transported to an intermediate store and then on to the power generating plant as needed.

Stick harvesting systems

These involve a number of operations before the chips are available for use. Sticks are cut with one pass of either a self-propelled or trailed machine, which are less expensive than cut and chip harvesters. The sticks are then laid on the headland. From here they are loaded onto a tractor with suitable attachments and transported to the farm storage area, where they are stacked and stored. The advantage of this system is that there is less investment in machinery, and if necessary the wood can be stored outside, without decomposing. The sticks can then either be chipped and transported as chips, or can be transported as sticks and processed at the power generating plant.

For more details, see Agriculture and Forestry Fact Sheet on *Mechanised Harvesting* published by ETSU for the DTI, and *European Energy Crops Overview*, section on Harvesting and Processing, also from ETSU.

Photo: Steve Wright

Chips on the way to storage

Storage

As a continuous fuel supply is needed throughout the year, most schemes will require some form of storage. Drying may also be required for some schemes. The nature of the harvested material means that it will not look out of place when stored in farm surroundings. The amount of space required will depend on the yield and size of SRC plantation.

The form of the harvested product will dictate the storage method:

- Chips require the most attention during storage, but have the advantage of being ready for use by the fuel-user. There has been extensive research into the drying and storage of woodchips from forestry residue and SRC, and methods to predict the performance of dryers have been developed. Chips need to be actively ventilated to reduce heating and to minimise the risk of mould and dry matter loss. Although chips could be stored outside they will require some form of containment, and if the store is unprotected from the elements some wastage is likely to occur because the wet layer of chips at the top may spoil and have to be removed.
- Whole sticks are bulky and awkward to handle, yet they require the minimal amount of care. The wood can be dried in piles, although this may be difficult given the humid weather conditions in the UK. Nevertheless, they can be stacked on the headland, will dry out naturally and are not particularly vulnerable to mould problems. Whole sticks can also be bundled to ease storage and handling, although this can bring its own problems (see Table 3).
- Short sticks and billets require a simple storage structure, such as a chicken wire cage, to prevent dispersal across the ground when being collected.

Safety

As with any agricultural crop, proper health and safety precautions should be taken during its handling and management. Operators need to maintain vigilance during harvesting to avoid accidents. As SRC is taller than a traditional arable crop, visibility from the harvesting machinery can be poor and extra care should be taken. For example, public warning signs should be put up in the area where harvesting is taking place. Workers should be provided with adequate protection from dust or mould spores from the stored crop, including masks and protective clothing.

Transport

The power generating plant will be the focus for traffic movement as it will require a regular supply of fuel from the farm or intermediate storage depots and the harvested material will be transported to the power plant by lorry. Vehicle choice will be determined by maximum payload, vehicle size and access to the farm.

For very small schemes it is possible that a farm tractor and trailer may be the best option. However, for schemes of any significant scale, traditional tipper or curtain-sided lorries will be used for chip transport, and flatbed or timber lorries for stick transport (also, see above under Mechanised Harvesting). There will also be some traffic generated by workers at the power plant.

Table 1 (in the Introduction) gives more details of the likely vehicle movements at plants of different sizes.

Traffic impact

The impact of traffic created by the power plant will certainly be a consideration in the planning application for the plant, and the developer will be asked to produce details of the likely traffic impact of the plant at an early stage, especially if an Environmental Assessment is required.

Developers should consider emissions from vehicles. Minimising traffic volume will be both economically and environmentally beneficial. Emissions will be reduced through the use of efficient and well-maintained vehicles. Developers will also need to consider access, local road usage, appropriate routes and community concerns as part of their planning application, and undertake detailed public consultation.

Mitigating the traffic impact is likely to form part of the conditions on any planning permission granted, and is likely to be carefully monitored and regulated by the planning authority (or the Highways Agency if on a trunk road). These conditions may cover:

- traffic flows
- delivery routes: these must be carefully chosen and then adhered to
- size and types of vehicles: usually no larger than normal agricultural vehicles.

Table 2

Goods vehicle movements (per day)

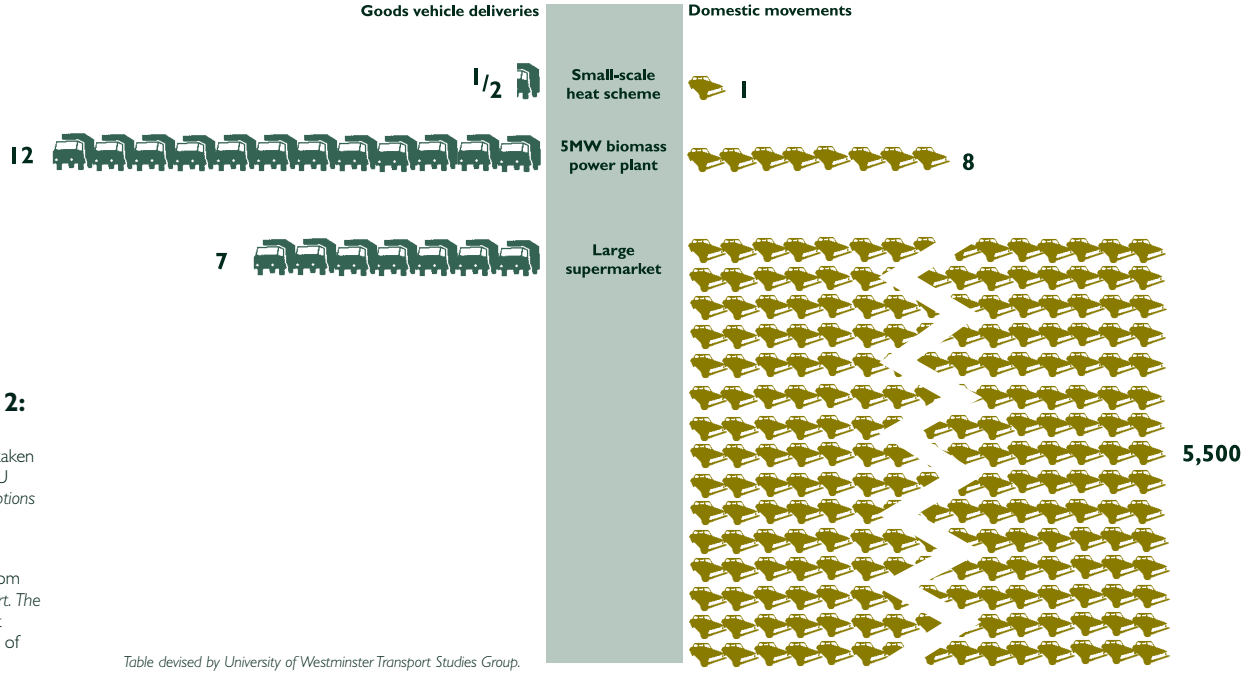


Table devised by University of Westminster Transport Studies Group.

Notes to Table 2:

- Biomass power station vehicle deliveries data taken from forthcoming ETSU report: *Supply Chain Options for Biomass Fuels.*
- Supermarket vehicle deliveries data taken from Goodwin et al, *Transport. The New Realism.* Transport Studies Unit, University of Oxford, 1991.

The impact of goods vehicle traffic will be dependent on the scale of the project. Table 2 shows the likely goods vehicle traffic flow to a small-scale heat scheme and to a 5MW power generating plant. To put this in context, deliveries to a large supermarket are also shown.

Managing traffic

In order to reduce the impact of traffic movements as much as possible, especially those close to the plant, certain guidelines need to be followed:

- The location of the plant requires careful consideration of the road usage requirements. Previous experience suggests that there is least concern where a power generating plant is on an industrial estate or close to a motorway junction.
- Good management of deliveries can help mitigate the problems of traffic flow around the plant itself, where it will be most apparent, and avoid queuing of lorries. A dedicated fleet of lorries can help ensure that only a limited number of heavy vehicles are involved, but the viability of this depends on the scale of the plant.
- Even small plants need to minimise the number of tractors loaded with crop going through small villages and other sensitive areas to reach the plant.
- The usual care should be taken to avoid mud on the roads from vehicles coming directly from fields.
- The plant will also generate traffic from its own workers, including shift workers. The scale of this traffic will depend on the scale of the plant, but reducing the impact should be considered by the developer in terms of good practice, for example by encouraging car sharing and possibly providing group transport.
- The developer of the plant should specify agreed obligations in any contract with a transport company. Developers have a duty of care and must only use reputable, reliable and conscientious haulage contractors who are properly licensed.
- Local sources of fuel supply may not only be more economic, but are likely to be more acceptable to the local community. Research carried out for a straw-fired power station revealed that local resentment was aimed principally at loads which had travelled longer distances.

Table 3

Benefits and potential problems of main harvesting, storage and transport options

	POTENTIAL PROBLEMS	BENEFITS
Whole sticks		
HARVESTING	• Higher cost as a result of double handling. • Length of product makes it awkward to handle.	• Flexibility to meet different user specifications.
STORAGE		• Can be stacked easily and stored on headlands. • Fewer mould problems. • Will dry out naturally. • Dry material loss less than chips.
TRANSPORT	• Any banding will need to be removed prior to chipping. • Poor bulk density of sticks and awkward length reduces lorry utilisation... ...hence more lorries.	• Can be handled and transported loose, or may be bundled or baled. • Could lead to better lorry utilisation and can simplify lorry loading/unloading.
Short sticks /Billets		
HARVESTING	• Requires specialised equipment.	
STORAGE	• Needs confining (e.g. with chicken wire) to prevent dispersal when picked up.	• Few mould problems. • Will dry out naturally. • Improved bulk density compared to whole sticks. • Easier handling (e.g. front-end loader). • Dry material loss less than chips.
TRANSPORT		• Better lorry utilisation than whole sticks... ... hence fewer lorries.
Chips		
HARVESTING	• Needs confining to prevent dispersal when picked up.	• Large range of machinery. Permits all year round utilisation of conventional harvesting equipment (with modifications).
STORAGE	• Needs active ventilation to prevent internal heating. • Outdoor storage without protection leads to waste.	• Best bulk density... ... therefore best space utilisation.
TRANSPORT	• Wet load could exceed lorry's legal capacity.	• Best lorry utilisation... ...hence fewer lorries.

Photo: Nordistribution Ltd

Wood fuel package plant in Kent, producing 800kW of heat

Energy production

This chapter gives good practice guidance for energy production from SRC. It outlines the key issues and ways in which the environmental benefits may be enhanced and any negative impacts minimised in the development of a power and/or heat generating plant. Schemes vary in size from small on-farm heat plants to significant power generating plants supplying electricity to the national grid. However, although all the principles raised in this chapter will apply to all schemes regardless of scale, the extent to which they are applicable may vary considerably depending on the size of the proposed development.

Energy production using SRC is still an emerging industry. There remain many alternative approaches to energy production and methods for project development.

The role of 'developer' in energy production is the central one. It may be taken on by a grower or the community as well as a specialist energy production company. Alternatively, a group made up of, for example, an operation and maintenance company, a regional electricity company and fuel suppliers, may take on the role of developer. Whoever the developer is, they will be concerned with the construction and/or running of the power plant. They will also specify in what form the fuel is required and how it is to be delivered. Therefore, while the level of involvement in growing and transporting the fuel varies, the developer will set those requirements and has overall responsibility for all the technical, commercial, environmental and consultative issues which arise. Indeed, in many cases, the developer may have led the development of the growing and may even be doing the harvesting themselves.

It is likely that planning permission will be required for almost all SRC energy production projects. Plants are also likely to need Authorisation under Part 1 of the Environmental Protection Act 1990 for which the most likely regulatory body will be the local authority. Plants may require statutory Environmental Assessment (EA) as well as environmental regulation and monitoring by the local authority. Whether or not statutory EA is required will depend on the nature, scale and location of the scheme.

Information on the planning process, and guidance on when and how to provide environmental information, are given in more detail below. In general, however, it would be good practice for developers of plants of any scale to produce adequate environmental information (even if no statutory Environmental Assessment is required), to consult statutory and non-statutory bodies, and to establish procedures for regular environmental monitoring.

Site selection

Finding the right site for a power generating plant is always a process of narrowing down the options. Even a very small on-farm scheme may need to consider more than one site. Experience suggests that large-scale developers will usually look at 10 to 20 sites, narrow those down to 1 or 2, begin negotiations and then confirm a favoured site. Where a bid for a NFFO contract is involved, the site will need to have been identified prior to any other significant project development work.

Local authority Structure and Local Plans (or Unitary Development Plans in unitary authority areas) increasingly include policies advising on the prospects for renewable energy development. Rather fewer Plans contain specific policies on biomass development. Most relevant policies advise on the acceptability of development through the use of environmental criteria, leaving locational and siting judgements to the planning application process. However, developers may find that in some Plans local authorities adopt a restrictive attitude to development in areas designated at national level for their landscape or nature conservation value.

Scale of development

Scale is the key factor affecting the regulatory requirements of an SRC energy production scheme. The decision on the scale of a scheme is likely to be led by:

- the opportunity to supply power or heat locally
- the sale of the electricity to the grid (as required through NFFO contracts)
- the chosen technology and equipment to be used (which will be based on principles of best technology to reduce emissions)
- the availability of fuel.

Technical requirements

Before considering specific sites, a number of technical requirements will be considered and addressed by the developer, such as:

- Supply of fuel: whether it can be grown in the area, its availability, reliability of supply, and cost.
- Availability of alternative fuel sources: it is likely that larger scale projects will need to guarantee an alternative source of fuel in order to acquire financial support, particularly during the early years as SRC plantations are developed and reach maturity; the most likely alternative fuel source is woodland residues.
- Accessibility to transport links and for large vehicles: for delivery of fuel.
- Water supply and discharges: consent of the water company and the Environment Agency may be required for larger power plants depending on location and planned operations.
- Access to grid connection: cost and ease.
- Access to other power markets, in addition to the grid.
- Smaller schemes, or those producing heat only, are likely to face fewer problems.

Environmental requirements

Developers should address the following environmental considerations when identifying the site for a large plant. Smaller schemes produce fewer potential impacts, but the following requirements should still be followed:

- Planning policies within Structure and Local Plans or Unitary Development Plans. These policies are likely to highlight local authority concerns relating to landscape, heritage and nature conservation designations.
- Landscape constraints. Account should be taken of landscape designations eg Areas of Outstanding Natural Beauty (AONBs), county level designations, National Parks.
- Air quality standards.
- Visual impact. The potential visual impact of the plant should be considered at this stage, bearing in mind that the site must be large enough not only for the plant, but for ancillary operations and storage and any required landscaping scheme to mitigate the visual impact of the development.
- Impacts on neighbourhood amenities such as noise, light pollution, dust, smells and traffic during construction and operation should be considered. Prevailing wind conditions need to be taken into account to avoid unwanted impacts on local residents.
- Access. Adequate and suitable means of access to the development, from the perspective of highway safety, needs to be available.
- Ecological and hydrological impacts. Consult the statutory conservation agencies (English Nature, Countryside Commission, Countryside Council for Wales, Scottish Natural Heritage) informally before considering a site in or next to a designated area (such as a Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) or Special Area of Conservation (SAC)) as there may be objections to developments in these locations. Any national or local nature conservation designation is a clear indicator of the sensitivity of the intrinsic ecological value and hydrological characteristics of the site and should always be taken into account.
- Built heritage impacts. As well as remains and buildings protected by statute or designation (such as Scheduled Ancient Monuments, listed buildings and Conservation Areas), account needs to be taken of other archeological remains and the vernacular of the area.
- Recreational impacts. Developers should take account of the use by the public of public footpaths and other rights of way.

Technology

There are three basic types of technology used to generate heat and/or power from SRC. These processes are summarised in Figure 3.

Figure 3
Types of technology currently available

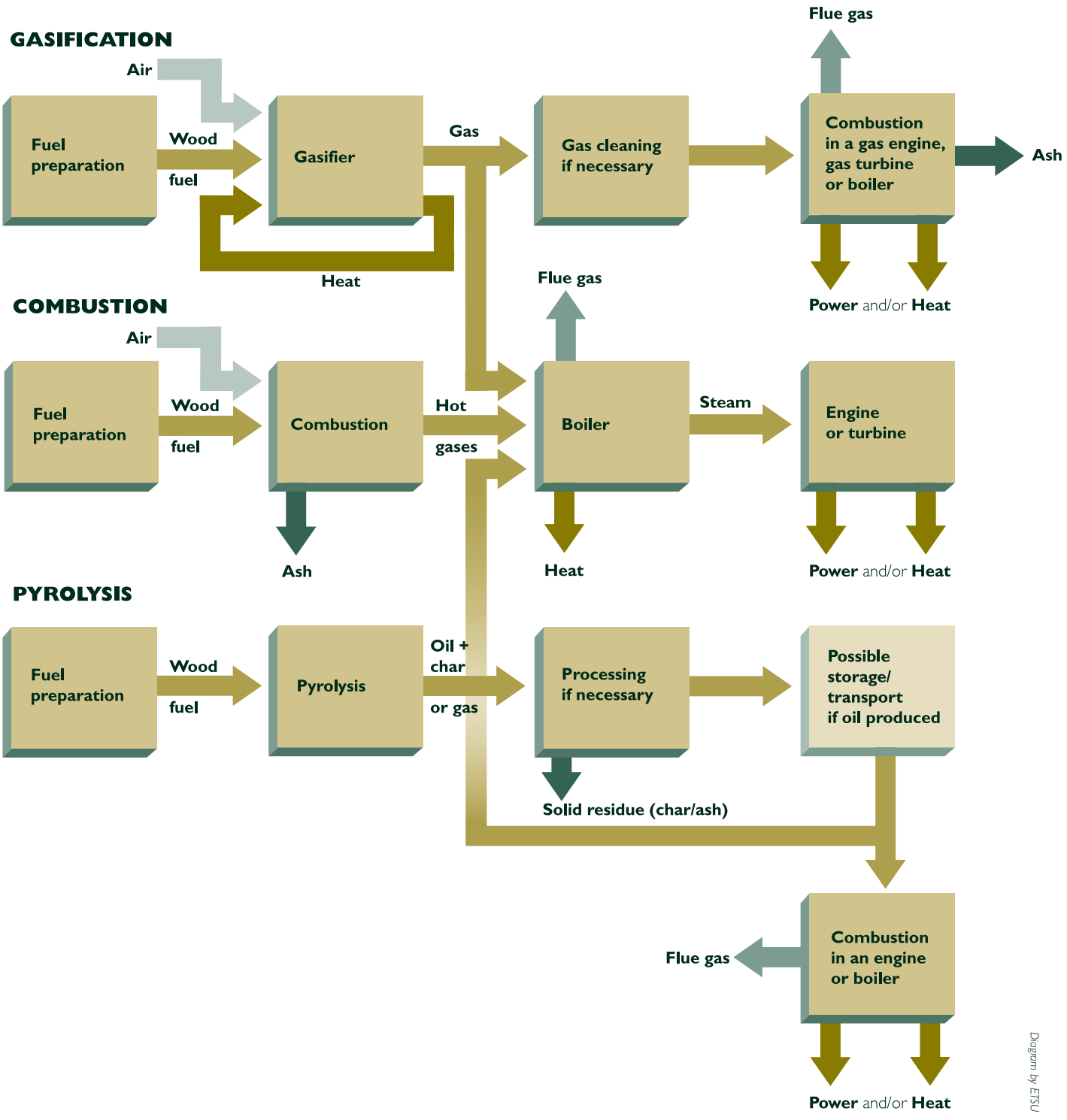


Diagram by ETSU

Planning permission

Power generating plants proposed by private developers are now considered under normal planning regulations. The Secretary of State for Trade and Industry has jurisdiction over applications which are for schemes of more than 50MW, although this is unlikely to apply to plants using SRC, the largest of which are likely to be between 5 and 10MW. Almost all power generating plants will require planning permission, so developers of schemes of any size are advised to check with their local planning authority at the earliest stage. Many plants will also require an Environmental Assessment (see Box 1) as well as regulation and monitoring by the local authority and the Environment Agency.

The extent to which a statutory Environmental Assessment (EA) and environmental statement are required will depend on the location, scale and nature of the scheme. See Box 2 for information on when an EA is required. See Box 3 for what an environmental statement should cover.

In a minority of small on-farm projects, planning permission will not be required because the proposed development is 'permitted development' (under Part 6 of Schedule 2 of the Town and Country Planning General Permitted Development Order 1995).

Where planning permission is required, negotiations will include initial discussions with the local authority prior to the formal process of planning application, and it would be good practice for all developers to consult statutory and non-statutory bodies at this early stage (see Appendix 2 for sample list). The planning process is outlined below.

Box 1

What is an environmental assessment?

Environmental Assessment (EA):

"A technique and a process by which information about the environmental effects of a project is collected, both by the developer and from other sources, and taken into account by the planning authority in forming their judgement on whether the development should go ahead ... the whole process whereby information about the environmental effects of a project is collected, assessed and taken into account in reaching a decision on whether the project should go ahead or not. The term 'environmental impact assessment' (EIA) is also in common use and for practical purposes is synonymous with EA" .

Environmental statement:

"A document setting out the developer's own assessment of his project's likely environmental effects, which he prepares and submits in conjunction with his application for consent."

Taken from *Environmental Assessment. A Guide to the Procedures*, published by HMSO/Welsh Office

Box 2

When is an EA required?

Statutory EA is only mandatory for a thermal power station with a heat output of 300MW or more (referred to as a Schedule 1 development under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988), and no power generating plants using SRC are likely to reach anything like the size where an EA is mandatory.

However, smaller plants will require an EA if they are likely to have significant effects on the environment because of their nature, size or location (referred to as Schedule 2 developments under the 1988 regulations).

'Significant effects' have no general definition, but Government guidance lists three main criteria of significance (taken from *Environmental Assessment. A Guide to the Procedures*, DOE/Welsh Office 1989):

- Whether the project is of more than local importance, principally in terms of physical scale
- Whether the project is intended for a particularly sensitive location, for example, a National Park or Site of Special Scientific Interest (SSSI), and for that reason may have significant effects on the area's environment even though the project is not on a major scale
- Whether the project is thought likely to give rise to particularly complex or adverse effects, for example, in terms of the discharge of pollutants.

Exactly what supplementary environmental information may be required in any application for planning permission would need to be negotiated in each individual case with the planning authority concerned. The regulations governing this procedure are the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (as amended) implementing EU Directive 85/337. These regulations include details of the matters to be addressed by an EA, and provide useful guidelines for any supplementary environmental information produced by developers (see Box 3).

Planning process

The process of obtaining planning permission is a crucial element of the overall development process of a power plant. However, although the formal planning process only relates to the plant and activities directly related to it, it is good practice for a developer to consider the overall impact of the whole project, including growing and harvesting, even though these would be outside the formal requirements of planning permission or Environmental Assessment.

The following summary of the formal planning process is not a step-by-step guide, since the actual procedure will vary according to the requirements of different planning authorities. Also, all assessments will be done in parallel, rather than one at a time. Moreover, this procedure does not cover all the actions required of the developer: others are necessary before and after planning permission is applied for and granted. However, the following is a summary of the way the planning procedure should work in normal circumstances.

1 The developer will make contact with the planning authority at an early stage. The planning authority with jurisdiction for the development will be either the district or county council, or unitary authority, depending on the local government structure in the area and the nature of the project (or the Secretary of State for Trade and Industry if over 50MW). Generally, the most local authority will be contacted first and they will refer on any developments which should be dealt with at a county level. Early discussions with the local authority's Environmental Health Officers are also important, in view of their later role in enforcement.

The initial contact will be with the Chief Planning Officer, who will decide whether he will deal with the matter himself or delegate it. There may also be contact with the economic development officer about larger schemes. At this stage, the project may not reach the public domain.

2 Between initial contact and a formal application for planning permission, most of the preparatory work for the development will be carried out. This will include regular contact with the planning authorities, especially relating to scoping work on the EA (or alternative provision of environmental information). The EA can be informally scoped in discussion, or formally scoped in correspondence. The latter approach would mean that the project will become public because the planning authority will consult statutory consultees. The need for a statutory EA will depend in part on how far, in negotiations, the developer agrees with the planning authority to address environmental issues which will be covered in detail as part of the licensing procedure. There will

Box 3

What should an environmental statement cover?

It is not possible to offer a definitive list of topics for an environmental statement, and developers will need to look at both wider and more local issues which cannot be identified in general guidelines. Also, circumstances and technologies change over time. Developers are advised to clarify issues with the local authority and, very likely, the Environment Agency. However, the 1988 Regulations (Schedule 3, paras 2, 3 and 4) state that an environmental statement should provide certain specified information including:

(a) a description of the development proposed, comprising information about the site and the design and size or scale of the development

(b) the data necessary to identify and assess the main effects which that development is likely to have on the environment

(c) a description of the likely significant effects, direct and indirect, on the environment of the development, explained by reference to its possible impact on:

- human beings
- flora
- fauna
- soil
- water
- air
- climate
- the landscape
- the interaction between any of the above
- material assets
- the cultural heritage

(d) where significant adverse effects are identified with respect to any of the foregoing, a description of the measures envisaged in order to avoid, reduce or remedy these effects

(e) a summary in non-technical language of the information specified above.

An environmental statement may include, by way of explanation or amplification of any specified information, further information on any of the following matters:

(a) the physical characteristics of the proposed development, and the land-use requirements during the construction and operational phases

(b) the main characteristics of the production processes proposed, including the nature and quality of the materials to be used

(c) the estimated type and quantity of expected residues and emissions (including pollutants of water, air or soil, noise, vibration, light, heat and radiation) resulting from the proposed development when in operation

(d) (in outline) the main alternatives (if any) studied by the applicant, appellant or authority and an indication of the main reasons for choosing the development proposed, taking into account the environmental effects

(e) the likely significant direct and indirect effects on the environment of the development proposed which may result from:

(i) the use of natural resources

(ii) the emission of pollutants, the creation of nuisances, and the elimination of waste (this includes secondary, cumulative, short, medium and long term, permanent, temporary, positive and negative effects)

(f) the forecasting methods used to assess any effects on the environment about which information is given under subparagraph (e), and

(g) any difficulties, such as technical deficiencies or lack of know-how, encountered in compiling specified information.

Where further information is included in an environmental statement in this way, a non-technical summary of that information shall also be provided.

Taken from *Town and Country Planning (Assessment of Environmental Effects) Regulations 1988.*

also be detailed consultation with the local community and with statutory and non-statutory consultees. Only when all this is completed, and all issues of concern addressed, should a formal application for permission be made.

3 If a major project is planned, a more intensive dialogue between the developer and the planning authority, prior to the submission of the planning application, is recommended. It is good practice to submit the environmental statement (or informal environmental information) at the same time as the planning application.

4 The formal process begins with the submission of the planning application, which will lead to some form of statutory consultation. The planning authority is obliged to publicise the planning application as soon as it is formally received, at which point anyone can make comments on the proposals.

While planning applications and EAs require a high degree of technical input, it is important to recognise that these are public documents, and developers should ensure that results are presented in as accessible a form as possible, with the minimum of technical or scientific jargon. In addition, the developer will be required to produce a non-technical summary planning statement for public information, and a formal summary will be required if there is an EA.

If the development does require a formal EA, the local authority has 16 weeks to deal with the application. If no formal EA is required, the local authority has up to 8 weeks. The developer has the right to appeal against the failure of the local authority to decide the application at the end of 8 or 16 weeks.

5 The Secretary of State has the ability to call in planning applications, at which point they are taken out of the hands of the local authority. This may happen if there is considered to be a breach of the development plan policy or if the Government Regional Office (in England only) considers that the proposed development raises issues of more than local concern. If the developer is working effectively with the local authority and local community, any such issues and potential problems will have been identified at an early stage.

6 If planning permission is granted, developers will be aware of the need to comply with any agreed planning obligations and planning conditions, which will have been negotiated prior to granting any permission. Discussions will have been held with planning authorities to agree methods of complying with those conditions, which may involve some form of monitoring. Some elements could be dealt with through a liaison forum set up from the links the developer has already established with the local community. There may also need to be agreement to off-site highway improvements, which would involve discussions with the Highway Authority and local landowners.

7 If planning permission is refused, developers have a right to appeal within six months.

Overall, if a site is suitable, and a well-considered planning application is made, which seeks to take into account the concerns or likely concerns of local communities and statutory consultees, it is much more likely to receive a positive response.

Grid connection and route of power lines

Not all schemes will require grid connections. For example, heat schemes will only require pipe networks for circulating the hot water. However, in projects where electricity is being generated, planning consent is required for the grid connection. The developer will have established a dialogue with the Regional Electricity Company to determine the route and will have assessed any visual implications of the preferred route and method of grid connection. Planning consent for the grid connection is obtained from the Department of Trade and Industry (DTI) under the Electricity Act 1989. The developer will make direct contact with the consent section at the DTI or the relevant department in the Scottish Office. The DTI has two months to make a decision on the application, unless an Environmental Assessment is required, in which case the period is four months. Environmental Assessment may be required, depending on the nature, scale and location of the grid connection proposal.

The scope of the application for consent will include the whole of any new overhead line

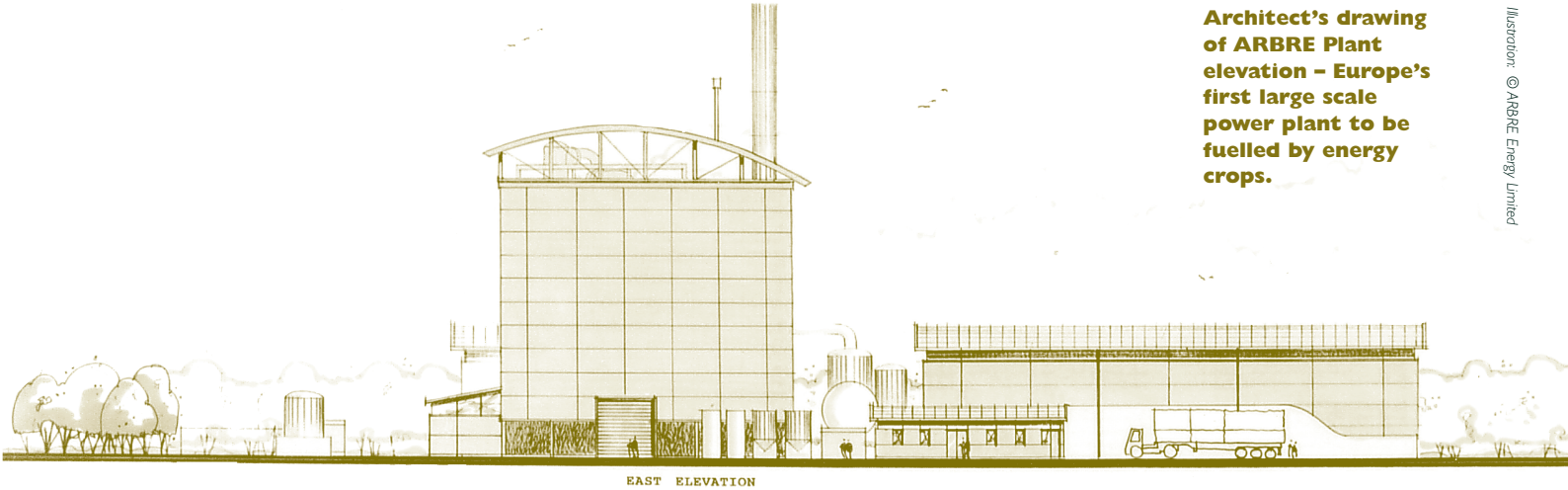
between the site substation and the point of connection with the existing electricity grid. The normal grid connection with an SRC biomass plant will be at 11 or 33kV, for which overhead lines will be carried on eight metre poles. Good practice suggests that the local planning authority should be consulted on the route of the line, as they have an opportunity to make representations or requests for amendments, or indicate that they have no objection, and developers may feel it would also be appropriate to consult local residents over the potential route of the line at this stage. County councils and district councils (or unitary authorities) are consultees on the application for consent, and objection by either council means that there is likely to be a public inquiry. However, it is the Regional Electricity Company which will ultimately determine the route and the nature of the grid connections. Therefore the line of the grid connection may not be completely known at the time that the planning application for the power generating plant is decided.

New connections will have an impact both on and off-site (ie lines or cables to make the connection to the grid). The visual effect of overhead lines can usually be mitigated to an acceptable level by careful route selection, but developers will plan for the likely route of a grid connection at the same time as they are planning the power generating plant. Where a grid connection already exists, there will still be an impact on-site (ie simple fixing to existing grid system). Underground connection reduces the visual impact and may in certain cases be economic in comparison with overhead lines. In this case, the visual intrusion is only short term whilst the work is carried out.

Construction of plant

The level of the impact of construction will depend on the scale of the plant being constructed. An on-farm heat generating plant is likely to have minimal impacts during construction. In larger energy generating schemes using SRC, in which electricity is supplied to the grid, a purpose-built power generating plant will be constructed, which is likely to entail new building, creating greater impacts which need to be mitigated. As with any new development, there are specific issues arising from the construction of the power generating plant which are more related (for neighbours) to living near to a building site than to a power plant. These include construction noise and dust, impact on the access road, transport noise, light pollution, emissions to the ground from diesel spillage, establishing a construction compound which may be larger than the final site, and negotiations for wayleaves.

A developer can apply to the local authority for a prior consent over times of working, noise levels, and similar issues (under the provisions of Section 61 of the Control of Pollution Act 1974). This may help provide reassurance to local residents: difficulties at this stage can damage the reputation of a plant before it even starts operation. It would also be good practice to consult with the local authority's Environmental Health Officers, as they would deal with any complaints and could defuse any local antagonism more quickly if they can give answers directly.



Architect's drawing of ARBRE Plant elevation – Europe's first large scale power plant to be fuelled by energy crops.

Illustration: © ARBRE Energy Limited

Method statement

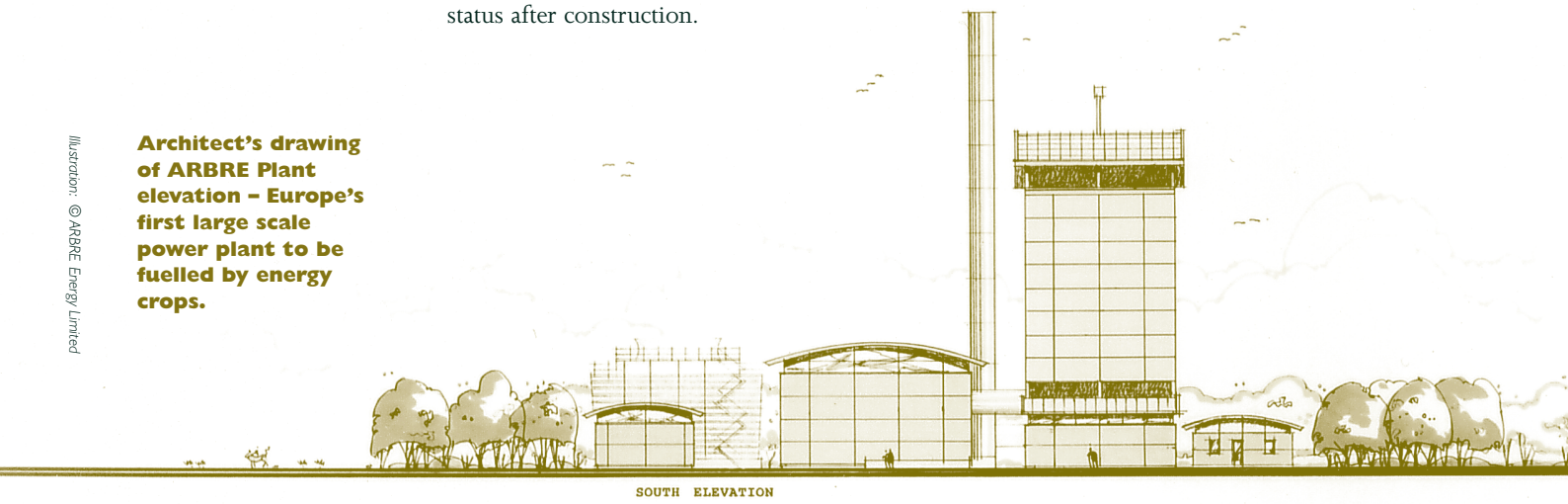
The specific measures which developers plan to take to minimise disruption and mitigate any undesirable impacts during construction should be spelt out in an agreed construction method statement, which will have been negotiated as part of the planning permission and which should be built into the contract with the contractors for the building. It should provide a comprehensive and site specific statement about how all the factors listed above will be mitigated. This would include:

- Reducing noise nuisance as much as possible by working only during the normal working day. It would be good practice to consult the local authority's Environmental Health Officer who can advise on acceptable construction site noise levels. Developers will wish to consult and have regard to British Standard (BS) 5228 on Noise Control on Construction and Demolition.
- Timing construction carefully, to avoid damage if the area or surroundings are environmentally sensitive (eg at certain times of year): there should also be consultation with the local planning authority regarding proposed traffic movements.
- Dust: water can be used to suppress dust.
- Lighting: consultation is recommended with the local authority's Environmental Health Officer for advice on guidelines on light pollution (further details on light pollution are given below).
- Size of construction compound: the site will need to be sufficiently large to allow space for mitigation of any construction impacts, as well as simply meeting the physical needs of construction. Attention should be given to returning the surrounding area to its original status after construction.
- Emissions to ground: bunding to reduce diesel spillage would probably be a requirement of planning permission.
- Duration of construction: an estimated construction timetable should be included in the method statement.
- Transport and traffic: the construction process might require consideration of:
  - off-site highway changes such as setting back hedges, hedge-trimming
  - bridges: need to consider loading and height
  - road developments eg minor road widening.

  See Harvesting and Transport chapter for more details on possible problems and mitigating activities.

The method statement can be required as part of the planning permission. Although it is good practice for a method statement to be prepared in all circumstances, it is unlikely that it will be required for small scale projects. The statement should be drafted by the developer, and discussed with the planners, the environmental health department of the relevant local authority and with community representatives and local people. This will help to demonstrate that the developer has thought about the possible problems and their mitigation, as well as about residual impacts and how to address them.

The method statement will need to provide detailed guidance for the construction contractors, but it would be good practice to produce an additional summary in plain English for planning authorities and local communities for the reasons outlined above.



Architect's drawing of ARBRE Plant elevation – Europe's first large scale power plant to be fuelled by energy crops.

Illustration: © ARBRE Energy Limited

Operation of plant

The power generating plant is the centre of the production of renewable energy from SRC. It is here that the balance between the global environmental benefits of SRC energy production and the local impact of its production is most apparent. Good practice requires careful planning to ensure that the benefits of clean electricity are matched by sensitively and effectively managed systems for energy conversion.

As with any agricultural or small industrial development, the operations of the power generating plant may have some negative impacts in terms of emissions and an increase in traffic around the plant. Some of these impacts, and therefore any mitigating activities, will be negligible in smaller schemes. However, even the largest SRC power generating plant currently envisaged will have far fewer negative impacts on the local area than many other developments, and can be compared more easily with other agricultural developments than with any conventional power plants. Nevertheless, and especially in larger schemes, attention needs to be given to the following,
all of which are covered in more detail below:

- **noise**
- **light**
- **dust and smell**
- **ash**
- **emissions to ground and water courses**
- **emissions to air (including plume)**
- **transport and traffic**
- **fuel storage.**

The regulations which will be in force depend on the scale of the development, as will the identity of the regulatory authority: it is likely to be the local authority as power generating plants using SRC are unlikely to exceed 15-20MW.

Noise

- The conditions of the planning permission are likely to specify noise limits. Expert advice is required in each case to identify and negotiate acoustic measures (if these are required) and noise conditions. Although not always essential, the developer and/or the local authority may wish to carry out a background noise survey to establish the ambient level of noise in the environment prior to the development.
- Sources of potential noise need to be identified, such as engines, condensers and chippers, and plans can then be made to mitigate these through appropriate design of the site, such as creating a hedge or tree barrier around the plant, and appropriate technology.
- Regulator: environmental health department of local authority.

Light

There are no statutory criteria for light pollution although measures can be taken to reduce unnecessary obtrusive light: light pollution can cause serious physiological and ecological problems, and wastes energy and money. The Institution of Lighting Engineers' *Guidance Notes for the Reduction of Light Pollution* suggests a number of measures, including:

- Lights should be directed at and not above their target; if aimed at observers, the main beam angle should be no more than 70°.
- In certain environmental zones, such as National Parks, Areas of Outstanding Natural Beauty (AONBs) or other 'dark landscapes', only light from public roads should be deemed acceptable for all night lighting. Similar guidelines apply to other special areas.
- Curfews should be introduced, for example between 11pm and dawn, when lights not required for security are shut off.
- Further advice can be obtained from the local authority Environmental Health Officer, or the Institution of Lighting Engineers.

Dust and smell

The combustion of SRC is unlikely to create dust and smell problems beyond the boundaries of the site. However, developers should consider the following:

- Potential problems need to be addressed through the design of the site, and expert advice is required in each individual case to consider:
  - what is likely to be discharged
  - what are the potential risks
  - how can they be avoided or at least minimised.
- Health and safety: problems can arise from spores which can develop when wood is harvested when wet and then stored for nine months or more. This is specifically an on-site problem related to health and safety at work and would not affect the wider neighbourhood.
- Regulator: Health and Safety Executive; local authority under the Environmental Protection Act (EPA) 1990.

Ash

There are two types of ash produced: ash collected in the combustion unit (the residue left in the primary chamber); and ash collected from the flue gases. There is, however, a closed circuit process for all ash since it is captured and can be safely contained prior to a decision on disposal or use. The amount of ash produced depends on the technology used; in gasification plants it is very small, only 1-2% of the original bulk. Handling procedures for ash would be dealt with by the EPA Authorisation. The following general points may apply:

- Ash can be a valuable by-product: it has considerable potential value as a low nitrate fertiliser, and may be used as a raw material in the brick and cement industries.
- The wood being burnt is likely to contain small quantities of heavy metals, either naturally occurring or from some types of fertiliser used to grow the fuel crop. Any use or disposal of the ash as a by-product will have to take full consideration of this. It is good practice for a full assessment of the contents of the ash to be undertaken before any use is determined.
- If there is no use identified, the ash will need to be disposed of in a landfill.

Emissions to ground and water courses

- Water courses could possibly be affected by emissions such as leachate, surface water run-off, abstraction and water tables being affected by site level.
- Any possibility of soil contamination from leachate from stored fuel, waste, ash or clinker will be dealt with at the planning stage in consultation with the local authority environmental health department and the Environment Agency.
- Regulator: Environment Agency (for rivers and watersheds); water authority (if there is any run-off into sewers).

Emissions to air (including plume)

As with the combustion of any fuel, there will be emissions to air. However, wood has a much lower sulphur and nitrogen content than coal, and therefore electricity generated through SRC (if displacing coal) will result in a reduction in the national emissions of sulphur and nitrogen oxides. In addition, energy produced from SRC will be carbon neutral (see Introduction). However, good practice requires making every effort to reduce the impact of operations on air quality and preventing emissions through the efficient use of conversion technologies and, where appropriate, best abatement technology. There is a variety of technologies which can be used for generating electricity and/or heat from SRC including gasification. For details of types of technology, see Figure 3.

For larger scale schemes it is likely that gasification processes will be used. Gasification is generally considered to be cleaner than combustion.

Exhaust stacks will be necessary for all plants, even though those for gasification and pyrolysis plants will generally be lower and smaller than an equivalent steam boiler unit because they use gas turbines and internal combustion engines. Reciprocating engine exhausts can have low visual impact because their small diameter flues can be arranged to follow a building profile. All SRC power plant exhausts contain very low levels of sulphur oxides and so the stack does not need to be high to disperse them. Steam plume should be avoidable but may be a problem in certain circumstances: for example, where the micro-climate may cause grounding of the plume if the chimney is not sufficiently high.

Specialist plume modelling exercises can help establish the appropriate height of the chimney, as the height of the nearby buildings and the general topography affects the visibility of the plume. These exercises can also help allay any concerns from local residents by confirming the correct height and design of the chimney. It is important that local people fully recognise the balance between mitigating the impact of the contents of the plume (ie water) and the permanent construction of a higher chimney, which may be less acceptable. This is an issue for detailed community consultation and expert advice from the Environment Agency.

Emissions to air will be strictly controlled and monitored under the EPA Authorisation, in accordance with the formal guidance. All records relating to the Authorisation are in the public domain and available for public viewing at the local authority offices.

The principal emissions that could arise from the plant are:

- Particulate: tiny particles in the flue gas, which would be minimised by pollution abatement equipment and good combustion control.
- Carbon monoxide: burning fuel in an oxygen rich environment, with good fuel and air distribution keeps carbon monoxide emissions to a minimum.
- Carbon dioxide: CO_2 is a greenhouse gas. One of the principal environmental benefits of SRC as a fuel is that it is carbon neutral. Any CO_2 emitted will be compensated by the CO_2 fixed by the growing trees planted for fuel. The fuel cycle is neutral over a cropping period of two to five years.
- Sulphur dioxide: The sulphur content of wood is 0.1% by weight, compared with UK coal which typically contains 0.8-1% sulphur.
- Organics: SRC is not likely to be a major source of toxic organic substances such as PAHs, dioxins and furans, which are produced as a result of many combustion processes. Controlled burning of SRC and use of appropriate pollution abatement equipment will keep these to a minimum.
- Nitrogen oxides: wood has a small inherent nitrogen content, typically 0.1% by weight for willow SRC, compared with coal which is typically 1%: so using SRC is likely to result in lower emissions.
- Water in the form of vapour will also be emitted. The water vapour will form the visual effect of a plume but has minimal pollution implications.
- Regulator: local authority, under the EPA 1990.

Transport

Details of the transport implications of the operations of the power generating plant are given in the Harvesting and Transport chapter, together with some guidance on mitigating action.

Monitoring

The scale of monitoring procedures depends to a great extent on the scale of operations. Monitoring the impact of an on-farm scheme may be fairly limited, while requirements for monitoring a 5-10MW power generating plant may be more stringent. Monitoring can have many positive effects: good monitoring procedures can be one of the most effective tools in boosting local confidence in the plant, as the impacts are seen to be constantly under scrutiny. Statutory and voluntary monitoring procedures will be required, both of which will be identified during the planning process and are likely to be set as a condition of planning permission.

Monitoring needs to start before operations begin, to ensure that an appropriate benchmark can be established against which future findings can be measured. All the impacts of the plant will need to be monitored, and a range of different types of monitoring will be required, such as:

- Some emissions to air need to be monitored comprehensively on the site of the plant itself and at sites surrounding the plant at varying distances; sampling (such as of foliage and soil) may also need to be carried out regularly. Much of this is likely to be a condition of the EPA Authorisation. Quarterly monitoring exercises may be required in at least the first year, reviewable at the end of that period, to reassure local residents and the local authority.
- Noise is unlikely to be monitored routinely on an official basis; for local authorities it is essentially a complaint-driven process.
- Traffic and transport routes need to be monitored to ensure that transport contractors are keeping to contract obligations and planning conditions, and that impacts are acceptable.

All these, and other issues, are only likely to be fully monitored if identified as potential problems early in the development process.

Decommissioning

As a matter of good practice, any developer will want to prepare and plan for change. They may therefore wish to consider possible alternatives for the facility at the end of its life as a power generating plant, in which case it would be good practice to consider decommissioning at the planning stage of the project.

A well-designed, good quality building in the right location may be able to be adapted (and sold) for alternative industrial uses if no longer required as a power plant. Alternatively, the land may have a development value. Like any industrial site, it will need to be checked for ground contamination (such as diesel fuel spillage) and assessment and remediation carried out. However, the risks are likely to be less in the case of a power generating plant using SRC than in most industrial developments.

The developer and local authority may wish to consider the possibility of limited life planning permission, 20 years for example, at which time restitution of the land can be discussed in detail.

Appendix I

Consultation on guidelines

The process

These guidelines were produced using consensus building techniques. Environmental Resolve, an undertaking of The Environment Council, managed the process, which brought together the industry, environmentalists, planners and government agencies in order to address potential stakeholder concerns and support the development of the industry in a sensitive manner. The process was designed and guided by a steering group made up of British Biogen, Friends of the Earth, ETSU and Environmental Resolve.

This innovative approach involved a series of workshops and small sub-group meetings during the first half of 1996. Participants used their experience to develop and agree detailed guidelines on what constitutes good practice in developing an economic, efficient, environmentally sound and publicly acceptable SRC energy production industry. Draft material was written up by an editor working to each group, circulated and amended by agreement, and then collated by the overall editor. A full list of those involved is given below.

Steering Group

- Peter Billins, British Biogen
- Caroline Foster, ETSU
- Anna Stanford, Friends of the Earth
- Pippa Hyam and Jennifer Marusiak, Environmental Resolve

Working groups and seminars

Three working groups met twice each during the process to develop the three main chapters (Growing, Harvesting and Transport, Energy Production). There were also several larger workshops and seminars: one at the beginning of the process to set the parameters and identify key participants, a smaller sub-group to agree the structure and contents of the guidelines, and another larger meeting at the end to consider the full draft. The following attended one or more of these meetings:

Julian Allen, University of Westminster
Chris Baines, Environmentalist
Peter Billins, British Biogen
Jim Birse, British Biogen
Adrian Bowles, Border Biofuels
Barnaby Briggs, RSPB
Mike Brown, University of Westminster
Rupert Burr, Roves Farm
Phillip Callaghan, Department of the Environment
Murray Carter, Ingerthorpe Hall
David Clay, Avon Vegetation Research
Karl Cradick, Terrence O'Rourke
Richard DeBoys, Forestry Commission
Fred Dumbleton, ETSU
Caroline Foster, ETSU
Vincent Furkettle, Forestry Authority
Robert Goodwin, Robert Goodwin & Sons
Ian Higham, ETSU
Joanne Hirst, National Farmers Union
Huw Jones, Countryside Council for Wales
Keith Kirby, English Nature
William Livingston, Mitsui Babcock Energy Limited
Jane McWilliam, MAFF
Andy Moffat, Forestry Commission
Lucy Morgan-Edwards, Country Landowners Association
Chris Muskett, Ashdown Environmental Ltd
Andy Neale, Countryside Commission
Martin Nellist, Silsoe Research Institute
Steve Parker, Long Ashton Research Station
Colin Pile, Barton Willmore Planning Partnership
Keith Pitcher, Yorkshire Environmental/ARBRE
Tony Redman, Nordistribution Ltd
Joanne Roberts, ETSU
David Royle, Long Ashton Research Station
Rufus Sage, Game Conservancy Trust
John Seed, Border Biofuels
Nick Sotherton, Game Conservancy Trust
Anna Stanford, Friends of the Earth
Edward Stenhouse, ESL
Candy Stevens, SWEB
Paul Tabbush, Forestry Authority
Marcus Trinick, Bond Pearce Solicitors
Ros Twemlow, S C Banks
Michael Wall, Forestry Commission
Adam Wallace, FWAG
Jackie Ward, Mid-Suffolk District Council
Georgina Welling, S C Banks

Editors

Three editors drafted text on behalf of the participants:

Diane Warburton (overall editor, and for Energy Production group)
Roderick Robinson (Harvesting and Transport)
Carla Smith (Growing)

Environmental Resolve team

Pippa Hyam (project manager)
Jennifer Marusiak

Appendix 2

Statutory and non-statutory consultees

The bodies which are consulted will depend on the scale, location and nature of the proposal. However, it would be good practice for developers of SRC energy production plants to consider which of the following bodies are likely to have an interest in, or be affected by, a new plant or coppice plantation and consult them at an early stage. This is by no means an exhaustive list, and may be extended to include specific local organisations, or additional organisations relevant to particular local circumstances.

Specifically, under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (8.5), the authority is required to consult the following bodies when an environmental statement is produced:

a) any body which the local planning authority would be required by article 15 of the General Development Order (amended by SI 1986/435) or any direction under that article to consult if the application were before them

b) the following bodies if not included in paragraph (a):

i) any principal council for the area where the land is situated, if not the local planning authority (including consultation of the county council by the district council)

ii) the Countryside Commission (or Countryside Council for Wales, or Scottish Natural Heritage)

iii) English Nature (formerly the Nature Conservancy Council)

iv) the Environment Agency (formerly HMIP, NRA and others) in certain circumstances.

Within local government

Different departments within the planning authority may require consultation. Some of these may require consultation across the boundaries of the responsibilities of county and district authorities, or may be within a unitary authority:

- Environmental Health
- Engineer/Technical Services
- Highways
- Planning Policy/Economic Development
- Built Heritage (Conservation Area, Listed Buildings)
- Waste Disposal
- Minerals
- Archaeology
- Environment/Countryside Management/Wildlife Conservation
- County Fire Officer.

Other consultees

It will be appropriate, depending on the size and nature of the scheme, to consult with a range of other consultees. The following sample list is not exhaustive:

- Government Office (generally, when major scheme proposed; Department of Transport/Highways Agency if a trunk road is affected)
- Town and Parish councils
- Health and Safety Executive
- Regional/local water company
- English Heritage
- Local amenity groups (eg preservation group, wildlife/naturalist trust, town society)
- Local environmental groups (eg Friends of the Earth local groups)
- Local community and residents groups
- Ramblers Association: if proposal affects a public right of way
- British Gas, BT or other telecom company, Railtrack: if near one of their installations, land or equipment
- Civil Aviation Authority or Ministry of Defence: if a major proposal and in close proximity to civil airport or military installation
- The RSPB regional office
- The county wildlife trust.

Appendix 3

Contacts

Ashdown Environmental Ltd
The Oast House, Upper Hartfield, East Sussex TN7 4AR

Avon Vegetation Research
2 Fouracres Close, Nailsea, Bristol BS19 2YF

Barton Willmore Planning Partnership
62 Margaret Street, London W1N 7FJ

Bond Pearce Solicitors
Ballard House, West Hoe Road, Plymouth PL1 3AE

Border Biofuels Ltd
Tweed Horizons Centre, Newtown St Boswells,
Melrose TD6 0SG

British Biogen
7th Floor, 63-66 Hatton Garden,
London EC1 8LE

Cadw Welsh Historic Monuments
Brunel House, 2 Fitzalan Road, Cardiff CF2 1UY

Council for the Protection of Rural England
Warwick House, 25 Buckingham Palace Road,
London SW1W 0PP

Country Landowners Association
16 Belgrave Square, London SW1X 8PQ

Countryside Commission
John Dower House, Crescent Place, Cheltenham, Glos GL50 3RA. Tel: 01242 521381. Contact for nearest office.

Countryside Council for Wales
Plas Penrhos, Ffordd Penrhos, Bangor LL57 2LQ

Department of Agriculture for Northern Ireland
Dundonald House, Upper Newtownards Road, Belfast BT4 3SB

Department of the Environment
2 Marsham Street, London SW1P 3EB

Department of Trade and Industry
Ashdown House, 123 Victoria Street, London SW1E 6RB

English Nature
Northminster House, Northminster Road, Peterborough PE1 1UA. Tel: 01733 340345. Contact for nearest office.

Environment Agency
Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol BS12 4UD. Tel: 01454 624400. Contact for nearest office.

Edward Stenhouse Limited
Newbridge, Colemans Hatch, Hartfield, E Sussex TN7 4ES

ETSU
Harwell, Didcot, Oxfordshire OX11 0RA

Forestry Authority - see Forestry Commission

Forestry Commission
231 Corstorphine Road, Edinburgh EH12 7AT.
Tel: 0131 334 0303. Contact for nearest office.

Friends of the Earth
26-28 Underwood Street, London N1 7JQ

FWAG
National Agricultural Centre, Stoneleigh, Kenilworth,
Warwickshire CV8 2RX

The Game Conservancy Trust
Burgate Manor, Fordingbridge, Hampshire FP6 1EF

Health and Safety Executive
Information Centre, Broadlane, Sheffield S3 7HQ

Highways Agency
Tollgate House, Houlton Street, Bristol BS2 9DJ

Ingerthorpe Hall Farm
Markington, Harrogate, North Yorkshire HG3 3PD

Institute of Hydrology
Maclean Building, Crowmarsh Gifford, Wallingford,
Oxfordshire OX10 8BB

Institution of Lighting Engineers
Lennox House, 9 Lawford Road, Rugby, Warks CV21 2DZ

Long Ashton Research Station
Long Ashton, Bristol, Avon BS18 9AF

Ministry of Agriculture, Fisheries and Food (MAFF)
Alternative Crops Unit, Room 401, 10 Whitehall Place,
London SW1A 2HH

Mid-Suffolk District Council
131 High Street, Needham Market, Ipswich IP6 8DL

Mitsui Babcock Energy Limited
Technology Centre, High Street, Renfrew PA4 8UW

National Farmers Union
Agriculture House, 164 Shaftesbury Avenue,
London WC2H 8HL

Nordistribution Ltd
The Broyle, Shortgate, Lewes, East Sussex BN8 6PH

Roves Farm Visitor Centre
Sevenhampton, Near Highworth, Swindon SN6 7GQ

RSPB
The Lodge, Sandy, Beds SG19 2DL

S C Banks Plc
29 St Neots Road, Sandy, Beds SG19 1LD

Scottish Office Agriculture,
Environment and Fisheries Department
Pentland House, 47 Robbs Loan, Edinburgh EH14 1TY

Scottish Natural Heritage
12 Hope Terrace, Edinburgh EH9 2AS

Silsoe Research Institute
Wrest Park, Silsoe, Bedford MK45 4HS

SWEB
800 Park Avenue, Aztec West, Almondsbury,
Bristol BS12 4SE

Terrence O'Rourke plc
Everdene, Deansleith Road, Bournemouth BH7 7DU

University of Westminster
Transport Studies Group, 35 Marylebone Road,
London NW1 5LS

Welsh Office Agriculture Department
Cathays Park, Cardiff, South Glamorgan CF1 3NQ

The Wildlife Trusts
The Green, Witham Park, Waterside South, Lincoln LN5 7JR
Tel: 01522 544400. Contact for nearest office.

Yorkshire Environmental
2 The Embankment, Sovereign Street, Leeds LS1 4BG

Appendix 4

Glossary

The following terms are used in these guidelines, and the definitions given refer to their meaning in the context of this document: other sources may use the terms differently.

Age-class: Forestry term relating the age of the crop to expected yield

Billet: SRC cut as short sticks 3-30cm in length

Biofuel: Any solid, liquid or gaseous fuel derived from biomass

Biomass: Fuel derived from agricultural or forestry material

Bunding: An artificial protective bank

Char: The solid residue from pyrolysis containing a high percentage of unburnt carbon

Chips: Small pieces of wood for energy conversion (2.5cm x 2.5cm)

Combined Heat and Power (CHP): Generating both heat and electricity. Generally more efficient than generating power alone.

Consultation: Encouraging the involvement of those with an interest in the development, by providing information and taking account of their views

Consultees: Those who are consulted about a development

Coppice: Dense growth of small trees or bushes regularly trimmed back for re-growth

Cropmarks: Archeological features, seen from the air

Decommissioning: Closing and dismantling the facility after its useful life

Dioxins: Toxic organic compounds

Energy balance: The ratio of energy into a process (inputs), to energy from a process (outputs)

Energy crops: Crops dedicated to energy production

Environment Agency: Statutory body regulating emissions to water, air and land. Formerly HMIP, NRA and WRA

EPA: Environmental Protection Act 1990

Exhaust stack: Chimney

Flue: Chimney

Fuel specification: Technical description of fuel characteristics and properties

Furans: Toxic organic compounds

Gas turbine: Rotary engine burning gaseous fuels

Gasification: Conversion of solid or liquid fuel into combustible gas

Grounding: Where stack emmissions are drawn to ground due to local weather conditions

Headland: Vehicle turning area surrounding the plantation

Hectare: Limit of area 10,000 square metres (2.471 acres)

Herbicide: Chemical product used to control weed growth

High input crop: Crop requiring intensive management and a high level of external inputs eg fertilisers, pesticides, herbicides

kV: Kilovolts

kW_e: Kilowatts of electrical energy

kW_{th}: Kilowatts of thermal energy

Low input crop: Crop requiring little management and a low level of external inputs eg fertilisers, pesticides, herbicides

Monoclonal: Planting consisting of a single clone (hybrid) of a particular species

MW: A unit of power. 1MW=1000 watts

MW_e: A megawatt of electrical power

MW_{th}: A megawatt of thermal power (heat)

Pathogens: Disease carrying organisms

PAHs: Polycyclic aromatic hydrocarbons - toxic organic compounds

Planning conditions: Conditions relating to the construction and operation of a development imposed as part of the granting of planning permission

Planning permission: Formal local authority permission to carry out development

Plume: Visible emission to air from chimney (water vapour)

Pyrolysis: Process by which wood is converted via carbonisation and gasification into a liquid fuel. Can be carried out in naturally aerated or vacuum conditions

Residual herbicide: Chemical compound applied to weeds which, having killed them, retains its effects for a period of time

Rides: Unplanted longitudinal areas between SRC plantations used for access

Root Mat: Network of roots created by crop immediately below the soil surface

Rotation: Length of time between harvests or 'cutting cycle'

Row crop: Any traditional arable crop eg. cereals, potatoes etc

Short Rotation Coppice (SRC): Willow or poplar grown as an agricultural crop on a short (2-5 year) rotation cutting cycle and at a planting density of 10-20,000 cuttings/ha

Statutory rights of way: Pathways or access routes which are legally recognised; must allow public right of way

Sustainable development: Development which meets present needs without compromising the ability of future generations to meet their own needs

Transmission losses: The decline in energy when it is moved from the point of generation to the point of use

Water table: The level in the soil below which soil pore space is saturated with water

Wayleaves: Rights of way for the provision of services

Woodland residue: Branch and brash material arising from woodland management

Appendix 5

Further Information

Background information

Biomass Farmer & User Newsletter. (Bi-monthly). Macpherson Associates, Maundrell House, The Green, Calne, Wiltshire SN11 8DL.

Crops for Industrial and Energy Uses - Support Schemes. Alternative Crops Unit, MAFF, 10 Whitehall Place, London SW1A 2HH. Tel: 0171-270 8323.

Energy: Policy and Perspectives for the Welsh Countryside. Countryside Council for Wales, 1993.

Energy Forestry in the Forest of Mercia. Department of Trade and Industry/ETSU, 1993. Ref ETSU B/W5/00241/REP.

A Farmers Guide to the Planning System. DOE/Welsh Office/MAFF. DOE, 1996.

The Future is Green - An introduction to biomass energy crops. ATB-Landbase. Available from British Biogen, National Farmers Union, Country Landowners Association, Timber Growers Association and ATB-Landbase.

Home-Grown Energy from Short Rotation Coppice. George Macpherson. Farming Press, 1996.

Principles and Guidelines for the development of Biomass Energy Systems. US National Biofuels Round Table.

Technical information

Agriculture and Forestry Fact Sheets on Short Rotation Coppice:

No 1: *Establishment*
No 2: *Clone Selection*
No 3: *Choice of Site*
No 4: *Chemical Weed Control*
No 5: *Herbicides which have been tried on SRC plantations*
No 6: *Energy Facts and Figures*
No 7. *Environmental Aspects*
No 8: *Plantation Design*
No 9: *Pest and Disease Control*
No 10: *Non-Chemical Weed Control*
No 11: *Pheasants*
No 12: *Songbirds*
No 13: *Beneficial Ground Vegetation and Associated Insects*
No 14: *Plantation Design: Combating Diseases and Pests*
No 15: *Insect Pests on Willow and Poplar SRC*
Mechanised Harvesting (in preparation)

Available from the New and Renewable Energy Enquiries Bureau, ETSU, Building 168, Harwell, Didcot, Oxon OX11 1RA. Tel: 01235 432450 or 433601.

Beetle Banks. The Game Conservancy Trust.

Enhancing the conservation value of short rotation coppice - Phase 1, the identification of wildlife conservation potential, by R.B. Sage, P.A. Robertson & J.G. Poulson. ETSU B/W5/00277/REP, 1994.

Environmental Assessment. A Guide to the Procedures. Department of the Environment/Welsh Office. HMSO/Welsh Office, 1989.

Environmental Assessment - The treatment of landscape and countryside recreation issues. Countryside Commission CCP 326 (1991). Available from Postal Sales, PO Box 124, Walgrave, Northampton NN6 9TL. Tel: 01604 781848.

'Factors affecting songbird communities using new short rotation coppice habitats in spring', by R.B. Sage and P.A. Robertson. 1996. *Bird Study* 43: 201-213.

'Factors affecting wild plant communities occupying short rotation coppice crops on farmland in the UK and in Eire', by R.B. Sage. 1995. In *Proceedings of the Brighton Crop Protection Conference 1995-The role of weed control in land use change*, 7D: 980-985.

Fertiliser Recommendations for Agricultural and Horticultural Crops, produced for MAFF by ADAS. Available from HMSO, ref RB209.

Forestry Commission Technical Development Branch Reports:

Selection of Equipment for Initial Testing (Ref 1/94)

Harvesting and Comminution of Short Rotation Coppice (Ref 1/94)

First Field Evaluations of Short Rotation Coppice Harvesters (Ref 11/94)

Second Field Trials of Short Rotation Coppice Harvesters (Ref 1/95)

Third Field Trials of Short Rotation Coppice Harvesters (in preparation)

Ground Damage caused by SRC Harvesters (in preparation)

Forestry Commission Technical Notes:

Layout of Short Rotation Coppice for Harvesting (Ref 2/95)

Harvesting Short Rotation Coppice Transport Options (Ref 11/95)

Initial Tests of Comminution Machinery in SRC (Ref 3/96)

Second Evaluation of Comminution Machinery in SRC (Ref 7/96)

Large Scale Comminution of Short Rotation Coppice (Ref 13/96)

Available from the Forestry Commission, Technical Development Branch, Ae Village, Dumfries DG1 1QB. Tel: 01387 860264.

Guidance Notes for the Reduction of Light Pollution. Institution of Lighting Engineers, 1994.

Herbicides for Farm Woodlands and Short Rotation Coppice, by Ian Willoughby and David Clay. Forestry Commission, Field Book 14.

Landscape Assessment Guidance. Countryside Commission CCP423 (1993). Available from Postal Sales, PO Box 124, Walgrave,

Northampton NN6 9TL. Tel: 01604 781848.

Poplar and Willow Clones for Short Rotation Coppice, Research Information Note 278, Forestry Commission.

Principles of Landscape and Visual Assessment. Institute of Environmental Assessment and the Landscape Institute, 1995.

A review of the status and control strategies of known and perceived insect pests on Salix and Populus in North West Europe, by R.B. Sage, 1994. ETSU B/M3/00388/10/REP.

Rust:

'Clonal mixtures of Salix - a control measure for rust', by W.M. Dawson, A.R. McCracken & C.Y. Allen. In *Proceedings of 9th European Bioenergy Conference* Copenhagen, Denmark, June 1996 (in press).

'Growing short rotation coppice willow (*Salix*) in clonal mixtures as a method of reducing the impact of rust disease caused by *Malampsora epitea var epitea*', by A.R. McCracken and W.M. Dawson, 1996. In *Eur. J. For. Path.* (in press).

Sewage sludge:

Code of Practice for the Agricultural Use of Sewage Sludge. DOE Publications. Tel: 0181-429 5186.

Sewage sludge. Free leaflet for farmers and landowners. From MAFF Publications. Tel: 0645 556000.

Sewage sludge (Use in Agriculture) Regulations 1989. From DOE Publications. Tel: 0181-429 5186.

Use of Sewage Sludge, by Andy Moffat. Forestry Commission.

Legislation and regulations

English and Welsh Statutes

1990 Town and Country Planning Act. HMSO, 1990.

1990 Environmental Protection Act. HMSO, 1990.

1995 Environment Act. HMSO, 1990.

English and Welsh Regulations, Circulars and Planning Policy Guidance Notes

Statutory Instrument 1988 No 1199. The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988. HMSO, 1988.

Department of the Environment Circular 15/88 (Welsh Office 23/88) Environmental Assessment. HMSO, 1988.

Department of the Environment Circular 7/94 (Welsh Office 20/94) Environmental Assessment - Amendment of Regulations. HMSO, 1994.

Department of the Environment/Welsh Office Planning Policy Guidance 7: The Countryside and the Rural Economy. HMSO, 1992.

Department of the Environment/Welsh Office Planning Policy Guidance 22: Renewable Energy. HMSO, 1993.

Scottish Statutes

The Town and Country Planning (Scotland) Act 1972. HMSO, 1972.

Scottish Regulations and Circulars

SOEnD Circular 1/1988. EC Directive on the Conservation of Wild Birds. HMSO, 1988.

SOEnD Circular 13/1988. Environmental Assessment - Implementation of the EC Directive. HMSO, 1988.

SOEnD Circular 13/1991. Nature Conservation and Part VIII of the Environmental Protection Act 1990. HMSO, 1991.

SOEnD Circular 26/1994. The Environment Assessment (Scotland) Amendment Regulations 1994. HMSO, 1994.

The Environmental Assessment (Scotland) Regulations 1988.

National Planning Policy Guidance Note 6: Renewable Energy.

This list of statutes, regulations and circulars is not exhaustive. Only instruments of general importance are listed. Regulations on areas of narrower interest and guidance on these areas are not included. Access to information on these documents can be obtained through the Environment Agency, local planning authorities or professional advisers.

Reprinting funded by the Department of Trade and Industry
through British Biogen.

First printed November 1996, reprinted July 1999

Copies of these guidelines are available from:
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These guidelines may be viewed on-line and downloaded at:
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Photo: British Biogen

Printed by Andus Print Ltd

This guide is printed on Mega Matt paper,
50/50 recycled and de-inked, and TCF pulp.