

Combined Horticultural Production & Energy Hubs: A Review



West Sussex Growers' Association



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CONTENTS

Executive Summary	1
1.1 <i>Background and objectives</i>	1
1.2 <i>Key consultation results</i>	1
1.3 <i>Investigation of existing hubs.....</i>	1
1.4 <i>Successful hub criteria.....</i>	2
1.5 <i>Sustainability.....</i>	2
1.6 <i>PESTEL analysis.....</i>	2
1.7 <i>Modelling</i>	2
1.8 <i>Wider Benefits.....</i>	3
2. Introduction and Background	5
2.1 <i>Industry background</i>	5
2.2 <i>Previous work.....</i>	5
2.3 <i>Project goals.....</i>	5
2.4 <i>Local benefits.....</i>	6
2.5 <i>Work undertaken</i>	6
2.6 <i>Modelling</i>	6
3. Planning and the Environment	7
SUMMARY	7
3.1 <i>European Policy.....</i>	7
3.2 <i>National Planning Policy</i>	8
3.3 <i>Local Planning Policy.....</i>	9
3.3.1 Arun District	9
3.3.2 Chichester District	10
3.3.3 West Sussex County	13
4. Energy Supply and Demand.....	15
SUMMARY	15
SUPPLY - SUMMARY	15
DEMAND - SUMMARY.....	16
4.1 <i>Introduction.....</i>	16
4.2 <i>Energy supply and demand options</i>	18
4.2.1 Energy supply.....	19
4.2.1.1 Fossil fuel.....	19
4.2.1.2 Renewable - RHI	20
4.2.1.3 Renewable – ROC’s.....	20
4.2.1.4 Alternative CO ₂	20
4.2.1.5 Fuel cost.....	21
4.2.1.6 CO ₂	21
4.2.2 Energy demand	22
4.2.2.1 Methodology of model – basic introduction	22
5. Water, Waste and Growing Media.....	25
SUMMARY	25
5.1 <i>Water</i>	25
5.1.1 Water gross margins	25
5.1.2 Water supply and demand.....	26
5.2 <i>Waste</i>	26
5.3 <i>Growing media.....</i>	27
6. Analysis of Hubs.....	29
SUMMARY	29
6.1 <i>Case Studies.....</i>	30
6.1.1 Land Settlement Association (LSA).....	31
6.1.2 Thanet Earth.....	31
6.1.2.1 Ownership	32
6.1.2.2 Energy.....	32
6.1.2.3 Analysis.....	32
6.1.3 Drax.....	33
6.1.4 Holsworthy.....	33
6.1.5 Yorkshire Forward.....	34
6.1.6 Cornerways Nursery, Wissington	35
6.1.6.1 Heat and CO ₂ supply	36

6.1.6.2	Analysis	36
6.1.7	Agriport A7, Middenmeer	36
6.1.7.1	Marketing	37
6.1.7.2	Energy	37
6.1.7.3	Analysis	37
6.1.8	Bergerden	38
6.1.8.1	Analysis	38
6.1.9	De Lier	38
6.1.9.1	Ownership	39
6.1.10	Nieuwprinsenland.....	39
6.1.11	Denmark	40
6.1.12	Poland.....	40
6.1.13	Ebbsfleet, UK	41
6.1.14	Ince Park, Cheshire	41
6.1.15	Terneuzen.....	41
6.1.15.1	Ownership	42
6.1.16	Rotterdam.....	42
6.1.17	Heerhugowaard.....	42
6.1.18	Almere	42
7.	Consultations	43
	SUMMARY	43
7.1	<i>Background</i>	43
7.2	<i>Grower interviews</i>	43
7.2.1	Land ownership.....	44
7.2.2	Glass house ownership	44
7.2.3	Energy ownership	44
7.2.4	Collaboration with other growers	44
7.3	<i>Allied commercial interests (service industry)</i>	44
7.4	<i>Planning and Policy makers</i>	44
7.5	<i>Landowners</i>	45
8.	Business and operations models.....	47
	SUMMARY	47
8.1	<i>Hub types</i>	47
8.1.1	Components.....	47
8.2	<i>'Classic hub' approach</i>	48
8.3	<i>'Node' approach</i>	49
8.4	<i>Operational models</i>	49
8.5	<i>Mathematical model</i>	50
8.6	<i>Summary of results</i>	51
9.	PESTEL analysis	53
	SUMMARY	53
9.1	<i>Political</i>	55
9.2	<i>Economic</i>	57
9.2.1	Exchange rates	57
9.2.2	Interest rates.....	57
9.2.3	Inflation.....	57
9.2.4	Energy supply and prices.....	58
9.2.4.1	Fossil fuels	58
9.2.4.2	Electricity	59
9.2.4.3	Trends in renewables.....	60
9.2.4.4	Conclusion	62
9.3	<i>Social/Cultural</i>	62
9.4	<i>Technological</i>	63
9.4.1	Glasshouse structures	63
9.5	<i>Environmental</i>	65
9.5.1.1	Water	65
9.5.1.2	Biodiversity	65
9.5.1.3	Emissions	66
9.5.1.4	Waste.....	66
9.5.1.5	Traffic.....	66
9.5.1.6	Climate change	67
9.6	<i>Legislative</i>	68
9.6.1	State Aid rules	68

9.6.2	Planning Legislation	68
9.6.3	Water Abstraction Licensing	68
9.6.4	Power Production	69
9.6.5	Short term restrictions.....	69
10.	Next Steps.....	71
	SUMMARY	71
10.1	<i>Planning.....</i>	71
10.2	<i>Land.....</i>	72
10.3	<i>Ownership and Operational Aspects.....</i>	72
10.4	<i>Energy.....</i>	72
11.	Modelling	75
11.1	<i>Introduction.....</i>	75
11.2	<i>Methodology.....</i>	75
11.3	<i>Further Consultation</i>	76
11.4	<i>The Future</i>	76
12.	The Models	78
	SUMMARY	78
12.1	<i>Modelling</i>	78
12.2	<i>Hub Size.....</i>	79
12.3	<i>Ownership</i>	79
12.4	<i>Energy Mix and Infrastructure</i>	80
12.5	<i>Grower Mix.....</i>	82
12.6	<i>Horticulture/Food Industry.....</i>	83
12.7	<i>Associated Development.....</i>	84
12.8	<i>Social Development.....</i>	85
12.9	<i>Developing the Mix</i>	93
12.10	<i>The Three Scenarios</i>	93
13.	Summary of Modelling Results	95
14.	The BLUE Model.....	97
	SUMMARY	97
14.1	<i>Introduction.....</i>	97
14.2	<i>Conclusions.....</i>	98
15.	The GREEN Model	99
	SUMMARY	99
15.1	<i>Introduction.....</i>	99
15.2	<i>Mix.....</i>	99
16.	The PURPLE Model.....	101
	SUMMARY	101
16.1	<i>Introduction.....</i>	101
17.	Modelling Assumptions.....	103
18.	Conclusions.....	105
19.	The Way Forward.....	106
19.1	<i>Public opinion.....</i>	106
19.2	<i>Site.....</i>	106

APPENDICES

Appendix 1	Steering Group Members and Interviewees
Appendix 2	Policy and Regulation Affecting Energy Generation And Transmission
Appendix 3	Measures taken by the UK to encourage the increase in use of energy from renewables

FIGURES

<i>Figure 1: Map of Arun District showing possible suitable development areas</i>	11
<i>Figure 2: of Chichester District showing possible suitable development areas</i>	12
<i>Figure 3: Breakdown of West Sussex Industry emissions by source</i>	13
<i>Figure 4 Suitability of combustion technologies for CO₂ supply</i>	21
<i>Figure 5: Energy Balance for 80ha example</i>	23
<i>Figure 6: Large scale view of proposed Nieuwprinsenland</i>	40
<i>Figure 7: Detail view of Nieuwprinsenland with wind turbines</i>	40
<i>Figure 8: Single site classic hub schematic</i>	48
<i>Figure 9: Site node hub schematic</i>	49
<i>Figure 10: Matrix Showing Options for Ownership/Investment</i>	50
<i>Figure 11: Prices of Fuels</i>	58
<i>Figure 12: Comparative Wholesale/Retail Gas Prices 2007-2011</i>	59
<i>Figure 13: Comparative Wholesale/Retail Electricity Prices 2007-2011</i>	59
<i>Figure 14: FIM Timber Index (Nominal) September – March (Base Sept 2011)</i>	60
<i>Figure 15: Actual biomass supply 2006 & biomass supply (est.) in 2015 and 2020 (ktoe)</i>	61
<i>Figure 16: Key biomass feedstocks under the UK cost/supply curves</i>	61
<i>Figure 17: Schematic of Heating and Cooling in Ultra-Clima Glasshouse: Benched System</i>	64
<i>Figure 18: Layout of Heating and Cooling in Ultra-Clima Glasshouse – Air Circulation</i>	64
<i>Figure 19: Example of Basic Model Framework (Chesborough, 2006¹)</i>	79
<i>Figure 20: Matrix Showing Options for Ownership/Investment</i>	80
<i>Figure 21: The Role of an Energy Hub in a Mixed Development</i>	82
<i>Figure 22: The Horticultural Food Supply Chain</i>	83
<i>Figure 23: Resource Flows –Commercial</i>	84
<i>Figure 24: Owners’ Houses on Glasshouse Development (GoogleEarth)</i>	86
<i>Figure 25: Street View of Residential and Glasshouse Development in Westland (GoogleEarth)</i>	86
<i>Figure 26: Street View of Residential and Glasshouse Development in Westland (GoogleEarth)</i>	87
<i>Figure 27 Home and Glasshouses on Former LSA Site in Sidlesham (GoogleEarth)</i>	87
<i>Figure 28 Small-Scale District Heating and Electricity Generation Supplied by Local Gas Grid</i>	88
<i>Figure 29 - Attractive Glasshouse Gable and building for Display/Training Purposes</i>	88
<i>Figure 30 Display Glasshouses - RHS, Wisley</i>	89
<i>Figure 31 Gothic Roof Profile on Glasshouse Used for Retail Sales</i>	90
<i>Figure 32: Automated Loading of Robotic Transport System</i>	91
<i>Figure 33 Pie Chart Showing Current Employment by Occupation in Chichester and Arun Districts and with 1,000 Additional Hub-Based Jobs</i>	92
<i>Figure 34 Pie Charts Showing %age Employment by Occupation in Glasshouse Production</i>	92

TABLES

Table 1: Employment by Occupation in Chichester and Arun Districts (Jul 2011-Jun 2012) 90

Table 2: Occupations used in ONS Annual Population Survey 91

Table 3 Jobs/ha of Glasshouse Production by occupation 92

Table 4 Modelled Land Use Mixes 94

Table 5 Benefits of Modelled Outcomes 95

Table 6 Grower Economics 95

Table 7 Energy Economics 96

Table 8 Landowner Economics 96

Table 9 Hub Performance Over 25 Years 96

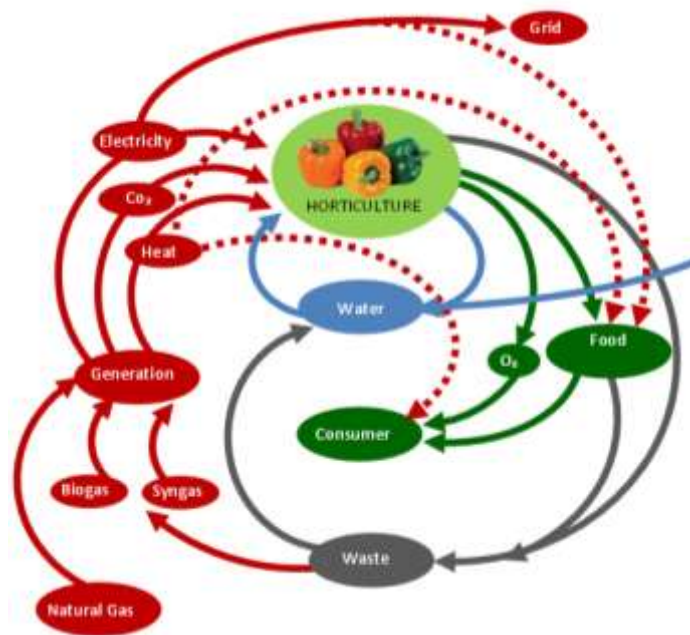
Table 10 %age Built Area Within Land Use Classes 104

Executive Summary

1.1 Background and objectives

This report is a continuation of the West Sussex Growers Association's strategy to support the sustainable growth of the sector on the Sussex Coastal Plain, specifically through cluster growth based on energy hubs associated with horticultural production; optimising resource use and increasing output. The project findings set ambitious goals for all stakeholders in the area since the

realisation of goals set by the project will require significant refinement of practice and policy, and advances in the use of technology, which can only be achieved through cooperation and collaboration between diverse stakeholder groups.



1.2 Key consultation results

It is clear from consultations with the industry that as well as being constrained by lack of affordable development land locally, this is also constraining the dynamism of the industry in terms of overall business development, and that there are significant available opportunities for further wealth creation which need to be opened up.

Figure 1 The Horticultural Cycle

Furthermore the industry in West Sussex needs a significant area of new glass merely to replace that being lost to new housing development now and in the very near future.

1.3 Investigation of existing hubs

Investigation of existing and planned UK and European hub sites has found characteristics common to successful developments and lacking from many failed or putative sites. Intelligence gained identifies:

- technical innovations, highlighting the pros and cons of a wide range of generation and heat recovery systems using both renewable and fossil fuels, CO₂ recovery and glasshouse environmental control and glasshouse design;
- business models, considering ownership and management structures, finance, and the role of renewable energy subsidy regimes;
- development models, providing guidance on the structure and management of relationships and responsibility required to realise the concept; and
- economic models, on which the project has based outline financial forecasts for a range of concepts that could be established on a number of sites in the area.

We have taken lessons from unsuccessful horticultural energy projects in order to ensure that the engineering, operational and ownership aspects of any West Sussex development will be sustainable. The most successful energy hubs are where there is a clear inter-dependence between energy provision and users. This is considered to be so central to success that the models

developed here have only been worked on that basis.

We have also identified clear and significant synergies within the different combinations of grower businesses that can be achieved in this type of hub, including graded heat use, combined packhouse operations and provision of lower cost cooling facilities.

Hub development in the Netherlands has taken place on a scale that is awe inspiring, with Agriport A7, 40km north of Amsterdam heading for 1,000 ha of glass, plus associated developments.

1.4 Successful hub criteria

It is clear from the findings of this first phase of the project that successful hubs are:

- established by robust groupings of business minds from stakeholder organisations; and
- that optimum returns result when all of outputs within the development are integrated to take advantage of associated benefits.

However, it is recognised that flexibility and adaptability must be built into the initial design so that any development will be resilient to external influences, and allow ongoing effective use of energy and other outputs that would otherwise be wasted.

1.5 Sustainability

The exercise has also taken into account wider issues of sustainability relevant to the locality, specifically alternative sources of water for crop production, to supplement water harvested from buildings, with on- and local off-site sources of organic wastes that might be used to supply feedstock for on-site energy from waste facilities.

1.6 PESTEL analysis

A PESTEL analysis undertaken as part of the project has identified influences on hub development, and the outputs will be used to inform a SWOT analysis that will in turn aid the development of planning policy, one of the major factors to be taken into account when putting forward any development proposal.

1.7 Modelling

Three indicative models have been considered, loosely based on a conventional approach to glasshouse development, one skewed towards a future construction of an Energy from Waste (EfW) plant, and another with leased land used for glasshouse construction and an institutional land-owner and investor. All models include an element for 'social' components, principally start-up units to encourage new businesses, horticultural and special needs education, employment and training. All models include areas for packhouse education and food factory development, and a small area of residential land. This last component is important as it may be used to generate funds to pay for the infrastructure of the main development.

The first model (Green) assumes a conventional approach, where a number of growers buy the land, and enter into one Joint Venture (JV) company for maintaining the infrastructure and another JV for the energy provision and sales.

The second model (Blue) is designed to fit in with a future Energy from Waste plant, and has natural gas dominating the energy supply for the first stage (it is assumed that an EfW plant will take a significant number of years to come on stream).

The third (Purple) model is less common in the UK, and involves a significant role for the landowner and institutional investor. Growers would lease land, and be partners in a JV for infrastructure and energy. All schemes employ a heat cost to growers of around 50% of the current rate, and nominally free CO₂ (at cost of chemical treatment and transmission). Electricity would be around

60% of grid cost, supplied.

The Green and Purple models are profitable in all sections, whereas the Blue model is marginal until the EfW plant is available.

1.8 Wider Benefits

Estimates of CO₂ saved by an 85ha hub development are around 25,000 tons a year, with greater savings possible if energy used in the hub is generated from locally-produced waste. All this whilst producing electricity to supply 6,000 homes.

An 85ha hub would produce sales of between £35m and £40m for the area from horticultural produce alone, and between 750 and 1,000 jobs in horticultural production, processing and packaging, and in energy generation. More jobs would come with activities associated with the other hub users, in workshops, offices and the community, all creating new wealth and opportunity for the area.

There is an opportunity to develop a centre of excellence, including strengthening the support industries that the industry relies on, enhancing training and education provision and encouraging start-up ventures and new entrants to the industry. It will leave a significant legacy in the WSGA area that will positively impact on the industry for many years to come.

Large scale developments such as an energy hub can also have impacts outside the hub itself and over a long period, not only bringing new opportunities to a small area over the next five or ten years, but creating development or employment opportunities outside the hub, as businesses move on leaving space for other types of development. These remote and long term impacts can have significant beneficial effects provided they are recognised, planned for and ultimately realised.

A hub will occupy a large area of land, but by integrating activities it offers an unparalleled opportunity to create a development that will bring prosperity to the area, enable people to live and work in a sustainable community that can be integrated into existing settlements, and establish a centre of excellence that will set the standard for all future horticultural development in Britain, and possibly western Europe.

2. Introduction and Background

2.1 Industry background

Horticulture and protected cropping have formed a significant part of the local economy in West Sussex for many years. The industry is mainly concentrated south of the A27 between Portsmouth and Worthing, and forms clusters of diverse horticulture-related businesses more than 70 of which are members of the West Sussex Growers Association (WSGA). The area is home to about 170ha of glasshouses and produces crops with a retail value of more than £500 million, providing more than 4,300 Full Time Equivalent (FTE) jobs and about 7,000 seasonal jobs in the area.

2.2 Previous work

WSGA has previously commissioned a report into the viability of the horticultural industry in West Sussex¹ in 2009 and a strategy for implementation, Growing Together in 2010²; followed by annual implementation plans in 2010 and 2011³. Taken together these documents provide a Strategy for planned growth in the glasshouse sector and the local growing sector generally. At the heart of the Strategy is a requirement to identify more land for horticultural use and encourage the development of horticultural clusters based on individual or collaborative ventures. The concept of cluster growth is underpinned by a desire to maximise efficiency in use of resources, and whilst this project is primarily concerned with the development of energy hubs associated with horticultural production, it attempts to embrace efficient use of all resources used in horticulture, including energy, water, nutrients, land and labour. This is an ambitious goal and its full achievement is likely to require radical innovations in terms of technology employed and collaboration between multiple stakeholders from both inside and outside the horticultural industry.

2.3 Project goals

In order to move towards achieving this goal, on behalf of WSGA this project aims to:

- Determine the commercial and operational viability of an integrated facility for horticultural and energy production based on the principles of minimising overall resource use and environmental impacts;
- Evaluate the likely economic, social and environmental impacts of such a facility in West Sussex;
- Gain information from the experiences of existing facilities using similar principles on the technologies and approaches they have worked elsewhere, and to learn from the errors of others;
- Identify Best Practices based upon the trials, operation and outcomes of existing facilities;
- Identify policy and legal constraints, and issues that are likely to hinder the implementation and success of a combined horticultural production and energy hub; and
- Reach a position whereby suitable recommendations can be made on how best to advance the project.

¹ WSGA, The Viability of the Horticultural Industry in West Sussex, Reading Agricultural Consultants, 2009

² WSGA, Growing Together report, Step Ahead Research, 2010

³ West Sussex Growers' Association, Implementation Plans, 2010 & 2011

2.4 Local benefits

The anticipated benefits for the West Sussex area likely to be associated with the Project include:

- Sustainable production of high quality produce;
- Creation of skilled employment opportunities and associated knock-on economic benefits
- Reductions in waste produced by, and emissions from, the horticultural sector;
- Innovative development and integration of established methods for improving socio-economic and environmental performance that can be viewed as benchmarks for future projects; and
- Improvements to the financial viability of developments through the generation and trading of energy and utilisation of wastes.

2.5 Work undertaken

Using initial guidance from the project steering group (List of members at Appendix 1), this first phase of the project has sought to engage with growers and other sections of the produce supply chain, and energy and waste companies, in order to identify mixes of resource inputs and energy demands; for instance the ability to utilise or store the various grades of heat (or cooling) arising from electricity generation, whilst exploiting CO₂ for vegetative growth.

We have also undertaken interviews with representatives of the following: local growers and horticulture-related industries; successful, unsuccessful and putative UK, Dutch, Danish and Polish horticultural hubs; energy and water supply companies; local government officers; and educationalists. A list of participants in the process is also attached at Appendix 1.

We have developed economic and technical models to demonstrate the key aspects for viability of various scenarios of land, infrastructure, greenhouse and energy systems ownership.

2.6 Modelling

In order to quantify key economic and environmental indicators associated with hub development, a model framework has been constructed into which three representative combinations of variables, loosely based on conventional glasshouse developments, have been placed. All three modelling runs include social elements such as educational, training and starter units, and a small area of residential development in addition to glasshouses, packhouse and processing facilities and other associated commercial developments.

The three models also consider different energy sources, including construction of an Energy from Waste (EfW) plant, and varied ownership models are employed to demonstrate how investment within a structured joint venture generates returns for growers, land owners and institutional investors.

All models are based on systems that include heat and CO₂ recovery and associated infrastructure to serve the dominant horticultural demand and ancillary domestic and commercial heating and cooling.

The sales revenues from horticultural produce are estimated, based on different combinations of glasshouse type, together with job numbers associated with horticultural production, processing and packaging, and in energy generation. The number and types of jobs associated with ancillary activities and other hub users, in workshops, offices and the community have not been modelled because of the unpredictability of take up of non-horticultural production and processing units in the hub.

3. Planning and the Environment

Summary

Generally planners in the area have indicated that they would welcome proposals for horticultural development that fully embrace the principles of sustainable development, and believe that the findings of this research may help inform ongoing policy development by providing worked examples of how the development of horticultural hubs can contribute to their districts. This report addresses the three pillars of sustainable development, environmental, economic and socio-political, the effective delivery of all three being critical to the over-arching concept.

As part of our research, we have considered the planning experiences of other UK hub sites, together with the outcomes of recent applications/appeals. Proposals for housing development on the coastal plain will lead to the loss of an estimated 15ha of glass in Arun District in the near future and at the time of writing no proposals have been brought forward for the replacement of this resource. This will directly result in the loss of jobs in the area as well as in likely job losses in ancillary businesses that support operations in the area.

The replacement of this glass offers an opportunity to test the acceptability of the hub concept in Arun District and the Council has expressed an interest in proposals that might lead to the creation of a horticulture-based development that satisfies the three pillars of sustainable development and has potential to deliver substantial benefits in the District.

The findings of this research will attempt to integrate the development of local planning policy, and the experiences and needs of other stakeholders with specific proposals to be tested for feasibility in the light of national planning policies, and within the context of the long term needs of the industry.

3.1 European Policy

European policy regards the conservation of natural resources in a low-carbon economy as key to securing growth and jobs. As well as opening up economic opportunities, it should improve productivity, reduce costs and increase competitiveness.

The EC's Roadmap to a Resource Efficient Europe sets out ways in which the Commission intends to support and legislate for resource efficiency, and work to produce the cross-cutting policy mix that will permit the necessary complex and interlocking approach necessary for synergies and trade-offs between interests to be realised.

The EU recognises that significant innovation will be necessary to achieve the transition to a green and low-carbon economy, in terms of both technology used by developers and investors and policy

written by national and local government. Support for technological innovation is likely to be available over the next eight years as part of this flagship initiative under the Europe 2020 Strategy, including realignment of the Common Agricultural Policy and the development of innovative financial instruments to encourage resource efficiency.

3.2 National Planning Policy

The English planning system aims to help communities work towards achieving sustainable development, of which there are three dimensions: economic; social and environmental. One aim of this report is to inform policy development in respect of building a strong and competitive horticultural sector within a strong and healthy community, whilst protecting the local environment, optimising resource use with minimal pollution and making provision for climate change.

The Government's planning policies are set out in the National Planning Policy Framework (NPPF), together with guidance on policy application. Within this structure Councils are expected to produce their own distinctive local and neighbourhood plans, to reflect local needs and priorities; local planning policies must also take into account EU obligations and statutory requirements.

The NPPF sets out to support a prosperous rural economy by promoting economic growth order to create jobs and prosperity through sustainable new development. Specifically, the government recommends growth and expansion of businesses through *inter alia* the:

- construction of well-designed new buildings;
- promotion of the development and diversification of land-based rural businesses; and
- promotion and development of community facilities for sport, culture and education.

Cooperation between neighbouring local authorities is emphasised as a duty, specifically to respond to local housing need, but this might be logically extended to the assessment of 'the needs of the food production industry and any barriers to investment that planning can resolve', as stated in the NPPF. Generally the promotion of sustainable development in the form of well-designed and provisioned centralised services support groups of businesses in order to enhance or maintain business development should be viewed favourably both in planning policy terms and at the determination of any planning application that might be submitted.

Proposals and policy should endeavour to satisfy all three dimensions of sustainable development as defined in the NPPF:

- *'an economic role – contributing to building a strong, responsive and competitive economy, by ensuring that sufficient land of the right type is available in the right places and at the right time to support growth and innovation; and by identifying and coordinating development requirements, including the provision of infrastructure;*
- *a social role – supporting strong, vibrant and healthy communities, by providing the supply of housing required to meet the needs of present and future generations; and by creating a high quality built environment, with accessible local services that reflect the community's needs and support its health, social and cultural well-being; and*
- *an environmental role – contributing to protecting and enhancing our natural, built and historic environment; and, as part of this, helping to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate and adapt to climate change including moving to a low carbon economy.'*

The NPPF emphasises the mutual dependency of these three aspects of sustainable development, which it is stated should be regarded as *'a golden thread running through both plan making and decision-taking'*.

The Framework recommends that any development proposal that accords with the relevant development plan, or in the absence of such a plan does not conflict with the NPPF, should be

granted permission unless the adverse impacts of the development ‘*would significantly and demonstrably outweigh the benefits.*’

The promotion of the taking of multiple benefits from mixed use developments in urban and rural areas, recognising that some well-designed developments can deliver many functions, including food production, education, flood risk mitigation, biodiversity and carbon capture is also central to the NPPF.

Waste policies will be covered by an as yet unpublished as part National Waste Management Plan for England, although the existing Waste Planning Policy Statement remains current until its publication. Local authorities will be responsible for preparing their own waste plans and decisions on waste applications will have regard to policies in the NPPF so far as it is relevant.

3.3 Local Planning Policy

Local planning policy has a significant role in the future of the industry on the Sussex Coastal Plain, as is evidenced by experiences elsewhere in the United Kingdom and Channel Islands. For example in Guernsey horticultural development has been tightly restricted in terms of location and scale, resulting in a loss of growing area that reflects an overall decline in the sector over the past 25 years.

In the Epping Forest District, the industry seems to be incompatible with the objectives of the Lee Valley Park and although limited development is accepted in policy terms, a recent sector study⁴ has found that the local industry is currently in decline and recommends that areas designated for glass development should be expanded and adapted to allow for large scale development.

These two examples should be compared with Kings Lynn and West Norfolk Borough Council’s policy position, when in 2006 planning permission was granted for a 52,000m² extension to one of the largest glasshouse developments in the UK, in the absence of any specific policy to address horticultural development⁵.

Three planning authorities have responsibility for planning policy and its implementation in the WSGA area: Chichester and Arun District Councils, and West Sussex County Council, which is responsible for waste planning matters.

3.3.1 Arun District

Arun District Council (ADC) aims to publish its emerging Local Plan for consultation in the summer of 2012, after which comments will be reviewed and a new draft published in anticipation of approval by the Secretary of State and adoption of a definitive document before 2014.

Thus far, consultation on employment growth in the District, which may include provision for horticulture-related development, has ascertained that local people feel that it should be limited to match housing growth, although overall opinion is split over a proposal to allocate 27ha of employment land in the District.

In the near future the District will lose to residential development, in the region of 15ha (37 acres) of glass from the Toddington area, north of Littlehampton. It is understood that there are no immediate plans to relocate this area of employment and production in the District,

⁴ The Lea Valley Glasshouse Industry: Planning for the Future. Epping Forest DC. Laurence Gould Partnership Ltd, 2012

⁵ Kings Lynn and West Norfolk Borough Council Planning Application 06/00198/FM Construction of horticultural glasshouses (renewal), Wissington Sugar Factory Stoke Ferry Norfolk

although the emerging Local Plan is likely to include policies that will encourage economic development, which may include provision for glasshouses.

It is understood that ADC is likely to include economy-centric policies in the emerging local plan, in order to support and create jobs in the District. Policies will probably favour eco-industries and high value technology-related developments, including food technology, which will provide good employment prospects for local residents and reduce the amount of daily commuting from and to the District.

Whilst it is understood that ADC is highly unlikely to identify specific areas for horticultural development, it is likely that areas of brown-field land, including WW2 airfields, existing concentrations of horticultural development and some suburban margins may be considered favourably by emerging policies.

As in much of the Sussex Coastal Plain, lack of infrastructure is a major obstacle to development. East-West communications in the area are limited and weak north-south links, often passing through village settlements, limit development that involves significant use of road transport to service activity. Figures 2 and 3 show communication links in the area in relation to potential development areas, identified using criteria discussed later in this report, clearly demonstrating that the potential for development is restricted to a handful of sites in the District.

3.3.2 *Chichester District*

Chichester District Council (CDC) is also in the process of preparing a core strategy for its local development framework, an informal draft of which will be published for consultation in August 2012, and the subsequent processes culminating in its adoption in late 2013. Concerns in strategy development have centred on infrastructure, particularly improvements to the A27 and wastewater treatment issues. These issues may also be relevant to the location of any concentrations of horticultural development in the wider Sussex Plain.

As part of its policy framework CDC designated a number of Horticultural Development Areas (HDAs) in its district at Almodington, Runcton, Sidlesham and Tangmere (see Figure 2). These cluster areas provided about 342ha (845 acres) of land where horticultural development would be looked upon favourably within the planning process, but this policy has recently been used to oppose horticultural development outside an HDA. The drawing of hard lines around areas targeted for development places undesirable constraints on the size, location and layout of future horticultural development, particularly where the area of previously undeveloped land is limited in terms of shape and area. The designation of land for specific use can also hinder glasshouse development where land owners seek to obtain excessively high sale prices, sometimes in anticipation of future redevelopment. This constraint might be overcome by allowing some flexibility in policy interpretation for suitable proposals centred on HDAs, but falling in part or in their entirety outside the existing boundaries.

As in ADC, Chichester District faces multiple pressures on development, particularly residential development which is blocked by overloading on the local sewerage network in much of the District. It is understood that this is due to a combination of ingress of storm flows to the system and loadings on waste water treatment works that discharge into sensitive coastal waters.

Figure 2: Map of Arun District showing possible suitable development areas

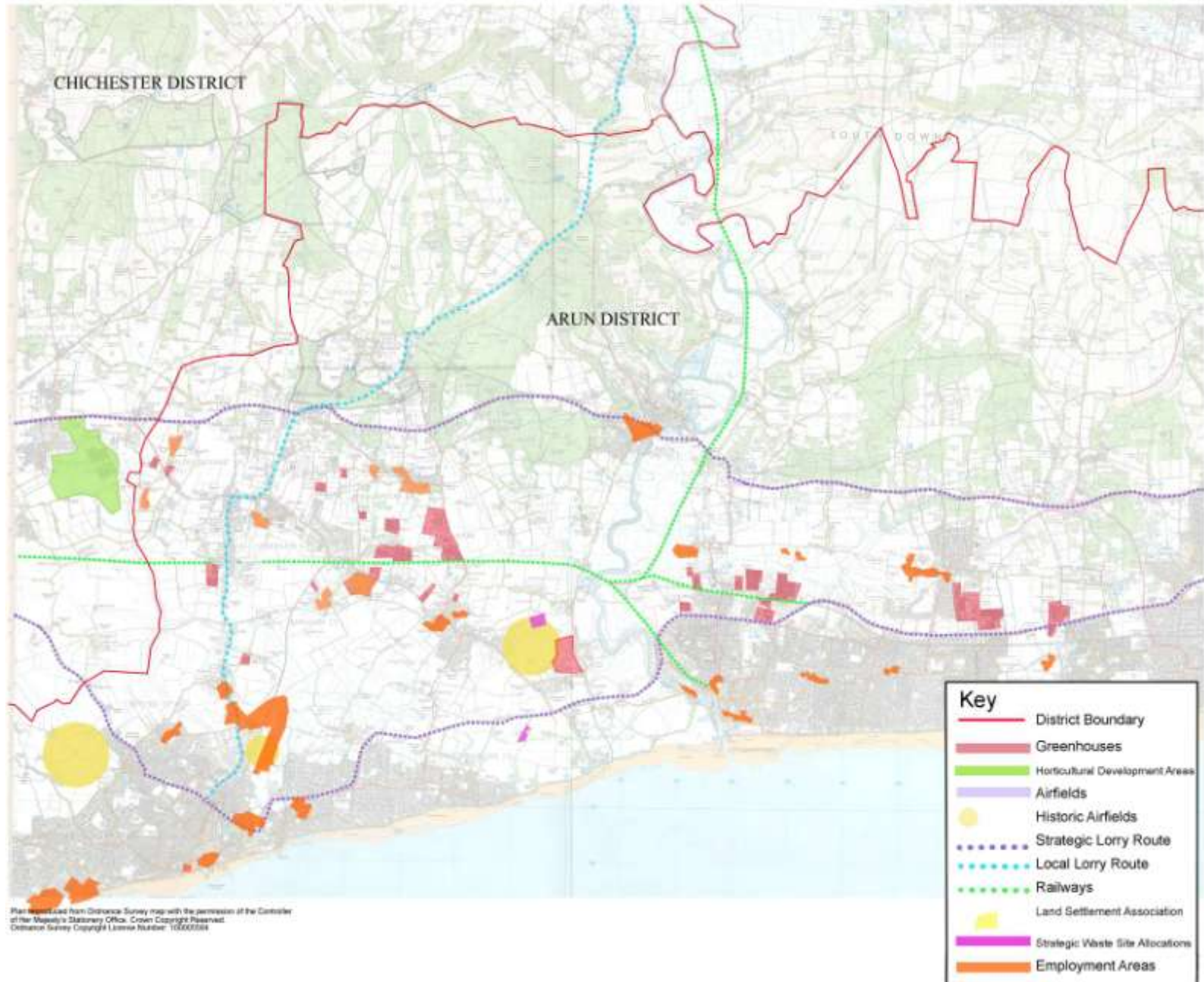
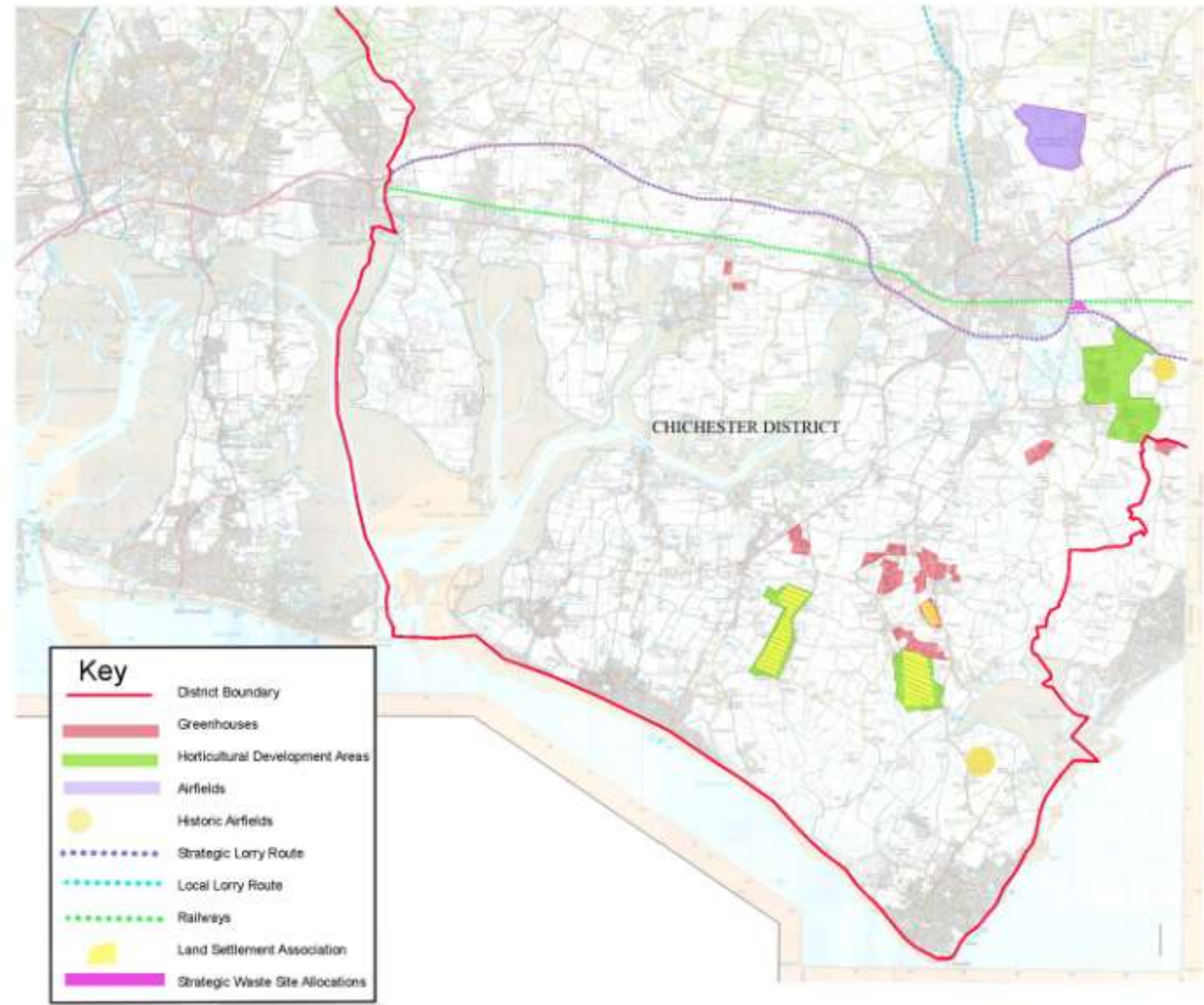


Figure 3: of Chichester District showing possible suitable development areas



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3.3.3 West Sussex County

West Sussex County Council (WSSCC) is preparing a Minerals and Waste Core Strategy, which will, when adopted replace the Revised Deposit Draft of the Waste Local Plan (2004). Until the new Strategy is adopted, waste planning policy in the county will reflect the new NPPF as far as it is relevant, supported by Planning Policy Statement 10, dealing with planning for sustainable waste management.

WSSCC has pioneered the use of carbon budgeting on a county scale as part of its overall sustainability strategy, which is based around the four pillars of: Carbon Budgeting; Resilience to Climate Change; Resource Use; and Business as Usual. This development reflects the requirements of the 2008 Climate Change Act, which introduced into law a national carbon budget. The Act commits the UK to reducing carbon emissions by 80% from contemporary levels by 2050. Whilst much can be achieved at the national level, action at a local level will be essential to achieve success and WSSCCs plan is part of this initiative.

West Sussex businesses emit about 17.5 million tonnes CO₂e annually, of which 6% is attributable to agriculture, forestry and fishing (see Figure 4)

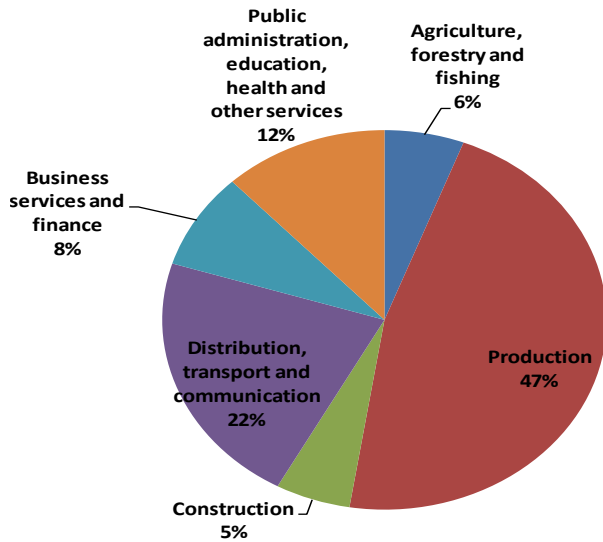


Figure 4: Breakdown of West Sussex Industry emissions by source
Total 17.5 million tonnes CO₂e

This assessment includes direct emissions, emissions from electricity consumption and indirect emissions in supply chains. The breakdown of emissions is not clear at this level, but historic data for horticultural production shows that high energy users will consume around 450kWh/m² of heating fuel, and around 25kWh/m² of electricity. However the contribution of food packing and processing associated with the horticultural sector to the 8.2 million tonnes of CO₂e attributed to ‘Production’ in West Sussex is not known, although the majority of that amount is ascribed by the authors to the supply chains of purchased materials or ingredients. Clearly the relationship between horticultural production, packing, processing and transport should be explored in the context of this project.

The Draft West Sussex Waste Local Plan was published in June 2012, with the objective that waste generated in the County is dealt with in a sustainable way and the goal of ‘zero waste to landfill’ by 2031. Six sites are identified for new built waste management facilities to enable the transfer, recycling and/or treatment of waste, including sites at Ford, Climping and Bognor Road, Chichester. Of these, the Ford site may be suitable with other land for development with other uses including horticulture.

The Draft plan is not technology specific, but it does support the provision of suitable and well-located new facilities for reuse, composting, recycling and treatment of waste in identified areas located within or close to the main urban areas on the coastal plain.

At the time of writing this policy is open for consultation and WSCC is keen to work with district councils and other stakeholders to integrate policy where the benefit of synergies can be realised.

4. Energy Supply and Demand

Summary

Energy use and production underpin this project and the research has been guided by what is already proposed and practised in the area, together with innovative developments from elsewhere in the UK and abroad. As well as considering more conventional fossil-based generation systems, renewable and co-generation (CHP) based schemes have also been investigated. Whilst the current generation and heat subsidy system may be seen as a distortion of the true market in renewables, initial estimates of returns are based on the UK tariffs regime and include ROCS and RHI. In the light of uncertainty over the Government's proposed Carbon Reduction Commitment, its potential influence has not been taken into account.

Glasshouse technology has combined the co-generation of electricity and heat with sequestration of carbon dioxide emissions for increasing crop yield within greenhouse atmospheres for many years, viewing all three outputs (electricity, heat and CO₂) as valuable. The industry has also developed operating regimes and storage systems to optimise this. This might mean that in areas where co-location of points of use of outputs is not practical, it may be necessary to transport one or more components of the resource balance away from the point(s) of production. For instance, biogas may be produced at an anaerobic digestion facility served by the waste industry which is remote from the site(s) where heat and CO₂ can be used; biogas can be transported relatively cheaply using underground pipelines to link sites. The principal point of use of CO₂ and heat too, may not be balanced, since not all glasshouses have a large heat requirement, in which case(s) it may be possible to co-locate complementary users of heat, such as homes, schools or public swimming pools. Where heat has to be transported over a significant distance, the use of steam in electricity generation will be considered, it being more economical to transport high grade heat in steam form than warm water.

Supply - Summary

It is likely that the site will have a large component of energy provided by renewable sources in order to optimise support payments (Renewable Heat Incentive (RHI) and Renewable Obligation Certificate (ROC)).

Whilst there are many options for heat generation to attract the RHI the most likely is biomass combustion for the following reasons. Co-generation is likely to form a

significant component in order to obtain ROC's. For co-generation the most likely fuel options are biogas from Anaerobic Digestion (AD) or biomass combustion, however there is a 200kW(th) cap on heat from AD cogeneration that effectively rules this out. ROC's are being discontinued in 2017, and whilst there is likely to be a successor scheme, this is not guaranteed.

CO₂, for those crops which benefit the most from it, is likely to also be from a renewable source, probably combined with liquid CO₂ during periods of plant shut down, these to be timed to coincide with reduced crop CO₂ demand. Exploitation of CO₂ from co-generation maximises benefits arising from the use of this efficient technology.

Demand - Summary

Calculations of energy demand indicate that a significant summer surplus would exist, specifically of heat. This surplus might be utilised economically through use of absorption cooling, with some used for packhouse/product cooling, and the remainder for production or office cooling. This relies on the use of the UltraClima design of glasshouse which utilises an integrated heating/cooling coil, and also the RHI (which allows for payment on heat to drive absorption chillers).

There are obviously many possible scenarios for sizing the various components of the mix and achieving a viable energy match.

4.1 Introduction

The UK National Renewable Energy Policy set out a framework for action within which the UK's 2020 renewable target will be delivered to meet the EU Renewable Energy Directive (2009/28/EC), which is scheduled to be reviewed in 2014. The framework has three key components:

- Financial support for renewables;
- Unblocking barriers to delivery; and
- Developing emerging technologies

All three of these components will have a bearing on the feasibility and design of a horticultural energy hub in West Sussex.

In terms of financial support the main mechanisms encourage investment in electricity generation by way of Feed in Tariffs (FITs) and Renewable Obligation Certificates (ROCs) and in the use of heat created from renewable sources, including as a co-product of electricity generation through the Renewable Heat Incentive (RHI).

The Government is also proposing a Carbon Reduction Commitment, which, if it happens, will be a mandatory scheme aimed at improving energy efficiency and cutting emissions in large public and private sector organisations, which may include businesses already operating in West Sussex. The scheme is designed to use reputational, behavioural and financial drivers to encourage organisations improve energy efficiency through the development of energy management strategies and promotion of an understanding of energy usage.

As well as using these financial and moral motivational tools to drive energy efficiency and the use of renewables, the Government is also looking into the possibility of a Green Investment Bank to help fund innovation and the introduction of renewable energy.

The primary barriers to delivery to the use of renewable energy in the UK are generally perceived to comprise: the general economic environment; the planning system; supply chains; connection to the grid; and the availability and use of sustainable bioenergy. The government is looking at ways in which wider communities can benefit through the development of community-owned renewable energy schemes, which might help reduce local opposition to specific elements of schemes. For example, the possibility of communities that host Energy from Waste (EfW) projects retaining any additional business rates they may generate as part of these schemes may provide a financial incentive to accept such a facility as part of a hub development.

The Government's current thinking on the development of emerging technologies appears to be targeting AD and biomass (including gasification) above wind, which might now be regarded as a mature technology with high investment due to good returns. The current problems with AD and biomass relate to undeveloped markets for feedstock and poor system reliability, both of which are likely to be overcome as the technologies mature. Further development in the sector will also require more readily and easily available grid connections and probably an element of smart grid infrastructure to support the integration of a hub into the wider electricity supply system.

In terms of the horticultural sector, UK power utilities already operate co-generation plants that are integrated with large greenhouse complexes. In these cases the generating company sells electricity through the national grid and the greenhouse grower makes use of the heat generated in the greenhouse and the CO₂ produced for glasshouse atmospheric enrichment leading to enhanced yield. Most horticultural co-generation units were installed in the 1990s when the tariff structure was different, and provided extra incentives for embedded generation. The majority of these units were subsequently sold-off to the growers by the energy developer as the economics altered. Recent schemes tend to be ones whereby the grower owns and operates the cogeneration plant, with direct export and electricity purchased by a supply company under contract. A minimum 11kV site connection is generally required. This model is relatively stable going forward and lends itself to use in a hub structure. The development of a hub must have flexibility and adaptability at its core, this is imperative to avoid failure of a facility that would have significant and long lasting impacts on one or all of its stakeholders. For instance, in situations where gas prices for CHP plants are related to the size of supply mains, when electricity demand falls below that used in the initial budget, operators have found themselves with an uneconomic heating system. Where operators have found themselves in this position, some have been able to negotiate a reduction in gas price with the supplier, but this favourable result is not inevitable.

There are various greenhouse sites with photovoltaic installations, but by definition this is limited to the ancillary buildings (packhouses etc). In the UK the tariffs for solar PV have been cut and are now marginal, making the technology unattractive. In the Netherlands, the government has reduced its earlier emphasis on financial support for technologies such as photovoltaics and wind power in favour of the use of natural gas-powered clean and high efficiency co-generation units through well-established Seasonal Time Of Day (STOD) tariffs, where surplus electrical energy is sold to a power utility while (stored) heat and CO₂ are used in the greenhouses as required.

West Sussex is one of the most wooded counties in England, having about 19% woodland cover⁶. The Forestry Commission's Woodfuel Strategy set targets for the marketing of wood for fuel and by breaking down the South East of England's contribution by woodland area, West Sussex might be

⁶ National Inventory for Woodland and Trees – West Sussex, Forestry Commission, 2002

expected to produce in the region of 80,000 tonnes of biomass per annum from this source alone⁷. This is equivalent to about 260MWh and 17TJ of heat a year. Currently much of the local harvested resource is exported to other UK regions for biomass generation.

In addition to locally-sourced biomass, consideration has also been given to imported biomass, such as sustainably produced oil palm kernels (waste product) imported through the Port of Littlehampton.

The generation of energy from waste, both domestic and commercial, also presents a significant potential as an energy resource in West Sussex, particularly at a time when the WSCC Waste Plan is being developed. Whilst WSCC does not favour any particular waste treatment technology in its first draft plan, it has identified sites for development, only one of which might be suitable for anaerobic digestion or combustion and associated electricity generation, which provides opportunities for CO₂ use in greenhouses and opportunities for the use of a wide range of grades of waste heat.

The analysis of business case for the range of options identified by this project is based on the application of Process Integration Technology (a holistic diagnostic tool) to inputs/outputs, in order to provide objective, comparable and quantifiable results. These basic outcomes are then considered in the context of both historical and likely future trends and indicators; for example, the ongoing dialogue between government and the CHP sector about how to increase the use of CHP in UK horticulture.

4.2 Energy supply and demand options

The horticultural industry has been staggeringly successful in driving down energy use; halving inputs has more than doubled the output/input ratio over the past 20 years. It does however face both social as well as economic pressures. In order to remain vigorous and yet become a sustainable in order to meet customer expectations, the sector will need to replace fossil fuels with renewable energy sources that can be used throughout the year, in order to do this the system(s) selected for development must be both flexible and balanced, making maximum use of co-products of electricity generation where they arise.

This section outlines the prevailing regime for energy subsidies, specifically: Feed in Tariffs (FITs); the Renewable Heat Incentive (RHI); Renewables Obligations Certificates (ROCs); and the Carbon Reduction Commitment (CRC). Despite the market distortion caused by subsidies, they can increase the attractiveness of well-balanced multi-strand energy production that would be economically-attractive anyway by effectively exploiting the broad range of co-products including: waste heat from generation; CO₂ from combustion; and digestate from Anaerobic Digestion. Under the present subsidy regime, any energy hub is likely to include energy generation from renewable resources in order to attract RHI payments; electricity generation using renewable fuels would also attract ROC's.

Due to the considerable burden of regulation bearing on the energy sector and the plethora of measures intended to promote the use of energy arising from renewable sources, an overview of regulation is attached at Appendix 2 and a summary of measures that the UK Government is taking to encourage the increase in use of energy from renewable resources is attached at Appendix 3.

CO₂ for those crops needing it is also likely to be available from a renewable source, although a back-up liquid CO₂ system would be necessary for use during periods of plant shut down, although shut downs would be timed to coincide with reduced demand for crop CO₂.

⁷ Woodfuel Supply and Demand in West Sussex, WSCC, 2009

4.2.1 *Energy supply*

The key factors that impact on the energy aspect of the hub are summarised below.

- Fuel source
 - renewable or fossil;
 - availability of clean CO₂ at reasonable cost;
 - transport logistics;
- Fuel cost;
- Co-generation – eligibility for ROCs (requires renewable fuel source); and
- Equipment selection – impact on Capital and Operational Expenditure and reliability.

The major decision to be made in this area is whether to go for a renewable or fossil fuel based energy supply, with eligibility for RHI and ROCs payments having a huge financial influence. The internal rate of return example below illustrates the difference between natural gas and renewable (biomass) for a CHP scheme.

Biomass CHP	34%
Natural gas CHP	-3% (the attractiveness of natural gas as a fuel can be quite site dependent, and there is one new gas fired CHP installation being planned at a glasshouse site at present).

Whilst the energy market is highly volatile and new projects with gas fired CHP are rare, the current support regime makes renewable forms of energy far more attractive for the majority of the energy output.

In general the capital expenditure for renewable fuel installations is significantly greater than for fossil fuel ones, hence the provision of support payments as ‘compensation’. As an example a 2MW natural gas boiler will cost around £35,000 installed, and a similar sized wood fuelled boiler around £250,000. This is compensated for by the lower fuel cost, see below, as well as through subsidy.

4.2.1.1 *Fossil fuel*

Gas

Natural gas is still an ideal fuel due to its good combustion characteristics, ease of delivery, low cost equipment and high efficiency.

Coal

Although coal remains economically plausible, and there are massive reserves, it must be assumed that it is not an option for any energy hub proposed here. However, there is some merit in having a biomass system that is flexible enough to offer dual fuelling with both biomass and coal combustion.

Oil

Under current price structures oil does not offer any advantages over gas, and simply tends to be used as a backup for interruptible gas supplies.

4.2.1.2 *Renewable - RHI*

The range of biomass fuels and approximate costs are most easily shown according to the RHI categories. In terms of horticulture, the relevant categories are:

Biomass (excluding biogas)

Generally from wood or straw, and realising 1p/kWh from RHI at large scale, on a sliding tariff for sub 1MW capacity installations; this equates to around 3p/kWh.

Biogas

Most biogas is derived from waste food or crop residues/grade outs, sewage and animal manures. 7.1p/kWh RHI but limited to 200kW, which is irrelevant in any large scale installation.

Biomethane injection is currently extremely expensive and, in the absence of significant off-site use for transport or low cost grid injection, is unlikely to be viable at the scale of development envisaged here.

Geothermal

It is unlikely that geothermal energy would be practical for electricity generation due to potential temperature limits, but its use may be possible linked with the RHI.

3.4p/kWh (RHI)

Solar

A glasshouse is by definition a device for passive solar, in other respects solar is incompatible with greenhouses developments as it blocks light which is a prerequisite for crop growth.

Wind

This is fundamentally (in commercial terms) for power generation only so not relevant as a main heat source.

Heat pump

Air and ground source: 3.4p/kWh RHI

4.2.1.3 *Renewable – ROC's*

With regard to electricity generation the banding for ROC's is slightly different to the RHI, but for most of the relevant technologies double ROCs would be obtainable. The only conceivable technologies that might not achieve double ROCs are Energy from Waste (EfW), landfill gas, or co-firing with fossil fuels.

The value of ROCs varies, but at the time of writing stands at around 4.1p/kWh, thus typical returns for generating are about 5.5p/kWh for the electricity base price, including Levy Exemption Certificates and TRIAD charges, plus a further 8.2p/kWh for any associated ROCs.

The financial benefits of ROCs and RHI can be combined (but not duplicated), thus as a simplified example a 5MW output biomass steam boiler with CHP plant at 20% generating efficiency (1MW) would be able to claim 1MW of double ROCs plus 4MW of RHI.

4.2.1.4 *Alternative CO₂*

It is conventional to use liquid CO₂ for enrichment in horticultural developments, but this is expensive at around 8.0p/kg. The possibility of extracting CO₂ from the air exists, and

there are numerous projects around the world attempting to achieve this at reasonable cost. However, it is likely that even when the technology exists the associated costs will still be fairly high since the electrical energy required to extract CO₂ will be derived from a secondary energy source with associated increasing costs. Estimated costs are 2 to 4p/kg, less than half the cost of liquid CO₂.

At this stage it must be assumed that it is likely that CO₂ will need to be derived from the hub heating system, which dictates that at least some of the heating be carbon-based.

4.2.1.5 Fuel cost

Trends in fuel prices play a significant role in the decision-making process, as they give an indication of supply and demand issues; these are covered in the PESTEL analysis at Table below. In general the trend for fuelling has been away from fuels that require greater intervention, typically solid fuels like coal and biomass, and towards easily-managed fuels like gas. A market surplus of gas will tend to suppress prices, as in the UK in the 1980's and in the US today. The rise in numbers of Liquefied Natural Gas (LNG) import facilities has to some extent militated against this market behaviour.

Current raw energy prices for different fuels are given below.

-
- Wood £13.5/MWh
 - Straw £12/MWh
 - Natural gas £20/MWh
 - Electricity £85/MWh
-

4.2.1.6 CO₂

Obtaining CO₂ from flue gases arising from the combustion of renewable fuels such as wood is harder than for those associated with combustion of fossil fuels, notably natural gas but to a lesser extent kerosene. The table below illustrates the fundamental differences between the main technologies in this respect.

Fuel	Technology	CO ₂ Use	
		Direct – no scrubbing	Requires scrubbing before use
Biomass	Moving Grate	No	Yes
Biomass	Gasifier & Direct Combustion	Yes	No
Biogas⁸	Direct Combustion	Yes	No
Biogas	SI Engine CHP	No	Yes
Biogas	Gas Turbine	Yes	No

Table 1 Suitability of combustion technologies for CO₂ supply

Some technologies such as geothermal are harder to generalise due to their dependence on very site specific aspects. At this stage it is not necessary to incorporate all options.

Both geothermal and heat pump technology have issues with a lack of CO₂ being produced, requiring liquid CO₂ instead, which is high cost (around £80/tonne).

The CO₂ obtained from flue / exhaust gases will be sufficient for enrichment under normal operational practice.

⁸ Subject to fuel composition – sulphur will need to be removed where present

Some technologies such as geothermal are harder to generalise due to their dependence on site specific needs. At this stage it is not necessary to incorporate all options.

4.2.2 *Energy demand*

4.2.2.1 *Methodology of model – basic introduction*

The objective of this exercise was to ascertain the level of integration that could be achieved, thus optimising the energy resource. The technique employed to investigate energy demand and optimise utilisation of different streams is a simplified version of Process Integration Technology, otherwise known as Pinch Tech. This is a well known procedure which has been used successfully for several years in many industries where there are inputs which are both qualitative and quantitative, with the original application being distillation processes with heating and cooling.

The system employs energy streams containing sources and sinks which are defined in terms of quantity and quality, and with quality designated as high, medium and low.

System parameters

Three crop production regimes have been employed, to typify high, mid and low temperature regimes. These are tomato, young plant and strawberry, with set-point day temperatures of 21°C, 16°C and 12°C. Frost protection only has not been included due to the low energy use. Typical values have been employed, for example: gas boiler efficiencies of 92%; biomass boiler efficiency of 85%; and generator efficiency of 100%. Set-points for crops are based on standard blueprint values.

Buffer tanks are considered as 100% efficient, and are treated as both a source and a sink. The greenhouse climate can also offer a buffering capacity, and this is considered in a similar manner.

Meteorological observations for the Met Office's Southampton station have been used, with some additional local data for light levels from grower environmental computers.

Humidity control is difficult to model and has been simplified into a basic energy/area relationship that is employed by most growers operating a minimum pipe regime.

Time variability

To simplify the time aspect of the system there are 4 defined periods during each 24 hours – morning, day, afternoon, night; and 3 seasons: summer, spring/autumn, winter. Each season has been assumed as 90 days and 180 days for the combined spring/autumn.

Results

The following example is for a development with a land area of 80ha, with details as shown:

Areas for production houses (ha)

Tomato house	20
Young plant house	10
Strawberry house	10
Commercial & packhouse area	4.2

Table 2: Production Use Mix

Energy (MW)

Electrical output	4
Heat output - CHP	16
Heat output - boiler	8

Table 3: Energy Balance

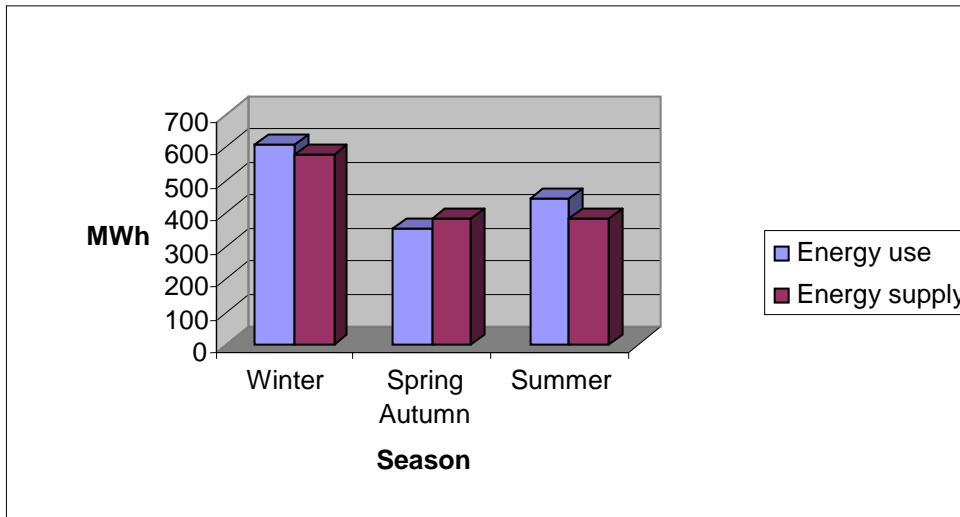


Figure 5: Energy Balance for 80ha example

Two key components of this integrated system are the use of screens, in higher energy houses, and buffer tanks. The annual energy consumption for this example is calculated as below:

Tomato	474 kWh/m ²
Young plants	269 kWh/m ²
Strawberry	184 kWh/m ²

Table 4: Energy Consumption by Crop

It can be seen that as would be expected energy mismatch is greatest in winter, which is reflected in current industry practice. The usual solution for salad growers is a combination of use of buffer tanks to even out loads, operating minimum pipe temperatures and on occasions a raised set-point to deplete the buffer tanks. In the scenario set out above it is more economical to include a natural gas boiler. This is necessary as a back-up facility for heat, but could also be used to support the provision of CO₂ during shut-down periods of the main plant.

Absorption cooling has been included and can be provided as a centralised or distributed energy service. The capital cost of such coolers is high, and historically this has mitigated against their widespread use, but the process heat required to drive adsorption coolers is eligible for RHI payments, and would also assist in obtaining the CHPQA Quality Index rating. The operational expenditure is lower than for conventional DX refrigeration, thus offering a financial benefit to any packhouse and food processors located on site (approximately 30% excluding RHI payments). The financial benefits are also more significant in terms of greenhouse cooling, which allows greater concentrations of CO₂ to be maintained with corresponding associated yield increase. Initial analysis suggests that

a 10% yield increase justifies the investment, and it is likely that the yield response will be greater than this. There could be additional applications of cheaper cooling, for example long cane raspberry production, strawberry production (including runners) and hydrangea production.

Notes

RHI and ROCs eligibility and tariffs are subject to regular updates and interpretations, and although the figures employed here are believed to be correct at the time of writing they should be verified continuously in any future investment modelling.

5. Water, Waste and Growing Media

Summary

The water gross margins, on a yield basis, for the proposed energy hub using tomatoes as an example are 70kg/m³, around three times that of field potatoes. The net revenue gross margins for the proposed hub using tomatoes as an example are around 11 times that of field potatoes.

There is likely to be an annual deficit of collected water to required water of around 16% on an area for area basis, but opportunities exist to incorporate other waste streams into the water balance to reduce or even remove this deficit.

The majority of waste from the hub will be green waste, and this can be processed in an anaerobic digester to produce biogas for power generation in a CHP plant. Treated water from this component may be used for irrigation.

5.1 Water

5.1.1 Water gross margins

Protected cropping is a highly efficient way of utilising water. The table below illustrates the improvements in water gross margin in terms of production/m³ of water, increasing from 20.4kg/m³ to a current level of 56kg/m³ (probably conservative for the proposals). In comparison to field vegetables (example used is potatoes) the yield per m³ of irrigation water is almost treble, and the revenue per m³ irrigation water is more than 11 times as high.

Tomatoes - classic round	Historical		
	Proposed	2005	1980
Yield (kg/m ²)	84	70	51
m ³ irrigation water/m ²	1.2	1.5	2.5
Yield kg/m ³ water	70	46.67	20.4
Net revenue £/m ³ water	£77.00		
Field crops (potatoes)			
Yield (kg/m ²)	5.5		
m ³ irrigation water/m ²	0.2		
Yield kg/m ³ water	27.5		
Net revenue £/m ³ water	£6.88		

Table 5: Irrigation Water Gross Margins

The most significant consumption of water is related to production, and all modern high use systems employ run-off collection and recirculation. Improvements in humidity control and

yield have enabled further increases in water gross margins.

5.1.2 Water supply and demand

The following illustrates the likely scale of water demand:

	Water use m³/yr	Area ha	Water m²/yr
Tomatoes	240,000	20	1.2
Young plants	40,000	10	0.4
Strawberries	160,000	20	0.8
Total m³	440,000		
Average annual rainfall	781	mm/yr	
Area covered (inc reservoir)	55.5	ha	
Rainfall on area	433,455	m ³	
Collection and storage	85%		
Total available	368,437	m ³	
Deficit	71,563	m ³	

Table 6: Scale of Water Demand

The water deficit in this case is just less than 72,000m³, based on 85% efficiency rating for collection and use of rainfall. Options for making up this deficit may include other waste sources, for example waste water from a local water company, depending on site location.

Water use in non-production areas is relatively insignificant, and can often make use of other integration strategies, for example recycling high sodium irrigation run-off for grey-water uses.

5.2 Waste

The main waste stream generated on site will be green waste from production houses, which will comprise leaf trimmings, waste fruit, and waste plants/flowers. Typical waste output (simplified) from the various type of production systems are shown below (per 10ha block).

- | | |
|---------------------|-----------------------|
| • Salads (tomatoes) | 7t/wk (over 8 months) |
| • Young plants | 1t/wk (over 6 months) |
| • Soft fruit | 4t/wk (over 3 months) |

Note: Production periods for soft fruit can be staggered more readily than for other produce.

The total site output would be of the order of 15–20t of waste per week throughout the year, and it should therefore be possible to combine this with other waste streams available in the area to feed a small AD unit, say rated at 0.2 MW(e), or otherwise with a larger AD facility serving a larger catchment. The inclusion of a small-scale facility would currently optimise support payments from the RHI due to the qualifying criteria limiting heat from this type of plant to 200kWth (c.0.3MWe),

and also with the use of small gas turbines (micro-turbines) that allow exhaust gases to be utilised directly, with no cleaning, for CO₂ enrichment. Alternatively other waste streams could be sourced to increase this to a more viable 1+MWe unit which would not be eligible for RHI payments and would require exhaust gas cleaning; the greater output from this scale of plant would help defray the necessary capital expenditure.

5.3 Growing media

The main growing media likely to be used in a hub development are substrate slabs for salad crops, and compost waste for young and bedding plants. Consistency in mass streams provides a potential match of materials, however the overall quality associated with this type of product has generally been inadequate for the demands of professional growers, and it would be unwise to assume this could be integrated with any waste arising from the hub site.

6. Analysis of Hubs

Summary

Historically, successful hubs have been shown to have a significant positive influence on the horticultural industry locally, as seen in hubs established by the Land Settlement Association, Agriport A7 and Cornerways Nursery.

None of the multi-occupancy sites have significant systems for heat integration.

Where there is significant heat integration these are single occupancy sites with an additional major industrial partner.

Of the multi-occupancy sites studied, none has a significant system to balance heat demand. Where heat integration does exist, the sites have single occupancy and involve an additional major industrial partner.

Whilst the results of this survey are not statistically sound, it is clear that the most successful sites in terms of realising truly integrated and balanced use of resources are Cornerways and Agriport A7.

The most successful UK integrated energy site is Cornerways, which is a single integrated company (sugar factory and glasshouse) operating with what is possibly a unique, transparent contract for valuation and sharing of resources, including energy. Cornerways is a dedicated site using waste heat and CO₂ arising from an established industrial plant, and forms part of a highly sophisticated integrated production and waste recovery system.

The scale of Agriport A7 is impressive, but in its original form offered little as an energy hub. Recent developments driven by Dutch national energy markets suggest that the role of renewable energy in this already successful initiative is increasing.

Many putative hubs have failed. The reasons for failure stem from both the planning and implementation stages of development. Failure is often associated with poor relationships amongst stakeholders or financial issues, including lack of seed funding or insufficient returns on investment.

It is clear that, without transparent shared management and responsibility, many of the financial and environmental benefits that might be associated with an energy hub are easily lost, for instance to an independent centralised energy operating company. Effective exploitation of sources of waste heat offer very promising returns, which can be lost over time due to the lack of flexibility to adapt to developing technologies that

might be ignored by a single-issue dominant partner in a hub venture.

There are almost as many hub models as there are hubs, and it is clear from the analysis that very few that operate realise the classical hub concept where resource use is optimised amongst a coherent group of stakeholders. Several of the hubs studied set out with the intention of maximising economic and environmental benefits subsequently either simply failed to successfully manage the relationships or simply abandoned the concept.

Reasons for failure also appear to be associated with poor design and operation rather than concept, for example problems were encountered with CO₂ distribution at the Bergerden development, where the concept is effectively identical in operation to that successfully implemented at Cornerways.

Amongst all of the examples studied, Agriport A7 is exceptional in terms of its success, but this appears to be due to the sheer scale of the enterprise, rather than a noticeably novel design concept.

It should be noted that the Dutch energy market is significantly different to the UK one, with Seasonal Time Of Day (STOD) tariffs for gas, and therefore some Dutch business models may not apply to the UK.

Clearly integration of outputs within the development is part of the key to success, including, but not exclusively: electricity; 'waste' heat; and CO₂ enrichment, although benefits can be lost through the implementation of more efficient technologies for energy generation or emissions control. If this problem is to be overcome in future, flexibility and adaptability must be built into the initial design so that effective use of energy can be made from what would otherwise be wasted.

A summary matrix of the business structures and scale of operations in the above hub developments is attached at Appendix 4.

6.1 Case Studies

Several existing, defunct and potential hubs have experienced major issues in terms of realising grower demand expressed in the planning stages. This, together with lack of communication between diverse stakeholders, has often resulted in mismatches between infrastructure availability and operational requirements, as at Thanet Earth for example. In order to identify problems individual, confidential meetings have been held with individuals and businesses involved a broad spectrum of developments. The findings of these meetings are not expressed in the following sections, which restrict information to:

- the planning history of sites;
- general technical and planning issues encountered;

- business/ownership structure;
- evolution of involvement;
- drivers underlying the establishment of the operation; and
- finance of the operation;

Detailed case studies have been undertaken of:

- Five UK hubs at: Thanet Earth; Drax; Holsworthy; Yorkshire Forward (Genesis); and Cornerways Nursery, Wissington,
- Five Dutch hubs at: Agriport A7, Middenmeer; De Lier; Bergerden; and Nieuwprinsenland,
- plus brief outlines of hub concepts in Poland and Denmark.
- Other sites, covered in less detail include: Ebbsfleet and Ince Park in the UK, and Terneuzen; Rotterdam; Heergowaard; Almere and De Lier in the Netherlands.

6.1.1 *Land Settlement Association (LSA)*

The use of hubs to exploit synergies and take advantage of symbiotic relationships between horticultural businesses is well established. The Land Settlement Association was set up with charitable support in 1934 to provide employment for the long-term unemployed in depressed areas of the UK. Three LSA estates were set up on the Sussex Plain with 118 tenants, and are still recognised as focal points for horticultural activity, although many former smallholdings are now in residential or recreational use.

At the start of WW2, the LSA's policy of relocating the unemployed to its estates was halted and, instead, men with agricultural experience were let holdings in order to maximise food production as part of the war effort. After the War the programme became part of the Government's statutory smallholdings policy to provide start up opportunities for people with agricultural experience.

The LSA's evolution of has seen transition from a charitable effort to provide work on to a Government-supported initiative providing specialist advisory and logistical support to a defined group of growers; the West Sussex estates were supported by a central facility located at Chalk Lane. The LSA archive records⁹ describe the work of the Association as:

“propagates plants, picks up the tenants' produce, takes it to the packing sheds, grade and markets the crops, for a charge to the tenant. Describes stores, which sell to tenants. Describes and shows estate office and describes what they do, describes service [machinery pool] for tenants.”

In summary the LSA 'hub' provided: transport and co-operative marketing; a machinery pool; horticultural sundries; and technical and estate services.

One of the largest salad groups in the UK, Snaith Salads Ltd, is a 17-member co-operative which originated on an LSA site near Selby, Yorkshire. This group was also a significant factor in the retention of Stockbridge as a horticultural research centre after the MAFF closure.

The success of the LSAs is described in further detail in the section covering social and cultural issues.

6.1.2 *Thanet Earth*

This site was initiated by the Fresca Group with Dutch companies Rainbow Growers and Redstar Trading, the latter providing packing expertise. The site is anticipated to include a

⁹ LSA archives CR 3LSA PH6/2

projected 51ha (126 acres) of glass as part of a 91ha (225 acres) site previously used for field vegetable production. Planning commenced in 2005, permission was obtained in 2007, and construction began in 2008.

The site was chosen partly because of its location in a designated regeneration zone, based around the redundant Chislet Colliery in an area of high unemployment. Development in the area attracted grant support of up to 30%, and also furthered the aims of local planning policy. The proximity of high voltage electricity infrastructure and ease of connection was also cited as an important aspect in site selection.

The site is currently covered by 25ha (61.7 acres) of glass, with 3 growers: Kaaij Glasshouses UK Ltd (10ha tomatoes), Rainbow (8ha peppers), A & A (6ha cucumbers). Kaaij is planning to build a further 8ha (20 acres) in 2012.

The original concept was based around a centralised generating facility providing heat and CO₂ to surrounding glasshouses, but this vision changed and when the site was built each unit had its own CHP plant, with installed capacity as 3x3.3MWe, 1x3MWe, and 1x2.4MWe; all CHP units are Jenbacher.

6.1.2.1 Ownership

Growers on the site own their own land, and the associated greenhouses structures. A joint venture company, owned by the three growers owns and manages the residual real estate and the infrastructure. In the event of a member of the joint venture wanting to expand, an agreed formula is used for determine the prices used for land sales. All of the produce from the site is marketed through Fresca, and a central packhouse is used by all the growers. Charges are distributed across according to separate cost centres according to the level of use.

6.1.2.2 Energy

The site experienced early problems with its electrical connection, which appear to be related to lack of understanding of the UK Grid requirements on the part of the Dutch engineering consultants working on the project. It is understood that the site's 11kV substation was sold to EDF for £1 in order to make connection possible. Gas used in the generating sets is purchased separately by individual growers, with input prices negotiated jointly on their behalf by Energy Combination Wieringermeer (ECW), a Dutch energy trading body; electricity is marketed jointly by ECW.

It is unlikely that any benefits would have been associated with the construction of a centralised 'energy hub' at the site because of the similarity of energy profiles for all three operations. However, cooperation in energy purchase and sales does show benefits to all involved in the joint venture.

The only significant difference in energy profiles is that Kaaij operate supplementary lighting on their site. The company uses only electricity generated on its own site, and does not buy off the other members of the joint venture.

6.1.2.3 Analysis

No physical energy hub exists at this site, and grower attitudes appear to suggest that they see no benefit in a truly collective approach to generation, management and cost sharing. However, the land ownership and land/infrastructure management model appears to be effective, and the marketing aspect of the development works well, although since the project was initiated by Fresca this is hardly surprising.

Despite initial interest being shown in the concept, no UK growers participated in this project. The reasons for this probably relate to timing, finance and strong links between members of the joint venture and Fresca. In general it appears not to have been perceived as offering a significant commercial benefit. One comment was to the effect that the Dutch approach to the project was very different to one that would be adopted by a UK-dominated venture.

6.1.3 *Drax*

Construction of greenhouses at Drax commenced in 1980 under the auspices of the Central Electricity Generating Board (CEGB) the then owner/operator of Drax power station. The development is based around an 8ha (19.8 acre) structure supplied with waste heat from the power station by an umbilical main. The heat supplied was of low grade, piped over and run through 600 heat exchangers to a warm air system.

A further two construction phases increased the total area to 14ha (34.6 acres). The enterprise has subsequently been privatised, and the nursery has seen a variety of owners over the years; and is currently owned jointly by Glinwell and Hedon Salads.

In 2004 the hot air system was replaced with a piped hot water system, gas boilers installed, and the umbilical cord cut. This change was due to efficiencies realised at the power station, reducing the temperature of the waste heat down to 26°C, culminating in the installation of a flue gas de-sulphurisation plant that reduced temperatures to a non-viable level.

Tomato growing at the site has been historically problematic for various reasons, including the poor hot-air heating system, older style greenhouses and low light levels, which were in part due to the frequent cloud cover generated by condensed water vapour from the cooling towers.

6.1.4 *Holsworthy*

The Holsworthy anaerobic digestion facility was the UK's first such facility established with the primary aim of producing renewable energy. It is relevant as a case study since whilst intended to be an energy hub it failed to develop fully the level of integration necessary for viability, as well as incurring other technical problems. The site was constructed in 1998 by Farmatic Biotech Energy ag, which was also the main shareholder in Holsworthy Biogas Ltd., the remaining shares being held by local farmers and the local community. Initially feedstock comprised a mixture of cattle, pig and poultry waste, plus some food waste (20%). However the digester had problems with variation in feedstock and did not fulfil its potential. Additionally there was no heat utilisation, thus reducing the potential income.

The installation benefitted from a £3.5m EU Grant under Objective 5(b) but had a total cost of £7.7m. Projected outputs were 3.9m m³ of biomethane per year (c.39mkW energy) with a budgeted power output of 13.5mkWh of electricity a year and a potential heat yield of more than 30MW. The electricity produced was sold under a 15 year Non Fossil Fuel Obligation (NFFO) agreement at a rate of 5.93p/kWh (2003 price, index-linked).

The site was bought in 2005 by Summerleaze AnDigestion. AnDigestion was established in 2004 by Summerleaze Ltd to develop and commercialize anaerobic digestion (AD) as a viable waste-treatment technology. The plant is currently running at about 66% of its 150,000tpa design capacity with a 30% proportion of food waste, the balance being made up by abattoir waste and a majority of cow slurry. There remains a significant variation in the nature and volume of waste taken in.

An unknown amount of gate fees for non-farm wastes make up a significant part of the site's income, plus an estimated £1.1m in revenue from electricity sales¹⁰.

The site provides 15fte jobs at a variety of levels, but is reliant on the goodwill of local farmers to provide some feedstock and land for spreading digestate at zero cost, and on long term contracts for high energy organic wastes without which biogas production sufficient for the plant to be viable.

6.1.5 *Yorkshire Forward*

This commenced in around 2002 as the Genesis Project, originally including 14 growers, but the number of participants reduced to seven over time, leaving: R Sayer; Hedon Salads; John Baarda; Humber Growers; John Locke; and Plant Raisers). Several growers around Cottingham which are still successful today (Hailsham Salads and de Langs) were part of the original project group but dropped out early on.

The proposal included options to encourage younger growers and new entrants, including rented houses and partnership agreements.

The main aims were to achieve a large area of new production to allow for expansion and provide this with a lower cost energy source.

Analysis

There appear to have been two key reasons for failure of this model, firstly timing and secondly finance.

The rate of development was too slow for the proposed partner, Guardian Glass, who needed to build their factory and required a £600k financial input for the necessary work to upgrade gas mains and install additional heat reclaim facilities. This third party input was not forthcoming, and so the glass factory proceeded without the additional facilities and effectively precluded the glasshouse hub.

These delays in obtaining finance were due to the project itself being unable to leverage external funds and growers not being prepared to commit sufficient sums to establish the joint venture company. Originally the scheme was also reliant on obtaining planning permission to develop existing nursery sites for housing, with 50% of the proceeds from this going into the new glasshouse hub development.

In the event, the only funds that could be sourced were for the Producer Organisation (PO) aspects, since State Aid cannot support near-market or production-related investment. Further, UK banks were unwilling to lend to a project without adequate security (land), and growers were reluctant to make other assets available as collateral. The group tried to access funds through Dutch banks (Rabo and Amro), which declined to lend against UK assets.

A further contributory factor was the perception that the land adjoining the factory, owned by the Regional Development Agency, Yorkshire Forward was over-priced, the RDA wanted £60–£80k/acre for land purchase; commercial leasing was out of the question as it was based on industrial, not horticultural rates.

Towards the end when it became clear that the scheme was failing, David Baarda, who wanted to expand his business, took the concept on single-handed. He identified the Immingham fertiliser site, operated by Terra Nitrogen Ltd, which in turn is 50% owned by Yara, (see Terneuzen below), and brokered a deal.

¹⁰ Case Study – Holsworthy (Summerleaze) Biogas Plant, University of Glamorgan, 2007

The resultant model was to provide heat and CO₂ (almost pure) from the fertiliser plant *via* an umbilical; the cost of heat was 50% of that derived from other sources. Both partners are contractually obliged to provide and use heat, on a long term contract (10 years plus). Baarda purchased land off Cambridge University to construct 23 acres of glass with the infrastructure for a further 17 acres, although it is understood that there is a potential for a total of 400 acres of horticultural development in the area..

Baarda succeeded in borrowing £20 million from UK banks, although this includes an estimated additional cost of £1.2 million, associated with operating under the aegis of a bank, primarily due to having to use RIBA contracts and due diligence investigations. The legal services costs necessary to facilitate the deal were alone over £260k.

The glasshouse included supplementary lighting and was fully lit, which would not be the case today because of higher electrical costs and lower tomato prices. The company struggled with high interest payments, and was subsequently taken over by The Greenery.

It was stated that the key to success is to get the understanding of the heat supplier and its acceptance of the importance of the glasshouse operation.

6.1.6 *Cornerways Nursery, Wislington*

This project was initiated by British Sugar Technical Services, which was looking for alternative uses for the waste heat from gas turbines installed for operating the sugar factory during the processing season. It was recognised that the model would facilitate year-round operation in a viable way, as well as achieve Good Quality CHP status and associated CCL benefits; any further improvements in performance will count towards the businesses' Carbon Reduction Commitment.

The site has 66MW of electrical capacity installed in 1997, comprising a GE LM 6000 PD gas turbine generating 42MW, and a steam turbine generating 24MW. The turbine is fitted with Dry Low Emissions technology resulting in NO_x emission levels of around 25ppm. The sugar factory and glasshouse site is an excellent example of a highly integrated production system, producing sugar and using co-products to: generate electricity; and produce bio-ethanol; animal feed; topsoil; aggregate; and tomatoes. The heat transfer circuit includes eight heat exchangers and a 2km umbilical.

Glasshouse construction commenced in 2000 with a first phase of 5ha, followed by two further phases of 6ha and 8ha being completed in 2010. The heat used by the nursery accounts for about 15% of the energy input to the CHP, which is lower grade heat than can be used in the prime application, this being for the sugar beet processing. The development of phases has been interesting, Phase 2 maintained in-house heat levels similar to Phase 1, but overall heat demand on the CHP system was reduced through installation of thermal screens in the glasshouses. Phase 3 increased heat supply to the glasshouses through improved recovery of waste heat from factory processes and installation of buffer tanks (1 million m³) to allow heat to be captured when available and used as required. The site has land available for expansion, although none is planned.

There is no internal trading of heat or electricity, and electricity from the CHP is exported to the grid at times when it is not required in the factory. CO₂ and heat are piped from the factory to the greenhouses.

In 2012 a joint venture British Sugar/Air Liquide capture and liquefaction process will become operational, capturing 70,000 tonnes p.a. of CO₂ from the on-site fermentation process. At the time of writing it seems unlikely that this will provide additional, low cost CO₂ for use in the nursery.

In 2011 Cornerways became a full member of the Coforta Co-operative, which markets fruit through The Greenery.

6.1.6.1 Heat and CO₂ supply

Heat recovery and conservation have been improved across the site due to insecurity of an adequate supply. For instance, heat recovery from the factory has been optimised delivering true waste heat, which it would otherwise have been necessary to destroy to allow factory processes to continue. Although the nursery is wholly owned by British Sugar, it is a separate company and it paid for the capital expenditure on the heat recovery installation. The nursery is charged nothing for heat and CO₂, but pays the additional running costs associated with heat and CO₂ recovery, for example the electricity for pumps and fans for heat and CO₂. This is a highly unusual situation, which significantly improves the financial viability of the nursery operation.

In addition to the heat recovery circuit, an additional heat exchanger is connected to the site's original steam boiler circuit, providing back-up when the main factory is on shut-down, or in case of emergency. This energy is paid for at a price linked to the cost of natural gas. During shut down periods liquid CO₂ is used to augment the atmosphere in the glasshouses.

6.1.6.2 Analysis

This nursery has proved hugely successful, despite severe teething problems in the first year due to late completion, and inadequate heat provision. Nursery and factory are wholly-owned by the same parent company, and there has been very strong technical collaboration between the two businesses, through the nursery manager and the British Sugar Technical Services Department, the latter of which has been involved from the inception of the project. Issues that are common on third party CHP sites, such as where the energy generating partner minimises reliability issues at the expense of heat delivery to the nursery, have not arisen on this site.

6.1.7 Agriport A7, Middenmeer

Middenmeer comprises around 200,000ha of land reclaimed in the 1930's; the man-made nature of the land reduces its potential to provide natural resources.

The Agriport project was developed by one farmer, Anton Hiemstra, a vegetable grower looking for land to construct new packing facilities. Initially, he purchased 50ha of land, but was joined in 1997 by a glasshouse grower, Frank van Kleef. Together, from 2000 they negotiated with local farmers and the local government to develop the site, their proposals for which were approved in 2005. In 2004 Hiemstra had purchased a further 100ha of land, and continued to buy up land in the area as it became available. Where necessary he helped local farmers obtain replacement land outside the proposed development area to which they could relocate. The development started in 2006, and 260ha have now been built and the full original amount of 600ha has been sold. In 2007 approval was given to extend the area of glass to 1,000ha.

Land was bought by Hiemstra's holding company, developed then sold on to growers after the infrastructure, including roads, power and telecoms, had been installed. The infrastructure company initially retains all rights and responsibilities for eight years, after which it will resurface roads and undertake necessary repairs to other infrastructure before passing it on to the local authority for adoption. In addition to handing over the infrastructure, a financial allowance is made for future works.

The role played in the development by local government has two interesting aspects. Firstly, it undertook significant improvements to the off-site local highway network to cope with likely additional traffic, and secondly it accepted points opposing plans for a tourism-related recreational lake in the area made by local farmers in 2008. Opposition was based on the assumption that horticulture would provide more to the local economy than the tourist use of a lake, and thus was not in the economic interest of the region.

Water and drainage (a big issue as the area is below sea level!) infrastructure is owned by a joint venture between the growers and the water company, but the growers are trying to have this taken over by the water company and merely become individual customers.

6.1.7.1 *Marketing*

Nine **large** growers have established operations at the site, the average size of their holdings being 30ha; all are part of FresQ marketing group. The companies involved are:

- Agro Care. 30ha tomatoes (60 ha greenhouse land)
- Barendse - peppers
- CombiVliet - 12ha tomatoes
- van Kwekerij Helderma – 23ha peppers
- Kesgro – 27ha tomatoes (also in Westland)
- Kwekerij de Wieringermeer - paprika
- Red Harvest – 23ha tomatoes constructed in 3 phases, 55ha of glasshouse, phase 3 (7.5ha) has supplementary lighting.
- Royal Pride Holland – relocated to Agriport A7 in 2006.
- Sweetpoint – paprika with supplementary lighting.

6.1.7.2 *Energy*

All growers at Agriport A7 have their own CHP and boilers, typically 20MW(e) per 30ha unit. There is no heat or CO₂ grid on the development, although power transfer is facilitated intelligently. This allows a grower with a heat requirement to generate electricity to satisfy local demand and store heat arising in a conventional on-site buffer tank for use as necessary. External energy contracts are negotiated by a single trading company, Energy Combination Wieringermeer (ECW). Agriport A7 has avoided central purchasing due to known risks of growers defaulting on debt owed to energy company joint ventures, causing losses to be shared amongst the remaining growers.

Overall, the site currently has a generating capacity of around 150MW with a 150kV grid connection.

At the time of writing, Agriport A7 is exploring the possibilities of anaerobic digestion and geothermal energy, supported by a national subsidy regime for renewable energy.

6.1.7.3 *Analysis*

Agriport A7 has been notable in many ways: its scale, speed of development and the existence of support from a local authority, which was aware at very early stage of the economic benefits it would bring. Extrapolating values from the WSGA Viability study onto the scale of Agriport A7, the current extent of the development equates to around 2,100 fte jobs and an income to the local economy of £160 million a year, providing 8,100

jobs and £1 billion income at the agreed next level, excluding the knock-on benefits to other sectors.

Agriport appears to have been a single development enterprise based on the identification of a suitable site (logistics, large scale and climate), engineering of win-win situations and solving of problems before they became troublesome. The development appears to be based on the premise that both public and private partners recognised and accepted their respective responsibilities to the local environment and local people, and growers committed to production at the site.

It is interesting to note that following on from this successful enterprise two further horticultural hub developments that are targeting not just the production but the added value of renewable energy and logistics have been proposed.

6.1.8 *Bergerden*

This hub was conceived in 1994 as to relocate 600ha of glass from an area re-zoned for housing in 1990. The proposed development was approved in 1999, and received a central government grant of €10.3 million for infrastructure. The land is owned by the individual growers, but was purchased centrally and then sold to growers for £112,000/ha. In 2006 permission was sought to extend the designated glass area to 1,000ha.

Bergerden has a central energy plant providing heat and CO₂ to greenhouses *via* a network of pipelines. Membership of the co-operative energy company, Energy Cooperation Bergerden (ECB), was compulsory for all growers at the site, and this in return promised a 10% reduction in energy costs. Operation was problematic and the enterprise went bankrupt in 2008, following which it was bought by the 17 original growers as a joint venture, Greenhouse Energy. In 2008 only 110ha of glass out of the planned 600ha had been built.

There are currently plans to construct an AD plant with CHP on site, providing heat to the energy company, taking advantage of the national renewable energy subsidy regime.

6.1.8.1 *Analysis*

The site has experienced many problems, with poor take up of available land, lack of co-operation between growers, lack of promised energy cost savings, high cost of energy infrastructure and poor reliability of infrastructure, notably fouling of the CO₂ distribution system.

One interesting third party observation is that the different mentalities of growers make it difficult for them to co-operate, thus some may be very conservative and like long term fixed contracts, whilst others prefer to play the spot market, somewhat akin to Bulls and Bears in the stock market.

The location in the south of the country is not ideal, with lower light levels than in the north near the coast.

6.1.9 *De Lier*

The major players in this development were provincial and local governments, which treated the project as a commercial equivalent of a social housing project, with the growers having little or no say in the structure or working of the venture. The resulting arrangement was not able to accommodate different interests and a balanced commercial model was not produced¹¹; it remains to be seen whether the new, grower-based joint venture is successful.

¹¹ Transformation and Sustainability in Agriculture: Connecting Practice With Social Theory, Vellema ed., Wageningen

This hub was built to service three existing glasshouse sites with support from a technology grant in 1999. It comprises a steam boiler fuelled by waste biomass (mainly sawdust) driving a steam turbine generating electricity, with heat supplied to the three glasshouses *via* a secondary hot water circuit. Power is exported, and its generation and sale is administered by Westland Energy. There is no CO₂ augmentation associated with the power generation.

The installation was manufactured by de Lange, with a Nadrowski multi-stage back pressure steam turbine rated at 745kW. The boiler is rated at 4.6MW, 30 bar pressure, suggesting a target electrical efficiency of 16%. The flue gases are cleaned using a multiple cyclone and electro-static precipitator. The superheater component of steam raising failed rapidly, and as a consequence the turbine was operated at around 60% of rated capacity for much of its early life. It would appear that part of the problem with the superheater was the result of 'load following', that is varying temperatures in the combustion chamber, and part related to contaminants in the sawdust fuel. The installation was closed in 2003 due to breaches of emissions limits, and rebuilt in 2006; the installation still fails to achieve its design output.

6.1.9.1 Ownership

The energy company maintained ownership of the energy plant and inter-connector, largely because of the retro-fitted nature of the project. The users were billed according to a heat meter for the heat supplied.

6.1.10 Nieuwprinsenland

This site is located on land reclaimed from the sea 300 years ago, and it is proposed that companies from the agro-food sector will locate in a development area associated with an existing sugar beet factory, bringing with them development including 220ha of glasshouses. The proposal is for a mixed model, with centralised heat and CO₂ generation, plus utilisation of waste heat from the Dintel sugar beet processing factory. The factory is owned by Suiker Unie, which in partnership with Tuinbouwontwikkelingsmaatschappij (TOM) (AKA the Horticultural Development Company) is promoting the initiative, and processes around 2.5 million tonnes per year, compared with 3.2 million tonnes per year at Wissington. The proposed model for heat use is similar to that established at Cornerways/Wissington, with low grade heat and CO₂ being piped from the factory to the glasshouses. In addition, waste water from the factory would be used for irrigation of crops and for lower grade purposes such as washing down. Gas from a centralised AD plant would be used within the factory as required, with any surplus used in the greenhouse energy complex.

The site is planned to be a major renewable energy hub, including 21MW of wind power as well as the centralised AD plant. Only a small proportion of the waste heat arising from the factory would be used in glasshouses, although full details of the site energy balance are not known. The first grower, de Jong, is already producing paprika on site.

In addition to production glasshouses, it is proposed that there will be a further 50 ha of land dedicated for use by agro-food businesses. The whole site would be landscaped using broad banks around the site perimeter for screening and shelter, see artists impression from the site publicity below.

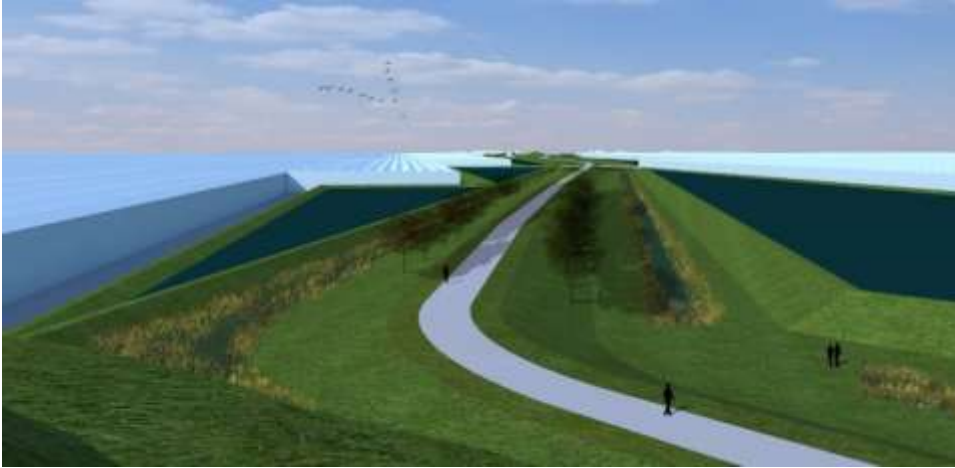


Figure 6: Large scale view of proposed Nieuwprinsenland

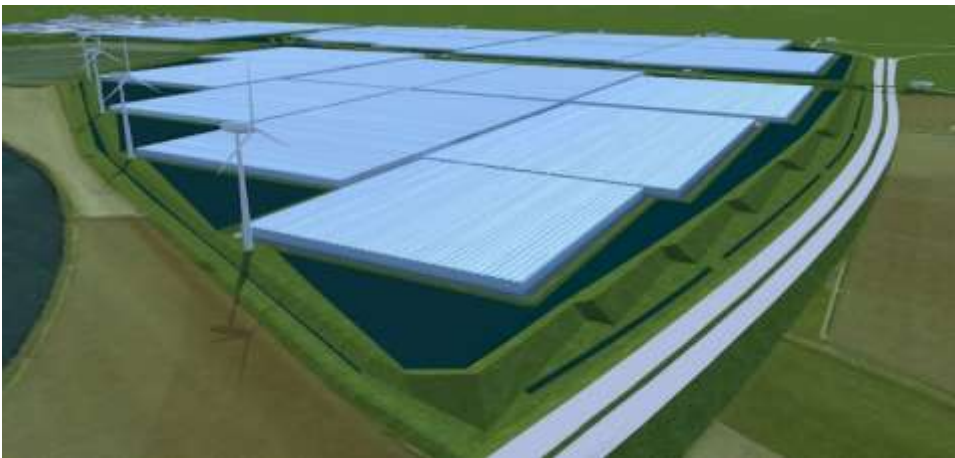


Figure 7: Detail view of Nieuwprinsenland with wind turbines

In the long term the ambitions of the site's promoters are for a local 'bio based economy' complete with offshore algae farms and ethylene production use in for chemicals processing.

6.1.11 Denmark

This proposed development is ongoing, based on the redevelopment of an industrial site where greenhouses are seen as beneficial to the overall project. The land would be developed for horticulture with a long-term view to it being taken over for residential development in future. This is seen as a desirable temporary use for the site because to construct housing over the entire area in a single development would swamp demand and so depress prices.

The total area of glass planned is around 20ha, with heat from a CHP plant also used for district heating in the residential areas and as a source of CO₂ for augmentation in the greenhouse complex.

Glasshouses would be leased to growers, and heat/CO₂/power provided under contract at discounted rates linked to energy indices.

6.1.12 Poland

PPO Siechnice, one of the biggest producers of greenhouse vegetables in Poland and owned by Citronex, plan to develop 96ha for tomato and cucumber production utilising waste heat and CO₂ from an existing power station.

The energy source is Torow power station (located on the German border at Bogatynia), which is co-fired 85% coal and 15% biomass. The power station has Circulating Fluidised Bed boilers (CFB) with a total electrical output rated at 1.5GW. The units are relatively new, installed in phases during the past 15 years. Maximum emissions from the boilers are stated as:

- NO_x 371 mg/Nm³
- SO_x 347 mg/Nm³
- CO 150 mg/Nm³

It is likely that the flue gas cleaning is chemical (ammonia and limestone injection) plus cyclones and electro-static precipitators and finally an SCR.

The contractual arrangements for the supply of heat and CO₂ to the development have not been made public yet, but it appears that the overall costs will be significantly lower than gas equivalents. The power station has a bad reputation for pollution, largely due to its size and some of the older plant on site, and this project appears to be a 'green' mitigation measure to reduce nett CO₂ emissions from the site. In addition there will be a cost saving to power generation through a reduction in cooling water used at the station.

The power station is owned by the energy provider, Elektrownia Turow, with the glasshouse unit owned by Citronex. The total project cost is €220 million, wholly paid for by Citronex.

6.1.13 *Ebbsfleet, UK*

This proposal was for 52ha of glasshouses in nine blocks of varying size up to 10ha, with a centralised energy plant. The development would have been constructed in three phases and followed by planned redundancy of the glasshouses. The motivation behind the project was utilisation of a land bank with extant planning permission for residential development, with a view to the investment in the primary infrastructure installed for the glasshouse site being re-used for the subsequent housing areas. Various UK and Dutch growers were approached and expressed an interest, and the project was under serious consideration, however, the landowner withdrew because the concept was not sufficiently attractive financially.

6.1.14 *Ince Park, Cheshire*

This is an old energy hub concept that has been recently resurrected as part of a new proposal for an Eco Park, which is part of an integrated plan for the Mersey-Manchester Ship Canal Corridor. The development has received outline permission on a 51ha site, that will include an AD unit, a 95MW(e) Energy From Waste (EfW) plant, and other industrial facilities producing biofuel and aggregate from incinerator ash. Much of this is part of the larger Peel Holdings/Covanta Energy investment operation. The site includes 36ha of land with potential for glass, and in addition to on-site resources, there is also potential to take waste heat/CO₂ from the nearby Yara GrowHow fertiliser production plant.

This concept follows on from the successful David Baarda venture with Yara GrowHow at Billingham, and the proposals for Ince Park have driven this new activity, which may provide competition when trying to attract participants to any hub development that might be promoted in West Sussex.

6.1.15 *Terneuzen*

This is a proposed major site in the Netherlands, comprising 250ha glass to be developed in three phases. It has similarities to the original Yorkshire Forward project, in that it will utilise waste heat and CO₂ from the nearby Yara fertiliser production plant.

6.1.15.1 *Ownership*

Land for development would be owned by the growers, with heat and CO₂ provision through a spin-off company called WarmCO₂. Energy costs would be fixed on a 15-year price deal linked to an energy index.

6.1.16 *Rotterdam*

The Port of Rotterdam has a long term strategy to become the main energy port for Europe, including LNG and biomass. The Port sees CO₂ capture as a critical part of this strategy and is working with Air Liquide on capture solutions and subsequent uses. Glasshouses are seen by the partnership as a useful energy buffer as well as a user of CO₂, and the site also offers significant benefits in terms of logistics, being at a communications hub linking to the European canal, road and rail networks as well as the global shipping system through Europort.

6.1.17 *Heerhugowaard*

There are 21 smaller growers in this area that is rapidly developing as a centre of excellence for the use solar energy, but there is little public information relating directly to horticultural development in the region.

6.1.18 *Almere*

This proposal was centred on a 300ha glasshouse complex to accommodate glass relocated from the Aalsmeer area, where land had been re-zoned for residential development. The development would have been sited on the edge of the existing new town at Almere, which acts as a dormitory for Amsterdam. Waste heat from a power station seven kilometres distant would have been used to heat the glasshouses and to provide district heating for residential development in Almere.

The project has been referred to as a 'paper exercise' by one Dutch source, presumably referring to academic input from Wageningen, but the economics did not make sense and the proposal has never been pursued seriously. The area provisionally allocated for greenhouses has now been developed with houses.

7. Consultations

Summary

The most striking part of the consultation was how the views of many industry interviewees appeared to have been blinkered by perceived lack of opportunities to develop businesses and apparent restriction on built development and land use change. Many discussions stimulated perception of new opportunities over and above existing business expectations that had already been written off by consultees. This is both encouraging and worrying; it seems to be that the dynamism of the industry and the ability of stakeholders to identify new opportunities are often constrained by the perceived lack of opportunity for new developments, resulting in missed opportunities for new business and employment.

A major point arising from the consultation is the loss of greenhouse facilities likely to occur over the next few years, facilities that are currently rented by some of major producers. This means that a further 15ha-20ha of facilities will be required on the West Sussex Coastal Plain merely to maintain current levels of activity.

The general level of support for the project was high across the range of Stakeholders, not merely because of the opportunities for new glass within an energy hub, but because of the greater collaboration and synergy it was believed would stem from this type of development. Addressing some wider needs such as training and new entrants was also seen to have significant potential benefits for the local industry.

This project may fail to attract large-scale growers operating elsewhere across the UK due to the promotion of broadly similar, competing schemes promoting flexible ownership/tenancy models currently being proposed at other sites in the UK and in mainland Europe.

The credible level of interest in new glass in the WSGA area would be for about 60ha.

7.1 Background

Consultations were undertaken with a large number of representatives across a wide range of stakeholder groups, mainly those concerned with operating the hub, assisting in its formulation through development of planning policy, and those who would be stakeholders through either use, land ownership or finance. The groups are covered in separate sections below.

7.2 Grower interviews

The key points discussed were the level of interest in operating from a new site, and then if there

was an expression of such what ownership models of land, glasshouse and energy supplies would be acceptable and preferable.

7.2.1 *Land ownership*

The overwhelming (90%+) majority of growers interviewed were open to either buying, renting or leasing land, the key factor being the viability of the whole business proposition.

7.2.2 *Glass house ownership*

The overwhelming (90%+) majority of growers were open to either buying, renting or leasing greenhouses, with the key factor being the viability of the whole business proposition. The ownership of an asset such as glass is attractive to long-term, unsecured, investors, whereas institutional lenders normally require security against loans for such capital investment.

7.2.3 *Energy ownership*

Energy options were more contentious, and although most growers accepted that they could work with all of the models discussed, there was scepticism that a sufficiently robust contract could be drawn up between parties. This is partly because of bad experiences that are well documented, partly tempered by knowledge of some successful projects. It is likely that ownership of the energy component of the hub will be the most problematic aspect of the scheme, particularly where dependence on the hub as provider is significant. Some growers do not consider third party involvement in CHP schemes to be attractive.

7.2.4 *Collaboration with other growers*

Respondents were split significantly on this, with over 50% having had experience of collaborative ventures of some degree or other that encouraged them to accept this as a viable option, and the remainder opposing it, either because of bad experiences or general, in-principle opposition to the concept.

7.3 Allied commercial interests (service industry)

All commercial respondents from allied industries were keen on the idea of renting commercial premises on a hub site, and saw it as an opportunity for business expansion. It was felt that this could lead to expansion of existing training and apprenticeship schemes, and also support and strengthen employment as these businesses expand into other sectors.

It is assumed at this stage that the ownership of the land, and probably commercial buildings, would be retained by the land owner or possibly the infrastructure company.

7.4 Planning and Policy makers

The inputs of planning and policy stakeholders are addressed in detail at Section 3, but generally respondents were positive about the concept of a horticulture-based energy hub and the benefits that it would bring, particularly to areas of high unemployment and social deprivation in parts of the developed coastal strip.

The availability of a large enough area of suitable land is an issue in West Sussex, where adjacent land uses have to be considered before development is proposed and the existence of identified industrial and horticultural development areas taken into account. For instance, certain recent planning decisions have centred on the existence and definition of designated sites. In Arun District about 80ha of land have been identified for industrial development, which at recent past letting rates will take decades to bring into use. It is possible that by bringing part of such a site into medium-term horticultural use, together with other, peripheral land, synergistic benefits may arise

for a wide range of stakeholders.

7.5 Landowners

The Land Agent for the Church Commissioners stated that the Commissioners own 7,000 acres locally, and Chichester is one of four main landholdings in the South East, along with Canterbury, Winchester and Petersfield. The Commissioners' normal approach is to retain land where the asset value is increasing, as is the case locally where there are existing tenancies and a freehold value is generally greater than a tenanted one. In general though, they would sell if the price was right. The Commissioners would also rent land to growers, as offered at Tangmere, but apparently never taken up. A 25 year lease is not likely to present a problem.

Some of Church land would clearly not be viable, for example some of it is designated SSSI, and some within the coastal protected area; another area near Bognor is anticipated to be designated for housing development. The sale of land would not be allowed to prejudice future development opportunities, so for example land would not be sold for a proposed AD plant that would be too close to a potential future housing allocation. Tenanted farms can be made available generally subject to suitable compensation to the tenants, and likewise it is usually possible to remove parcels of land from the tenancies by negotiation where required.

The Commissioners may well be interested in investing, but not in running, a suitable venture, and so might be considered as a potential partner in any joint venture energy hub as well as as landlord for leased sites. It is also likely that they would also be interested in building roads for infrastructure if this could subsequently be used for residential development after use for greenhouses.

All of the Church Commissioners' dealings have to show due diligence because of the charitable status of the organisation, although this should not be too onerous and in general merely has to demonstrate that a sound business decision has been made.

Other issues that have been raised relate to WSCC land south of the A27, where some land is thought to have been allocated for possible road improvement, some is in a long term tenancy, and still more has minerals extraction rights that have yet to be exercised; digging is due to start on one block in the near future. There are also other sites where a use such as for an out-of-town hotel has been identified as desirable.

In terms of specific areas that have been identified by one or more consultees, Ford Airfield has numerous synergies that make it appropriate for hub development, including: a site identified by WSCC as appropriate for waste-related built development; a Southern Water waste water treatment works; an existing horticultural production area at HM Prison Ford; and a significant area of brown field land comprising concrete runways and aprons.

It is notable that a significant part of land farmed by local growers Barfoots is rented, and of the Company's owned land much of it is within the coastal reserve or the Chichester flood plain. The Company has 35 acres of land adjacent to its main farm that might be used for greenhouse development, including ten acres adjacent to the digester. A site such as this has potential for use in a node type hub.

In the region of 500 acres of land adjacent to the Batchmere Horticultural Development Area (HDA), which has been the subject of a recent planning appeal, is owned by Madestein Ltd or those associated with the company with the intention of developing it for horticultural purposes. The immediate future of this area depends on the findings of the Inquiry Inspector, but the long term prospect of land adjacent to an HDA being unavailable for horticultural development is paradoxical.

8. Business and operations models

Summary

The likely and optional components of hubs are considered, and also a ‘classic’ centralized hub and a nodal type hub are described.

A model has been developed, which considers combinations of scenarios based on the landowner selling or leasing land, and glasshouses being either constructed by the landowner and rented to the grower or built by the grower, and the energy company either owned solely by the landowner or as a Joint Venture with all parties.

The results of this show that the most profitable scenario for all parties is where the land owner retains the ownership of the land and invests in the infrastructure, and the grower builds the glasshouses, and the energy supply side is a JV of all parties.

8.1 Hub types

8.1.1 Components

The main components of hubs are listed below, not all of which need be included in all hubs.

- Infrastructure – roads, utilities connections, water storage, landscaping.
- Greenhouses
- Main commercial blocks
- Start-up for new entrants
- Packhouse
- Commercial / industrial units
- Training centre
- Care and training unit for those with learning disabilities
- Energy centre

Optional components:

- Residential housing, which could easily be brought into the land use mix of a hub development and would also assist with Part L of the Building Regulations towards achieving zero carbon status for developments.

The range of hub size range is generally between 50ha and 200ha, although Agriport A7 will be the largest when completed, at a projected 1,000ha.

The size of hubs is governed by economic limits, which are generally related to energy distribution costs within and between sites; for instance, whilst electricity and gas are relatively cheap to convey, heat is expensive to transport in any form over significant distances. This is underlain by the general principle that the higher the energy content of the transport medium, the lower the cost of transportation. Thus in terms of heat transfer, energy-dense steam is more economical to transport than hot water. The table below

illustrates this by showing typical costs of steel pipe for 1MW capacity:

Medium	Transport	Cost/m
Steam	76mm	£4.00
HTHW 20°C F&R	114mm	£8.00
LTHW 10°C F&R	159mm	£13.00

Table 7: Costs of Transport 1MW Heat

The additional cost of insulation, which is necessary to minimise heat loss, particularly over long distances, further magnifies these differences. The installation costs associated with each system are not dissimilar. The pipe diameters will be dependent on distance and many other factors such as working pressure, but it is apparent that heat transfer systems based on steam are likely to cost around 50% of high temperature hot water, and 25% of the cost of low grade heat transfer. In terms of hub design this favours steam distribution networks for the greatest loads over long distances, and where only low grade heat is available, the point of use has to be close to the energy centre.

Purely for illustrative purposes to transport 8MW capacity of steam (i.e. 50% of the example output) over the likely distances involved in a hub of up to 2 km would require a 219mm pipe at around £20/m (bare pipe). For any inter-site connections it will be necessary to use buried pre-insulated mains at around £60/m, which is around double the cost of insulated above-ground pipe.

8.2 'Classic hub' approach

This approach, shown in Figures 8, is based on a single site and constructed around a centralised centre with services radiating to glasshouses, or distributed energy centres inter-connected with a ring main for example. A secondary use, such as a packhouse may be included in the model.

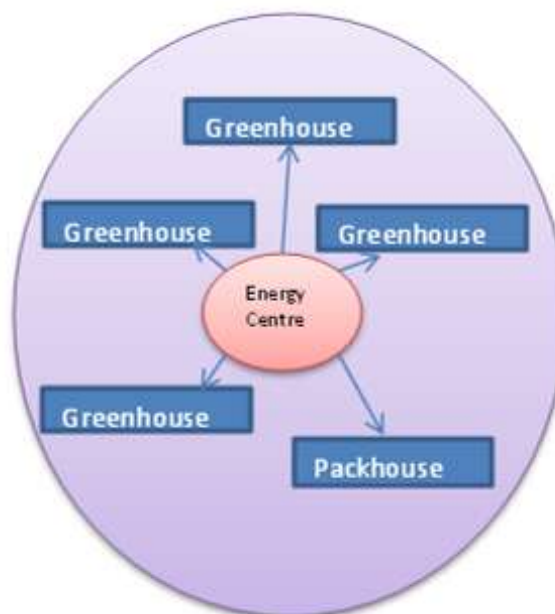


Figure 8: Single site classic hub schematic

8.3 'Node' approach

The experience of many successful Dutch sites is that an electrical connection, sometimes combined with other infrastructure such as IT, linking multiple generating sites is a good working model. There is some merit in this approach in that it allows a limited amount of heat control on sites, where plant can be operated for electrical production and the associated electricity management aspects of the hub and low grade heat arising during generation stored at or near the point of use. This permits use of what may be termed an energy node approach, where disparate sites are linked by a private electricity distribution network. A further extension of this concept would be to link sites more comprehensively, either by cross transfer of useful combustion products (heat and CO₂) or transfer of an un-combusted energy source, such as biogas or syngas. In order to reduce costs of connection of the former, the likely format of these would be steam and CO₂ extracted from exhaust gases, as opposed to the more conventional transport of the entire exhaust gas. For the latter it is conceivable that biogas from an AD plant, or syngas from a wood gasifier, could also be transported from a central site to nodal CHP generators.

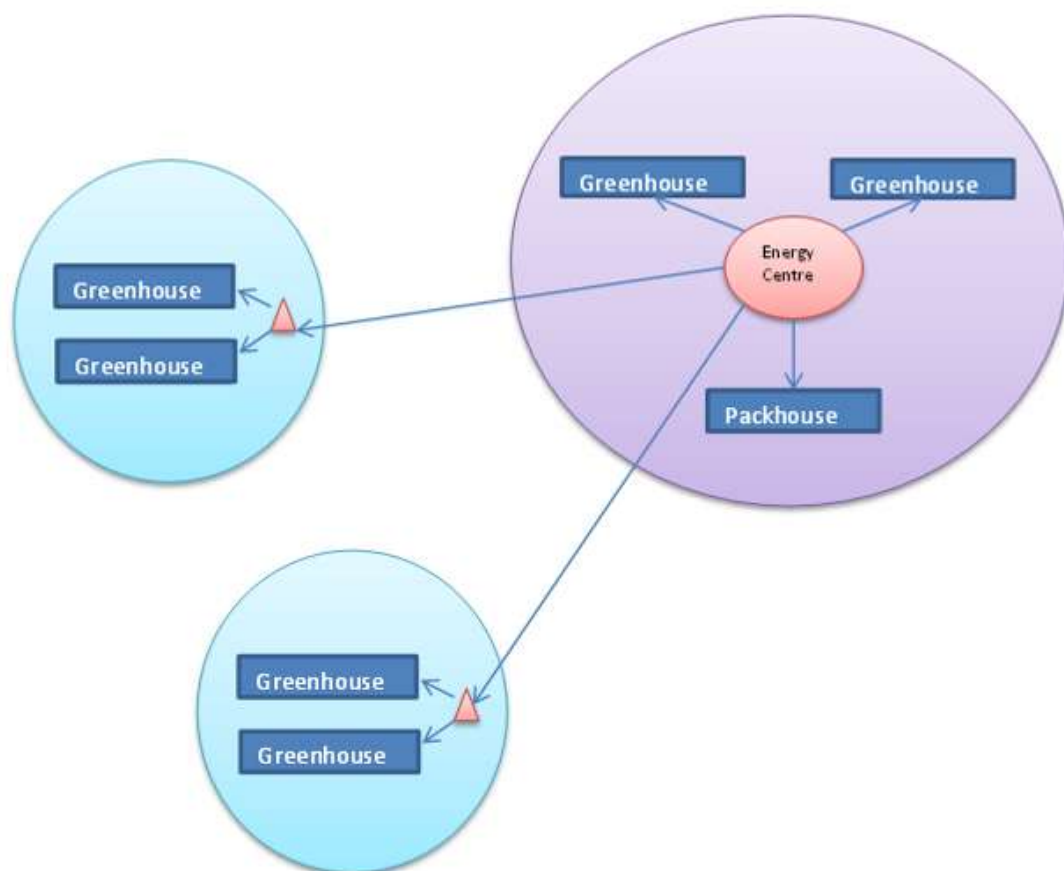


Figure 9: Site node hub schematic

This approach is less ideal than a classic single hub in many respects, but would work well with a primary energy distribution system based on biogas or syngas.

8.4 Operational models

The main options for ownership/investment in the three are shown in Figure 10 below:

	Land	Glasshouses/ Infrastructure	Energy Company
Landowner	Landowner investment	Landowner investment	Owned by landowner
Grower		Rented off landowner	
Energy company			
Landowner	Retained	Rented off Landowner	JV
Grower	Rented off Landowner	Grower investment	
Energy company			
Landowner	Sold to Growers	Grower investment	JV
Grower			
Energy company			

Figure 10: Matrix Showing Options for Ownership/Investment

8.5 Mathematical model

The model employed is uses financial returns based on some key assumptions as below:

- Future land sales are considered as percentages for glasshouse, commercial and residential uses.
- Three production systems have been included for the grower model – tomato, young plant and strawberry.
- The energy model includes RHI and ROCs where appropriate, and is based on current prices as shown above.
- Equalised annual incomes are designed to equate future capital returns and current returns.
- Future land asset rises are not included in grower and energy models, i.e. it is assumed that the grower is in business for production returns not capital gains. In reality this is not true, but it is the model most growers seem more comfortable with.
- Interest rates are assumed to be 6%.
- Lease options are for a period of 25 years.

The following assumptions have been made with respect to values applied in the model:

	Value £/ha
Bare land	27,000.00
Greenhouse development land	100,000.00
Residential land	2,000,000.00
Commercial / industrial land	800,000.00

	Rental income (£)
Greenhouse land only	1,000.00
Greenhouse unit	105,000.00
Commercial land only	10,000.00
Commercial unit	200,000.00
Management costs	10%

A refined model, developed in the light of further industry consultation is presented in Section 12 of this report.

8.6 Summary of results

WSGA energy hub financial model

Summary

		Landowner sells land, Occupiers invest	Landowner builds infrastructure only, Occupiers invest on lease	Landowner builds all, rents to Occupiers
Grower returns (per ha)	Initial investment	£936,667	£900,000	£0
	GM with normal energy	£200,000	£199,000	£95,000
	GM with hub energy	£260,000	£259,000	£155,000
	IRR - normal energy	20%	21%	n/a
	IRR - hub energy	26%	27%	n/a
	Equalised annual income	£244,615	£242,994	£155,000
Energy company returns	Initial investment	£4,155,000	£4,100,000	£3,700,000
	GM	£1,534,400	£1,514,400	£1,134,400
	IRR	34%	34%	29%
	Equalised annual income	£1,425,848	£1,407,250	£1,062,077
Landowner returns	Initial investment	-£2,346,667	£7,199,333	£64,799,333
	GM	n/a	£171,000	£5,481,000
	IRR	n/a	43%	13%
	Equalised annual income	n/a	£4,476,559	£9,786,559

Table 8: Modelled Financial Outcomes for Diverse Ownership Scenarios

9. PESTEL analysis

Summary

This PESTEL analysis is intended to inform the making and implementation of WSGA's strategic plan for future development in the local growing sector. The outcomes of the analysis are summarised in Table 9 below and the following text.

The biggest threats to the strategy identified by the PESTEL analysis are:

- *political, associated with the threat of reduced trade restrictions on and thus greater imports from EU peripheral states such as Morocco;*
- *economic, relating to exchange rates and availability of investment capital.*

The significant positive drivers identified by the analysis include:

- *economic, developing policy and associated energy subsidy system to encourage the use of low carbon technologies;*
- *social, the potential for provision of a large number of jobs across the skill range and integrated training for all levels of ability;*
- *technological, with rapidly developing improvements in greenhouse technology to reduce energy use and increase adaptability;*
- *legislation, revising up the marketing of energy.*

ISSUE	IMPACT
Political	
<ul style="list-style-type: none"> • Reduced trade restrictions • Common Agricultural Policy • Local attitude to development • Emerging local development plans • Growing political focus on food security 	<ul style="list-style-type: none"> • Uncertainty over future external competition • Uncertainty over CAP change in the € zone • Pressure on local politicians from local interest groups to stop development • Uncertainty over policy • Pressure to produce food for the UK
Economic	
<ul style="list-style-type: none"> • Unpredictable volatility in energy pricing and subsidy 	<ul style="list-style-type: none"> • Ability to attract high carbon businesses to use low carbon heating and power resources

ISSUE	IMPACT
<ul style="list-style-type: none"> • Uncertainty over the Euro • Access to capital 	<ul style="list-style-type: none"> • Subsidies for renewable energy loaded to assist emerging technologies, which may distort the market. Operational regime has been the subject of repeated short notice alteration by government, and continues to be unreliable. • Unwillingness of banks to lend to novel enterprises
Social/Cultural	
<ul style="list-style-type: none"> • Provision of Education and Training • Underused local resources • Availability of new staff • Employment 	<ul style="list-style-type: none"> • Opportunities to provide local political and social capital • Capacity available at local port facilities • Difficult to fill vacant jobs created by retirements and promotions • Provision of large number of jobs in a broad range of skills
Technological	
<ul style="list-style-type: none"> • Improvements in glasshouse design • Improvements in Energy Efficiency • CO₂ from biomass • Capacity of local sewerage infrastructure 	<ul style="list-style-type: none"> • UltraClima greenhouse design allows use of low grade heat • Changing energy balances make it difficult to forecast economics involving complex interactions • Combustion of biomass for energy generation now capable of providing high grade CO₂ source • Restriction on certain development without significant 3rd Party capital expenditure
Environmental	
<ul style="list-style-type: none"> • Increased vehicle movements • European Energy Efficiency Plan • Climate Change • Water availability • Vulnerability of local waters to nutrient pollution 	<ul style="list-style-type: none"> • Pressure on local road network driving need to consider alternatives to road transport • Pressure to integrate development to provide enhanced efficiencies in energy use • Need to build resilience into design • Need to identify and secure water resources in the face of reduced water availability • Need to control emissions to the water environment

ISSUE	IMPACT
Legislative	
<ul style="list-style-type: none"> • State Aid Rules 	<ul style="list-style-type: none"> • Limit on level of subsidy available for a single development
<ul style="list-style-type: none"> • Developing Planning Regime 	<ul style="list-style-type: none"> • Uncertainty over Planning policy
<ul style="list-style-type: none"> • Water Resources Act 	<ul style="list-style-type: none"> • Availability of water for irrigation
<ul style="list-style-type: none"> • Use of waste in horticulture 	<ul style="list-style-type: none"> • Use of recovered water for irrigation
<ul style="list-style-type: none"> • Energy policy – operational level (OFGEM) 	<ul style="list-style-type: none"> • Changes in the energy market may to the benefit or detriment of small-scale generators
<ul style="list-style-type: none"> • Energy policy – governmental level 	<ul style="list-style-type: none"> • Commits the UK to 50% reduction in CO₂ emissions by 2050

Table 9: PESTEL Summary

This PESTEL analysis addresses issues that may have specific impacts on aspects of this project when compared with other projects, thus for example changes to national Health and Safety legislation that impact on the industry generally are not considered because there is a broadly equal impact on all businesses. To some extent the exercise merely flags up potential issues, there being an element of unpredictability in the precise magnitude of impacts that might occur.

9.1 Political

All levels of political pressure apply to the horticultural sector, from global trade agreements to district planning policy.

The Doha round of WTO negotiations started in 2001 and has not completed at the time of writing. Negotiations have been conspicuously unsuccessful in the areas of improved to markets; reduction and ultimate elimination of export subsidies; and substantial reductions agricultural subsidies and tariffs. It is unlikely that any progress will be made in the foreseeable future.

Of more immediate concern are countries such as Morocco, Egypt, Jordan and Turkey that have or have had trade agreements with the EU that limit their trading ability, notably with respect to fruit such as tomatoes. The liberalisation of trade in agricultural products treaty between the EU and Morocco was ratified recently in Feb 2012¹² and will reduce customs duties by over €100m/year on a wide range of agricultural products. Amendments to other agreements could significantly impact on income, and thus profitability in the short term, although previous experience of countries such as Spain entering the market suggests impacts will be short-lived until the producers' cost base increases and water supply and quality becomes an issue.

CAP reform, to be in place by 2014, should have a minor, but generally positive impact on horticulture, although some proposals may increase the competitiveness of smaller growers in less climatically favourable areas of Europe. When the outcomes of the current review are known, the environment for investment in large scale capital projects is likely to improve as clear market signals give elements of the supply chain and investors confidence to enter into longer term commitments where residual risk and volatility can be managed effectively.

¹² P7_TA-PROV(2012)0055 EU/Morocco Agreement concerning reciprocal liberalisation measures on agricultural products and fishery products

Reduced market distortion associated with the subsidy of naturally less efficient enterprises will allow the sector to focus more on the twin goals of productivity and sustainability that are likely to underpin policy direction for the foreseeable future. The current main area of concern relating to political instability is the Euro crisis. Whilst this is most likely to impact on the availability of capital, it may have an adverse impact on exchange rates and/or affect the ways in which the CAP is implemented in 'competitor' countries such as France, Spain, Portugal and Italy. Because the UK domestic production of tomatoes is less than 20% of the total market it is unlikely that knock-on effects of Euro issues would impact beyond what is considered below under the heading 'Economic'.

The UK Government appears only recently to have become concerned about food security, although DEFRA's 2010 review of UK Food Security¹³ was remarkably sanguine over the outlook, only raising mild concerns over the issue of global resource sustainability. DEFRA statistics, which should be treated with some caution, indicated a net trade deficit of £18.4 billion in food and drink for 2008.

Globally, Asia is having an increasing influence on the food market, for example New Zealand agricultural exports rose by 16% to £16.4 billion in year 2010-11 predominantly driven by an increase in demand from China and OPEC members¹⁴. Australia exports £20.4 billion, of which the top four countries, led by China, are Asian, and account for 43% of total exports¹⁵.

The implications of these shifts in trade could be twofold: first, a potential reduction in pressure on UK producers from imports possibly leading to greater returns; and second, increased opportunities for exporters. The first outcome tends to be militated against by the buying power of the supermarkets, which are likely to reflect anticipated trends in production costs in pricing.

At a local level, all development has to pass through the applicable planning and permitting processes. The recently issued National Planning Policy Framework (NPPF) simplified planning policies, but required local authorities to have adopted local plans in place to deal with local issues. Arun and Chichester District Councils are preparing local plans for publication in late 2012-2013, and Sussex County Council is working to a similar timetable on its County Waste Plan. This means that it is difficult to make valid conclusions regarding the influence of planning policy on hub development, although this is counteracted by the potential for this report to influence development of policies.

Local pressures imposed by specialist interest groups can also have a politically-driven impact, for instance where influence is exerted on the decisions of committee members with respect to general policy or specific developments. Recent experiences with two major local horticulture-related planning applications have highlighted issues related to the interpretation of planning policy, specifically, what sort of development is appropriate in a Horticultural Development Area (HDA), and that horticultural development should be focussed within HDAs, rather than outside. Applications that have received officer recommendations for approval, have been refused by planning committees, which have applied different interpretations of policy to those applied by officers of the Council. Only one of the applications has been taken to an appeal to the Secretary of State and, at the time of writing, remains undetermined.

UK horticulture is generally highly successful, but many external pressures affect food production and prices for consumers in the UK, as evidenced by a world food price spike in 2008. The spike marked the end of a long-term decline in the relative price of food in the UK, as global markets saw the price of wheat rise by 130%, soya 87% and rice by 74% in the 12 months to March 2008¹⁶.

Fruit and vegetables saw price rises of about one third, which were probably driven by input costs,

¹³ DEFRA, UK Food Security Assessment: Detailed analysis, August 2009 (updated January 2010)

¹⁴ <http://www.mpi.govt.nz/news-resources/statistics-forecasting/international-trade>

¹⁵ Australia – China Free Trade Agreement Joint Feasibility Study

¹⁶ http://news.bbc.co.uk/1/hi/in_depth/world/2008/costoffood/default.stm

primarily energy and market change due to climatic impacts on rice and wheat harvests.

Within the UK, the events of 2008 have raised awareness of many related issues, coinciding with a falling national self-sufficiency ratio; the influence of 'global' retailers; declining farm incomes; public health worries over food safety; increasing awareness of environmental issues; potential minor interruptions to fuel supply; and longer-term concerns over energy security and climate change.

These issues will not be addressed by the food production sector alone, but some of the cross-cutting measures necessary to deal with food security in the UK and across the world are likely to impact on the development of an energy hub in West Sussex.

For instance policy is likely to develop to address:

- contingency planning for supply disruption – which may encourage development of strategic storage facilities;
- strengthening energy security, through diversification of fuel sources and generating technology;
- promotion of food security in developing countries through *inter alia* trade entitlements;
- strengthening trade within the single European market;
- the resilience of critical infrastructure e.g. ports and utilities;
- promoting a flexible, skilled and market-oriented sector, across the EU and domestically, particularly developing the ability to flex production in extreme circumstances; and
- more robust and enforcement of food safety regulations.

9.2 Economic

9.2.1 Exchange rates

The most significant economic pressure bearing on a project of this type and scale is the relationship between Sterling and the Euro. Development costs, other than possible land purchase, are very likely to be dominated by outlay on imported specialist equipment for which a strong Pound would be a benefit. However, strong sterling would encourage competition from imported produce and depress domestic prices, which disadvantage would be overcome by a weak Sterling rate.

9.2.2 Interest rates

Interest rates are at a low at present although it is likely that there will be an increase within several years; the model used assumes current rates throughout. Uncertainty over exchange rates makes it difficult to prepare a robust case when preparing business models, resulting in an unwillingness of potential investors to commit funds to the project.

However, sustained low interest rates mean that, where funding is available, low servicing costs for borrowed capital would ease financial burdens in the early life of the project.

9.2.3 Inflation

The areas of inflation that will impact most are food prices, labour and energy. Retail food prices (fresh fruit and vegetables) increased by 3.7% in the financial year 2011-12 (ONS, March 2012 CPI Bulletin), and as a percentage of total household expenditure it fell from 19% in 1990 to 16% in 2010 (ONS, Quarterly Prices, 2012). The UK average earnings index has risen by 140% from 1991 to 2011 (Retail Food Price Inflation modelling, Universities of

Nottingham & Exeter, 2011) Energy prices are volatile and discussed above.

Whilst there are many individual economic aspects to a project such as this, the likelihood is that the economy generally is currently at or near the bottom of the business cycle and therefore likely to improve as the project moves forward.

9.2.4 Energy supply and prices

The main drivers on the energy sector at present are the financial incentives offered for the use and generation of renewable energy. These subsidies have been and remain heavily loaded to assisting emerging technologies, and it is reasonable to expect that the 20 year contracts mentioned above should be seen in a similar light and that subsidies will reduce after that. The following section looks at energy price trends.

9.2.4.1 Fossil fuels

Gas is the main horticultural fuel of choice, and prices have been less volatile over the past two years, in part due to reduced domestic demand but also probably due to increased capacity, via an additional Norwegian inter-connector, expansion of LNG terminals and increased storage capacity. Price volatility associated with seasonal demand will always remain to some extent. According to the National Grid UK gas capacity is presently running at around 2100 TWh/yr, and demand at 1,200 TWh/yr. This does not reflect peak demand issues, but new storage facilities that are coming on stream will assist with these. It can be reasonably forecast that all these factors will lead to a more stable gas market for the intermediate future. There is increasing evidence that this trend of stability and even downwards pressure may continue, since the USA is moving rapidly to becoming self sufficient in fossil fuels due to extensive development of shale gas and oil reserves, and likely to be self sufficient in gas for the foreseeable future¹⁷. Whilst this is unlikely to be exported it will reduce demand from the US for LNG thus increasing availability elsewhere. Historically, coal has the most stable price structure of all fossil fuels, although there are significant planning issues associated with new plant, as well as the lack of easily usable CO₂ that make this option unattractive for deployment in horticulture.

The graph below shows recent price trends for industrial users over 20 years, which indicate clearly the levels of volatility over the past 8 years.

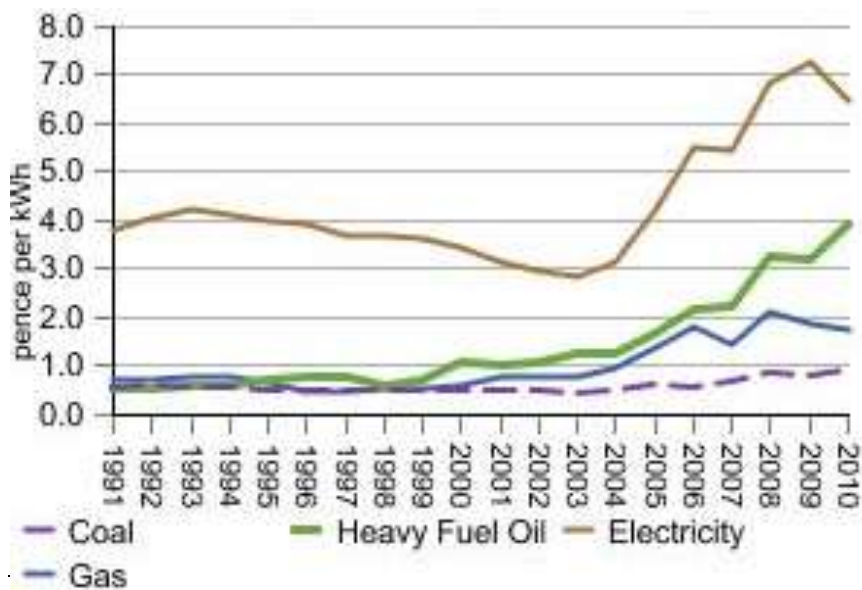


Figure 11: Prices of Fuels

Purchased by Manufacturing Industries¹⁸
 Excludes blast furnace supplies & Oil product prices include hydrocarbon oil duty

¹⁷ Lord Browne, Oxford Environmental Conference, July 2012

¹⁸ Office for National Statistics

Trends in wholesale gas prices over the past 4 years are shown below:

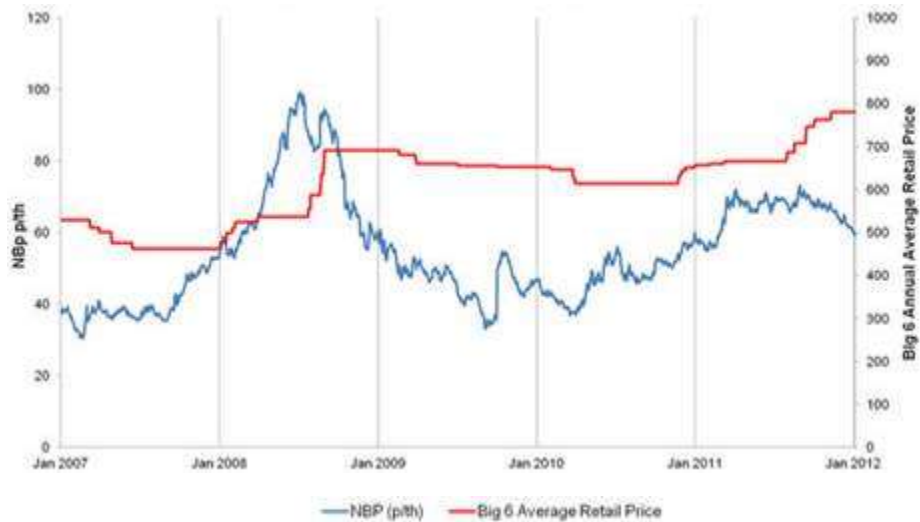


Figure 12: Comparative Wholesale/Retail Gas Prices 2007-2011¹⁹

9.2.4.2 Electricity

There has been significant variation in the price of electricity as shown in the graph of trends in wholesale prices below. There have been repeated warnings of a looming shortfall in generating capacity within the UK, and potential for rises in prices of about 30%, however this is likely to be dependent upon overall economic activity. Current National Grid data show an ASC peak demand of 59 GW with generating capacity of 96GW (61%), and forecasts for 2017 an ASC of 60GW and generating capacity of 108GW (55%), with the majority of new capacity associated with renewables and CCGT (gas). To some extent this increase is necessary due to the intermittent nature of some renewable supplies, with CCGT being the stopgap to make good shortfalls, however they do indicate a reasonably robust capacity base. In view of these figures the predictions of increased charges, other than those related to tax burdens, should be treated with some scepticism.

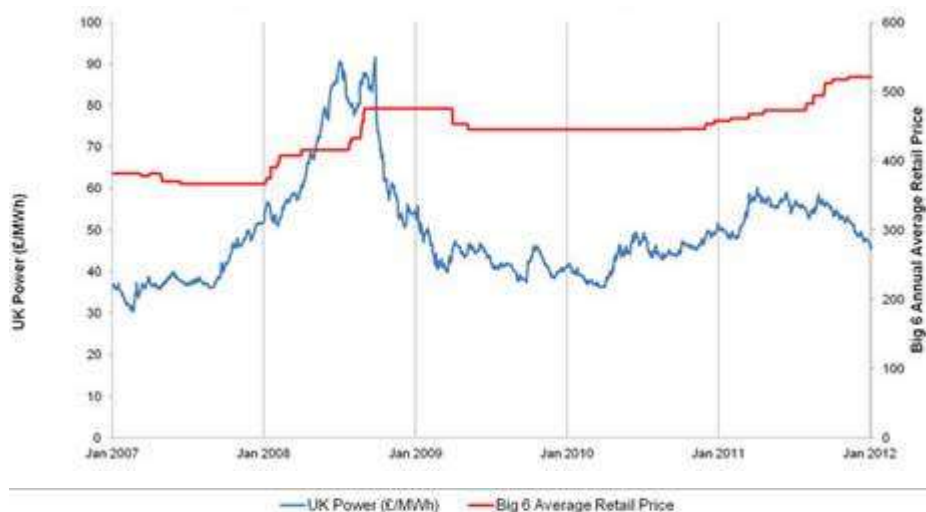


Figure 13: Comparative Wholesale/Retail Electricity Prices 2007-2011²⁰

¹⁹ Office for National Statistics

9.2.4.3 Trends in renewables

With the advent of double ROC’s on AD-derived power, the availability of easily processed organic waste has reduced substantially, subject to local variation. The main remaining waste stream tend to be mixed waste containing animal products, which is both harder to digest and also has more stringent licensing and operational rules, and consequently costs. One of the main concerns with both ROCs and the RHI is the apparent lack of foresight and realism, with tariffs set far too high then reduced dramatically after a short period. The latest indications from OFGEM imply further radical changes may be imminent, none of which is attractive for long term planning.

Algae

One possible threat to the supply of cheap low grade waste heat may come from its potential for use in algae production, which in turn can be used in ethanol production. There is a significant amount of research into this topic at present, and some commercial ventures already. Some development

Biomass

The price of all types and grades of biomass supplied in the UK has recently seen upward trends due to the substantial increase in demand from large scale biomass and co-fired power stations, although increases in demand remain slower than the peak in the mid-1990’s. To some extent increased costs will be limited by greater use of waste and imported materials, and transfer of the use of timber to other materials. The lower end of the woodfuel market competes with wood for pulp and various other industrial uses.

The Woodfuel Implementation Plan was introduced as a Forestry Commission initiative in 2010, and aims to deliver a further 2Mt of material into the UK wood fuel supply chain by 2020.

Sawlog prices are shown below; these are indicative of all wood fuel prices in raw form, whereas the chip wood price is driven by other factors and so is not a useful general indicator.

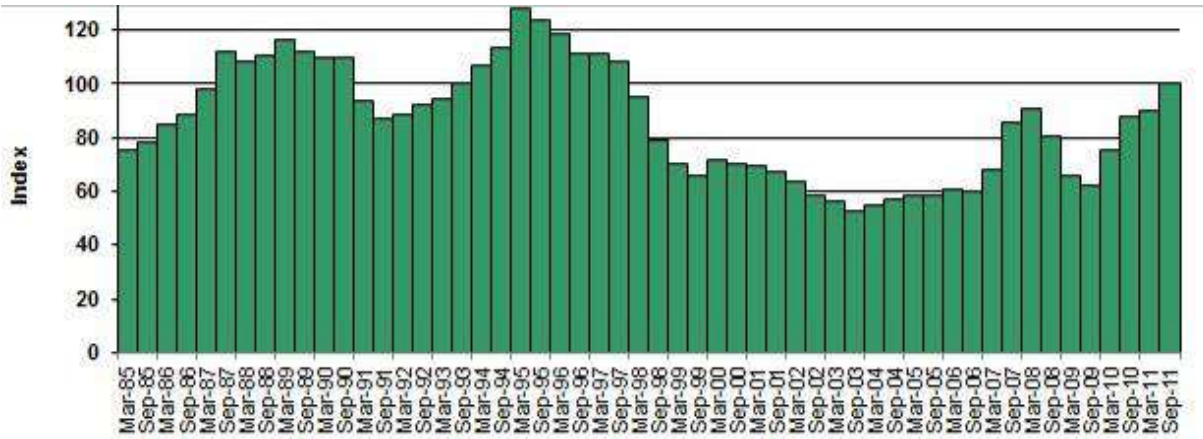


Figure 14: FIM Timber Index (Nominal) September – March (Base Sept 2011)²¹

²⁰ Office for National Statistics

²¹ Forestry Commission, FIM. Office of National Statistics

Straw prices

The UK produces around 10Mt of straw per annum²², of which the surplus in the East of England alone is around 3Mt, and surpluses/deficits in other regions tend to vary according to price fluctuation and weather. A large straw fired power station will typically require around 0.25Mt p.a. Straw in the Chichester area can currently be bought (standing) for around £30/ac.

The chart below indicates one scenario for biomass energy resource changes in the UK.

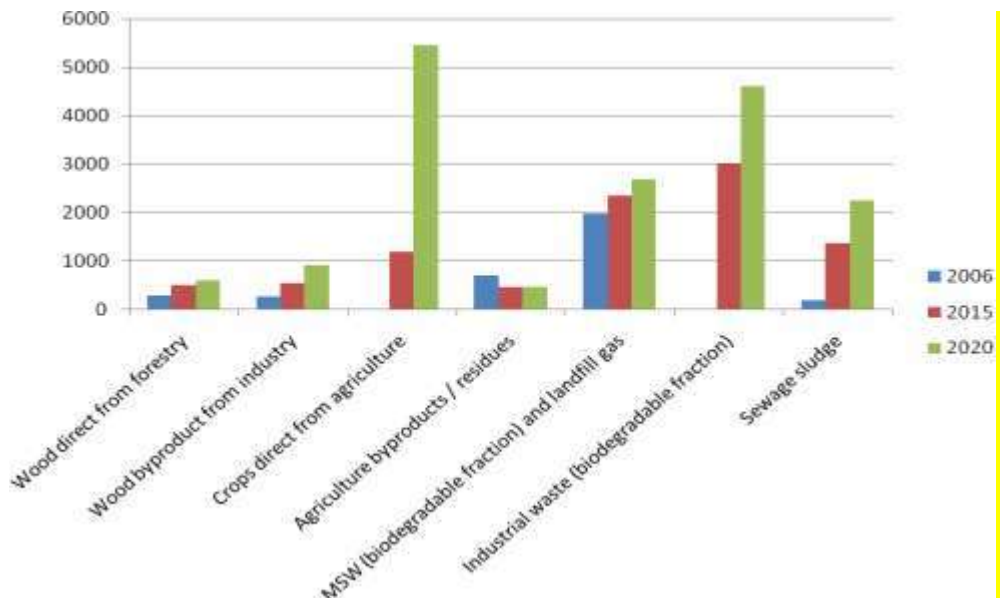


Figure 15: Actual biomass supply 2006 & biomass supply (est.) in 2015 and 2020 (ktOE)²³

Biomass feedstock	2010		2020	
	Cost point €/GJ	Contribution ktOE	Cost point €/GJ	Contribution ktOE
sludges / wet manures	0.5	957	0.6	893
post consumer wood	0.8	1539	1.0	1621
dry manure	1.9	1550	2.9	917
perennial grassy crops	not significant		2.9	2446
municipal solid waste	no data		2.9	1981
paper and card	6.3	2142	7.7	10215
additional roundwood	8.8	1405	11.1	1277
current roundwood	11.0	1744	13.8	1585

Figure 16: Key biomass feedstocks under the UK cost/supply curves

²² Farmers Guardian, 9th Dec 2011

²³ Outlook on Market Segments for Biomass Uptake by 2020 in the UK, C Panoutsou; A Castillo, 2011

9.2.4.4 Conclusion

In general flexibility of energy supply can always be used to advantage, and one of the benefits of the combination of biomass combustion (moving grate boiler) with a steam turbine is it is that it is very flexible in terms of the types of fuel it can use. Installations originally constructed to take woody biomass and coal and can be adapted relatively cheaply to burn straw.

9.3 Social/Cultural

Planning policy requires that wherever possible all three dimensions of sustainable development are satisfied by proposals. This is considered to be of particular relevance in a sector with a long history of social inclusion and cooperation, particularly in the fields of education and training, which in the mid 20th century was largely driven by philanthropic support.

Three of the existing concentrations of horticultural production on the Sussex Plain are based on areas formerly owned by the Land Settlement Association (LSA), which was a government initiative supported by the Plunkett Foundation and Carnegie Trust. The LSA was set up in 1934 to provide land based employment for the long-term unemployed from depressed areas. The scheme evolved rapidly into an apprenticeship and new entrants scheme for the horticultural industry. After WW2, the Settlements came under the control of the Ministry of Agriculture and were integrated into County Council schemes to provide agricultural and horticultural start ups. The horticultural settlements became the horticultural hubs of their day, moving away from mixed husbandry, concentrating on high value crops first using Dutch Lights, then glasshouses to grow tomatoes, cucumbers and more recently peppers. The estates were sold to their tenants in 1983, as horticultural businesses.

In the WSGA area the LSA had three estates, at Sidlesham, and Batchmere with 118 tenants, plus a central servicing facility at Chalk Lane.

The settlements were constructed and ongoing maintenance carried out using government funding, and specialist advisory support was also provided together with plant propagation, a machinery pool and logistics support, sales of sundries, and crop grading, packing and marketing.

The West Sussex LSAs were highly successful and the three estates now include 17 operational horticultural businesses, with a total area of maintained and utilised glass of 21ha, and an estimated turnover of £25 million and employ 200 staff.

One of the largest salad groups in the UK, Snaith Salads Ltd, is a 17-member co-operative which originated on an LSA site near Selby, Yorkshire.

West Sussex is also home to the Chichester College and Chichester University, both of which include horticulture-related courses on the curriculum from 'A' levels through NVQs to degree level.

Chichester College has a campus at Brinsbury, where practical aspects of horticultural production are taught, including at the Acorn Centre, a vocational training centre run by the Aldingbourne Trust where students with learning disabilities can complete qualifications and gain awards and experience. The Aldingbourne Trust has three main training and employment components, one of which is a greenhouse unit. It has plans to expand and these include opportunities for integrating into a hub, including a unit for food processing. It would welcome any opportunity to develop its involvement with work and training programmes that might be associated with a hub set up.

Courses at Chichester University focus more on the aspects of business management and systems that are applied in horticulture, but both ranges of education might be usefully integrated into any hub that might be established, particularly through delivery of: on site college courses; student placements/apprenticeships in horticultural production units; and student placements/apprenticeships in associated on-site business, notably engineering, within the energy

hub.

At least one of the service companies that have expressed an interest in establishing an operation on the site already takes several apprentice electricians each year, and new development would allow this scheme to expand both in number of apprentices and range of skills.



Students at GROW

A logical development of the work carried out by the Aldingbourne Trust at Brinsbury is horticultural therapy, which can also provide employment for disabled people, notably in the case of the Guernsey-based GROW for those with Down's syndrome. Work in connection with growing appears beneficial to participants, and there are limited opportunities at the established facility in the area offering work with mainstream businesses.

9.4 Technological

9.4.1 Glasshouse structures

The most important technical change currently facing the industry is the UltraClima type greenhouse, which has taken some of the aspects of the closed greenhouse design and utilised them for novel purposes. The system involves an additional internal gable end, with Air Handling Units (AHU) and an internal / external flap valve allowing air to be drawn in either from outside the structure, through a cooling pad if required, or re-circulated internally. Air is blown down twin PE tubes with staggered outlets and a regulation of vents allows the house to be positively pressurised when drawing in external air. Temperature and humidity control are excellent, and the system allows for use of lower grade heat than would otherwise be the case and causes a significant reduction in energy consumption whilst maintaining higher yields.

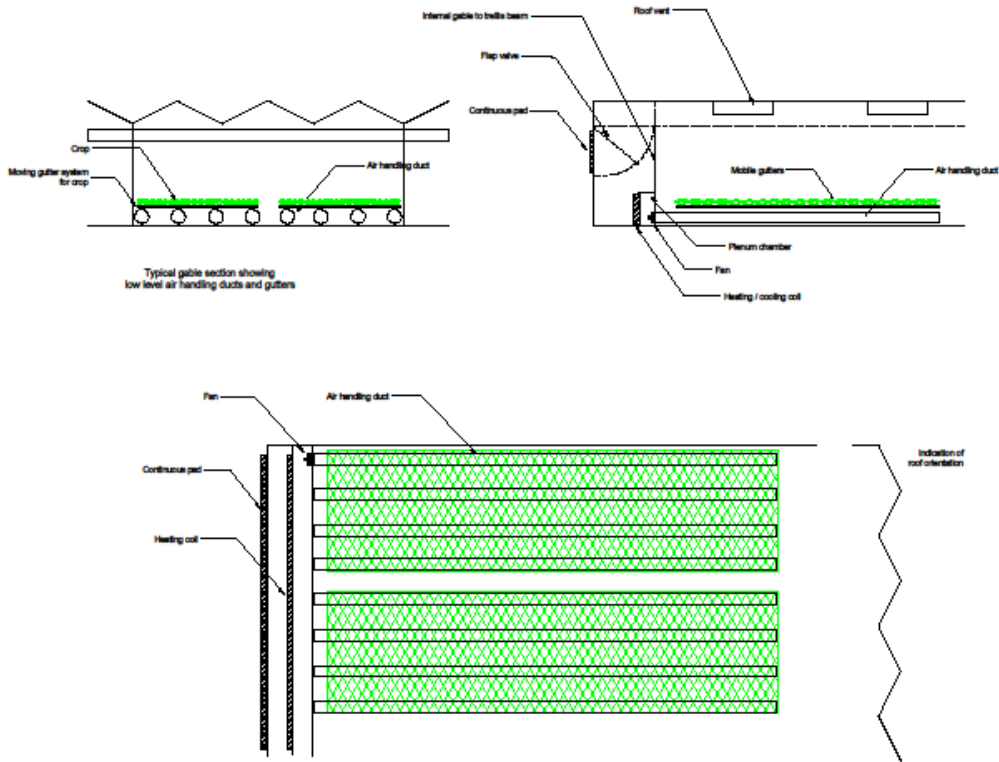


Figure 17: Schematic of Heating and Cooling in Ultra-Clima Glasshouse: Benched System

The implications of this are generally helpful to the energy hub concept, primarily because they improve the utilisation of any low grade heat that might be available, but additionally because they increase CO₂ retention thus reducing overall CO₂ demand.

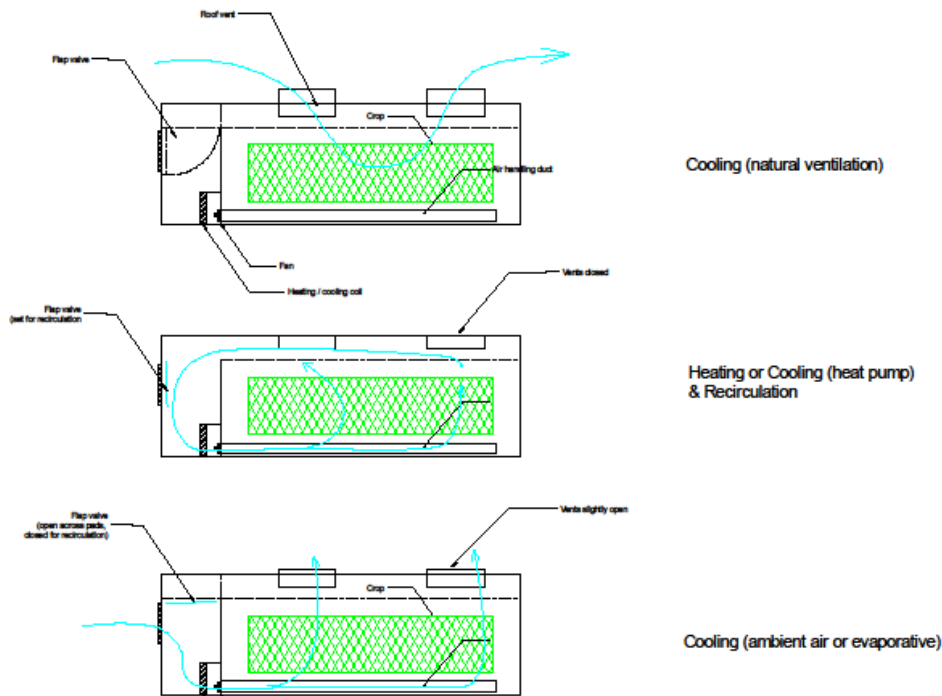


Figure 18: Layout of Heating and Cooling in Ultra-Clima Glasshouse – Air Circulation

Technological development has also given rise to a wide range of measures to improve energy efficiency that cannot always be effectively or economically retro-fitted to existing

structures. For instance:

LED lighting is likely to become more commercially viable over the next 10 years, and thus reduce power requirements;

CO₂ capture from emissions has seen a significant amount of recent research, but a knock on effect of this could be the availability of carbon dioxide from air extraction systems that would reduce the need for flue gas extraction and therefore the need for costly large diameter feed pipes;

CO₂ from biomass technology is currently moving from the theoretical and prototype scale to commercial, with one installation in Canada across 4ha and another in Australia on 0.5 ha.

9.5 Environmental

9.5.1.1 Water

Water is a major issue on the Sussex Coastal Plain in terms of both resources and quality. Local watercourses support a diverse range of habitats as well as abstractions for agriculture, industry and public water supply. Two major aquifers, the Chalk and the Lower Greensand, underlie much of the area, and these are the area's most important water resource, also supporting surface water flows *via* springs and wells.

Although parts of West Sussex suffered flooding during the winters of 1993/94 and 2000/2001, pressure from new development and rising household demand in the area is increasing the need for water. The Environment Agency's Catchment Abstraction Management Strategy (CAMS) describes the delicate balance between meeting the demands of existing abstractions and the need to protect river flows to meet environmental and other in-stream requirements, as driven by the Water Framework Directive. In order to address this, the Environment Agency has made a general presumption against any further consumptive abstraction from both the Chalk and Lower Greensand aquifers, and from rivers during the summer.

In 2001, the total licensed abstraction in the Environment Agency's Arun and Western Streams CAMS area was about 440MI/d, which is about 30% of average effective rainfall. About 56% of current licensed abstraction is for public water supply, 31% for industry and about 13% for agriculture, although the impact of modern protected cropping on these values is minimised through water harvesting and recirculation.

About 145MI/d of treated effluent is discharged to the rivers and streams within the CAMS area, which is about 55% of all effluent discharged in the CAMS area, the other 45% being discharged directly to sea *via* four large sewage works located on the South Coast. Thus in the region of 50% of the water abstracted in the CAMS area is lost directly to sea through long-sea outfalls. This is a potential source of low grade water for possible use in protected cropping or field scale horticulture.

9.5.1.2 Biodiversity

The area supports a group of internationally important wildlife sites: Arun Valley Special Protection Area (SPA) and Ramsar site; Pagham Harbour SPA and Ramsar site; Chichester and Langstone Harbour SPA and Ramsar site; and Solent Maritime candidate Special Protection Area (cSAC). The South Downs, which back the coastal plain, have recently been designated a National Park.

9.5.1.3 Emissions

Greenhouse Gas emissions (GHG) are responsible for the greenhouse effect and climate change. Any factor that alters the radiation received from the Sun or lost to space, or that alters the redistribution of energy within the atmosphere and between the atmosphere, land, and ocean, can affect climate. The EU emission trading scheme (ETS) was launched in 2005. The ETS comprises more than 11,000 factories, power stations, and other installations, each with a net heat excess of 20MW, in 30 countries. Each member of the scheme monitors and records their GHG emissions, in order not to exceed their emission allowance, which is allocated to them. Any allowances that are not used are sold back to national governments, thus creating an incentive to reduce GHG emissions.

The principal emissions related to horticultural production in West Sussex relate to energy, transport, and agrochemical manufacture. It is likely that there will be a tightening of emissions standards relating to particulates and NO_x, since these have been introduced in many countries due to concerns over their health impacts. This is likely to have most effect on biomass type installations where particulates can be an issue.

9.5.1.4 Waste

Waste in the horticultural sector is not as great an issue as in agriculture, horticultural wastes include: empty chemical containers and plant containers, and organic wastes from packhouses and processing plants.

Organic waste can provide a resource for energy production, including use in anaerobic digesters. Food waste and other biodegradable waste streams are all options for use in energy production in a hub. Anaerobic digestion can also be useful source for production of high quality compost, although not for use as a compost replacement in growing media. Compost from AD is mainly used as a fertiliser replacement in field scale vegetable production, provided that it meets the use criteria of the British Retail Consortium's Safe Sludge Matrix. Specifications are available for digestate and composts produced to rigorous protocols and used in field-scale production. BS PAS 100 and 110 were prepared by the Association for Organics Recycling (AfOR, now part of the Renewable Energy Association) to demonstrate that materials arising from the processes were no longer considered to be wastes for the purposes of regulation.

9.5.1.5 Traffic

Every business creates traffic; within horticulture, individual businesses can have a significant impact on traffic, including: transport of the fresh produce; delivery of chemicals; equipment; journeys to work (which increase during the growing season); and general transportation. Traffic has a direct impact on the local road network, and can cause conflict between residents and producers. Horticultural businesses in West Sussex generate a large amount of traffic annually on a relatively local road network comprising small roads, many of which pass through small villages. The West Sussex local transport plan states that *'Local businesses see transport as a significant factor in local sustainable economic growth although there is concern about the availability and cost of parking, the quality and frequency of public transport, and the perceived lack of investment in strategic transport improvements to our road and rail networks.'*

Fuel input

For all fuels apart from natural gas and electricity, which would be conveyed using the existing grid systems, there will be a significant volume of material associated with power

generation that needs to be brought to site for instance biomass, oil or coal for combustion and organic waste for AD.

Rail

The local rail network is limited to a mainline east-west link with spurs to Bognor Regis and Littlehampton Harbour. In addition there is an abandoned MoD siding to the east of Chichester, which it is understood serves an area that has been identified for use for an out-of-town hotel, retail or logistics development.

Sea

Southampton / Portsmouth

The proposed biomass power station at Southampton will be importing in the region of 500,000 tonnes of biomass a year, and there may be a possibility of purchasing material from such a big importer. This could work in terms of transshipping to a smaller freighter and unloading at say Littlehampton (see below) for the site. It is unlikely to be possible by road due to the planning restrictions that are likely to be imposed if it proceeds.

Littlehampton

The harbour facility is currently rented to Tarmac and previously served the Tarmac Topbloc works on Ford airfield, the primary use now being for Asphalt manufacture. According to Littlehampton's Harbour Master the facility is underutilised. The dock can berth 70m boats, and Tarmac import up to 1,200 tonnes per boat of aggregate from Ireland and France. Vessels are unloaded by a 360° excavator with clam grab, and then loaded into truck by loading shovel. There is limited space on site for storing materials and this is currently all used for aggregate. It would be possible to use the facility subject to financial details and authorisation from higher up. It was pointed out that with the current handling system it takes a long time to move the materials and then requires a large number of lorry movements to remove imported material from the site. There would be no labour available for helping as is all fully utilised, likewise the handling equipment (loader) is also fully utilised.

Littlehampton Harbour lends itself to a range of cargoes that can be handled by short sea shipping linking with ports at Southampton, Portsmouth, Brighton and Shoreham. Cargoes could include bulk materials such as wood and other wastes for use as a biofuel, containerised materials such as organic wastes for use in one or more AD plants and potentially products for transshipment and export.

9.5.1.6 Climate change

The main impact of climate change that is assured is that the weather will become more unpredictable, and protected cropping scores very highly with respect to this. It is imperative to build resilience to climate change into any design, and whilst sea level rise and the need for sea defences or managed coastal retreat is a factor to be addressed at higher levels, in-built flexibility at the design stage will allow adaptation to fluctuating markets for energy outputs and fuel inputs. The design of structures such as the UltraClima glasshouse also provides resilience through operational flexibility to cope with changes in temperature.

Provision for water storage, recovery and recycling should also be included in any hub concept, to provide for possible changes in rainfall cycles, such as drier summers and more intense spring and autumn rainfall events that may have an adverse impact on water resources locally.

9.6 Legislative

There are few foreseeable future changes in laws and regulations that might have a significant impact on the development or running of a horticulture-based energy hub. The principal areas of concern relate to: finance in relation to subsidies relating to development and energy; and resources, primarily the availability of water for irrigation and potential to use water recovered from waste water treatment works in food production. Minor issues are associated with the planning and environmental permitting regimes.

9.6.1 *State Aid rules*

One of the main legal restrictions for the horticultural industry with regards to funding for development and energy generation are the State Aid rules. These ensure every industry complies and is consistent across the UK and Europe with the European Treaty for State Aid. Up to €200,000 can be made available in state aid to fund any business over any three year period. Within the rules of state aid, there are a number of regulations which relate to the agricultural sector. These outline, in detail: the objective of aid, how aid is delivered, who can benefit, eligibility and conditions.

This means that the development of multiple, small-scale, non-energy generation related projects may be eligible for significant funding to encourage appropriate development on the Sussex Coastal Plain, whereas a single development may fall foul of limits, necessitating careful programming of works and/or splitting of businesses into discrete components.

9.6.2 *Planning Legislation*

The planning guidance and legislation in the UK covers every aspect of development and there are many points applicable to horticultural development. In addition to new local planning policy, the Government has recently published a National Planning Policy Framework (NPPF), which lays out criteria for development where aspects aren't covered by local policies.

All aspects of a large-scale development will require planning permission under the Town and Country Planning Act, including works such as underground infrastructure, which are often considered Permitted Development when undertaken in isolation. A major part of planning legislation for large developments is the assessment of the impact it will have on the environment and the surrounding area, and the ability to return the development site to its original condition. There are numerous aspects to EIA, which is carried out on most types of large development that are deemed to have a significant impact on the environment. The procedure is undertaken as part of the planning process as required by national and European regulation. Aspects that are evaluated include: environmental damage (loss of wildlife, trees and damage to nature); noise impact; electricity supply; infrastructure planning; lighting impact; air, water and soil pollution impacts; and sustainability generally.

Screening and scoping exercises should be carried out before any assessment of environmental impacts is undertaken. The first process is to determine whether or not the development is covered by the regulations and the second to determine those impacts that are considered significant enough to require assessment under the regulations. Effective consultation with statutory consultees and the relevant planning authority often minimises the scope of any assessment that might be required, and can result in EIA being unnecessary, although in the case of a major energy hub this is considered unlikely.

9.6.3 *Water Abstraction Licensing*

A water abstraction licence is required for all abstractions where more than 20m³/day (c.

4,400 gallons) is taken. Abstraction licences are time limited and are granted by the Environment Agency, in line with the local Catchment Abstraction Management Strategy (CAMS). All water used in the hub, not taken from the public water supply, is likely to require a licence.

Proposals for a revised water abstraction licensing regime are currently out to consultation, and it is likely that water resources for any hub development will be dealt with under some form of revised regime.

9.6.4 *Power Production*

Legislation surrounding production of power includes the Electricity Act 1989, Electricity (Guarantees of Origin of Electricity Produced from Renewable Energy Sources) Regulations 2003 (SI 2003/2562); Electricity (Class Exemptions from the requirement for a licence) Order 2001, Electricity (Applications for Licences, Modifications of an Area and Extensions and Restrictions of Licences) Regulations 2008. The legislation involves requirements for licences and guarantees of origin for electricity produced from renewable energy sources. The Greenhouse Gas Emissions Trading Scheme Regulations 2005 (SI 2005/925), requires a Greenhouse gas emission permit required for biomass combustion over 20MW (excluding hazardous or municipal waste installations) this is applicable in the case of an energy hub in West Sussex.

Where waste is used as a fuel, the installation will require a permit to operate from the Environment Agency. The permitting process is best scoped and subsequently run in parallel with the EIA process in order to minimise conflict between the two regimes.

9.6.5 *Short term restrictions*

Significant downturns in prices that can be achieved for outputs can be caused by product bans relating to food health, both within the UK and on the Continent. For example, the 2011 outbreak of E. Coli infections in Germany, wrongly blamed on Spanish vegetables. These incidents are by nature sporadic and unpredictable.

10. Next Steps

Summary

In order to make the review more practical the following section gives an example of one possible means of how the project could progress, so that the key points within it can be demonstrated, and potential issues aired in advance.

The potential use of cooling on site needs to be considered in more depth as part of any business that may be associated with the hub. The inclusion of appropriate secondary businesses in the hub model will have a significant impact on both the configuration of the hub and on its economic turn out.

Ownership models are likely to be heavily influenced by the potential finance options. It will be critical that the ownership model ensures that stakeholders in all three components of the mix understand and value the others' needs and expectations, particularly those involved in energy generation and use.

10.1 Planning

It makes sense that any proposal should garner the widest possible support, in order to overcome the perception of it being 'big industry raping and despoiling the countryside with no consideration of others'. The following aspects of an integrated hub development could be used to convey this message and encourage support from a wide range of stakeholders:

- The continuity of an historical legacy (LSA);
- Provision of start-up facilities for new entrants, training facilities and apprenticeships in horticultural trades;
- Strengthening local industry that provides employment directly and indirectly (for comparison in North Holland²⁴ for example:
 - Replacement of existing facilities lost to housing;
 - Creation of new jobs and new wealth;
 - Environmental benefits of green energy and greater utilisation, waste reduction and utilisation;
 - Improved water efficiency;
 - Social benefits, such as horticultural training and employment unit for those with learning disabilities.

To show the potential positive impact such a hub can make, one possible scenario would be as laid out below:

- 80ha site with 50ha of glasshouses, plus energy hub, packhouse, training facilities and commercial units;
 - Income generation of about £40 million per annum;
 - Creation of 550 new jobs;

²⁴ "Agricultural prospects in the province of Noord-Holland to 2040. Building blocks for the structural vision of the province" North Holland provincial government, 2009

- Creation of four start-up businesses;
- Generation of 30GWh of renewable electricity;
- Sub-regional scale waste processing, recovery, recycling;
- Creation of 20 apprenticeship places;
- Satellite study centres for horticultural and business training and research; and
- Horticultural therapy unit for 25 adults with learning disabilities working collaboratively with businesses on the site.

10.2 Land

It is evident that a single-location hub will be easier to initiate than a multiple node model, and it is also likely to be the lower cost option, making it most desirable. The number of potential sites in the study area is extremely limited, and the best means of pursuing the viability of these is to identify individual sites in order to undertake reviews of planning policy and attitudes of land owners and other potential stakeholders to any hub that might be established.

This would allow one or more site-specific hub models to be outlined and tested in the next phase of this project.

10.3 Ownership and Operational Aspects

The ownership model of any hub will be driven primarily by the finance model applied to the scheme. It is also clearly highly desirable to have as few different groups as possible, thus the smallest model would comprise land-owner and growers with:

- finance from the landowner providing capital for infrastructure development;
- growers investing in glasshouse facilities; and
- a joint venture between the all parties to provide investment in the on-site energy company.

Due to financial constraints this may not be possible, in which case the involvement of an energy supply company would be the next logical progression.

10.4 Energy

At this stage it is clear that renewable energy will form a large component of the mix, and from a strategic planning point of view it is important to note that the RO cut-off date is 2017, and the RHI is also a finite resource (based on capacity not date). The critical points that need to be addressed for any site are:

- export capacity of the electrical connection;
- logistics of fuel supply; and
- availability of natural gas.

Depending on the outcome of the W Sussex waste review a twin track approach would also make sense, thus pursuing the possibility of locating an Energy from Waste facility on the site. The timing of such an EfW project is likely to fit quite well into a Phase 2 development, thus it is likely that a Phase 1 will comprise say 25ha to 30 ha with associated RHI and ROC's dependent energy plant. Based on the recent Viridor Glasgow EfW which will process 200,000 t.p.a. and has a rated electrical output of 15MW the available thermal output is likely to be in the range 10 – 20MW depending on heat recovery. Since the majority of waste is generated along the coastal strip the transport of this by barge would therefore seem to be an attractive option, thus lending the Ford Airfield even more credibility, with a short road haul along the A259.

There have been several recent schemes where councils have partnered with EfW companies for design, build, operation and finance, generally on 25 year contracts. Possible partners for such an EfW could include, amongst others, the following.

- Viridor
- Grondon
- Peel Holdings
- SITA
- EnerG

11. Modelling

11.1 Introduction

The modelling phase of the project uses three simple models to demonstrate the feasibility of a range of combinations of scenarios for the development of a horticultural energy hub and provide insight into the ease, or difficulty of implementation. This work will help to identify at least in outline the likely benefits and impacts of a range of possible horticultural/energy developments in terms of the local environment and the local and national environmental accounts, and more specific economic impacts in the south of England and more locally.

Large scale developments such as that proposed here also give rise to a wide range of 'out-of-boundary' impacts, leaving development or employment vacuums for others to fill, or making space available for other types of development. These types of impacts may be felt in 20 to 30 years' time as the development reaches the end of its 'useful' life and production may conceivably move on to other locations, although rising land prices may make it more attractive to redevelop land developed for glasshouse production. Such remote and long term impacts can bring significant beneficial effects provided they are recognised at an early stage, planned for and ultimately realised, in the same way that adverse impacts are designed-out of developments and avoided.

Using the findings of the earlier review of horticulture-based energy developments this phase sets out to simulate the long-term development of three different combinations of cropping and land use in three different situations, anticipating a range of benefits and impacts throughout the lifetime of each and speculating on potential legacies that they might have, for the horticultural industry, the area and local communities.

The models used anticipate the growth of three hubs in a range of ownership and usage combinations identified in Phase 1, estimating the number of jobs created both on and off site, the amount of energy generated and resources saved, not only in the horticultural and associated food businesses likely to be associated with a hub, but also commercial, industrial and social developments that might benefit from what such a site has to offer.

The first part of this report used examples to provide insight into the reasons for success and failure in similar developments and foresight into the challenges for implementation of a hub development. This phase completes the report and is intended to help identify the best way forward and lay out clearly aspects of hub development that should be taken into account when developing a transition path that will culminate in a successful planning application and subsequent development.

The successful progression of this project is likely to require behavioural change in a wide-ranging group of stakeholders, it will need to motivate and reassure partners and communities and stimulate a desire for collective action. This final output is intended to provide a vision of the likely most successful route leading to implementation of a truly integrated, inclusive and sustainable energy hub based on horticultural production on the Sussex Coastal Plain.

11.2 Methodology

Following meetings with the Project Steering Group, Officers of the local authorities and the Coastal West Sussex Partnership, and members of the WSGA, draft models and interactions have been reviewed, and outputs compiled in a clear structure to allow comparison between scenarios using as comprehensive a selection of variables as practicable.

Building blocks for all of the land use, energy generation and other, associated hub components are described and simple assessments made of relevant inputs and outputs to ensure that the modelled mixes of activities are realistic.

The final output is in the form of the narrative text, flow charts and tabular summaries found below. Projections of the likely business, energy, employment and associated social outcomes in five, ten and twenty-five years' time are laid out in tabular form with brief narrative descriptions of assumptions used in the model and likely future direction.

11.3 Further Consultation

Before starting on the second phase of the project, the team held meetings with groups and individuals to gauge reactions to the findings of Phase 1 and opinions regarding its overall direction.

Growers were encouraged by the findings of report and confirmation of the outline feasibility of the hub concept. The dismissal of an appeal against refusal of planning permission to construct 21ha of glasshouses at Almodington, which was published during the project period demonstrated some misconceptions of the industry. Growers are now even more keen to demonstrate to the wider community the important role it plays, and the benefits it does provide and can increase.

It was also recognised that the timing of this project coincides with the publication of the National Planning Policy Framework and associated reviews of local planning policy in Chichester and Arun Districts and waste planning policy in West Sussex, and that there existed an opportunity to influence policy development through the consultation process.

Local authority planning and economic development officers and other members/officers of the Coastal West Sussex Partnership viewed the outputs from Phase 1 favourably and invited formal submissions to the ongoing consultations on the draft local plans. The problems associated with proposals for large scale developments in the area are recognised by officers and many aspects of energy hub developments were generally viewed as positive in that they serve to deliver sustainability goals.

General constraints on development in the area were discussed, including transport and communications infrastructure, and how objections to siting might be overcome, although these issues are better addressed when potential hub sites have been identified. The synergies that can be achieved in hub developments with mixed land use, including horticultural, commercial, residential and processing/packing were also recognised and emphasis was placed not only on the environmental aspects of the development, but also on the economic benefits that could be associated with a hub, specifically infrastructure provision and the inclusion of residential and social development in the land use mix.

Other interested parties that were consulted included professionals that had recently been involved in the planning appeal regarding the proposed Almodington development. The experience gained in the testing of local planning policies and the Inspector's interpretation of Chichester District Council's policy on Horticultural Development Area and consideration of the local highway infrastructure were of particular interest.

11.4 The Future

The realisation of any horticulture-based energy hub will require development and acceptance of an organisational framework with its own decision-making structures, and mechanisms for sharing costs, revenues and risks. This project does not set out to identify in detail what structures and mechanisms might be necessary for a hub to be successful, but simply proposes three groupings of activities, all of which contribute to and/or benefit from the production of energy at a site where horticultural production is the primary land use.

As with any large-scale development, the process will need to be carefully managed in order to maintain balance between competing interests. The final section of this report describes the combinations of participants, activities and related issues, all of which bear on the transition process that will be essential for a successful establishment of a sustainable horticultural energy hub.

12. The Models

Summary

Three models (Blue, Green and Purple) have been constructed on a basic framework each representing a combination of land use, ownership and energy types and estimating revenues, carbon savings and job creation. The main outcome of the modelling exercise is that all three of the scenarios modeled are viable, albeit with the following caveats:

The 'Blue' model is reliant on the establishment of an Energy from Waste (EfW) plant, details of which cannot be predicted at this stage, making calculations difficult. If an EfW plant was successfully incorporated into the hub it would be a huge boost to the viability of the scheme, otherwise a setback.

The 'Green' scenario relies on finding landowners that are prepared to sell the land to the Hub venture.

The 'Purple' scenario is realistically the most likely to get started within a reasonable time-frame, since it does not involve as many unknowns, and offers good returns to all parties.

All schemes demonstrate a significant benefit to the local economy (employment, skills, training, business development, income generation), national economy (wealth creation plus reduction in imports), as well as wider, environmental benefits.

It is assumed that in all cases there would be a joint venture holding company to manage infrastructure issues, in line with the structure of other successful models, and it is likely that this would also include the social elements of the scheme (for example ownership of start-up glass and adaptable education facilities).

12.1 Modelling

The modelling exercise that forms the core of Phase 2 of this project utilises simple building blocks representing land ownership, energy and grower mixes and various other commercial, residential and social land uses to represent the elements identified as having been successfully employed in energy hubs in Phase 1. The blocks lie within a standard reference framework in order that valid comparisons can be drawn between models and blocks can be applied, removed or substituted to reflect change or adjustment. Figure 19 shows the basic framework, based on Chesbrough, (2006)²⁵, which is repeated in the summary section of each model description.

²⁵ Chesbrough, H., 2006, Open Business Models, Cambridge Mass., Harvard Business School Press.

Partners	Activities	Value	Activities	Participants
Land Owner Grower Businesses Grower Coop Energy Company Waste Processor	Energy Generation Glasshouse Construction	Low Cost Green Energy Modern Glass	Growing Water Treatment Food Processing	Tenanted Glass Salads Soft Fruit Young Plants Ornamentals
	Resources	Work Units	Resources	Food Packer Food Processing Education
	Fuel Inputs Wastes Wood Fuel Land	Residential Infrastructure	Gas CO ₂ Heat Water	
Investment			Revenue	
Land Purchase Structures and infrastructure Waste Treatment Infrastructure Energy Infrastructure			Property Rentals Resource Sales Property Sales	

Figure 19: Example of Basic Model Framework (Chesborough, 2006¹)

Modelling a horticulture-based energy hub is complex due to number of blocks available and the number of interrelationships between and within activities, particularly when dealing with economic and environmental aspects of the development. The range of interactions between hub elements in terms of resource use is smaller, and secondary resource use, such as domestic heating and commercial cooling, is negligible in comparison with the primary resources necessary for plant growth: water; energy; and nitrogen, but encompassing carbon dioxide, and major plant nutrients.

Upon and within this basic structure have to be superimposed economic elements, location, and land use and business mixes. Inevitably, the large number of options available for modelling makes the number of available combinations and therefore the number of possible models vast.

In order to overcome this, the modelling process was simplified by using combinations of elements within six major building blocks at three distinct locations. The outputs of the three models and the interactions between elements can be used to make initial assessments of other mixes of elements in other locations before going on to model further proposals in detail.

12.2 Hub Size

The hub area used in the modelling exercise is 85ha (210 acres). A single size has been used to ease comparison between the models, specifically in terms of ownership and land use combinations.

Whilst 85ha is a relatively large area for a purely horticultural development, this development is not glasshouses alone, glass occupies about 50% of the developed area in the models, and development is phased over 10-25 years.

There is no maximum size for a hub development, Agriport A7 will cover more than 1,000ha at its maximum, and it is not clear what would constitute a minimum size. Some existing single user glasshouse developments with CHP systems serving a co-located packhouse might be considered a hub, but this project has looked at multi-user occupancy in order to demonstrate the feasibility and sustainability of a hub that would involve more than one business and would create a mixed development that would help a broad spectrum of individuals and businesses benefit from collocation.

12.3 Ownership

The range of ownership/investment models is summarised at section 8.6 and developed below.

Model	Land	Glasshouses	Infrastructure	Energy Company
Landowner	Retained	Grower investment	Landowner investment & JV	JV and EfW
Grower	Leased off Landowner			
Energy company	Leased off Landowner			
Landowner	Sold to Growers	Grower investment	Grower investment & JV	JV
Grower				
Energy company				
Landowner	Retained	Grower investment	Landowner investment & JV	JV
Grower	Leased off landowner			
Energy company	Leased off landowner			

Table 10: Matrix Showing Options for Ownership/Investment

The colours used in this table represent modelled scenarios

In order to accurately reflect the wider issues of ownership and new development in the context of an evolving industry, that is one that vacates premises as new sites become available, this report considers the benefits that might accrue to landowners, growers and investors both at the start of a hub development and at the end of its use for the design purpose.

For instance, as a glasshouse grower vacates a relatively low-tech facility in order to move into a new, high-tech installation, that facility becomes available either for a new, possibly previously marginal use, a new entrant or it can be redeveloped as brownfield land for residential or commercial use. At the time of writing 20ha of horticultural glass at Toddington, north of Littlehampton, is to be taken out of production and redeveloped for residential use within five years. In this case the site was purchased from its original owners by a development company before use for horticulture ceased. Further, the loss of 21ha of glass proposed for construction at Almodington has effectively halted horticultural development in the area.

Given attitudes expressed during interviews, the project anticipates that evolution of land use might allow development of a site already identified and not immediately required for commercial development to be first developed for horticultural use, including the green infrastructure associated with an energy hub, in anticipation of the site being redeveloped for its original designated use at the end of the design life of the original structures, or parallel, non-horticultural development taking place on adjacent land. This is also in line with the pattern of greenhouse evolution that has been experienced over the years, with increased production from reduced areas and changes in technology making new demands on existing sites.

With good design and close consultation with the planning and economic development sections of local authorities, redevelopment could be phased over 10 to 30 years, working in a planned way through relatively short-life developments such as polytunnels on to longer-term structures such as high tech glasshouses. This concept of ‘nurse’ development may present landowners with an opportunity to benefit from phased investment, first in transport, energy and IT infrastructure and subsequently in complete land use change associated with construction.

12.4 Energy Mix and Infrastructure

Phase 1 of this study considered a wide range of energy sources that might be utilised in an energy hub. Whilst trends in fuel price may play a significant role in decision making on a day-to-day basis, flexibility and long-term utility are considered to be a primary driver when considering a large-scale, multi-use development such as proposed, along with the prevailing support regime for renewable forms of energy.

With this in mind, the form of primary energy favoured for modelling is gas, either natural, bio- or synthesis (syngas) that has a relatively high energy density, is easily transported and plant can be readily adapted to burn different grades. However, a realistic alternative may be direct raising of high pressure steam to drive a steam turbine using biomass combustion, which may prove viable in the light of the current support regime for generation of renewable energy.

Natural gas is already widely used in horticulture, and is an extremely 'clean' fuel with few non combustible impurities.

It is envisaged that the initial primary energy source used in a hub development would be natural gas, distributed through a private network that could be extended across the site.

Biogas is a product of the biological anaerobic breakdown of organic material. It is commonly produced using waste agricultural residues, but can also be derived from commercial and domestic food wastes. Biogas mainly comprises methane and carbon dioxide, with trace amounts of water (after de-watering), hydrogen sulphide and other hydrocarbons. Contaminants can cause problems in combustion when they produce acid and silicon deposits, both of which cause damage to engines. Biogas can also be upgraded to produce biomethane, a relatively high grade, standardised fuel, although this process is relatively expensive in terms of initial capital expenditure.

Biomethane could be injected into a local grid system to augment natural gas supplied from the wider grid network, either inside or outside the existing Green Gas certification scheme.

Syngas is derived from a variety of sources including steam treatment of natural gas, and gasification of biomass, including wastes containing organic fractions. Syngas is a mixture dominated by hydrogen and carbon monoxide and which can be produced from the gasification of renewable resources, primarily wood. Syngas has many advantages over solid fuels, primarily that it is easily transported and combustion is more controlled compared with solid fuel.

Tar-free syngas can be produced from wood, transported and burnt in reciprocating engines connected to a generator with heat recovery. The gas can also be used in dual fuel internal combustion engines.

Syngas could be produced on a scale great enough to replace all natural gas inputs to the system. This would make the energy hub independent of external sources of fossil fuel as all gas-driven engines were converted to use locally-produced syngas. All components in the system could be specified to convert between syngas and natural gas in the event of interruptions in supply.

Figure 20 shows how a central syngas production facility might be established at the centre of a horticulture-based hub, with gas piped out to embedded generation facilities around the hub. Electricity would be produced using syngas-fuelled CHP units with CO₂ recovery in much the same way as is current practice. CHP in residential areas might be brought into use when there is an established heat demand, with CO₂ and surplus heat moved off-site into a neighbouring horticultural development. Similarly, CO₂ and any other surplus energy could, for instance be exported from a commercial zone to neighbouring horticultural site. On sites where there exists a parallel demand for cooling, absorption-chilling associated with horticultural use, food processing or cold storage could be included in the energy node (see 12.7 below).

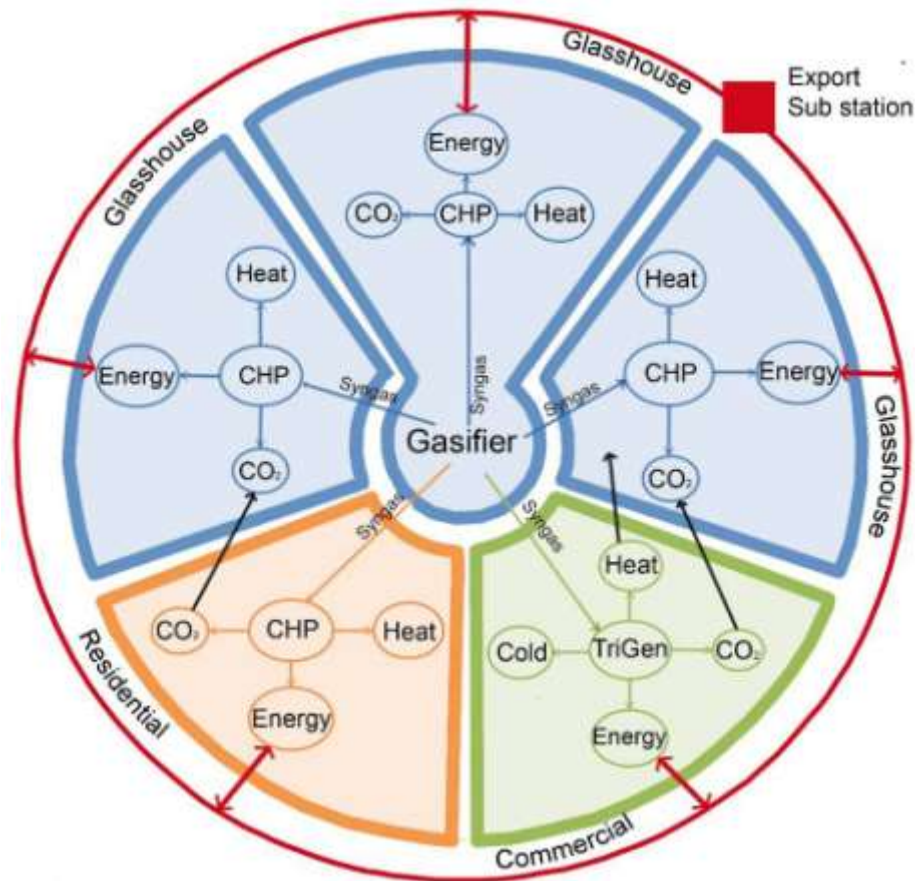


Figure 20: The Role of an Energy Hub in a Mixed Development

By owning and operating a local electricity distribution system, designed to distribute power around the site, users would be assured of green provenance and surplus could be fed into the wider, grid through a single 'gateway'. This option would only be possible where a single energy business had control of gas production, and electricity generation and export, monitoring and balancing hub demands for heat and CO₂, and exporting surplus electricity to the national grid.

12.5 Grower Mix

West Sussex is home to a wide spectrum of horticultural businesses, including: intensive fruit and vegetable production, pot, bedding and ornamental plants, salads and field scale vegetables, as well as conventional agricultural production, which plays a key role in the rotation of crops.

It is envisaged that any horticultural hub would reflect the diversity of the wider area, with a group of two or three key enterprises that, in one model with a waste management company, would be the pioneer businesses and principal shareholders in the hub venture.

As the hub became established, it would be possible to involve other, smaller horticultural and other commercial/industrial businesses as either shareholders with, or tenants of the main business(es). The initial mix would depend on the willingness and ability of individual businesses to enter into relatively long-term agreements, possibly with established operators from outside the sector.

It is likely that the first occupiers of any hub would have in place a phased expansion plan over five to ten years, at the end of which they may occupy between 10ha and 20ha of glass within an overall developed area extending to between 50ha and 100ha.

In order to ensure that maximum benefit is gained from the hub development a mix of types of

glass would need to be established on site: high temperature (e.g. tomatoes and peppers); medium temperature (e.g. leafy salads and herbs); and low temperature (e.g. bedding plants and flowers). Since energy needs may change over time there would need to be some mechanism to encourage the optimum use, possibly along the lines of national energy system charges based on a mixture of long term contract and short term incentives and penalties.

12.6 Horticulture/Food Industry

A majority of the horticultural production of West Sussex is consumed outside the area and so any hub would sit at the beginning of an often long and complex horticultural supply chain (*Figure 21*), much of which operates in a controlled environment. Opportunities for energy-hungry developments near the front of the chain exist at any hub, including added value processing operations such as salad and ready meal preparation.



Figure 21: The Horticultural Food Supply Chain

Much of the logistics-related activity is controlled by large-scale retail purchasers that organise shipments to optimise capacity, reduce visit numbers and distances travelled. The co-location of multiple growing, packhouse and processing operations would help customers reduce costs and improve environmental impacts without placing additional burdens on growers.

The mixes of operations that might make use of a hub development are well-suited to the use of tri-generation for the production of heat, power and cooling in a close coupled, tri-generation system. Installations can be optimised for energy efficiency serving a single building, multiple buildings or industrial processes by examining daily and monthly energy demand profiles using energy modelling software.

Figure 22: *Resource Flows –Commercial* shows how a tri-generation plant in the commercial segment of a hub development (Figure 20) would work in its own immediate site, for example by providing chilling and hot water in a packhouse, and how it would potentially integrate with other hub operations, including district and glasshouse heating, CO₂ and electricity supply, including export to the national grid.

The economic viability of tri-generation improves significantly where both the heating and cooling base loads exceed about 150kW, a load that easily be associated with a medium-scale chilling and packing facility, such as might be established at the site.

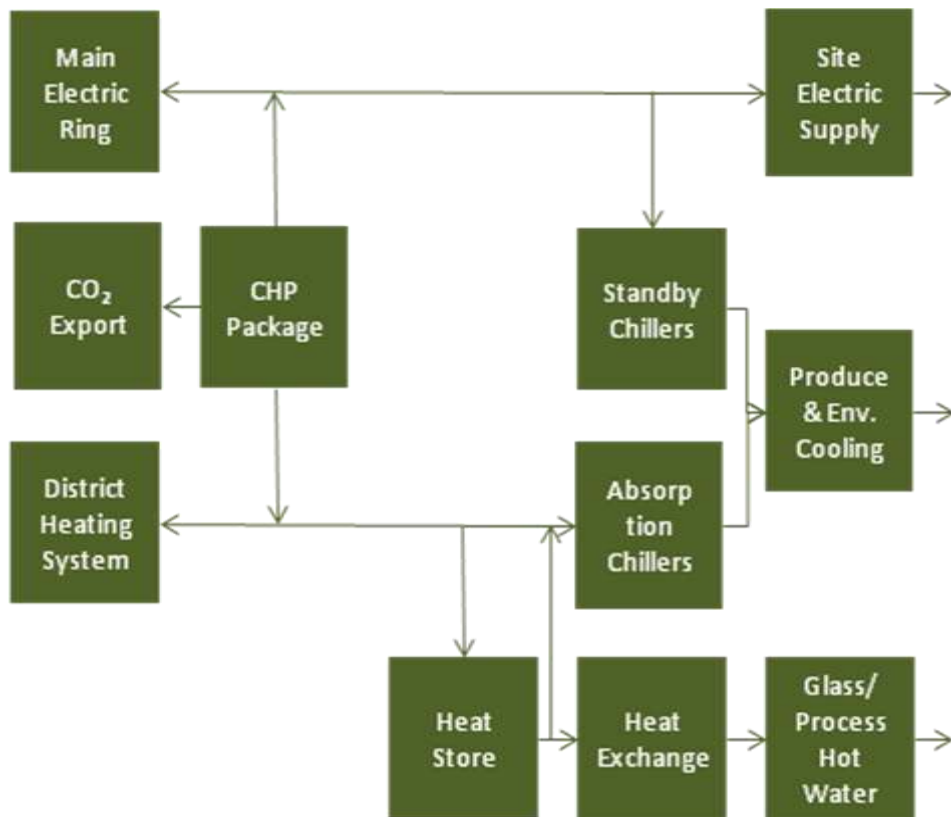


Figure 22: Resource Flows –Commercial

A central CHP/TriGen installation fuelled by Syngas from the Hub gasifier would feed electricity into the local distribution grid from which surplus would be exported

12.7 Associated Development

Key to the success of this type of integrated development is recognition of the key objectives of the proposers, in this case growers in West Sussex, but the needs and expectations of other stakeholders is also crucial; other development associated with the hub is a major part of this.

Whilst this project does not identify specific site(s) for hub development, the surroundings of the hub will to some extent determine its scale, layout, use mix and landscape and ecology. Understanding and accounting for these elements in terms of how people get to work, how goods are delivered and produce taken away, will help achieve a more sustainable end product.

Underpinning any development is the infrastructure that serves it. The hub concept proposes that local gas, electricity, heat and CO₂ grids be designed and constructed for hub occupiers, and kept under local control. Similar principals could be applied to IT and communications, with potential for new high speed broadband provision within the hub area.

In addition to developments related to horticultural production, an energy hub may also attract other energy-hungry or ‘eco’ operations with relatively constant year-round demands for heating, cooling and power that would benefit from close association with a green source of energy. Whilst the approach of greenhouses in the past has been to seek existing energy users and ‘piggy back’ them, there is no reason why this should not be reversed and other users follow a horticultural development.

Whilst new education facilities may not be a major part of the development mix, a hub development would provide opportunities for practical experience and some specialist areas for training and academic supervision close to the workplace. This large-scale integrated approach to

practical education would help the area become a centre of excellence for horticultural education and provide opportunities for research that would help businesses improve both environmental and economic performance.

Commercial developments would also provide accommodation for associated businesses such as IT, heating, electrical and structural engineers that are a necessary part of modern horticultural businesses. These enterprises would also provide opportunities for training in the area and support for research and development at both academic and grower levels.

At the time of writing, West Sussex County Council is consulting on its revised waste policy, which whilst it does identify a limited number of sites on the coastal plain for waste-related developments, does not identify any preferred technology for disposal, destruction or use of the majority of wastes arising in the area. This project has identified Energy-from-Waste (EfW), as an option for an energy source for the hub, and this would require some form of waste processing facility to be integrated into the proposal.

Waste water treatment has also been identified as a potential component of the development mix. Existing Waste Water treatment Works' (WWtW) in the area already have anaerobic digesters to reduce the polluting load of waste waters and produce biogas for use in generators that export electricity to the grid. Existing plants could be integrated into a horticultural hub, feeding surplus heat and CO₂ into the local grid and producing waste water that could be upgraded into grey water suitable for non-food production use at the site.

It has not been possible to model the impact of all potential associated developments at the site, for instance modelling the integration of a EfW installation with horticultural production is complex and beyond the remit of this project, but it is self-evident that the integration of such a facility into a hub, feeding syngas into a local grid would bring significant benefits in terms of reductions in carbon emissions and increased efficiency in resource use.

12.8 Social Development

In addition to horticultural and other commercial developments, benefits would also arise from co-location of residential, educational and leisure developments with an energy hub and horticultural production. A carefully designed mixed development would provide opportunities for the establishment of closely-related living, leisure and working areas that would all benefit from proximity to an energy hub.

Mixed developments can also be designed to encourage the establishment of sustainable communities of different ages, economic status and lifestyles, which balance demands on community facilities and avoid concentrations of similar housing types. Mixed uses also allow the use of a variety of building form and scale, with open spaces and community buildings close to homes and places of work within walking or easy cycling distance, all serving to establish an attractive and diverse living and working environment.

Close juxtaposition of the three land uses is already common in places such as the Westland area of the Netherlands, south of Den Haag, although not necessarily part of a hub development. Many areas of horticultural production in Holland originally resembled the original LSA developments in the UK, with the owner's house at the front of the site and production to the rear (Figure 23) with workers living locally, within cycling distance.



Figure 23: Owners' Houses on Glasshouse Development (GoogleEarth)

Adjacent land uses can also bring visual benefits, where housing can be used to screen or break up the built landscape and screen glasshouse development that would otherwise present a uniform horizon to the viewer.

Figure 24 and 25 show street views in Westland, Holland, where new residential development has been built next to existing glasshouses, providing an effective mitigation to any visual impact they may have.



Figure 24: Street View of Residential and Glasshouse Development in Westland (GoogleEarth)

Whilst the glasshouses seen in Figure 24 are about half the height of modern, high-tech structures, it can be seen how the diverse streetscape replaces the glass 'wall' often associated with glasshouses, whilst Figure 25 shows how full-height horticultural structures can be integrated into a contemporary residential environment.



Figure 25: Street View of Residential and Glasshouse Development in Westland (GoogleEarth)

Figure 26 shows a street view of a former LSA site in Sidlesham, which reflects the juxtaposition of glasshouse and owner's dwelling seen in Figure 23, although many such sites have been removed from horticultural use and are now in residential and associated leisure use, although some grower businesses have amalgamated blocks of land to create larger, more sustainable horticultural businesses.



Figure 26 Home and Glasshouses on Former LSA Site in Sidlesham (GoogleEarth)

Residential Development

Residential areas have been included all modelling scenarios. The allocated areas (an average of 4% of the total site area) contain 60% built development at an overall density of between 30 and 50 Dwellings per hectare, which is similar to that found in current development proposals in the Arun and Chichester Districts.

The layout of the residential areas would 'look in' to community space, surrounded by glasshouse development on part of its perimeter, possibly excluding glasshouses from views out of the area. District CHP units, fed from the local gas grid would feed electricity, heat and CO₂ into the distribution grids, heat being used locally, possibly sharing large-scale heat stores with adjacent glasshouse areas, although heat and power balances would have to be calculated at the detailed

design stage. Surplus electricity would be used elsewhere on the hub site and exported to the national grid, and CO₂ fed into glasshouses as shown in

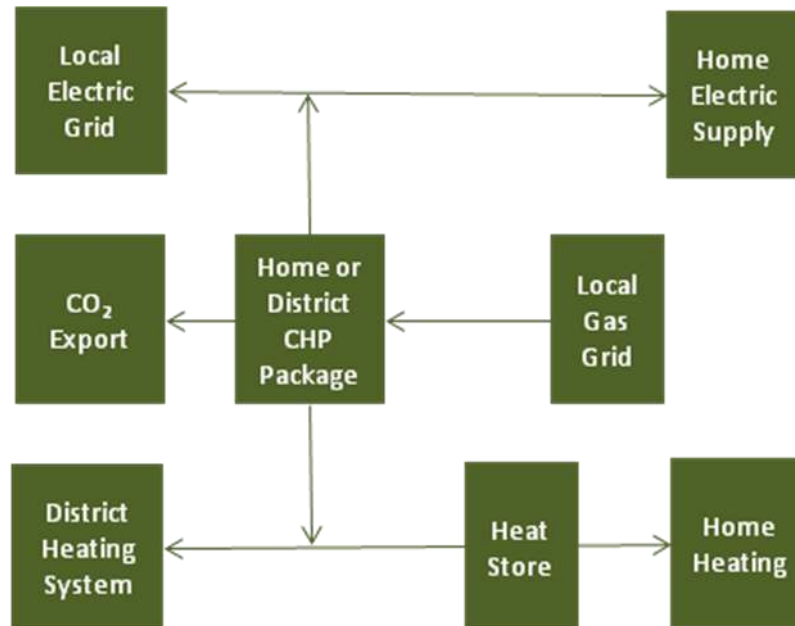


Figure 27 Small-Scale District Heating and Electricity Generation Supplied by Local Gas Grid

Educational Development

As already suggested, the integration of educational development into the hub is seen as key to the establishment of a horticultural centre of excellence. Any educational development would at first be satellite to other established institutions in the area, such as the University of Chichester and Chichester College, which could occupy a small amount of office and multi-purpose teaching space on the hub.



Figure 28 - Attractive Glasshouse Gable and building for Display/Training Purposes

Education would be carried on in the hub at a practical level with shared teaching and study space for degree level students and other work-based education, and shared workshop training space for NVQ and 'A' Level students. The facility would complement the existing teaching provision at Chichester College's Brinsbury campus, where the Aldingbourne Trust also has the Acorn Centre to provide vocational training for students with learning disabilities. The hub could provide

opportunities to support students on hub-based work placements and develop courses in food handling, packing and processing.

Degree level students from Chichester University would have opportunities to undertake practical work within diverse production systems on businesses' management, with the possibility of new courses in horticultural production and engineering being established working with growers and other hub businesses to establish a regional, if not national, centre of excellence in horticultural research and education.

Leisure/Community Development

The establishment of a centre of horticultural excellence in West Sussex brings with it opportunities to raise the profile of horticultural production to visitors to the area, providing access to glasshouse production, processing and packing with suitable interpretation and educational material. Figures 29, 30 & 31 show how an end section of a glasshouse can be adapted and made attractive for leisure visitors or businesses looking to have show houses for new crop varieties or growing technology.



Figure 29 Display Glasshouses - RHS, Wisley

Buildings for leisure and community use are central to any social development, and the integration of these facilities into a hub that includes horticultural and other commercial uses can bring significant benefits including opportunities to use facilities for a large proportion of hours, seven days a week. For instance, multi-use community halls can be used for evening and daytime community activities, but would also be available for use by businesses on the hub, and leisure facilities could be used by residents and workers alike, with opportunities for multiple sessions each day drawing from a large and diverse audience.

Employment

The development of an energy hub and associated horticultural and other businesses will bring with it a number of temporary and more permanent jobs, some of which will be transferred from elsewhere and others new. Where existing local businesses move onto a site such as this, they often leave behind less modern, but still functional facilities, which immediately become available for sale or rent to other horticultural businesses or redevelopment for another purpose. Local experience suggests that there is an ongoing demand for older, lower-tech glasshouses for uses such as soft fruit and plant production, which are in a position to take advantage of the facilities offered, but would not necessarily be in a position to make the capital investment necessary to build new glass.



Figure 30 Gothic Roof Profile on Glasshouse Used for Retail Sales

This natural movement to fill a vacuum created by new development makes it very difficult to calculate the true number of new jobs that would be associated with a hub. In order to overcome this, we have taken a conservative approach to our estimates of jobs created by the hub, restricting estimates to the full spectrum of jobs associated with the glasshouse operations on the development.

The resulting estimate of jobs likely to be associated with the hub therefore does not include ‘temporary’ jobs, which will fluctuate during the construction period, or permanent jobs associated with energy production, waste treatment, food packing, processing and sales, engineering, electrical and IT support, and non-horticultural industries occupying commercial units.

Whilst the greatest number of jobs would be associated with horticultural production, the final number of jobs created is likely to be larger and include groups not directly associated with glasshouse production.

Estimates of employment likely to be associated with the horticultural aspects of the hub have been made based on job numbers per hectare of production. The total number of jobs for each type of production has been broken down into four groups of occupations used by the Office of National Statistics (ONS) and reproduced on the NOMIS database of official labour market statistics, and this enables a simple comparison to be made between the socio-economic profile of the Arun and Chichester Districts and glasshouse production.

Table 11: Employment by Occupation in Chichester and Arun Districts (Jul 2011-Jun 2012)

Arun and Chichester	Chichester (%)	Arun (%)	South East (%)	Great Britain (%)
Soc 2010 major group 1-3	49.5	41.9	48.2	43.5
Soc 2010 major group 4-5	21.7	22.1	21.3	21.9
Soc 2010 major group 6-7	17.9	18.6	16.6	17.3
Soc 2010 major group 8-9	10.9	17.5	14.0	17.4

Source: ONS annual population survey

% are for people over 16 and represents a proportion of all persons in employment

The groupings used in Table 11 comprise the occupations shown in Table 12

Table 12: Occupations used in ONS Annual Population Survey

Group 1 Managers, directors and senior officials
Group 2 Professional occupations
Group 3 Associate professional & technical
Group 4 Administrative & secretarial
Group 5 Skilled trades occupations
Group 6 Caring, leisure and Other Service occupations
Group 7 Sales and customer service occs
Group 8 Process plant & machine operatives
Group 9 Elementary occupations

It is apparent from the employment statistics that the occupations of residents in the Arun and Chichester Districts are weighted towards managerial, professional and technical jobs, with nearly 50% of the population filling such roles, whilst there are relatively few filling operator and elementary roles, which include horticultural workers. By comparison horticultural developments provide relatively few managerial, professional and technical jobs, with about 66% of jobs falling into groups 8 and 9, operator and elementary occupations.



Figure 31: Automated Loading of Robotic Transport System

It is also clear that the socio-economic profile of workers in the horticultural part of an energy hub differs from that of the population of the Districts, but it should be borne in mind that the majority of starter jobs for young people are within the lower two bands of occupations, rather than in management or skilled trades, and that the sector offers significant opportunities for advancement that are not often available in other employment areas.

The overall impact of all 1,000 hub workers coming into the Districts would have a negligible impact on the socio-economic profile of the Districts, with a shift of 0.3% from the top group of occupations, to the bottom group, as seen in Figure 32. This comparison does not take account of occupations allied to the hub, which are more likely to be in the top three bands, rather than operator or elementary occupations.

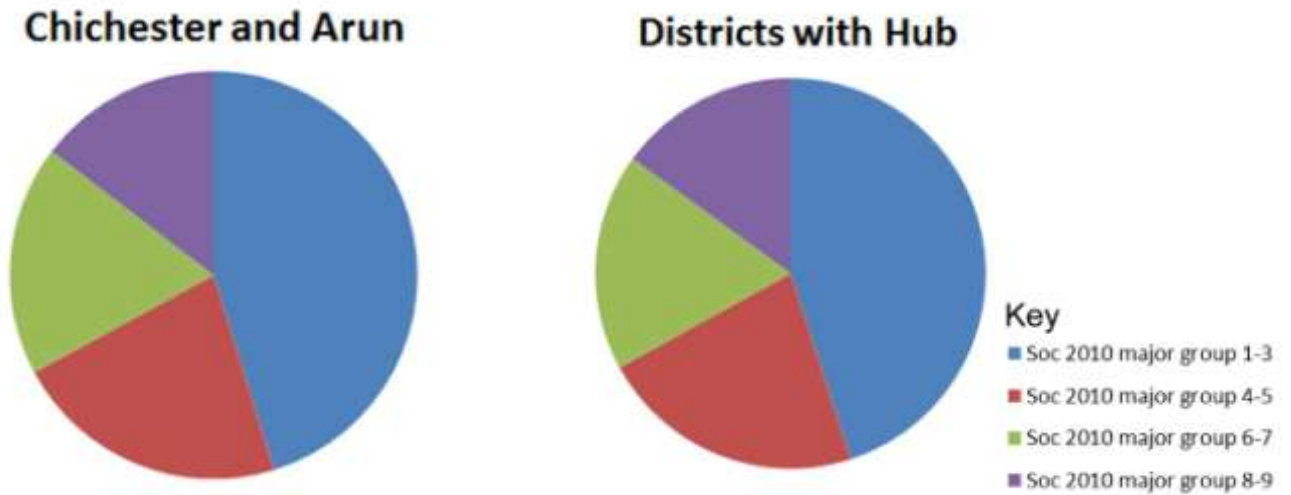


Figure 32 Pie Chart Showing Current Employment by Occupation in Chichester and Arun Districts and with 1,000 Additional Hub-Based Jobs

The proportions of the range of occupations supported by different types of glasshouse production are broadly similar, with a greater proportion of jobs in operator and elementary occupations, than in management, sales or supervisory roles.

	Young plants	Tomatoes / peppers	Strawberries
Soc 2010 major group 1-3	0.8	1.5	0.6
Soc 2010 major group 4-5	3	3	2
Soc 2010 major group 6-7	0.8	1	0.5
Soc 2010 major group 8-9	11	8	7

Table 13 Jobs/ha of Glasshouse Production by occupation

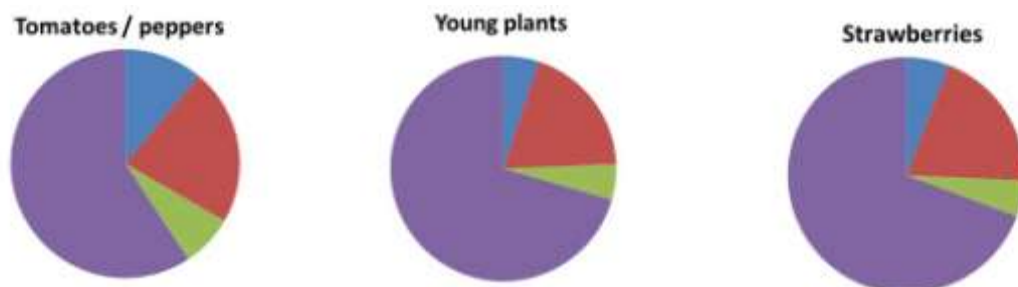


Figure 33 Pie Charts Showing %age Employment by Occupation in Glasshouse Production

Horticultural production is changing rapidly as the use of robotic machines and systems increases. Whilst skilled manual jobs, such as picking and plant propagation are difficult to replace with robots, many handling and transport tasks are becoming based on robotics, as seen in FiguresFigure 31

&Figure 34. With increased use of robotics come an increasing number of skilled jobs in building, programming and maintenance of the machines.



Figure 34 Robot Transplanter for Containerised Plants

12.9 Developing the Mix

In order to represent a wide range of the vast number of variations that might be derived from the variables described above, three models have been designed and the interactions between all of the factors studied and quantified where appropriate.

The model structures are not intended to represent any specific circumstances, and the combinations of elements included in one or more models have been analysed because it was felt that they were representative of the type of opportunities and situations most likely to arise. Some elements of the models reflect the position(s) of stakeholders expressed during the consultation process, particularly in terms of possible land use combinations and likely demand for facilities. All of the scenarios have been rigorously examined and feasibility checked and outcomes verified

12.10 The Three Scenarios

The model has been used to predict outputs for the three illustrative scenarios proposed, each on a site with total area of 85ha (210 acres), and with land use mixes as shown in Table 14 *Modelled Land Use Mixes* below.

Apart from ownership of land and structures, the key differences between the three models relate to the inclusion of 10ha (25 acres) of land for a future Energy from Waste (EfW) facility in the 'Blue' option, and the inclusion in the 'Purple' model of a greater level of renewable energy investment than the others, capital expenditure for which would primarily be as part of the investor portfolio.

Both the 'Green' and 'Blue' scenarios have a higher proportion of natural gas fired equipment than the 'Purple'. For the 'Green' scenario this is used to reduce Capital Expenditure, and for the 'Blue' reflects likely delays in constructing and commissioning the EfW plant, and to provide heat in the interim. There are also minor differences in land allocation to reflect the above, for example the 'Blue' model has a reduced packhouse / food processing area due to the presence of the EfW plant; the 'Green' scenario has reduced social facility area.

A small amount of residential development has been assumed in each case to provide seed funding for key infrastructure costs. This is considered necessary to reduce interest payments and enable realistic returns to be achieved in a meaningful timeframe and is based, for example on the experiences of the *Yorkshire Forward* scheme, as outlined in the Phase 1 report).

More detailed assumptions regarding the combination of elements within the models are attached at Section 17 below.

	Green	Blue	Purple
Site Area (ha)	85	85	85
Commercial	57.4	45.9	49.0
Social Glass	2.1	4.7	4.3
Energy Plant Area	2.5	12.3	3.1
Packhouse, Food Factory and other Industrial	1.5	0.9	1.7
Commercial Floorspace	0.3	0.3	0.3
Residential	1.0	2.0	3.1

Table 14 Modelled Land Use Mixes

13. Summary of Modelling Results

Local and national benefits

The differences between the outcomes of the three scenarios are relatively small, with variations of 20% in employment and 5% in reduction of CO₂(eq) emissions. The 'Green' model performs best in employment, with 910 jobs created and the 'Purple' in CO₂ reduction, with a reduction of 25,034 tonnes per year CO₂ eq. As a comparative illustration these figures indicate employment at approximately equal to that of the Rolls Royce motors Goodwood site.

	Green	Blue	Purple
Jobs Created*	910	740	868
Reduction in CO₂ eq t/yr**	23,788	16,438	25,034

Table 15 Benefits of Modelled Outcomes

* No economic multiplier effect for new jobs created has been included.

EfW jobs are included in the blue option, not others.

No construction employment has been included.

Employment related to residential development or infrastructure is not included.

** At 25 years. Does not include residential and commercial energy use, nor future reductions from EfW.

The generating capacity of the 'Green' model is estimated to be sufficient to power 6,000 homes, and 3,500 homes for the 'Purple' model.

The Grower Model.

The economic results for the growers also show little variation, with the 'Green' scenario producing the optimum results, followed by 'Purple'. The grower returns are indicative, since these are vastly dependent on markets which have many external influences, and are best considered as long term averages.

Economics – Grower Model (annual)	Green	Blue	Purple
Net Sales Value to Region	£39,811,556	£34,957,134	£38,764,080
Grower Equalised Return (Excluding Finance)	£13,656,137	£10,748,432	£11,601,173

Table 16 Grower Economics

The Energy Company Model

The energy company has been modelled as a joint venture, for the reasons outlined in Phase 1 of this Project. Table 17 below shows the returns to the energy company, based on the charge to growers as shown. The scenario in the 'Blue' model is not viable. This is due to the extensive use of natural gas in the early stages prior to, and in anticipation of, an EfW plant coming on stream. As such it should be treated with caution, since the latter part of the project may offer compensation with heat provided at significantly lower levels than £13/MWh. The 'Purple' scenario provides the best return, 50% more than the 'Green'.

Economics – Energy Company (annual)	Green	Blue	Purple
Heat Sold to Greenhouses (£/MWh)	£13	£13	£13
Profitability (Excluding Finance)*	£1,594,194	-£179,900	£2,433,366

*Including proposed revised DECC Tariffs

Table 17 Energy Economics

The Landowner Model

The economics of the landowner model are skewed by the larger area of land designated for the EfW plant. For a potential landowner interested in the scheme it is clear that the 'Purple' scenario is the most attractive, combining the second highest actual annual return (*i.e.* that money which will really come in) with the second highest equalised income (*i.e.* that taking into account future values) and also retaining virtually all the land.

Economics – Landowner Model (annual)	Green	Blue	Purple
Annual Income Achieved	£287,746	£90,847	£182,851
Equalised Annual Income*	£460,480	£1,016,365	£613,838
Land Retained by Landowner (ha)	0	82	80

*Taking into account future values, but excluding retained land

Table 18 Landowner Economics

The Development Timeframe

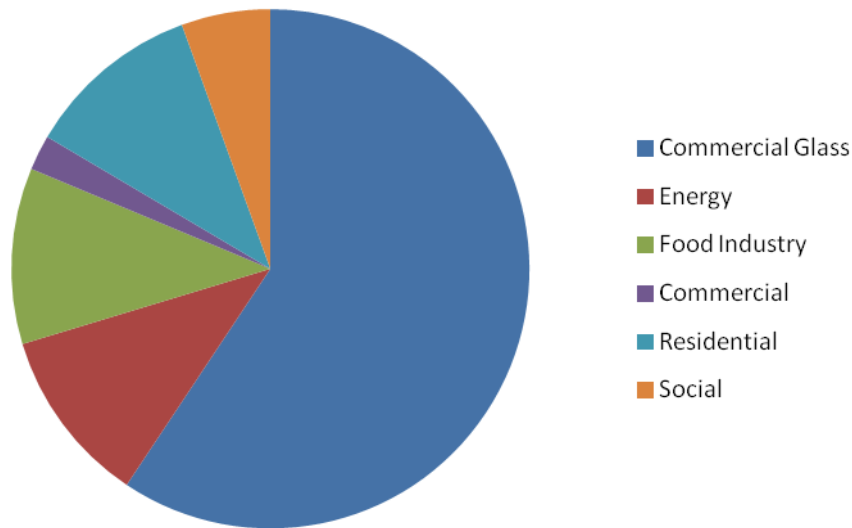
Table 19 below summarises key changes in the modelled scenarios over the period of study.

	Year 1	Year 5	Year 10	Year 25
Job Numbers				
Green	324	740	910	910
Blue	271	616	740	740
Purple	307	703	877	877
CO₂eq Reduction (t)				
Green	9,515	21,409	23,788	23,788
Blue	6,575	14,794	16,438	16,438
Purple	10,014	22,530	25,034	25,034
Glass Area (ha)				
Green	23	52	57	57
Blue	18	41	46	46
Purple	20	44	49	49

Table 19 Hub Performance Over 25 Years

14. The BLUE Model

Summary



The landowner income is positive so it should be acceptable to an institutional landlord.

It offers the potential for housing an EfW site and also importantly offers a means of using the heat and CO₂ on site.

For an EfW site it offers the advantage that the infrastructure can be in place before the EfW plant, thus facilitating operation once the decision is made.

The initial energy company returns are negative based on the reduced price of £13/MW.h, so this would need to be increased to nearer normal market values.

14.1 Introduction

The model is suited to an institutional investor with a particular interest in the establishment of an EfW plant.

It includes higher levels of educational facilities within the social mix, to reflect the probable interest of the owner.

There is an area of residential development to cover the cost of the infra-structure and social aspects.

1.2.3 Mix

It is assumed that the site is available for the full range of grower and other business partners that would be involved in the development. The model only considers the horticultural aspects of the site economics and assumes that other commercial partners (waste processing and other non-food activities) are attracted to the site with associated economic benefits accruing.

Commercial glass is the major land user on the site, with 45.9ha of glasshouses on 51ha of land.

The percentages and areas of glass are as below:

High temperature	30%	13.8ha
Medium temperature	30%	13.8ha
Low temperature	40%	18.4ha

Social areas occupy 9.35ha of land, with the following mix of uses:

Start-up glass	2.3ha
Learning disability	0.5ha
Education	1.9ha

12.3ha of land is allocated for a centralised energy plant.

4.25ha of land is allocated for packhouses and food processing / industrial units, comprising:

Packhouses	0.3ha
Food factory	0.4ha
Other industrial	0.2ha

The commercial designation is as below, on 1.7ha of land.

Office	0.1ha
Leisure	0.1ha
Other	0.1ha

Residential land area is 3.4ha, providing scope for the development of between 100 and 170 dwellings.

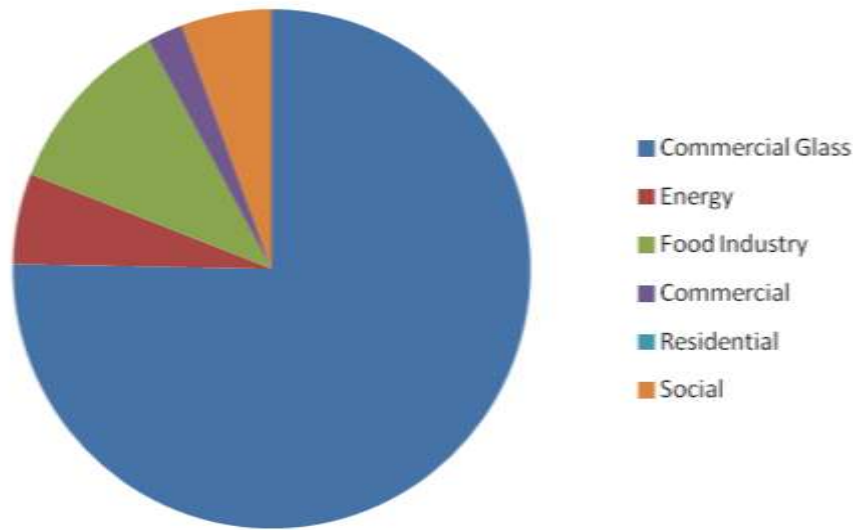
14.2 Conclusions

The benefits of this modelled scheme can be summarised as:

Jobs created	740
Reduction in CO ₂ (eq)	16,438 t/year
Additional income to region	£35m+

15. The GREEN Model

Summary



This model includes the greatest area of commercial glass, and provides greatest number of employment opportunities.

The returns to the landowner are good but it would also involve the sale of land, which historically has presented difficulties associated with either unwillingness to sell, or perceived excessive land values.

15.1 Introduction

The model could be located anywhere in the study area, although good transport infrastructure would be desirable. The site would extend to 85ha and is based on growers being able to buy and develop their own sites. This model includes a smaller area of non-commercial glass than the other two models.

The infrastructure for the whole site would be the responsibility of a Joint Venture company which would be controlled by a small group of principal shareholders but include other equity shareholders with interests in the hub.

The initial capital expenditure on the project is minimised by including an energy mix that is more reliant on fossil fuels (natural gas).

A small proportion of residential land is included in the model to cover the cost of the infrastructure and social aspects.

15.2 Mix

It is assumed that much of the area to be developed with glasshouses would be sold to growers at appropriate valuation, with or without riding clauses to address future uses or sales. The model only considers the horticultural aspects of the site economics and assumes that other commercial partners occupying commercial units would be attracted to the site with consequential benefits in

terms of rental/sales revenue and employment.

Commercial glass would be the major land use, with 57ha of development on 63.75ha of land.

The percentages and areas of glass are as below.

High temperature	50%	28.7ha
Medium temperature	25%	14.3ha
Low temperature	25%	14.3ha

The social areas are as below, on 4.25ha of land.

Start-up glass	1.1ha
Learning disability	0.5ha
Education	0.5ha

2.5ha of land is allocated for energy plant.

7.65ha of land is allocated for packhouses and food processing industrial units, comprising the following

Packhouses	0.5ha
Food factory	0.8ha
Other industrial	0.3ha

The commercial designation is as below, on 1.7ha of land.

Office	0.1ha
Leisure	0.1ha
Other	0.2ha

The residential land area is 1.7ha scope for the development of between 50 and 85 dwellings.

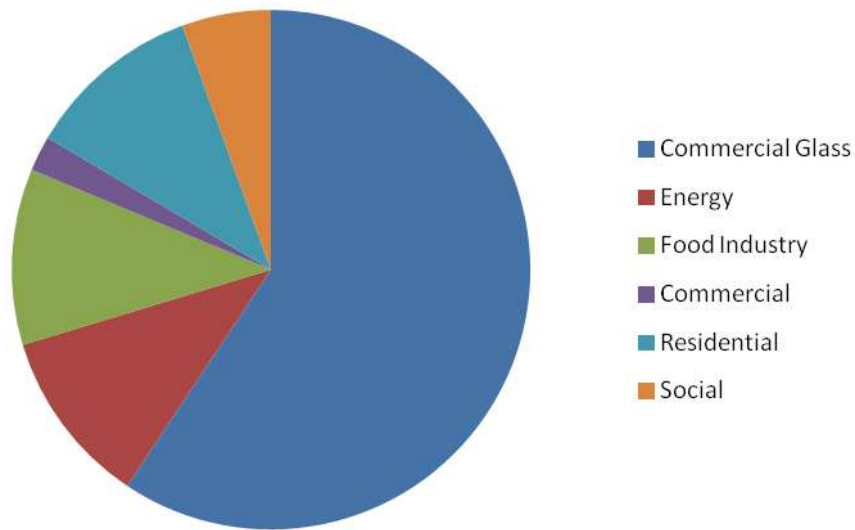
1.2.4 Conclusions

This summary of benefits this scheme offers is shown below.

Job created	910
Reduction in CO ₂ (eq)	23,788t/year
Additional income to region	£39.8m

16. The PURPLE Model

Summary



Projected landowner income is in excess of £2,000/ha, which is greater than currently achievable farm rental values and should encourage participation by institutional land owners.

The model would result in a significant long term improvement in asset value.

Land ownership is retained.

It is assumed that the land owner will also be an equity partner in the Joint Venture energy company, providing an opportunity to add a significant renewable energy asset to its portfolio.

The income from the energy company is positive, based on an energy cost to growers set at 50% of current levels.

16.1 Introduction

This model assumes the involvement of a large-scale institutional land-owner that is interested in developing a project to improve a commercial land asset and establish a renewable energy development. It is assumed that the landowner would also be willing to enter into agreements to fund social aspects of the development through the Community Infrastructure Levy. The cost of basic infrastructure developments and aspects of the scheme such as entry-level glass would be covered by sale of residential housing land.

Mix

Commercial glasshouses are the major land use on the hub development with 45.9ha of glass on 51ha of land.

The percentages and areas of glass are as below.

High temperature	30%	14.7ha
Medium temperature	25%	12.2ha
Low temperature	45%	22.0ha

The social areas are as below, on 8.5ha of land.

Start-up glass	2.6ha
Learning disability	0.9ha
Education	0.9ha

3.1ha of land is allocated for energy plant.

8.5ha of land is allocated for packhouses and food processing / industrial units, comprising the following

Packhouses	0.5ha
Food factory	0.9ha
Other industrial	0.3ha

The commercial designation is as below, on 1.7ha of land.

Office	0.1ha
Leisure	0.1ha
Other	0.1ha

The allocated residential land area is 5.1ha, providing scope for the development of between 100 and 170 homes.

1.3.4 Conclusions

The benefits of this modelled scheme can be summarised as:

Jobs created	877
Reduction in CO ₂ (eq)	25,034 t/year
Additional income to region	£38.8m

17. Modelling Assumptions

Caveats

The modelled scenarios are assumed to run for 25 years, although the various energy support schemes (RHI and ROC's) only run for 20 years and loss of support is likely to have an impact on financial outcomes in at least the last five years of each scenario.

Various aspects of the modelled scenarios can be varied to take into account total area and percentage mixes of land use associated with the hub.

The model also permits selection of percentages of energy supplied by renewable and fossil fuel, and percentages of CHP derived heat from each.

Employment

The majority of figures used to estimate jobs created by land uses came from the second edition of the Home and Communities Agency's Employment Densities Guide, 2010. The values used to estimate employment density incorporate some broad assumptions and the outputs should be treated appropriately.

Floor space ratios for specialist land uses not listed in the Employment Densities Guide have been defined as following:

- packhouse and food factory areas were deemed to be a mixture of 'industrial' and 'cold storage' and the employment density figures from the Yorkshire Forward "Planning for employment" report were used. The figures do not include delivery drivers based at, but working away from the site.

Job numbers related to energy generation were based on modelling undertaken for the E.On generation facility at Northwich (EfW) and from personal experience of sites for the remainder.

Employment ratios for the social aspects of the hub exclude students, specifically the employment of those with learning disabilities. These jobs are legitimate and very important to the hub concept, but they do not significantly impact on wealth creation which is the basis of the report.

Where figures for other social activities are used, they have been based on either glasshouse use or empirical values for educational use.

All estimated financial outputs shown are pre-tax.

All costs and projections assumed in the modelling process are based on current values; no allowance has been made for inflation.

Energy

The efficiency of Combined Heat and Power plants varies according to the fuel used. The assumptions used in the modelling are based on 38% efficiency for gas-fuelled generation, and 20% for a biomass fuelled steam turbine.

Assumed thermal output ratios (thermal to electrical) are 1.5 for natural gas and 3.0 for biomass.

Assumed boiler efficiencies are 92% for natural gas and 85% for biomass. These values are relatively high, based on the assumption that operational hours are high, and that buffer tanks would be used for thermal storage.

Carbon savings are based on CO₂ equivalents and include other greenhouse gases such as NO_x. The values used in the model are taken from published data on the Zero Carbon Hub website. Zero Carbon Hub is a public/private partnership responsible for the delivery of new homes to zero carbon standards by 2016.

Woody biomass has been costed at £45/t delivered to site, giving an energy price of £13.5/MWh. Natural gas is assumed at £20/MWh, reflecting possible future drops in price as shale gas comes on stream. Electricity prices are £50/MWh for export and £85/MWh for import.

Thermal energy for industrial, commercial and residential users has not been included since it forms a relatively small part of the load on the system, which may be derived from heat stores, and can be assumed therefore not to affect peak loads. Any benefits derived from this use will therefore have additional positive financial effects on modelled financial and CO₂ outcomes.

All electricity generated on the Hub is assumed to be sold to grid, whereas in fact a small proportion will be used on site at greater profitability. Any impact of this will have positive financial effects on the modelled outcomes.

No value has been attached to carbon credits which could be of use to larger stakeholders under the EU scheme, depending on how the site is organised.

Financial

Interest rates are set to achieve a gross 4% return to investors, and 6% borrowing rate from financial institutions.

Values for agricultural and greenhouse development land are based on local information gathered from the Project Steering Group and Land Agents, and for residential land values are based on estimates on the Audacity.org website and data from the Valuation Office Agency .

Agricultural land values are difficult to determine and there are no valid recent comparables in the study area. Anecdotal evidence from elsewhere in the South East indicates that the values used in the model may be 50% of what may be achieved if land did become available.

The percentage utilisation (built area) of the total land area under individual land uses is based on the following estimates:

Land Use	Built Area (%)
Glasshouse	90
Social Enterprises	50
Packhouse and Food Factory	20
Commercial	20
Residential	60

Table 20 %age Built Area Within Land Use Classes

All of the modelled scenarios include a 4% margin of undesignated land. Access roads, parking and outdoor storage areas are all assumed to be contained within the utilisation factors above.

18. Conclusions

Phase 2 of the project has established further parameters for progressing the energy hub concept which was explored in Phase 1. These are summarised below.

- The hub will need to have a mix of commercial glass and other business uses.
- One likely means of facilitating the hub development is the inclusion of a small area of residential development, which can provide finance for other aspects of it thus avoiding the same fate as the Yorkshire Forward hub.
- The inclusion of the various ‘social’ elements discussed within the scheme is likely to benefit any proposal that might come forward.
- The most likely option is that with leased land with individual growers constructing their own greenhouses, and with infrastructure looked after by a jointly owned holding company.
- The most profitable scenario for all parties is to have the energy services operated by a jointly owned holding company.
- A mixed development to avoid the ‘*wall of glass*’ vista often associated with large scale greenhouses is likely to be more acceptable in planning terms.
- Should an opportunity for outright purchase of land become available it is still financially in all parties interests to operate the infrastructure and energy aspects in the same manner as above.

The level of support from the Local Authorities is high and needs to be maintained by working in partnership with them as far as is practical.

The economic benefits to the local area have been quantified, and are of a scale which is likely to be broadly welcomed as such by most when this is put across in a clear manner. The similarities between the employment benefits from such a hub and the Rolls Royce motors site at Goodwood may prove a useful analogy for people to grasp.

There may be significant synergies with the West Sussex waste plan, but the timescales and certainty levels of this will be difficult to match with that required for the hub.

There are significant environmental benefits resulting from this scheme, in terms of energy saving, greenhouse gas emissions and waste minimisation and re-use.

19. The Way Forward

This report is the culmination of many years of work by the WSGA to identify, plan out and initiate a development strategy for the growing sector in West Sussex. The process must now be followed through to its natural conclusion, the establishment of an energy hub based on horticultural production.

The next moves need not be controversial or drawn out, but in order to achieve this change the process must be managed carefully at all levels and in all areas, with complete transparency.

There are two key elements to taking the scheme forward: ensuring that public opinion is at least neutral and at best supportive; and finding a suitable site and working that to a stage where planning permission can be sought.

19.1 Public opinion.

It makes sense that any proposal should garner the widest possible support, in order to overcome the perception of it being big industry despoiling the countryside with no consideration for anything apart from profit.

A plan of how to achieve this should be developed, learning from successful large scale applications, for example Newlands in Lagness and Eden in Cornwall, and also the rejected ones, such as Easton Farm at Almodington, plus other relevant ones.

19.2 Site

Those items requiring the longest lead times should be addressed first: specifically these are likely to relate to possible sites and ownership models for involved parties.

Simultaneously to this there will need to be an exercise in evincing support from various quarters, prior to a specific site application being made.

It is likely that the most effective means to progress any scheme will be by preliminary discussions with the landowner and applicable local authority, with the grower interest represented at this stage by the WSGA rather than individual growers.

The objective of this initial process should be to establish the following parameters.

- Site location
- Acceptable ownership models for land, infrastructure, social elements and energy.
- Feasible land use areas (amount of glass, food processing / industrial, residential).

Following on from this there needs to be a clear commitment to take the project further, this being from both landowner and interested growers, and made manifest by commitment of funds to process the development to the next stage.

APPENDIX 1

STEERING GROUP MEMBERS AND INTERVIEWEES

Steering Group Members

John Hall (Chairman)	WSGA
Paul Sopp	Fargro
David More	Langmeads
Dick Houweling	Tangmere
Julian Marks	Barfoots
Chris Moncrieff	VHB Herbs
Martin Brassfield	Downsview
Siobhan Walker	West Sussex CC
Anthony Everitt	Arun DC
Shelagh Legrave	Chichester College
Kenrick Garraway	Chichester DC
Tracey Flitcroft	Chichester DC
Ron Crank	Coast to Capital LEP
Alex Williamson	Coast to Capital (Goodwood)
Caroline Wood	Coastal West Sussex
Jane Whiteman	Environment Agency
Mark Froud	Sussex Enterprise
Jon Tilley	SSE
John Archer	NFU
Paul Petty	British Gas Centrica
David Cooper	University of Chichester

Growers & UK hubs

Chris Need	Roundstone Nurseries
Gregg Hill	Hill Bros
Ken Parkinson	Jakes Nursery
Martin Brassfield	Down View Nurseries
Mike Kendall	Plant Raisers
Tom Ball	consultant
Daniel van der Veen	Hall Hunter
Laurie Adams	Hall Hunter

David Kay	Hall Hunter
Gert van Straalen	Kaiij Growers
Chris Moncrief	Humber VHB
Chris Wall	Eric Wall Ltd
Neil Stevenson	HH Nurseries
Chris Wade	Almodington Nurseries
Norman Lee	Woodlea Nursery
Julian Marks	Barfoots
Philip Pearson	A Pearson & Sons
Matthew Kerr	GROW Ltd
Steve McVickers	Capespan
Dick Houweling	Tangmere
Peter Moog	Wight Salads
Peter Zwinkels,	Maderstein
Colin Frampton	Donaldsons
David Godsmark	Swallowfield Nurseries
Jeff Hooper	SGP
Mike Tristram	Farplants
Mike Norris	New Place Nurseries

Overseas hubs

Blazej Zarebski
 Robert Kielstra
 Henk van Tuyl
 Hans-Joachim Wagner

UK service industry

Mark Chivers
 Pete Stenning
 Ross Hibbs
 Douglas Briggs

UK other organisations

Andrew Thomas Strutt & Parker

Dave Incham	Littlehampton Wharf, Tarmac
Brian Shaw	Tarmac
Harbourmaster	Littlehampton Harbour
Jon Tilley	SSE
Martin Lenarts	Minstead Training project
John Woodward	Consultant
Matthew Kerr	GROW Ltd
Kenrick Garraway	Chichester DC
Andrew Tolfts	West Sussex CC (Officer)
Shelagh Legrave	Chichester College
Mike Furness	Woodfuel Woodland Improvement Grant
Karl Roberts	Arun DC
Jaqui Ball	Arun DC
Siobhan Walker	West Sussex CC
Peter Robinson	West Sussex CC
Mike Elkington	West Sussex CC
Tracey Flitcroft	Chichester DC
Jane Whiteman	Environment Agency
Jenny Stillwell	Environment Agency
Eamonn St Lawrence	Environment Agency
John Archer	NFU
Mike Wright	Dreisbach Florists
Alison Stevens	Chichester DC
Amanda Jobling	Chichester DC
Andy Jones	Eco Food Recycling
Nick Price	Environment Agency
Mark Hooper	Kingsbridge Estates
Susan Solbra	Southern Water
Ross Radclyffe	Peel Investments
Richard Barker	Peel Investments

APPENDIX 2

POLICY AND REGULATION AFFECTING ENERGY GENERATION AND TRANSMISSION

Legislation:	Applying to
s.36 and 37 and schedules 5, 8 and 9 to the Electricity Act 1989	Electricity Act consent is not required for infrastructure included in a Planning Act 2008 consent. An Electricity Act consent can also include deemed planning permission meaning a further planning application is not required. Generating stations in territorial waters adjacent to England and Wales over 1MW and up to 100MW
Overhead Lines (Exemption) Regulations 1992 (SI 1992/3074)	Exemption from s.37 of the Electricity Act 1989 for certain above ground electric lines
Overhead Lines (Exemption) (England and Wales) Regulations 2009 (SI 2009/640)	Exemption from s.37 of the Electricity Act 1989 and the Planning Act 2008 for certain above ground electric lines in England and Wales
Electricity (Applications for Consent) Regulations 1990 (SI 1990/455)	Electricity Act consent procedure for: - Above ground electric lines over 20kv and below 132kv in England and Wales
Part 1 of the Planning Act 2008	National policy statements
Parts 3 to 8 of the Planning Act 2008	Planning Act consent required for: -Generating stations in England and Wales over 50MW -Generating stations in territorial waters adjacent to England and Wales and in the renewable energy zone (except the Scottish part) over 100MW - Above ground electric lines of 132kv and above in England and Wales Planning Act consent can optionally include: - development associated with the infrastructure listed above and situated in England or in waters adjacent to England or in the renewable energy zone (except the Scottish part).
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (SI 2009/2264)	Procedure for applications under the Planning Act 2008
Infrastructure Planning (Examination Procedure) Rules 2010 (SI 2010/103)	Procedure for applications under the Planning Act 2008
Infrastructure Planning (Fees) Regulations 2010 (SI 2010/106)	Fees for applications under the Planning Act 2008
Infrastructure Planning (Miscellaneous Prescribed Provisions) Regulations 2010 (SI 2010/105)	Various provisions relating to projects considered under the Planning Act 2008, including the protection of certain operational and devolved consents.
Parts 2 and 3 of the Planning and Compulsory Purchase Act 2004	Local development plan

Legislation:	Applying to
Town and Country Planning Act 1990	Planning permission required for: <ul style="list-style-type: none"> -Generating stations in England and Wales up to 50MW -Above ground electric lines in England and Wales below 132kv -Underground electric lines in England and Wales -Other transmission and distribution network infrastructure in England and Wales (but excluding electric lines and pipelines falling within the Planning Act 2008) -Gas storage facilities in England and Wales (but excluding those falling within the Planning Act 2008) - Development in England and Wales for the transformation of biomass into biofuels or other energy products.
Town and Country Planning (General Permitted Development) Order 1995 (SI 1995/418)	Removes the need to apply for planning permission for certain development in England and Wales, such as certain transmission and distribution network infrastructure and certain domestic Microgeneration
Town and Country Planning (Fees for Applications and Deemed Applications) Regulations 1989 (SI 1989/193)	Fees for applications for planning permission in England and Wales
Town and Country Planning (Timetable for Decisions) (England) Order 2005 (SI 2005/205)	Exceptions to the requirements for timetables in England
Town and Country Planning (General Development Procedure) Order 1995 (SI 1995/419)	Procedure for applications for planning permission in England and Wales
Town and Country Planning (Hearings Procedure) (England) Rules 2000 (SI 2000/1626)	Procedure for applications for planning permission in England
Town and Country Planning (Inquiries Procedure) (England) Rules 2000 (SI 2000/1624)	Procedure for applications for planning permission in England
Town and Country Planning (Major Infrastructure Project Inquiries Procedure) (England) Rules 2005 (SI 2005/2115)	Procedure for applications for planning permission in England
Town and Country Planning (Determination of Appeal Procedure) (Prescribed Period) (England) Regulations 2009 (SI 2009/454)	Timetables for determination of the planning permission appeal procedure in England

Legislation:	Applying to
Town and Country Planning (Determination of Appeals by Appointed Persons) (Prescribed Classes) Regulations 1997 (SI 1997/420)	Procedure for planning permission appeals in England and Wales
Town and Country Planning Appeals (Determination by Inspectors) (Inquiries Procedure) (England) Rules 2000 (SI 2000/1625)	Procedure for planning permission appeals in England
Town and Country Planning (Appeals) (Written Representations Procedure) (England) Regulations 2009 (SI 2009/452)	Procedure for planning permission appeals in England
Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2000	Environmental impact assessment for infrastructure requiring Electricity Act consent in England and Wales, in the adjacent territorial sea or in the renewable energy zone (except the Scottish part).
Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 (SI 2009/2263)	Environmental impact assessment for infrastructure requiring Planning Act consent
Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999	Environmental impact assessment for infrastructure requiring planning permission in England and Wales
Conservation of Habitats and Species Regulations 2010	Site feature assessment for infrastructure in England, Wales or Scotland or in adjacent territorial waters (under Reg 61 of 2010 Regs) and potential protected species licence requirement (under Reg 53/54 of 2010 Regs)
Part 2 of the Food and Environment Protection Act 1985	<p>Food and Environment Protection Act licence required for the deposit of substances and articles in the sea.</p> <p>Infrastructure in waters adjacent to England or in the renewable energy zone included in a Planning Act consent can obtain a deemed Food and Environment Protection Act licence as part of the Planning Act consent.</p>
Schedule 4 to the Electricity Act 1989	<p>Procedure to obtain wayleaves for electric lines.</p> <p>Infrastructure included in Planning Act consent can obtain wayleaves as part of the Planning Act consent.</p>

Legislation:	Applying to
s.36A and s.36B Electricity Act 1989	<p>Procedure for generating stations in GB territorial waters to extinguish navigation rights.</p> <p>Infrastructure included in a Planning Act consent can extinguish navigation rights as part of the Planning Act consent.</p>
Animal By-Products Regulations 2005 (SI 2005/2347)	Approval of premises in England for the different types of treatment of animal by-products (such as incineration or bio-gas)
Environmental Permitting (England and Wales) Regulations 2010 (SI 2010/675)	Requirement for an environmental permit for various combustion activities and various activities involving waste
Section 41 Environment Act 1995	Charging schemes in relation to environmental permits
Greenhouse Gas Emissions Trading Scheme Regulations 2005 (SI 2005/925)	Greenhouse gas emission permit required for biomass combustion over 20MW (excluding hazardous or municipal waste installations)
Planning (Hazardous Substances) Act 1990	<p>Hazardous substances consent required for the presence of a hazardous substance on, over or under land in England or Wales</p> <p>Infrastructure included in a consent under the Planning Act or an Electricity Act consent can obtain deemed hazardous substances consent as part of the Planning Act or Electricity Act consent.</p>
Planning (Hazardous Substances) Regulations 1992 (SI 1992/656)	Procedure for hazardous substances consent in England and Wales
Electricity (Guarantees of Origin of Electricity Produced from Renewable Energy Sources) Regulations 2003 (SI 2003/2562)	Guarantee of origin for electricity produced from renewable energy sources
Guarantees of Origin of Electricity Produced from High-efficiency Cogeneration Regulations 2007 (SI 2007/292)	Guarantee of origin for electricity produced from high-efficiency cogeneration
Renewables Obligation Order 2009	Accreditation of generating stations as eligible for renewables obligation certificates
Climate Change Levy (General) Regulations 2001	Accreditation for climate change levy exemption certificates

Legislation:	Applying to
s.6 Electricity Act 1989	Licences for the generation, distribution, transmission or supply of electricity
Electricity (Class Exemptions from the requirement for a licence) Order 2001	Exemptions from the requirement for a licence.
Electricity (Applications for Licences, Modifications of an Area and Extensions and Restrictions of Licences) Regulations 2008	Procedure for applications for a licence
s.7 and s.7A Gas Act 1986	Licences for gas transporters, gas suppliers and gas shippers
Gas (Applications for Licences and Extensions and Restrictions of Licences) Regulations 2009 (SI 2009/3190)	Procedure for applications for a licence

APPENDIX 3

OVERVIEW OF REGULATION AFFECTING RENEWABLE ENERGY GENERATION

APPENDIX 3

OVERVIEW OF REGULATION AFFECTING RENEWABLE ENERGY GENERATION

Measure	Type	Expected Result	Targeted group and or activity	Existing or Planned	Start & end dates
Renewables Obligation (RO)	Regulatory	Increase generation of renewable electricity from a range of technologies across all scales (excepting most types of microgeneration following introduction of FITs) to 30%.	Primarily large scale renewable electricity generation by professional energy companies. Existing	Existing Planned	Started 2002 with support available to 2037 The new Government has proposed introducing a feed-in tariff for larger generation to operate alongside the RO.
Feed in Tariffs (FITs)	Financial	Incentivise generation of low-carbon electricity from a range of small scale technologies	Households, communities and small businesses investing in projects up to 5MW.	Existing	Introduced on 1 April 2010, this will close to new entrants in 2021 (although these new entrants will be eligible for 20 years support)
Renewable Heat Incentive (RHI)	Financial	A significant increase in renewable heat generation from a range of technologies to 12%	Individuals, communities and businesses generating renewable heat at all scales.	Existing	introduced in the United Kingdom on 28 November 2011
European Investment Bank (EIB)	Financial	EIB will provide up to £700 million towards bringing forward onshore wind projects up to the value of £1.4bn over the next three years	Onshore developers	Existing	
Green Investment Bank	Financial	To be determined	Developers of renewable generation	To be determined	To be determined

Measure	Type	Expected Result	Targeted group and or activity	Existing or Planned	Start & end dates
Bioenergy Infrastructure Scheme	Financial	Assist the development of the supply chain required to harvest, process, store and supply biomass to heat, combined heat and power, and electricity end-users.	Small or medium-sized producers of biomass in England supplying end-users in Great Britain	Existing	Started 2004. Round 3 of the scheme closed to applications in February 2010
Bioenergy Capital Grants Scheme	Financial	Promoting efficient use of biomass for energy by awarding capital grants toward the cost of equipment.	Businesses, organisations and charities in the commercial, industrial and community sectors that are considering investing in biomass-fuelled heat and/or combined heat and power projects, including anaerobic digestion	Existing	Started 2002. Round 6 closed to applications in April 2010
Woodfuel Implementation Plan and Woodfuel Strategy	Soft	Forestry Commission England will launch its Woodfuel Implementation Plan in 2010. This aims to deliver a sustainable biomass industry that brings forward an additional two million green tonnes of material per annum by 2020 from under-managed woodlands.	English suppliers of woodfuel – such as chips, pellets and logs	Existing	Launched on 29 June 2011. Plan for 2011-2014

Measure	Type	Expected Result	Targeted group and or activity	Existing or Planned	Start & end dates
The Rural Development Programme for England 2007-13 (RDPE)	Financial	Regional Development Agency grants are available to develop energy projects or small scale on farm renewable energy technologies, including AD, biomass boilers and CHP, and hydro or wind turbines. RDPE can also support alternative agriculture such as growing the feedstocks for use in low carbon renewable materials and fuel This includes bioenergy crops and niche and novel crops.	RDPE supports a range of eligible beneficiaries depending on the measures being enacted.	Existing	2007-2013
Energy Crops Scheme (ECS)	Financial	The ECS aims to increase the amount of perennial energy crops grown in England in appropriate locations for use in heat and electricity generation. It offers grants to farmers in England for the establishment of energy crops such as miscanthus and short rotation coppice.	Farmers (including tenants) and land owners (including local authorities but not central government).	Existing	The ECS is part of the RDPE 2007-2013. It is in place for the life of the programme.
Renewable Transport Fuel Obligation (RTFO)	Regulatory	Increase the proportion of renewable fuel in road fuel	Fuel suppliers, fuel consumers, farmers, investors, end users, public administration	Existing	15/04/08 – ongoing

Measure	Type	Expected Result	Targeted group and or activity	Existing or Planned	Start & end dates
Research on Indirect Land Use Change (ILUC) & sustainability	Soft	Behavioural change to understand the impacts of biomass use.	Investors, end users, public administration	Existing	Oct 2009 to Mar 2011
Development of advanced biofuels (Carbon Trust Grants)	Soft / Financial	Behavioural change /Installed capacity	Investors, end users	Existing	April 2009 to Mar 2011
National Planning Policy Statements	Regulatory	Large renewables projects (Nationally Significant Infrastructure Projects as defined in Planning Act 08) will benefit from a clear statement of national policy.	Decision making body for major projects. Also relevant to local planning authorities.	Existing	New Planning regime commenced March 2010
Zero Carbon Homes	Regulatory	All new homes in England to be zero carbon from 2016 – to stimulate greater uptake of on-site renewables (under review).	Development of new housing	Planned (under review)	To come into effect (subject to review) from 2016
Zero Carbon Non-domestic buildings	Regulatory	Ambition (under review) for all new non-domestic buildings in England to be zero carbon from 2019 (2018 for public sector buildings) – to stimulate greater uptake of on-site renewables.	Development of non-domestic buildings	Planned (under review)	To come into effect (subject to review) from 2018-2019

Measure	Type	Expected Result	Targeted group and or activity	Existing or Planned	Start & end dates
Low Carbon Buildings Programme	Financial	Individuals can apply for up to £2,500 per property and Charities, Schools communities and not for profit organisations up to £200,000 per project towards the cost of microgeneration technologies. It has supported over 19,600 projects to date.	Public	Existing	April 2006 - Spring 2010
Building Regulations	Regulatory	Progressive reduction in overall energy demand/carbon emissions of buildings – likely to stimulate greater uptake of on-site renewables.	All builders of new homes and non-domestic buildings and people carrying out work to existing homes and buildings.	Existing and planned	Ongoing New approved documents and guidance documents were published in April 2010
The Code for Sustainable Homes	Soft	Behavioural change. Voluntary standards for development of low carbon, and more environmentally sustainable homes, including promoting the role of renewable technologies.	Private and public sector house builders	Existing	Ongoing The Code was launched in December 2006

APPENDIX 4

SCALE AND OWNERSHIP OF EXISTING HUBS

APPENDIX 4

SCALE AND OWNERSHIP OF EXISTING HUBS

	Status	Glass Area now (ha)	Planned Glass Area (ha)	Energy source	No. of growers	Ownership model - glass	Ownership model - land	Ownership model – energy	Other businesses on site	Housing Component	Social elements	Logistics facilities link
Thanet Earth	Operational	25		4	3	1	1		No	No	No	No
Yorkshire Forward	Yes (Baarda)	9	17	1	1	1	1	1	No	No	Initially	No
Cornerways	Operational	19	19	1	1	2	2	1	No	No	No	No
Ebbsfleet	Stopped	0	56	2	9	4	2	1	No	Yes	Yes	No
Drax	Operational	20		1	1	2	2	1	No	No	No	No
Agriport A7	Operational	230	1000	4			1	2		No		Yes
Bergerden	Operational	110	600	2	17	1	1	3 then 2	No	No	No	No
Nieuwprinsenland	Operational		220	1 & 2		1	1	1 & 2	Yes	No		Yes
Terneuzen	In progress		250				1					Yes
Denmark	In progress		20				3	1	Yes	Yes	Yes	No
Poland	In progress		96	1	1			1				Yes
Almere	Never started	0	300	1		1	1		Yes	Yes	No	No

KEY:

Energy source
1. Waste heat / CO ₂ from secondary source
2. Centralised energy plant
3. Distributed with inter-connectors
4. Distributed – only power exchange

Ownership model - glasshouses
1. Owned individually by grower
2. Owned by energy source
3. Owned by landowner and rented to grower
4. Owned by landowner and leased to grower
5. Co-operative

Ownership model - land
1. Owned individually by grower
2. Owned by energy source
3. Owned by landowner and rented to grower
4. Owned by landowner and leased to grower
5. Co-operative

Ownership model – energy company
1. Privately owned
2. Joint venture amongst growers
Co-operative amongst growers

