District Eating
Turning kilowatt hours into food and flowers

MIDLANDS NET ZERO HUB

Midlands Net Zero Hub

Horticultural Waste and Energy Mapping Study

WP3: Project Identification and Development

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1.0 Introduction

District Eating Ltd (DEL) was contracted by the Midlands Net Zero Hub (MNZH) to complete a Horticultural Waste and Energy Mapping study across the Midlands region. The project was commissioned by Nottingham City Council on behalf of the MNZH and sponsored by BEIS. The primary aim of the study was to understand the linkages between energy and the agri-food sector and to seed projects for further development where possible.

The first work package, completed between November-December 2021, consisted of stakeholder engagement and mapping of key stakeholders in the MNZH region. This resulted in the selection of three sites for micro-feasibility work looking at the potential for low-carbon horticulture using waste heat. The second work package developed small-scale micro-feasibility studies that highlighted decarbonisation opportunities and new business models. The three micro-feasibility studies were completed between January 2022-March 2022.

This report comprises the final section of the project, Work Package 3. To conclude the project, DEL identified ideas for future projects stemming from the work completed, and developed new and related ideas. The remainder of this report summarises seven ideas for future project work that could build on the results of this project, and progress the opportunities identified to achieve measurable social, economic, and environmental impacts in the Midlands region and beyond.

2.0 Project Identification and Development

2.1 Local Authority Food Procurement Study

DEL encountered some common challenges during the micro-feasibility work, one of which was that when co-locating horticulture with sources of waste heat there may not be a large amount of land available for growing. This results in the need to develop business cases for greenhouses that are financially viable at relatively small sizes for commercial horticulture, often in the region of 1-3 Ha in area.

For a grower to have the confidence to grow at a commercial scale, they need a confirmed buyer for their produce. Buyers of this scale are typically wholesale purchasing organisations or supermarkets who buy for low prices and in large volumes. Although many growers aspire to sell locally, they are dependent on national wholesalers or supermarkets who purchase in bulk. Produce then goes to a centralised location, before being packaged and distributed widely, resulting in carbon emissions associated with food miles and loss of freshness and nutrition.

For a grower to consider selling locally, for example into schools, they would need to be able to bid for a significant purchasing contract before they invest in planting the crop. Developing a procurement strategy with this in mind, that prioritises decarbonisation and local production, could create and support a market that prioritises crops from variable scale, low-carbon localised greenhouses.

Procurement agreements with LAs could include the following attainable criteria:

- Carbon associated with production,

- Distance from point of consumption,
- Number of training/apprenticeship positions offered.

If greenhouse growers were able to bid for such contracts, they would benefit from building relationships with a reliable local buyer, and an understanding of the price point at which they need to produce to for a period of time. By specifying a requirement for low carbon produce, it would encourage new greenhouse developments and co-location, resulting in jobs and carbon savings. Growers would benefit from stable input prices compared with growers relying on fossil fuels.

Purchasing local, low-carbon produce for school meals directly from producers would appeal to LAs as it could contribute to regional decarbonisation strategies, as well as prioritising local economic development, job creation and food security. Some LAs already have local procurement strategies in place. For example, in Nottinghamshire, local procurement for school meals was calculated to generate over £5 million in value each year[1]. Furthermore, it was calculated every £1 spent on seasonal, local produce returns £3.11 in social, economic and environmental value[1].

Partnerships between greenhouses and local schools could create learning opportunities for pupils. Greenhouses could be used for educational visits, where pupils could see where and how the ingredients of their school dinners are produced. This could help engage children and young people in food growing and raise awareness of environmental issues. Greenhouses could also facilitate training and apprenticeship opportunities for older students. Another potential use of growing space could be for Social and Therapeutic Horticulture (STH), a

[1] https://www.foodforlife.org.uk/~/media/files/evaluation%20reports/fflp-nef----benefits-of-local-procurement.pdf

process of using plants and gardens to improve a person's physical and mental health[2]. This would help tackle the widespread anxiety that many children have struggled with since returning to school after the COVID-19 pandemic.

In order to set up procurement agreements between LAs and potential growers, the following questions should be addressed:

- What are LAs' current school meal procurement strategies?
- Do any existing initiatives encourage procurement of local and low-carbon produce for school dinners exist? If so, how do they work?
- What strategic interventions can be implemented to encourage more local food purchasing?
- Where local procurement strategies are already in place, how can new potential greenhouse growers benefit from these?
- Are local procurement strategies optimised? Is there room for improvement? Could growers be consulted to maximise effectiveness?
- How can LAs account for the added social value, biodiversity and carbon sequestration associated with switching to a local, low-carbon supplier?

This could be achieved with the following brief outline steps:

1. Conduct a review of existing procurement strategies and relevant academic literature and research. Include case studies of LAs with local procurement strategies in place.
2. Engage with key players from LAs, and with growers. Hold a workshop to discuss conditions required for purchase agreements between LAs and growers.
3. Recommend a methodology for measuring social value and scope 3 emissions arising from food supply chains in procurement policies.

2.2 Derelict Land Survey

DEL's approach in this project used sources of waste heat and renewable power as a start point and looked for land available nearby that is suitable for horticulture. An alternative method could be to search for derelict land that is suitable for horticulture and identify potential heat and power sources nearby. Derelict sites could also be considered for co-location of horticulture with new developments of technology that could provide heat and power, such as anaerobic digestion (AD), data centres, or other sources of industrial waste heat. This could be a suitable approach in urban areas, where land availability tends to be the main limiting factor. The first steps towards this would be a derelict land survey, identifying and mapping vacant and derelict sites in LA areas that could be used for growing, or wider ambitions, such as agri-park development. This work would build on the Vertical Farming Micro-Feasibility Study from Work Package 2 of this project, as a vertical farm could be a potential use of a vacant or derelict urban site.

Redevelopment or reuse of vacant sites is in the interest of LAs as it can bring a multitude of social, environmental, and economic benefits:

[2] https://www.thrive.org.uk/how-we-help/what-we-do/new-and-updates/social-prescribing-takes-step-forward

- Opportunities for carbon sequestration through urban farming, contributing to climate change targets.
- Increased urban food production, promoting local economic development, and reducing the need for imports.
- Stimulating local economic growth and job creation.
- Access to open and green spaces promotes health and wellbeing in cities.
- Using vacant urban sites as growing spaces reduces the pressure to build on rural greenfield sites, which can help conserve natural habitats and support biodiversity.
- Restoration and remediation of derelict land improves the feel of the area, creating liveable spaces for healthy and happy communities, and can lead to biodiversity improvements.

This project proposal is somewhat inspired by the Scottish Vacant and Derelict Land Survey, which was established in 1988. Every year, Scottish LAs collect data to establish the extent and state of vacant and derelict land in Scotland[3]. The survey is associated with the Vacant and Derelict Land Investment Programme, which has £50 million fund to support "place-based approaches to tackling persistent vacant and derelict land, delivering regeneration and sustainable inclusive growth as part of the green recovery."[4] The fund aims to promote equality, health and wellbeing, targeted at disadvantaged areas where persistent vacant and derelict land tends to be most concentrated.

[3] https://data.gov.uk/dataset/eef7eb74-f6b8-49bd-8efa-fc38730d3b3e/vacant-and-derelict-land-scotland
[4] https://www.gov.scot/publications/vacant-and-derelict-land-investment-programme/

Case Study: Urban Market Garden – Locavore, Glasgow

One example of how derelict land has been regenerated in Glasgow is Locavore's urban market garden. Disused, overgrown tennis courts were converted into a thriving garden producing fresh, healthy food less than 10 miles from Glasgow city centre. Locavore has used the growing space to build a successful social enterprise, supplying their shop, selling veg boxes to local customers, and supplying fresh vegetables to local cafés and restaurants.

Locavore's social enterprise has not only transformed two vacant sites, but also aims to provide social and environmental benefits. They support start-up growers by providing plots, and facilitate volunteering and informal training opportunities. Their local food production is estimated to save 200 tonnes of CO_2 per hectare of growing space, per year[5].

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A derelict land survey in the MNZH region could use the following outline method:

1. Obtain or create shapefiles of vacant and derelict land. Map vacant and derelict land alongside heat and power production to identify potential sites for horticulture.
2. Engage with relevant stakeholders in land management and urban planning to discuss potential for horticultural sites.
3. Conduct micro-feasibility studies for low-carbon horticulture projects on the identified vacant or derelict land sites.

2.3 Agri-park Feasibility Study

DEL's micro-feasibility work for this project involved greenhouses and vertical farms using waste heat and renewable power from industrial and agri-food sources. This encapsulates the idea of circular economy, as waste products from one process are used as inputs for another. Agri-parks build on this idea, giving it a broader scope. Agri-parks are more complex systems where a wider range of agri-food players operate together as a circular system. Collaborations

[5] https://www.landcommission.gov.scot/downloads/5f0d8d68ed71e_VDL%20Case%20Studies_14.7.20%20smaller.pdf

[6] Image source: https://www.slrmag.co.uk/glasgows-fresh-food-revolution/

are enabled between food production, processing, and waste systems. Opportunities beyond horticulture including aquaculture, myco-culture, insect farming, and algae and seaweed production can be incorporated. Future work could build on this project by investigating the potential to set up agri-parks around existing sources of waste heat, low carbon power, and waste CO_2.

Case Study: Agri-Food Innovation Park, Sungei Kadut, Singapore

Singapore has one of the most developed agri-tech sectors in the world. With little land available for agriculture, it is essential to maximise the use of space and increase urban food production. The planned 18-Hectare agri-park will be part of the wider Sungei Kadut Eco-District. The agri-park aims to co-locate high-tech vertical farming with food processing and packaging, distribution, consumption, research and development offices, skills and training facilities, waste management systems, and renewable energy generation[7]. This will facilitate collaboration between different players, enabling the discovery of synergies and circular economy solutions.

Image courtesy of JTC

Examples of synergies between agri-food businesses that could be facilitated in an agri-park include:

- Use of waste heat from industry to produce food via horticulture or aquaculture.
- Use of food waste and crop residues to make compost.
- Use of food waste and crop residues to produce biogas via AD.
- Use of biogas from AD to generate low-carbon power for use in horticulture or aquaculture.
- Use of solid waste from aquaculture to produce fertiliser for agriculture/horticulture.
- Use of fish sludge to culture black soldier flies, to provide protein for aquafeeds[8].
- Rainwater harvesting and circulation of water and nutrients.

To investigate the potential for agri-parks in the Midlands, DEL proposes the following steps:

[7] https://estates.jtc.gov.sg/sked/about#past-present
[8] https://www.globalseafood.org/advocate/an-introduction-to-circular-economy-principles-in-aquaculture/

1. Identify sites in the MNZH region with potential for collaboration between more than one agri-food business.
2. Conduct stakeholder engagement to find out about the perceived opportunities and challenges of collaboration across the agri-food sector.
3. Identify and engage with innovative agri-tech business in the MNZH region, including aquaculture and vertical farming.
4. Engage with other agri-parks from around the world to develop opportunities for learning and collaboration.
5. Hold a workshop with relevant stakeholders to discuss strategic interventions that could facilitate collaboration in an agri-park set-up.

2.4 Opportunities for Anaerobic Digestion Development and Co-location

The stakeholder engagement conducted in Work Package 1 of this project resulted in conversations with several AD plant operators in the MNZH region. Many of them were rural farmers who were interested in selling their waste heat into horticulture. DEL also received an expression of interest from Ancala, parent company of Biogen, one of the leading AD operating companies. Further investigation into the co-location of AD and protected horticulture could build on the stakeholder engagement and micro-feasibility work completed for this project by advancing understanding of the opportunities and challenges of collaborative relationships between AD and horticulture and identifying policy interventions that could aid their collaboration.

AD is of particular interest for several reasons:

- As of 2023, household food waste will have to be collected separately due to new regulations as part of the Environment Bill. If all LAs provide household food waste collection, the amount of food waste collected will increase by 1.35 million tonnes by 2029. This waste will need processing, and could be used as feedstock for AD. The number of AD plants is likely to increase over the next few years as these household food waste regulations come in. This means more opportunities for co-location of AD and horticulture, and opportunities to plan for co-location when building new AD sites.
- Of the stakeholders contacted during Work Package 1 of this project, the highest response rate was from AD operators. This indicates that AD operators are interested in forming collaborative relationships with horticultural growers and recognise the potential benefits of co-location.
- AD offers several opportunities for circularity when co-located with horticulture. For example, in addition to using waste heat form AD, horticulture can make use of the power generated via biogas CHP, and digestate can be used to make fertilisers. In turn, crop residues from horticulture can be fed back into the AD process. As discussed in the previous section, this could make AD sites suitable locations for agri-parks. Gas to grid AD plants produce a waste stream of high-quality CO_2, a key requirement for commercial horticulture, and another driver for co-location.

This proposed work package could be achieved with the following brief outline steps:

1. Engage with key stakeholders, for example LAs, food waste producers and processors, AD companies, AD plant operators, and horticultural growers, to learn about their perspectives on co-location of AD and horticulture.
2. Meet with LAs to find out how many new AD plants are in planning, where they will they be located, and if protected horticulture can be built into plans.
3. Add planned AD plants to map of existing AD plants.
4. Review how to facilitate planning for co-location of AD and horticulture.

2.5 Renewable Energy for Vertical Farming Mapping Study

During Work Package 2 of this project, DEL developed a first of its kind micro-feasibility study investigating the potential for vertical farming at a site with renewable energy generation. Vertical farming is a rapidly growing market that has generated significant interest from investors such as Walmart. Proponents believe that vertical farming has the potential to play a major role in food production systems as a sustainable supplement to conventional farming, thanks to its potential water savings, fertiliser savings, and no requirements for pesticides.

A key finding of DEL's vertical farming micro-feasibility study was that due to its high energy use, vertical farming must use electricity from renewable sources to avoid high CO_2 emissions and vulnerability to high electricity prices. This indicates that vertical farming could be co-located with existing and planned renewable energy generation to improve economic and environmental viability.

Co-location of vertical farming and renewable electricity generation can create win-win scenarios. When renewable electricity generators export electricity to the grid, they are paid a price per kWh that is lower than the national grid sale price of electricity. If they were to sell directly through a private wire to a customer, for example a vertical farm, both parties could benefit from cutting out the middleman.

Many sites with renewable power generation export some or all the electricity they produce to the grid. Although this project focussed on heat, many of the sites that DEL engaged with also produce electricity. For example, many AD sites, water treatment sites and biomass sites also have solar PV and/or CHP on site. Future work could investigate this further, re-engaging with DEL's contacts from this project and conducting another stakeholder engagement exercise, this time focussing on renewable energy instead of waste heat. This could help identify sites in the MNZH region and beyond that could be suitable for vertical farming.

Investigating the co-location of renewable energy generation and vertical farming could follow a similar format to the one followed by DEL for this project. The following steps provide an outline methodology:

1. Conduct a stakeholder engagement exercise with renewable energy generators and other key players, for example from LAs.
2. Map existing and future renewable energy sites and identify sites that could be suitable for vertical farming.
3. Monitor trends in renewable energy export price and purchase price, to decide on a win-win price that benefits both the generator and the grower.
4. Conduct micro-feasibility studies with outline economic modelling for vertical farms at sites with renewable electricity generation.

2.6 Crops for Vertical Farming Market Research Study

The most common crops grown in vertical farms at present are leafy greens, herbs and microgreens. These are high-value products that can be grown quickly, in a small area of space. The increasing number of vertical arms in the UK is likely to increase British production of these leafy greens, herbs, and microgreens. It is unknown how this will impact their market prices, or whether increasing availability of gourmet crops such as microgreens and less common herbs will impact the UK's appetite for them. Before recommending vertical farming as a viable business plan, it would be beneficial to have a better understanding of the market dynamics of the most common vertical farming crops.

With an increasing number of people interested in vertical farming, it would be beneficial to research other high value crops that could potentially be suited to vertical farming. The high level of control of environmental factors such as temperature, humidity, and combinations of different nutrients in a vertical farm suggests that it could be suitable for cultivation of medical grade plant extracts and oils. There could be opportunities for production of the following types of crops:

- Nutraceutical: edible substances that provide medical or health benefits, including the prevention and treatment of disease.
- Cosmeceutical: bioactive ingredients in cosmetic products that are purported to have medical benefits.
- Pharmaceutical: substances used in the diagnosis, treatment, or prevention of disease and for restoring, correcting, or modifying organic functions.

A market research study could assess the potential market opportunities in each of these categories, and address the regulations associated with production of each. For example, there are rigorous protocols regulating the quality of ingredients intended for medical use. Some

crops may need a license to produce, for example cannabis. The work should evaluate the licensing process to determine in what cases becoming a licensed grower would be feasible.

The proposed methodology for this project would be as follows:

1. Conduct desk-based research and consult experts and existing vertical farmers on the market trends and opportunities for different vertical farming crops, aiming to address the following questions:
    - What is the current and future potential market for herbs and microgreens in the UK?
    - Are herbs and microgreens likely to reach market saturation?
    - Is it technically possible and economically feasible to grow other fruit, vegetables or cereals in vertical farms, and if so, where are the likely market opportunities?
    - Are medical grade crops a viable opportunity worth pursuing?
    - Are there opportunities in the production of medical marijuana in the UK?
    - What is the potential for producing cosmeceutical, nutraceutical, and pharmaceutical feedstock crops?
2. Produce a report evaluating the opportunities and challenges, market trends and future potential of different crops.

2.7 Carbon Funding for New Entrants in Regenerative Farming

The green revolution is affecting all areas of food production, not just greenhouse horticulture. Due to the increasing prevalence of carbon offsetting, there is an emerging trend of international investors purchasing UK farmland and uplands for the purpose of carbon sequestration. Because of this, UK farmland is being taken out of production to sequester carbon to offset international business operations. A return on investment can be generated through the sale of carbon credits, so food production is not always prioritised in these arrangements. This process is resulting in high land prices, making land purchase of land for farming less accessible, especially for new entrants. It is also threat to our food security. With less land in production, the UK's reliance on imports will increase.

The trends towards impact investment and carbon offsetting mean that there is an opportunity to harness some of the finance to purchase land that can be used for regenerative agriculture that can sequester carbon and produce food, while also improving habitats and biodiversity. In addition, farming in this way could result in jobs, training and apprenticeship opportunities and access to land for new entrants if an organisation could be set up with these purposes in mind.

This issue could be investigated further by environmental consultants, in the following work package outline steps:

1. Complete a risk assessment evaluating the likely effects of using land for carbon sequestration on our national food security.
2. Conduct research into the following questions:
    - What is the carbon sequestration and biodiversity potential of regenerative agriculture versus wilding?
    - How much food could be produced through regenerative farming practices while also sequestering carbon in the soil? This comparison could be completed for different land types and geographical areas.

- Could the case be made for legislative protection in regard to removing land from production?

3. Explore business models that encourage new entrants in the agriculture industry. Develop business models for a UK land fund with a view to enabling access to land for regenerative farming, food production, carbon sequestration and increased biodiversity.

3.0 Conclusion

The Horticultural Waste and Energy Mapping Study completed by DEL contributed to innovation and decarbonisation in the Midlands by advancing discourse around co-location of horticulture and waste heat, and producing three micro-feasibility studies that can be used as blueprints across the region. These included two site-specific greenhouse proposals, and a first of its kind vertical farming introductory guide. As is often the case, these initial explorations led to more questions, and have revealed opportunities for further work.

The ideas for development in this report are just several of a potentially long list of future projects that could build on the Horticultural Waste and Energy Mapping Study completed by DEL, and contribute to decarbonisation, innovation, and development in the Midlands and beyond.