Community Energy Fund – Feasibility Report Structure

Background

Under Stage 1 of the Community Energy Fund (CEF), eligible organisations can receive funding to investigate the feasibility of successfully developing a community-scale, community-owned energy related Scheme. The results of this investigation must be presented to your Local Net Zero Hub in a feasibility report. The strength of the feasibility report will be a key factor in evaluating projects for further funding at Stage 2. To assist communities in gathering this information and to ensure a consistency of information across multiple projects, we have provided guidance on what your feasibility study needs to cover. Some of this guidance is only applicable to Type A Projects covering preparation for projects with energy assets. For Type B Projects working on energy efficiency schemes there will be more emphasis needed on the capacity building and community engagement achieved.

Using this template

The following guidance sets out the basic structure for compiling the feasibility report for Stage 1 of CEF. You should include all information that is relevant to your project.

Report length: There are no restrictions on report length, but please note that the report should only contain information which is of direct relevance to the project. Appendices can be used to include reports received from external consultants relating to specific aspects of the project.

Format: The report should address all sections listed below. Please answer the specific questions as well as adding any further information that will help assess the viability of taking the project forward to Stage 2 and beyond. Please also attach any relevant documents, maps, quotes, surveys, etc. undertaken as part of the feasibility study.

Key points to producing a feasibility report: Remember that a feasibility study is a formalised, written approach to evaluating your proposed Scheme. It can help you identify:

- What the needs of the community are
- Whether your idea is technically and financially viable or not
- Useful facts and figures to aid decision-making
- Alternative approaches and solutions to putting your idea into practice.

Outline structure: Your report should include, as a minimum, the following sections:

1. Executive Summary
2. Statement of Need and Location
3. Options Assessed and Preferred Solution
4. Land Rights, Planning, Permits and Consents (Type A only)
5. Community Engagement
6. Community Benefits
7. Financial Projections
8. Operation, Legal Structures and Governance
9. Scheduling
10. Conclusions and Next Steps

The detail on the following pages provides more depth to the elements you will need to cover in your report.

1 Executive Summary

1.1 Project summary

Please provide a short summary of the background to the project.

- Who is the organisation receiving CEF funds, and which community is involved?
- What legal structure does this organisation currently have?
- Who are the key players involved?
- What technology options have been explored?

Sheffield Renewables Ltd is a well-established community energy group structured as a Community Benefit Society (reg.no. 30736R) with ~200 members that vote on major strategic decisions at Annual General Meetings (AGMs). Our board of directors and advisors make day-to-day decisions through board, finance and project sub-committees, with the directors taking any key decision by majority vote. We have been in operation for over 10 years. During this period, we have channelled community investment from two successful share offers into funding and operating 5 solar photovoltaïc (solar PV) schemes for a school, a community centre, a police station, a wholesale food co-operative and a co-housing project. By providing our partners with green electricity, we have helped them make financial savings while also supporting their decarbonisation and energy resilience. Our action also extends to energy efficiency consultancy, sustainability advocacy and financial support for local and international initiatives aligned to our environmental and social values.

Sheffield Renewables (SR) has historically attracted potential partners. However, the COVID pandemic decreased our engagement level. Despite some success (e.g. Five Rivers Co-housing), our progression has since stagnated. At our 2022-2023 AGMs our shareholders conveyed a clear wish that their investments had more impact on Sheffield's decarbonisation by building up capacity. Since then, we have aimed to proactively screen Sheffield for new impactful projects and managed to secure grants to support this work.

Agriculture accounts for 12% of the UK greenhouse gas (GHG) emissions and ~50% of the country's methane emissions. ~15% of a UK farm's emissions come from energy use and dairy farms use 3 - 4 times more electricity than a regular farm. Within Dungworth, Sheffield, Cliffe House farm (a.k.a. Our Cow Molly Ltd) is a much-loved local dairy farm which has thrived in part by diversifying into ice cream production.

Sheffield Renewables has been approached by Edward Andrew, owner of Our Cow Molly, to help him increase the sustainability of his operation by expanding on-site renewable energy generation. Although the farm is situated close to the Peak District, it is also close to the deprived wards of Stannington and Hillsborough. It provides employment opportunities for local people as well as acting as a visitor attraction and education facility. Concurrently, the farmer has been approached by SYEcofit, a Sheffield-based Community Interest Company that offers building insulation improvement services and has also an interest in hydrogen production. SYEcofit offered the farmer to diversify his revenue stream by hosting a 1.5MW hydrogen production facility at Our Cow Molly.

A joint project was therefore devised in which:

- Sheffield Renewables would be in charge of assessing the feasibility of deploying a range of renewable electricity generators to power the farm and SYEcofit's 1.5MW hydrogen production facility, namely: rooftop and ground-mounted solar PV and a wind turbine.
- In order to reduce the farm's methane emissions, SYEcofit would investigate the feasibility of installing an anaerobic digester (AD) on the farm's estate.
- In order to diversify the farm's revenues, SYEcofit would investigate the feasibility of installing a hydrogen production facility at the farm, as well as defining a business case for the off-take of hydrogen.
- Various academics from the University of Sheffield would provide expertise in electrical systems integration and anaerobic digestion.
- The consultancy Pure Leapfrog would investigate possible governance structures and financial models for the project.

This formed the basis for our stage 1 Community Energy Fund application and its "sister" CEF application from SYEcofit.

1.2 Feasibility summary

Please provide a short summary of your findings.

- Is the technology suited to the location and proposed installation?
- Is there adequate community support for the project?
- Is the project likely to secure the planning and permitting required?
- Is the project likely to meet the requirements to raise suitable capital investment?

During the 9 months of this feasibility study, Sheffield Renewables actions and investigations have led to the following findings and results:

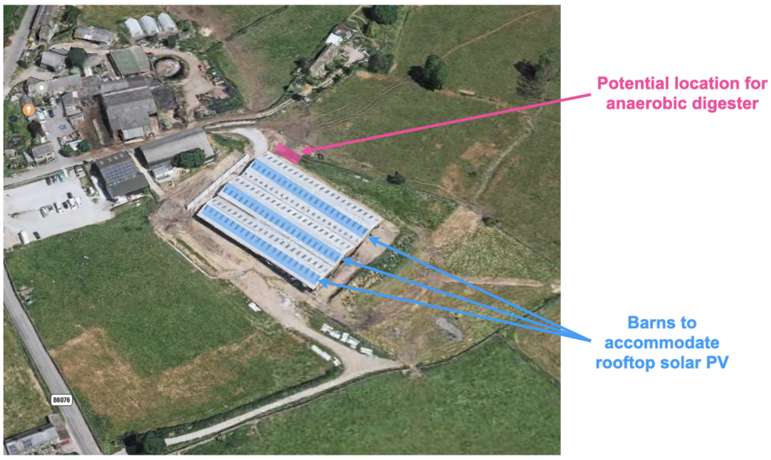
- Presentation of the project at local fairs in Sheffield, national Open Farm Sunday at Our Cow Molly and community energy conferences in York, Sheffield and London has revealed a strong community interest and support in our plans to decarbonise Our Cow Molly.
- Engagement with supporters through Sheffield Community Energy, the South Yorkshire Sustainability Centre (The University of Sheffield) and Sheffield Renewables shareholders.
- Our Cow Molly farm has an extensive and stable electricity usage (~350MWh/year, i.e. 3 times that of a high-electricity user dairy farm), 60% of which occurs between 7am-7pm. This translates into substantial annual electricity bills and the farm would therefore greatly benefit from on-site renewable electricity generation, notably solar PV.
- Our Cow Molly's location at the top of a hill (Dungworth, Sheffield) with wind speeds of 7-8 m/s and land availability suggest that the site is a prime candidate for wind power.
- The relative proximity of houses, power lines and the results of an initial road survey we have commissioned suggest that only turbines of up to 600kW (hub height ~40m) could be brought to site and installed.

- The shallow pitch and south orientation of large barns roofs and the availability of a field with a south-facing slope suggest that the site is also a prime site for both rooftop and ground-mounted solar PV, with the possibility to capture sunlight throughout the day.
- The farm has planning permission for an anaerobic digester and the local planning authorities have confirmed that rooftop solar PV on the barns would fall within permitted development rights.
- Because of its location in Sheffield's Green Belt and proximity to multiple dwellings and the Peak District national park, deployment of a permanent ground-mounted solar PV system and a wind turbine at Our Cow Molly would require enhanced community engagement and ecological and environmental assessments with substantial costs and risks with no guarantee of securing planning permission.
- The DNO/DSO Northern Powergrid have stated that up to 257kW of generation can be installed on the farm without the need to reinforce the local network.
- Within this local constraint, 200kWp of rooftop solar PV on the barns and a 33kW anaerobic digester would be sufficient to cover 64% of the farm's daily electrical load between April-September, and even more with load shifting to exploit the peak of solar generation.
- A budget estimate from DNO/DSO Northern Powergrid for the site has shown that deploying enough renewable generators to power SYEcofit's 1.5MW hydrogen production facility would trigger local grid reinforcement works costing ~£350k, and might also require a transmission grid impact assessment ("statement of works") to be submitted by Northern Powergrid to National Grid for the cost of ~£30k. Total duration: 28 months, up to 5-10 years if transmission work was needed.
- In order to be economically viable, according to Logan Energy's hydrogen feasibility report, SYEcofit's 1.5MW hydrogen facility (£5.2 million CAPEX, £300k annual OPEX) would need to operate at least 15 hours/day for 300 days/year and sell the corresponding 150kg hydrogen generated at £10/kg, with a payback time of 35 years. However, that report did not consider the electrical needs (4.5GWh-6.75GWh) and costs of the 1.5MW required by the hydrogen production facility.
- Consequently, the identification of these constraints have led to the decision to split the project into two phases:
  - Phase 1, more attainable, is logically focusing on decarbonising the farm's activities and our G99 application has led to a connection offer by Northern Powergrid to connect 200kWp of rooftop solar PV on the barns and a 33kW anaerobic digester.
  - Phase 2 would aim to deploy ground-mounted solar PV and a wind turbine to try to power a green hydrogen production facility aimed at diversifying revenue for the farm and generating income for SYEcofit.
- However, our investigations have shown that the total capacity of renewables that can be realistically deployed at Our Cow Molly (~2.16MW), even after going through the hurdles listed above, would not be able to provide enough electricity to power the hydrogen facility continuously.
- Since "phase 1" (i.e. 200kWp of rooftop solar PV on the barns and a 33kW anaerobic digester) does not require new planning permissions or grid improvements, it can be delivered relatively quickly by community investment and have immediate environmental and financial benefits for Our Cow Molly.

1.3 Case study statement

Please provide a summary 'case study' paragraph (approximately 200 words) which can be used to highlight the outcomes of the project's feasibility study. It should be suitable for use in promotional literature for CEF. A named quote from the organisation receiving CEF funds or a community-based partner should also be included. If possible, a photograph relevant to the project should be included.

Dairy farms contribute to ~20% of the UK's agricultural value output, play a significant role in food security and dairy products help protect against colorectal cancers. Funded by a stage 1 CEF, our case study of Our Cow Molly has confirmed that such dairy farms are intensive energy users. We have deciphered how Our Cow Molly uses electricity on a daily and annual basis and our investigations have also underscored the value of its roofs and land in decarbonising its operations by deploying renewable electricity generators. Our work shows that a suitable combination of rooftop solar PV on barns and an anaerobic digester can provide a substantial proportion of the dairy farm Our Cow Molly's annual electricity demand while also reducing its electricity costs.



"This feasibility study has allowed us to examine different technologies that can help decarbonise farming and move it along the road to Net Zero. We have developed a clear investable pathway for *Our Cow Molly* and we will share that knowledge with other community energy groups so it becomes a model for other dairy farms. The insights we have gained have been valuable learning for us and the other partners involved." Nicolas Viphakone, Technical Manager, Sheffield Renewables

(200 words)

2 Statement of Need and Location

Please summarise the requirements of the community that the proposed Scheme aims to meet. This should take any relevant output data from any technical assessment to provide specific information, for example electricity or heat demand, number of buildings to be served etc.

Where there is a specific energy asset (e.g. wind turbine, heat centre) please give an overview of the reasons for choosing the proposed site.

Information should be provided on:

- the legal status and cost of securing the land
- cost of connecting to the national grid and any expected constraints or time delays
- means of distribution to users.
- suitability of the site for the proposed technology
- restrictions on the site's usage (e.g. Site of Special Scientific Interest (SSSI) protection, Area of Outstanding Natural Beauty (AONB), National Park)
- requirements for support from any neighbouring landowners who could object to the use of the site or deny access

More detailed analysis for the proposed outcome for each of these factors will be covered in the sections below. In this section you should summarise these at a high level to support the selection of the chosen site.

As detailed in Section 1.1, our community of shareholders have expressed the wish that their investments had more impact on Sheffield's decarbonisation, asking us to build up project capacity. This feasibility study of deploying substantial renewable electricity generators at a local dairy farm embodies the strategy of new impactful projects that Sheffield Renewables is now pursuing.

Moreover, Edward Andrew and his dairy farm Our Cow Molly are a pillar of Dungworth's community and an exemplar of agricultural economic diversification, from upgrading milk into dairy ice cream, to being involved in horticultural research with The University of Sheffield, in local environmental education and tourism. In our experience, securing a site and cooperation with its owner constitute the main barrier to successful community energy projects. Therefore, we were delighted when Our Cow Molly approached Sheffield Renewables to increase the sustainability of its operations and help the farmer diversify further into renewable energies. Its owner Edward Andrew is a long term environmentalist with a strong interest in green technologies, however he has been restricted by finance and organisational capacity to progress his decarbonisation plans further.

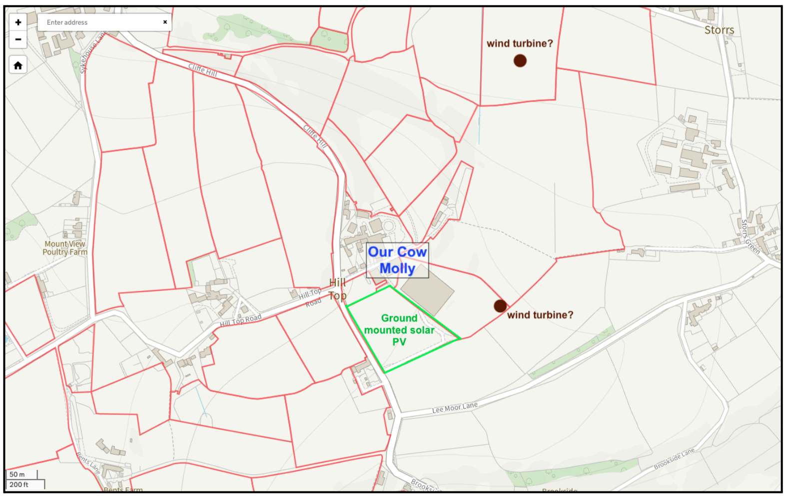
Our investigations have shown that Our Cow Molly has a substantial and stable electricity usage (~350MWh/year, i.e. ~3 times that of a high-electricity user dairy farm) spread across two MPANs: an old British Gas meter ("BG") for most of the farm and a modern meter with half hourly reading capability ("HH") for the dairy-related operations specifically. Importantly ~60%-75% of this electricity usage occurs during daytime. We have also delineated the farm's electrical load patterns and found that throughout the year, the farm as a whole experiences a 30kW base load and 2pm-4pm afternoon peaks of 130-140kW that could be shifted earlier in the day, according to the farmer. This heavy electricity usage stems from the various pieces of equipment that are nowadays essential for a modern and efficient dairy farm (e.g. lighting, milk bottles and tanks washing and sterilisation, chillers, fridges, etc). Consequently, the farm has a substantial electricity bill of ~£76k/year.

Collectively, all these findings suggest that Our Cow Molly's intensive and invariable electricity usage, a good fraction of which occurs mostly during daytime, could certainly be met with an adequate level of solar PV electricity generation. Moreover, methane from cow manure constitutes a non-negligible part of a dairy farm's GHG emissions. Therefore, a 33kW anaerobic digester that would use manure as feedstock could be a solution of choice to reduce the farm's methane emissions while also meeting its almost constant 30kW electrical base load. Combined, the deployment of these renewable assets would also reduce electricity costs for the farm.

Our discussions with the farmer and visits at Our Cow Molly have revealed that the farm is well-suited to accommodate our proposition. The newly-constructed barns (see picture above) were built with rooftop solar PV compatibility in mind and are already preparing to host an anaerobic digester (i.e. slurry collection, storage and circulation systems, planning permission secured). Besides, our investigations have shown that rooftop solar PV on those barns falls within permitted development (see section 3) and that 205kWp of rooftop solar PV and a 33kW anaerobic digester of renewable electricity generators capacity fits within the farm's current grid connection capacity (~270kW).

SYEcofit's proposition to diversify Our Cow Molly's revenues with a green hydrogen production facility has come with challenges that Sheffield Renewables was also in charge of investigating, mostly from a renewable electricity generation point of view. At the inception of the project, we were informed by SYEcofit that the facility would require a large amount of electrical power (1.5MW).

Since covering the new barns entirely with rooftop solar PV would only reach ~400kWp, with the support of the landowner Edward Andrew Sheffield Renewables explored other avenues to deploy enough renewables to meet the demand of this hydrogen production facility. Most of the surrounding fields belong to the farm (see picture below) and while Edward Andrew is supportive of renewables deployment, we were mindful in our assessments to limit land use for ground-mounted solar PV to a single parcel. This field is not essential to the farm's activities, is of relatively poor grass quality and could accommodate up to 1.15MWp of solar PV (see picture below).



Land parcels owned by Our Cow Molly (red-delimited) and putative locations for additional renewables

As the name of the locality suggests ("Hill Top"), Our Cow Molly is situated on a hill, at 230-250 meters above sea level and is locally renowned for its south-west wind throughout the year. In theory, these conditions make the site ideal to harness wind power. Once local constraints are taken into account (e.g. local power lines, bird paths, neighbouring properties/buildings), our investigations have identified two potential locations suitable for 0.2-2 MW wind turbines (see picture above and Section 3)

We were hoping that rooftop solar PV on barns, a ground-mounted solar PV farm and a wind turbine combined would have a higher chance of providing the huge electrical power that SYEcofit's hydrogen facility requires. However, a road access survey that we commissioned has shown that local road constraints between Sheffield M1 motorway and Hill Top could hamper the transport of components for the largest turbines (i.e. 1-2 MW) and therefore their installation (see Section 3). Moreover, our planning and wind consultants have highlighted numerous planning hurdles faced by both ground-mounted solar and wind power deployment at Our Cow Molly (e.g. ecological surveys, biodiversity net gain plan, visual impact studies, see Section 4) as well as the importance of winning over the support of the local community for this part of the project (termed "phase 2"). In particular, the support of a local beekeeper ("Sheffield Honey") who lives in the vicinity of the putative wind turbine site closest to the barns would have to be won over.

Finally, a "budget estimate" that we commissioned from the DNO/DSO Northern Powergrid has shown that connecting electricity generators beyond 270kW at Our Cow Molly would require local grid reinforcement works, at a cost of up to £400k (including £20k-£30k for a potential "statement of works", a study used to inform National Grid of the impact of connecting generators above 1MW). Importantly, during our conversations, Northern Powergrid also informed us that relying on the grid to produce hydrogen has to be avoided at all costs both to avoid losing the "green" label for the hydrogen produced (i.e. the grid is not currently free of GHG emissions) but also to avoid much higher electricity costs (usage and capacity charge) that would make such business case unviable. This has also been confirmed by Logan Energy and The University of Sheffield, contributing partners to this project as electrolyser solution provider and energy systems consultants respectively. Another financial concern would be the change of status for the farm that drawing so much power from the grid could trigger, from business energy user to industrial energy user.

Therefore, the location of Our Cow Molly, its buildings and land, operating patterns and the enthusiasm of its owner all demonstrate a strong potential for the deployment of some rooftop solar PV and an anaerobic digester to support the decarbonisation of this dairy farm (termed "phase 1"), while allowing it to reduce its energy costs. This aligns with the interests of both the farmer and our community of shareholders. On the contrary, this feasibility study has helped Sheffield Renewables realise that the deployment of additional renewable generators to power a hydrogen production facility to supplement Our Cow Molly's revenues is associated with numerous hurdles and issues that make "phase 2" a significantly larger challenge and more difficult to make financially sound (see "phase 2" in Section 3, Section 4 and more in Sections 7, 8 and 10).

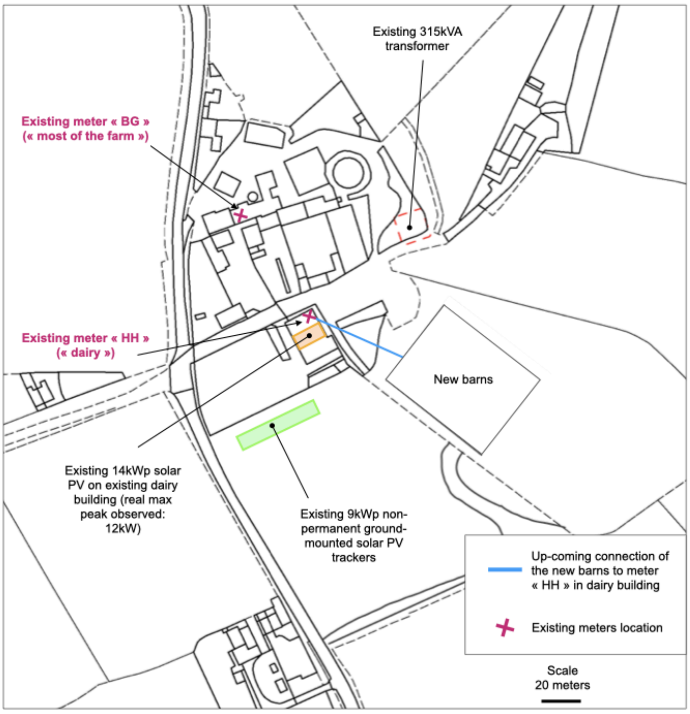
3 Options Assessed and Preferred Solution

Please outline what technologies have been considered and which technology or technologies have been selected to take forward by the organisation receiving CEF funds. Key things to cover:

- What is the preferred technical solution?
- What investigations have been carried out into the suitability of this technical solution to the proposed location?
- Have any alternative technical solutions to the preferred option been considered?
- What limitations to the technical solution have been identified (e.g. potentially limited times of operation, seasonality of operation, resource limitations, applicability constraints)?

Analysis of Our Cow Molly's current electricity demand and systems:

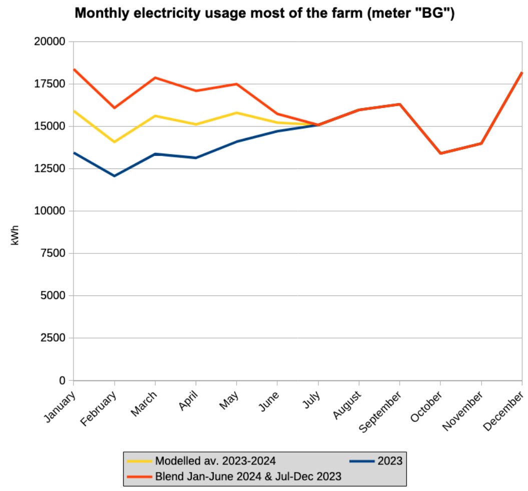
To understand Our Cow Molly's current electrical systems and demand, we obtained electricity costs, billing structure and some usage data from Jack Hernandez from Excel Utilities (broker of energy supply and related services for the farm). This company provided half hourly readings for the modern meter monitoring dairy-related electricity usage (that we term "HH") and monthly readings for the old British Gas electricity meter monitoring the usage for the rest of/most of the farm (that we term "BG"), see picture below.



Our Cow Molly current electrical system

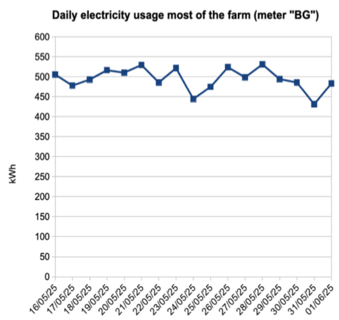
While we were given 3.5 years of monthly usage data for meter "BG", the farm gradually resumed its activities and electricity usage after the 2020 COVID pandemic, resulting in a 1.7-fold increase in annual usage in 2022 and 2-fold increase in annual usage in 2023, both when compared to 2021. Moreover, at the start of this project we only had six months of data for meter "BG" for 2024 but could already detect an additional

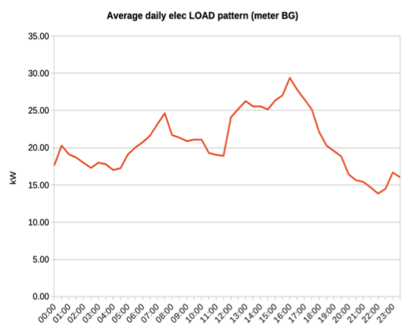
27% increase in electricity compared to the first 6 months of 2023. Initially, all this made it difficult to define a base pattern for monthly and annual electricity usage to work with.

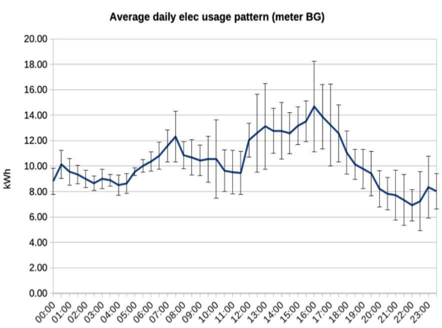


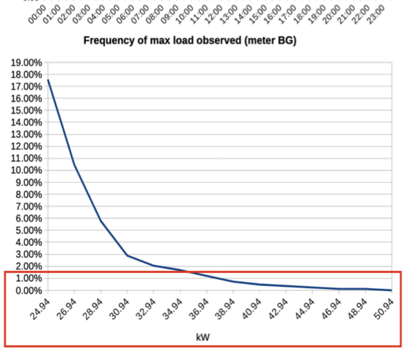
Consequently, we tried several modelling approaches and settled for a canonical year modelled from monthly averages between 2023 and 2024 (yellow curve, see picture opposite). This turned out to be the most accurate model (see below). We found that "most of the farm" connected to meter "BG" uses ~15MWh/month or ~185MWh/year, with very little month-to-month variation (~8%, see picture opposite).

In order to obtain granular electricity usage data for meter "BG", with permission from the farmer we commissioned the installation of a temporary half hourly monitor on meter "BG" from our regular solar PV installer [HomeEco Energy](). We collected and analysed only two weeks of data because as mentioned the electricity usage captured by meter "BG" is very stable, suggesting very similar usage patterns on a daily/weekly basis. Our own set of half hourly data for meter "BG" showed a very stable daily electricity usage of ~494.4kWh/day on average (see picture below). With ~30 days/month, 30 x 494.4 = 14.8MWh/month is very much in line with the monthly electricity usage we modelled for meter "BG" (see yellow curve picture above).





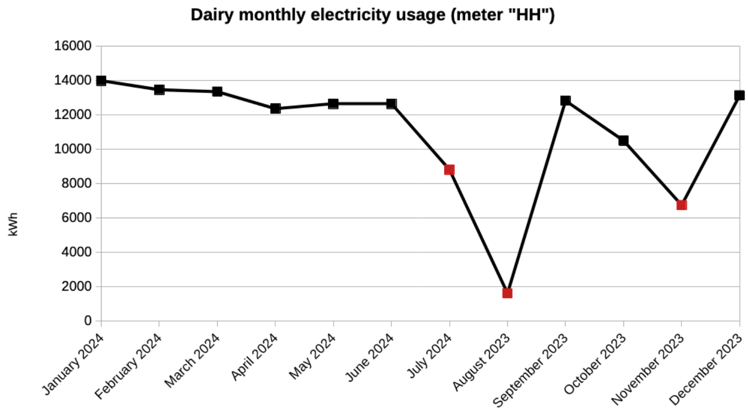




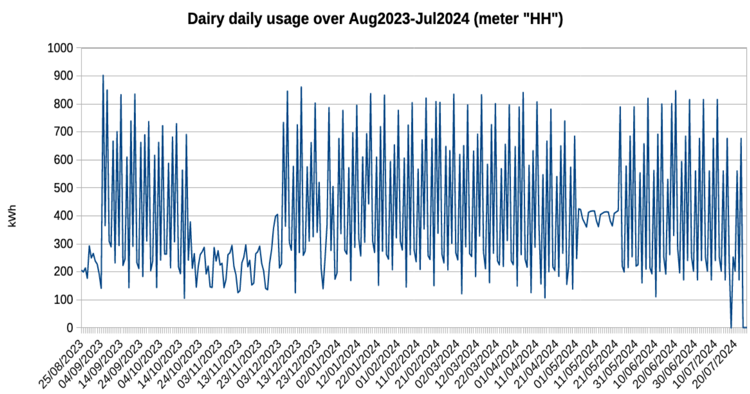
Most of the farm (connected to meter "BG") has an almost constant ~17.5kW base electrical load and an average daily load of 20.65kW (see picture opposite). On average, this load increases from 17.5kW to 20kW between 06:00 and 12:00 and then to 25-30kW between 12:00 and 16:30 to then decrease gradually between 16:30-22:30 back to a 15-17.5kW baseload.

However, this is an average and the actual maximum electrical load observed was 51kW. An analysis of the frequency of maximum load observed shows that while 18% of the load events at meter "BG" are >25kW, less than 0.5% of the loads are above 41kW (see picture above and red rectangle). We also found that 59.1% of the usage captured by meter "BG" occurs during daytime (7am-7pm), which shows that some of the demand on that part of the farm is compatible with solar PV. The farmer acknowledged that some of the load could be shifted to daytime to maximise the use of future solar PV generation. The lowest electricity usage is observed during Saturday-Sunday, 08:30-11:30 (load up to 12-16kW) while the highest usage is observed 12:00-18:00 any day of the week (load up to 34-50kW). Overall, electricity usage from meter “BG” at a particular time of day does not vary much from one day to another day (~15% variation on average).

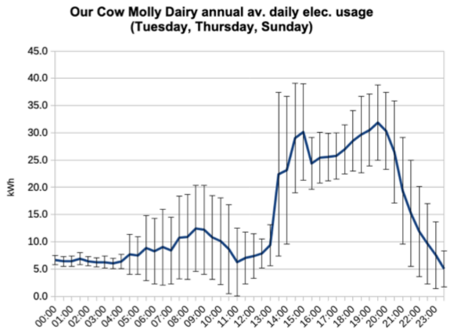
As mentioned above, in order to understand the electricity load and usage of the dairy (meter “HH”), we used half hourly data provided by Excel Utilities. However, a number of things complicated this analysis. Firstly, we were provided a year’s worth of data spanning across August 2023 up to July 2024, rather than one whole calendar year. Therefore, we converted them into a composite calendar year of data from 2023 and 2024. Secondly, we quickly noticed numerous periods with no electricity usage in the data from meter “HH”. The farmer confirmed that during the energy crisis caused by the Russian invasion of Ukraine, he reduced his use of electricity from the grid and resorted to diesel generators to power the dairy instead. Therefore, ignoring July, August and November 2023 as outliers, we found that the dairy uses ~13MWh/month, with very little month-to-month variation (~8%) and ~132MWh/year (see picture below).

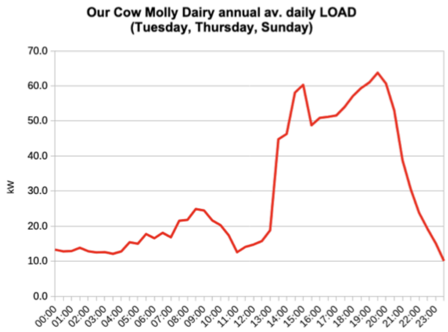


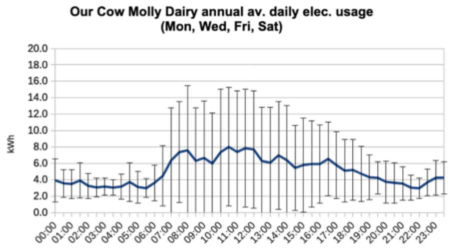
Thirdly, an analysis of the daily electricity usage for meter “HH” also revealed interesting see-saw patterns. These are caused by the fact that the dairy uses 600-800kWh/day when it operates on Tuesday, Thursday and Sunday and ~250kWh/day the rest of the week (see picture below).

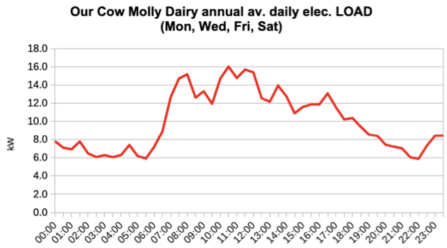


We also found that when the dairy is operating, 300kWh are used 5am-8pm whereas 100kWh are used 8pm-5am. Therefore, 75% of the dairy's electricity demand occurs during daytime and 25% during nighttime, which demonstrates again the suitability of this dairy farm for solar PV.



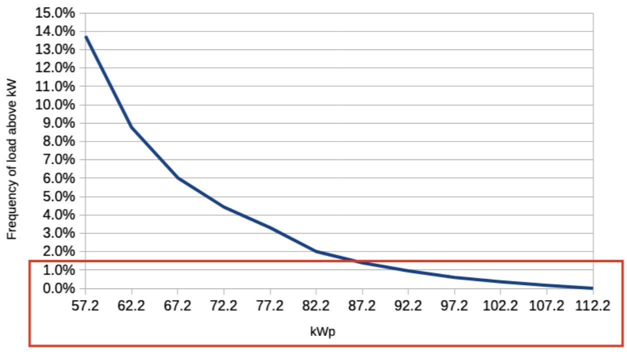






As seen in the picture opposite, when it operates the dairy has an almost constant ~13kW base electrical load and an average daily load of 29kW. On average, this load increases from 13kW to 20kW between 04:30 and 09:00 and then decreases back to 13kW between 09:00-12:30. It then shoots to 50-60kW between 12:00 and 20:00 to then decrease gradually back to a 13kW baseload between 20:00-23:30. On non-operating days, the dairy experiences a 6kW base load that increases to 12-16kW between 05:30-08:00 which then gradually decreases back to a 6-8kW between 17:00-23:30.

However, these figures are annual daily averages and the actual maximum electrical load observed at the dairy meter "HH" was 112kW. An analysis of the frequency of maximum load observed shows that while 14% of the load events at meter "HH" are over 57kW, less than 0.5% of the loads are above 97kW (see picture below).



These daily cycles of morning and afternoon load and this constant base load stem from milk bottles and tanks handling, washing and sterilisation, chillers and fridges that together form the core of the dairy's operations. These cycles did not fluctuate significantly between seasons, in line with the farm's almost constant monthly electricity usage (see above).

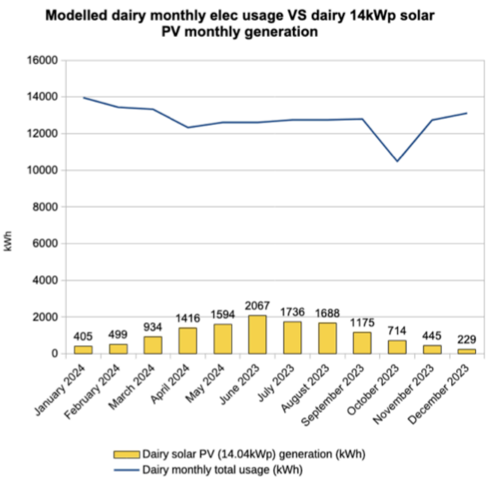
Fourthly and last, we found that the electricity usage data captured by meter "HH" is influenced by the dairy's current 14kWp rooftop solar PV system (see picture below).

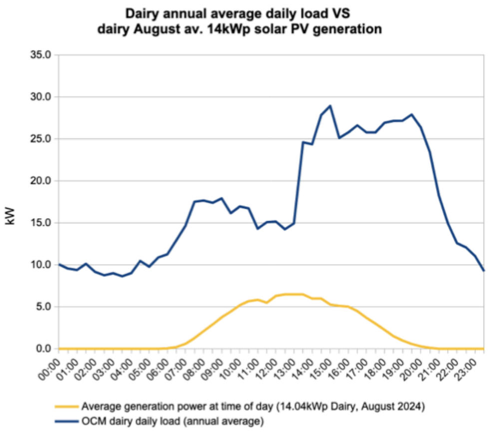
Obtaining usable data for this system has been challenging because the software provider admitted server issues that took them months to fix during our feasibility study. Moreover, the system experienced inverter issues that remained unnoticed by the farmer and the software provider for several weeks or months, resulting in gaps in generation. Consequently, we worked again with a composite year of data made of January 2024-May2024 and June 2023-December 2023 which only partially overlaps with the dairy's electricity usage data (i.e. Aug2023-Aug2024) and found some workarounds to extract useful information (see pictures below):

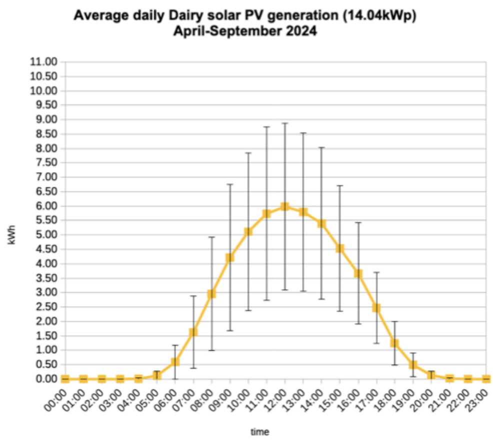
- The largest peak power ever-generated by the dairy's solar PV system is 12.02kW and occurs mostly in August.

- Considering the electricity usage and load of the dairy, the entire generation of this current solar PV system is completely used by the dairy with no export to the grid.

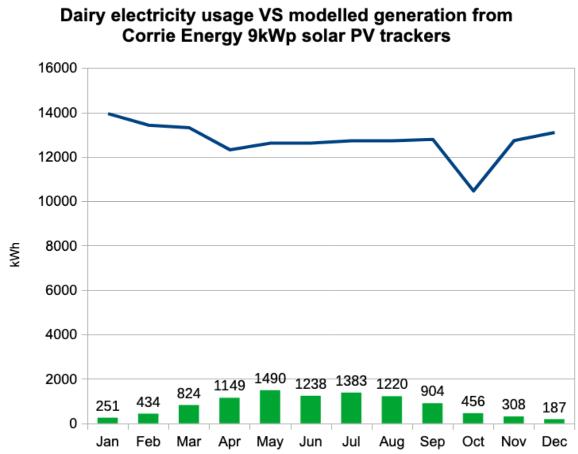
- This solar PV system covers ~8% of the total annual electricity usage of the dairy, and up to ~16% of its average daily usage.



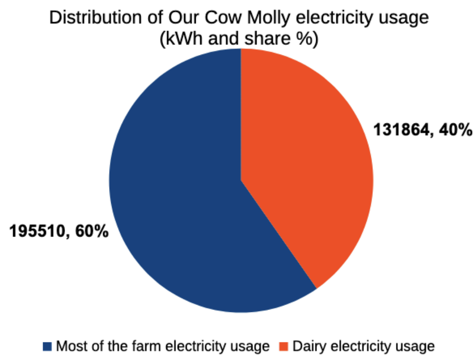


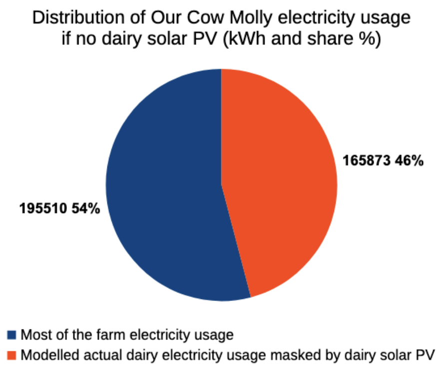


Finally, before the start of this feasibility study, the farmer Edward Andrew entered a partnership with [Corrie Energy](#) and The University of Sheffield to test a temporary ground-mounted 9kWp solar PV tracking system for three years (see earlier picture *"Our Cow Molly current electrical systems")*. It is connected to meter "HH" but was not online when we made our assessments and collected data. Even though it would only contribute to ~7% of the dairy's annual average daily usage (see picture below), we had to model its impact on the capacity of electricity generation available under the farm's current grid connection (see below about current grid connection).

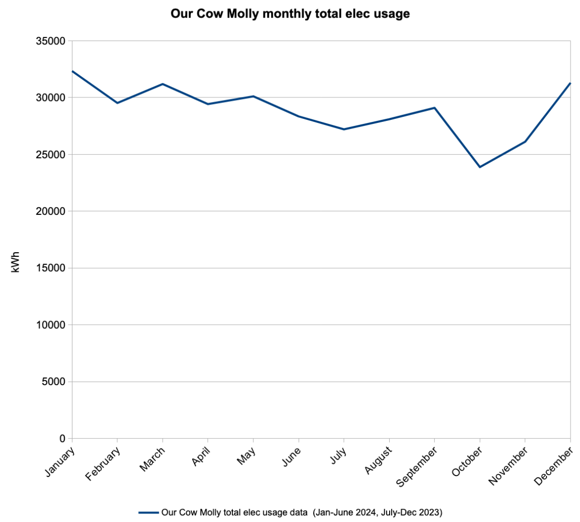


The farm's electricity demand is spread across the two MPANs as 60% for meter "BG" and 40% for meter "HH". As presented above, electricity generation from the dairy's 14kWp rooftop solar PV system partially masks the real ratio which stands as: 54% for meter "BG" and 46% for meter "HH" (see picture below).





During one of our visits to Our Cow Molly, our solar PV installer Chris Neil (Home Eco Energy), the farm's electrician Philip Mosley (Norcroft Energy), Edward Andrew the farmer and ourselves discussed the farm's current and historical electrical system. It has become apparent that the new barns and the dairy will soon be the focal points of the farm's electricity demand. Indeed, some new electrical loads will come online there (e.g. milking robots, manure scraper, lighting, etc) and the farmer also intends to move some equipment currently connected to meter "BG" into the new barns from which they will be connected to meter "HH" located in the dairy building. Therefore all experts on that day concluded that in order to simplify its electrical supply and system, the farm should eventually transition to one single MPAN, meter "HH" at the dairy, which Edward Andrew is now considering.

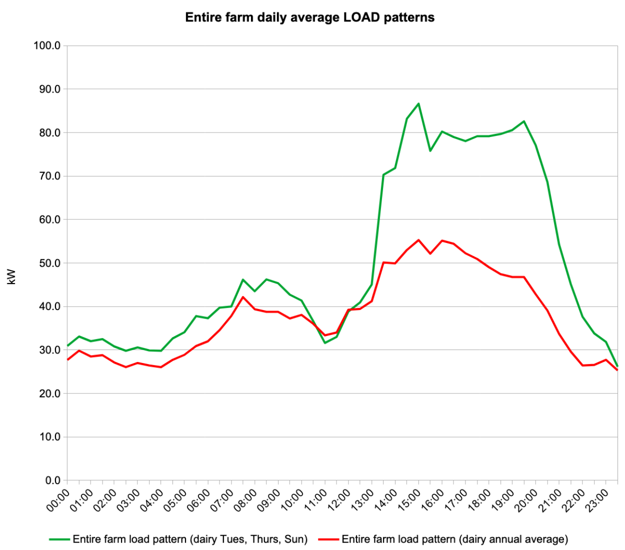


Therefore it is sensible to consider the farm's demand as a whole. The entire farm uses ~350MWh of electricity / year, with only 8% month-to-month variation and could reach 400MWh/year in the near future once the new barns are fully operational. To put this in perspective, this amounts to the annual electricity usage of 150 average UK households. This equates to ~30MWh/month or ~1000kWh per day (see picture opposite), with only 8% month-to-month variation, thereby mirroring each individual MPAN.

The annual average daily power demand of the entire farm follows a regular pattern (see picture below):

- a baseload of 30kW between 00:00-06:00
- increase to ~40kW between 07:00-12:00.
- increase to 50 or 80kW between 12:00-19:30, whether a whole week average (red curve) or only dairy operating days are considered (Tuesday, Thursday, Sunday, green curve).
- gradual decrease back to 30kW baseload between 19:30-23:30.

On average less than 1% of the farm's load is above 120kW. However, on days when the dairy is operational some peaks of up to 130-140kW can be observed between 2pm-4pm.



Interestingly, 60% of the entire farm's electricity usage occurs between 7am-7pm, supporting the notion that it would benefit from solar PV electricity generation.

Electricity costs

Given the farm's electricity usage and load, its annual electricity bill is quite substantial. According to Excel Utilities it amounts to ~£76k, broken down as:

- £4.5k of standing charge (96% of which is associated with the dairy's modern meter "HH").
- £1k of capacity charge (for meter "HH" only, calculated as £0.02745/kVA x number_days x current contracted capacity of 102 kVA)
- £70.5k of electricity costs incurred via the energy supplier's "daytime" (7am-12am) and "night time" (12am-7am) tariffs as:
    - Most farm/meter "BG": "daytime" usage 73.5%, "night time" usage 26.5%
    - Dairy/meter "HH": "daytime" usage 82.5%, "night time" usage 17.5%

Our Cow Molly current generation headroom and budget estimate:

Early on, we engaged with the regional DNO/DSO Northern Powergrid about our project of supporting the farm with more renewables. Our Cow Molly is connected to the electricity grid via a 315kVA transformer that also serves several other nearby customers (e.g. Sheffield Honey house, other nearby houses). Since Northern Powergrid has a duty to ensure that any new connection would not affect supply to these other users, we were initially told that there is 150kW of spare generation capacity on site (Supporting doc 1). This initial figure was then revised upwards to 200kW, and later on to 270kW after a "budget estimate" that we commissioned from Northern Powergrid (Supporting doc 2).

We originally requested this study to assess the feasibility of deploying a range of renewable electricity generators to power the farm and the 1.5MW hydrogen production facility of our project partner SYEcofit. Northern Powergrid explored the connection of three ranges of renewable generator capacities (combining solar PV, wind turbine or both) at Our Cow Molly:

	Option 1: 500kW	Option 2: 1500kW	Option 3: 4000kW
Lead time	6 months	8 months	24 months
Cost (ex-VAT 20%)	£147.5k	£350k	£1475k

We were also informed by Northern Powergrid that any connection above 1MW may require an impact assessment ("statement of works") of the interface between the local distribution network and the transmission grid to be submitted by Northern Powergrid on our behalf to the National Energy System Operator (NESO) for the cost of ~£30k and a duration of 3 - 4 months. If some improvement works were needed on the transmission side, current lead time from National Grid is 5-10 years.

The total costs and lead times to complete the necessary grid reinforcement works for any of these options meant that the project would not be deliverable directly as a whole. In order to pursue targets that were immediately achievable and impactful, it was decided to split the project into:

- "phase 1": decarbonisation of the farm's electricity supply and operations.
- "phase 2": diversification of the farm's revenues by installing a green hydrogen production facility on site.

Phase 1: solutions considered to decarbonise Our Cow Molly within current connection constraints:

At this stage, our understanding of Our Cow Molly's electrical systems and electricity usage made it clear that the farm's new barns, totally unshaded and purposely designed south-facing with a low pitch, would be an ideal location for rooftop solar PV (see picture below).

This would help cover the farm's electricity demand that occurs between 7am-7pm (~60% of total demand and even more if the farmer could shift some of the load to daytime to maximise the use of solar PV generation). In parallel, the farmer and our project partner SYEcofit decided to investigate whether the farm's manure and an anaerobic digester (AD) could provide the necessary electrical power to cover the farm's constant baseload of 30kW present during 12am-7am and 7pm-12am, but also when the dairy is not operating (see above).

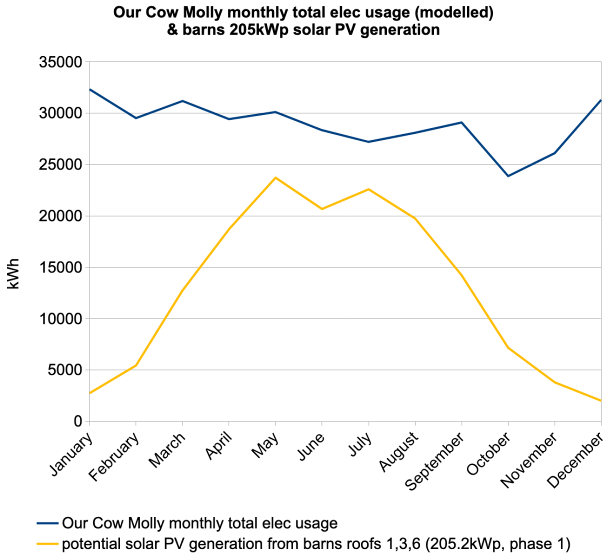
Because the site's electrical system and these solutions are intertwined, we had to interface with anaerobic digestion expert Dr Davide Poggio (The University of Sheffield) throughout this project. His investigations have concluded that Our Cow Molly's manure annual production and energy content, based on 150 cows producing milk (maximum that Edward Andrew told us his farm would ever accommodate), could allow up to 26.5kW of electrical power generation from anaerobic digestion. With this figure in mind, we were informed by SYEcofit and the farmer that their investigations of several quotes and feedbacks from farmers currently using such equipment led to the choice for a Bioelectric 33kW AD.

As mentioned previously, Northern Powergrid indicated that Our Cow Molly's current grid connection could support a maximum of 270kW of electricity generator capacity, including existing generators.

270kW - 33kW (AD) - 14kWp (dairy solar PV) - 9kWp (Corrie Energy temp solar trackers) = 214kW

Therefore **214kW** would be the maximum capacity headroom available for additional generators at the site of Our Cow Molly.

We modelled that the south east-facing roofs 1, 3, 6 of the barns (see red arrows, picture below) could accommodate 205kWp of solar PV, which fits within this 214kW connection constraint. On its own, this system would generate ~154-174MWh of green electricity annually. This conservative +/- 12% range was modelled by software and historical solar PV generation data from Sheffield Renewables.



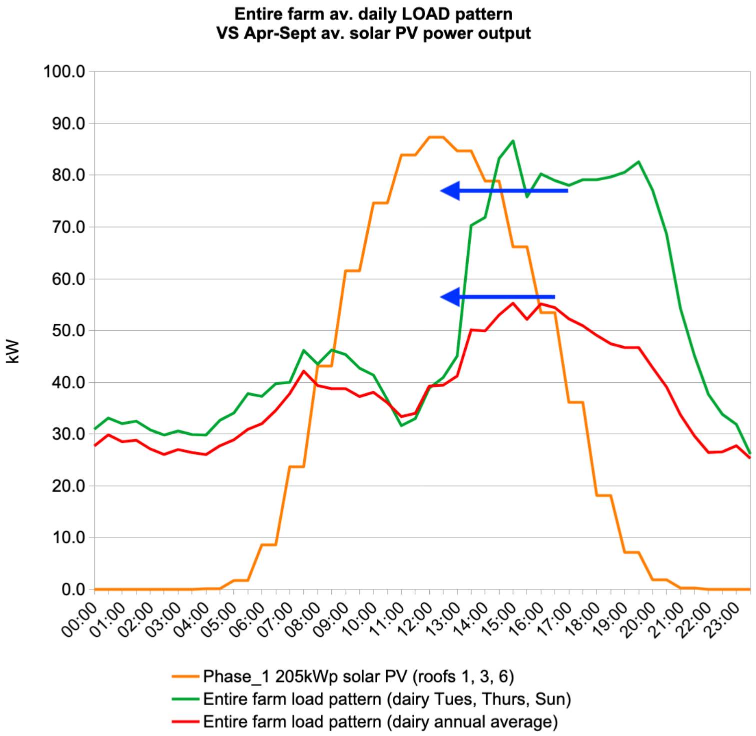
To model average daily generation patterns for this potential 205 kWp solar PV system, we used real average generation data (April-September 2024) available from the dairy 14.04kWp solar PV system. We normalised these hourly generation data to obtain kWh/kWp specific to the Our Cow Molly site and scaled these figures to 205kWp. With the caveats that June and July 2024 have only partial data because of inverter/monitoring issues, this approach was chosen and considered suitable because:

- April-September is the period of the year corresponding to the highest solar PV yield (see picture above)

- the dairy's 14.04kWp solar PV system has been operating for years and has been able to reach ~90% of its rated capacity recurrently, with real operating peaks of up to 12kW.

- the dairy and the barns only display 0-30 degrees variations of azimuth that would only result in ~1.5%-2% variation of output at the pitch used (16deg for the dairy's roof, 17deg for the barns roofs) according to the MCS irradiance table.

As can be seen in the picture below, 205kWp of rooftop solar PV on the barns ("phase 1") would be an excellent match for the farm's current daily load. It would be able to generate 40kW-87kW of average electrical power between 7am-6pm throughout April-September, thereby covering ~64% of the farm's daily load over that period. However, if Edward Andrew the farmer could shift some of his afternoon/evening load 3 hours earlier (see blue arrows in picture below), he would greatly benefit and optimise the use of solar PV generation even further. This would also limit export to the grid. Of course this analysis which considers the farm's demand as a whole implies a single point of connection moving forward (i.e. meter "HH").



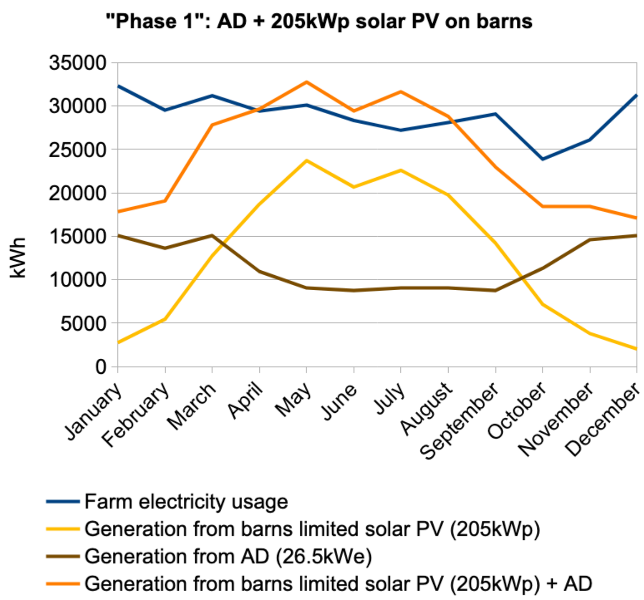
Our own solar PV installer HomeEco Energy has confirmed our solar PV modelling by producing a quote for 209kWp of rooftop solar PV on the barns roofs 1, 3 and 6 (see picture below and Supporting doc 3). During a site visit with us, Chris Neil (HomeEco Energy) and Philip Mosley (the farm's electrician from Norcroft Energy) estimated that the wiring from the barns to the dairy's meter "HH" would have to be upgraded to withstand the transport of 209kW of power. This should be relatively easy since the barns are not yet fully operational and cabling is yet to be fully buried.

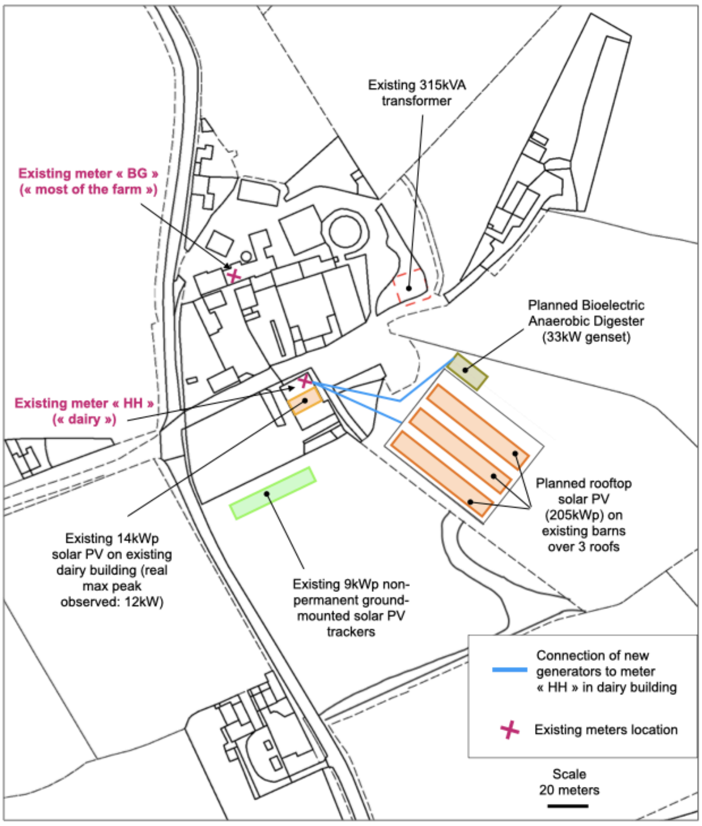
The sharp decrease in solar PV generation after 7pm/8pm, the farm's 30kW base load (see graph above) and the farm's need to reduce its methane emissions made it clear that a 26.5kW-33kW anaerobic digester running between 8pm and 7am (i.e. 46% of 24 hours) would nicely support and complement solar PV generation (see picture above). The anaerobic digester (AD) potential of the farm was modelled by Dr Davide Poggio for our partner SYEcofit across a range of scenarios using experimental measurements of the energy content of the farm's manure, information provided by Edward Andrew (land owner of Our Cow Molly) and known industry figures for ADs, namely:

- a production of ~2000L of milk/day from a current herd of ~100 cows, which means ~7300L annually per cow and the corresponding manure production.
- an extrapolation to 150 cows which is the maximum of cows that the farmer would ever have on the farm.
- a manure collection rate that fluctuates monthly as cows spend more or less time indoor: 100% during November-March, 75% in April, 60% May-September, 75% in October.
- 90% capacity factor and 30% efficiency of the associated Combined Heat and Power system.

This analysis shows that a 33kW AD at Our Cow Molly using only the farm's manure as feedstock would generate ~140.4MWh of electricity annually.

Knowing that 26.5-33kW would be sufficient to meet the farm's daily base load of 30kW, we combined these AD electricity output simulations with our 205kWp solar PV modelling for the barns. The analysis depicted in the picture below shows that if it is harnessed efficiently through load shifting and minimising grid export, the electricity generated by a combination of 33kW AD and 205kWp of rooftop solar PV (orange curve) could provide [(140.4MWh+154MWh)/350MWh] = ~84% of the farm's annual electricity usage.





Our Cow Molly phase 1: 205kWp solar PV + 33kW anaerobic digester

Therefore all these analyses show that within the current connection constraints, 205kWp of rooftop solar PV on barns combined with a 33kW AD offer an effective solution to both decarbonise the electricity supply of the farm and reduce its methane emissions, while also offering resilience against future potential energy price fluctuations.

In order to move forward with this "phase 1" proposal, we were asked by Northern Powergrid to file a G99 application to assess more precisely the capacity headroom of the current connection at Our Cow Molly. We discuss this further in Section 4 of this report.

"Phase 2": solutions to power SYEcofit's hydrogen production facility with renewables within a reinforced connection.

SYEcofit proposes to diversify Our Cow Molly's revenues by installing a green hydrogen production facility on its estate. To investigate the capacity of renewables required, we obtained the specifications of this facility from the report that SYEcofit had commissioned from the hydrogen consultancy Logan Energy (Supporting doc 4, pages 7-14). It consists in a 1MW alkaline electrolyser to split pure water into hydrogen and oxygen, made of 4 stacks of 250kW each, and in 0.5MW of ancillary equipments (e.g. water purification and demineralisation, hydrogen compression, filling station, storage, etc), totalling 1.5MW of new additional load on the farm. To determine the annual electricity demand of the facility, we used figures from the same report (Supporting doc 4, pages 12-13) to define the minimum number of hours of operating time required for the plant to be economically viable within a reasonable timeframe (less than 40 years).

Recent hydrogen allocation round awards from the UK Department of Energy Security and Net Zero had a weighted average strike price of £8.03/kg of hydrogen, therefore we considered £10/kg of hydrogen from Logan Energy's report to be an accurate starting point.

Therefore, using the following formula and Logan's figure of £10/kg of hydrogen:

operating time/day: CAPEX / (**Revenue H2 sales**-OPEX) = payback time

we obtain:

20 hours/ day: £5200k/(**£600k**-£300k) = 17 years
15 hours/ day: £5200k/(**£450k**-£300k) = 35 years
10 hours/ day: £5200k/(**£300k**-£300k) = infinite (economically non-viable)

We chose 15 hours of operation/day (i.e. 150 kg of hydrogen produced) as a reasonable compromise since it is unlikely that solar PV and wind would be able to provide electricity for 20 hours straight daily and 10 hours is not viable. In their report, Logan Energy also mentioned that the plant would operate 300 days/year, considering scheduled maintenance throughout the year.

This leads to 1.5MW x 15 hours/day x 300 days = 6.75GWh/year

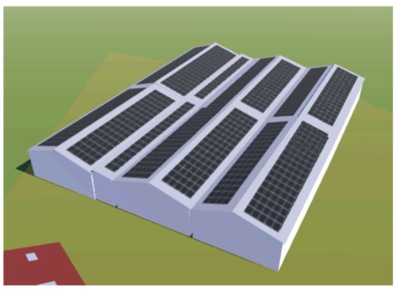
Therefore, the hydrogen production facility of SYEcofit at Our Cow Molly would have:

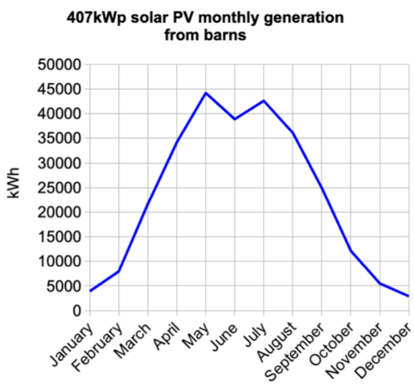
- a power demand of 1-1.5MW for 15 hours/day
- an annual electricity usage of up to 6.75GWh/year

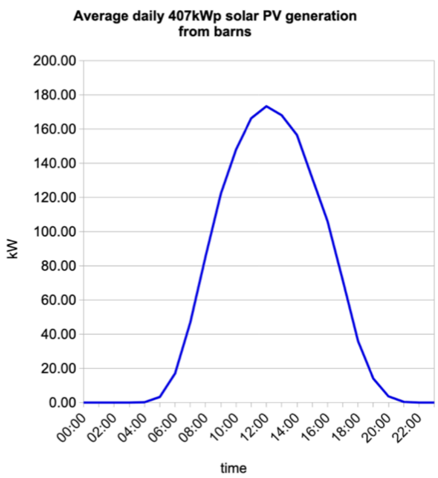
Electricity and water costs have not been mentioned in Logan's report, therefore we assumed that they were considered as OPEX (discussed in Section 7).

In order to find solutions to meet the electricity demand of SYEcofit's green hydrogen production facility, we adopted an agnostic approach that took into account all the features of the Our Cow Molly site (e.g. roof structure and layout of existing buildings, geographic location, land availability, etc) while also discussing with the landowner the types and amount of renewable generators that he would agree to have on his estate without affecting his current operations. This led us to investigate additional solar PV and wind power.

As a first step, we modelled the maximum solar PV system that could be deployed on the barns and reached 407kWp. This would generate 275MWh/year and, using the same approach as phase 1 we found that this system would deliver on average 50kW-170kW of daily electrical power between 7am-6pm throughout April-September (see pictures below).

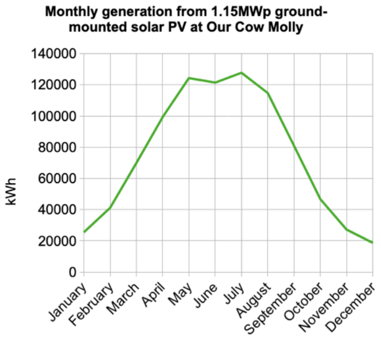


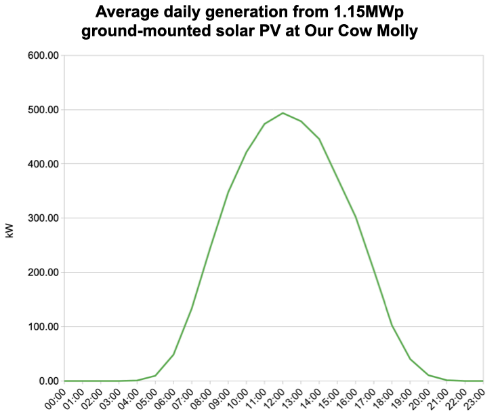




This by itself is obviously insufficient and therefore we also considered ground-mounted solar PV. As presented in Section 2, most of the fields surrounding Our Cow Molly belong to the farmer and he would support ground-mounted solar on a parcel south-west of the new barns (see picture below). We modelled that this field could accommodate 1.15MWp of fixed ground-mounted solar PV, generating 897MWh/year and delivering on average 100kW-500kW of daily electrical power between 7am-6pm throughout April-September (see pictures below).

Our Cow Molly parcel for ground-mounted solar PV





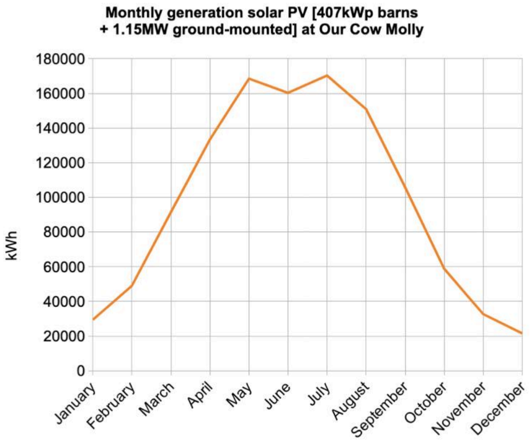
We also contacted Corrie Energy, developer of the existing non-permanent array of solar trackers located at the top (north) of that field (see earlier site picture for phase 1 and picture below) and asked them if they could suggest options for this field (Supporting doc 5).

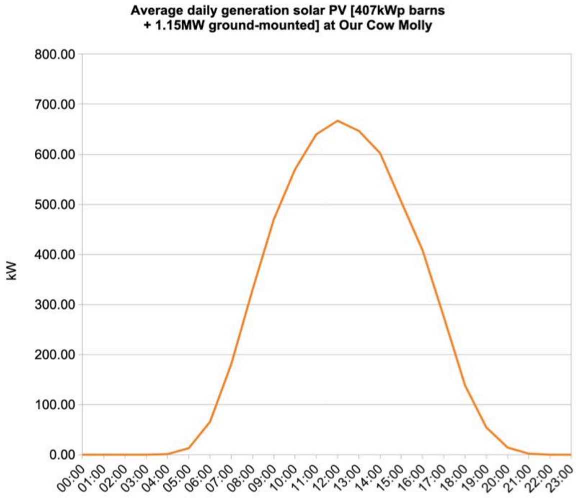
Unfortunately, in this instance, their suggestions

option A: 243kWp, 287MWh/year, 1183kWh/kWp
option B: 566kWp, 671MWh/year, 1111kWh/kWp)

would not perform as well as the fixed ground-mounted solar PV system we modelled. This kind of technology is about capturing as much solar energy during daytime as possible and is probably more suited to sites that have a long continuous daytime usage but with a lower electrical load than the H2 production facility in question here.

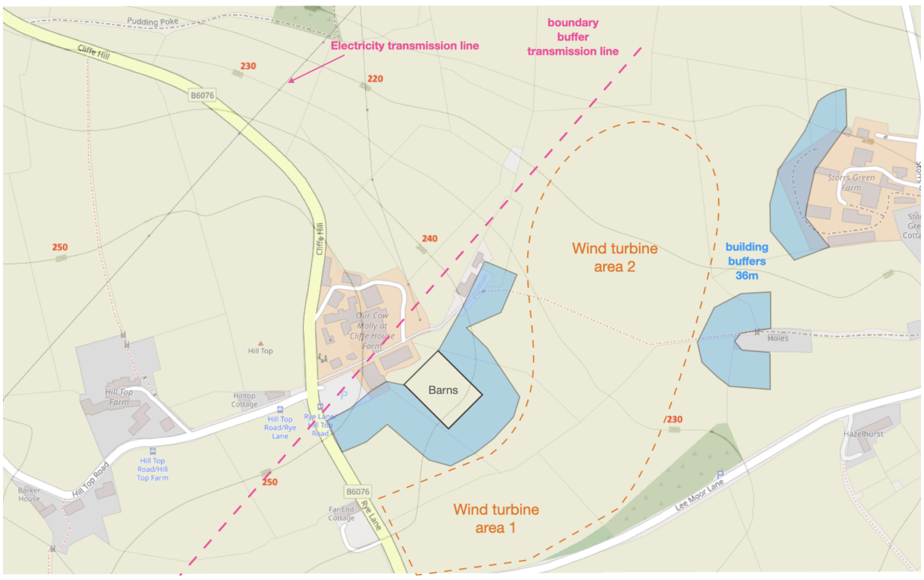
When combined, 407kWp of rooftop solar PV on the barns and 1.15MWp of ground-mounted solar PV on the field south-west of those barns would generate 1.17GWh/year, delivering on average 0.2-0.650MW of daily electrical power between 7am-6pm throughout April-September, with 8.5 hours of 0.350MW-0.65MW between 8am-4:30pm (see pictures below).





While these results were closer to the yield and power required to make SYEcofit's green hydrogen production facility economically viable (i.e. 1-1.5MW for 15 hours/day and 6.75GWh/year), this was still clearly not enough. Moreover, it was obvious from our other calculations above that an anaerobic digester (0.0265MW, ~140.4MWh/year) would also not be able to meet the electricity demand of even one of the four 250kW stack of the 1.5MW hydrogen production, even when combined with these solar PV generators. Therefore, we also looked at wind power.

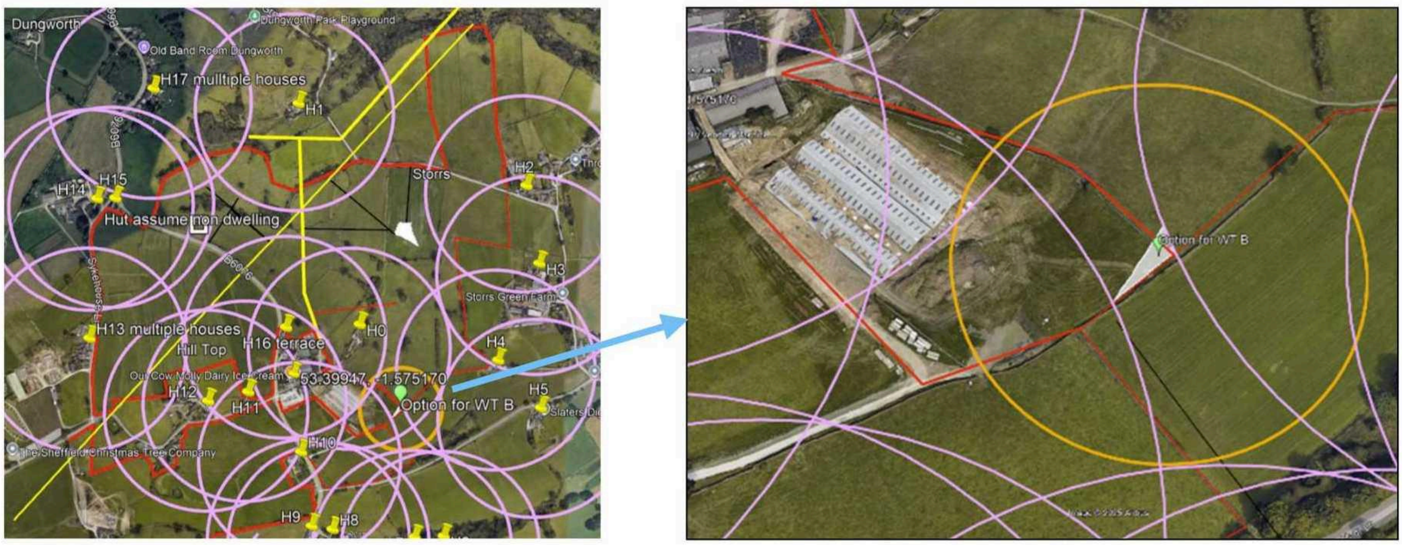
Cliffe House Farm (a.k.a. Our Cow Molly) is situated on a hill at 230-250 meters above sea level in the area of Dungworth, Sheffield, which is renowned for being windy. The preliminary investigations we did for our stage 1 CEF application had suggested a good wind potential for the site (wind speed ~7 m/s at 50 meters) and had highlighted two potential areas for wind turbines (see picture below).



In order to deliver a more thorough and precise assessment of the site's potential for wind power, we partnered with Hockerton Housing Project (HHP). This community energy group has years of experience of deploying and operating community-owned on-shore wind turbines and now provides wind power consultancy and support to other community energy groups, businesses and organisations throughout the country. Their findings are appended to this report as Supporting doc 6. Throughout their study, HHP considered Vestas turbines as they are available second hand and their spare parts are also readily available.

In the area owned by Our Cow Molly (see picture below, red lines), HHP have identified two potential sites for wind turbines east and north-east of the barns by integrating physical and regulatory constraints, namely: houses (250m, green circles), power lines (yellow lines, turbine height +50%), roads (120m), hedgerows (for bats) and wind turbine topple distance (orange circle). These sites lie within the areas Sheffield Renewables had previously considered (see above).

Our Cow Molly wind turbine site option A (zoomed on the right)



Our Cow Molly wind turbine site option B (zoomed on the right)

Cross section of the hill shows the lower altitude of Site A (~220m) compared to the farm Our Cow Molly (~245m)

Each site presented in the pictures above comes with its own pros and cons:

Site Option A

Pros:
- altitude lower than location A
- can accommodate wind turbines of up to 1.6-2 MW
- potential flickering shadows for some neighbours at times, notably houses H2 and H3

Cons:
- recurrent generation downtimes to reduce flickering shadows for neighbours
- away from main road access
- new road required to bring components to actual site
- longer cables for connection = higher costs

Site Option B

Pros:
- shorter cables for connection
- easier road access
- cheaper installation costs

Cons:
- can only accommodate 0.225-0.6MW wind turbines
- potential disruption for direct neighbours: here the distance from houses was reduced to 210m and house H0 “Sheffield Honey” would need to be supportive of the project

To supplement this site determination, we also commissioned an initial road access survey from Blue Shipping Water who were very professional throughout. Their local contractor investigated two routes starting from a potential delivery port for wind turbine components arriving from mainland Europe (Immingham, near Grimsby) all the way to Our Cow Molly. Their report is appended as Supporting doc 7. The two routes proposed differ once reaching the M1 motorway on the outskirts of Sheffield:

- either via the north of Sheffield via Chapeltown, Grenoside and Hillsborough,
- or via the east of Sheffield via Catcliffe, Parkway, Hillsborough.

The survey underscored a number of issues that may be manageable:

- the need for 6x4 tractor units because of some steep areas along the routes.
- the need for some parking restrictions at key points along the routes.
- overhead tram electric lines in Holmes lane and Bradfield road in Hillsborough, which would require permission to be granted to drive in the area.
- the point of entry once at Our Cow Molly (South West of the barns from road B6076), would need to be redeveloped to allow passage of trucks.
- the need to build a path to the turbine's final location on the farm's land.

This initial road survey did not address weight, particularly for some roads and at least one bridge. However, it concluded that loads of up to 35m long and components for wind turbines of up to 600kW maximum (hub height ~40m) might be transportable to Our Cow Molly.

Using Hockerton Housing Project's own transport costs for their wind turbine Vestas V29 (225kW) in 2009 between Newton Aycliffe to Hockerton, we also modelled and evaluated transport costs for wind turbine components from port (Grimsby) to site in the range of £8212-£11144 when adjusted for inflation.

The commissioning of the road survey was still on-going while HHP was doing its investigations of various wind turbine sizes. In order to model wind speeds at various heights and annual electricity output for various turbine sizes at sites A and B, Simon Tilley (Hockerton Housing Project) retro-engineered ten years worth of generation data from nearby wind turbines that were kindly shared by local landowner Mark Woodward.

Site A

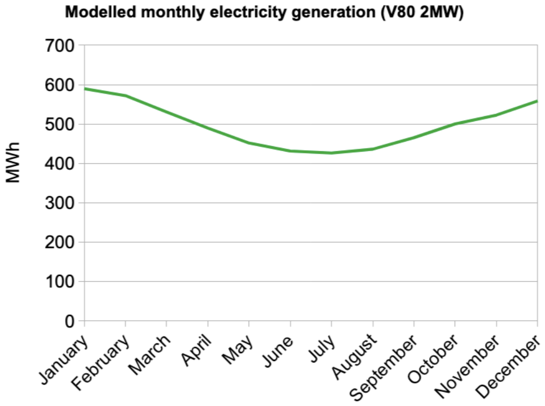
Turbine type	Hub Height (m)	Wind Speed (m/s)	Power curve predicted average power (kW)	Gross energy output GWh/year
V80 (2MW)	80	8.1	682	5.974
V44 (0.6MW)	40	7.3	150	1.314
V29 (0.225MW)	31	7.1	62	0.543

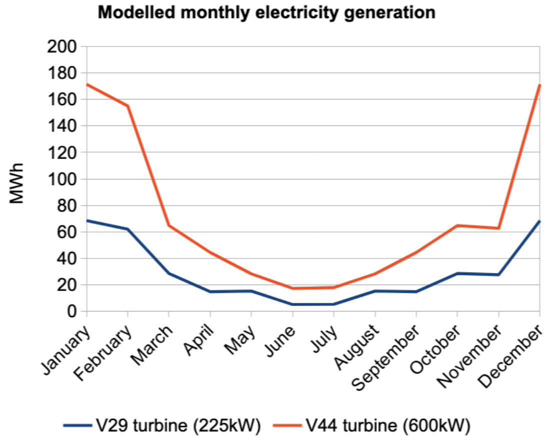
Site B

Turbine type	Hub Height (m)	Wind Speed (m/s)	Power curve predicted average power (kW)	Gross energy output GWh/year
V44 (0.6MW)	40	7.5	160	1.402
V29 (0.225MW)	31	7.2	64	0.561

Both locations were confirmed to display good wind potential from south and west, with wind speeds of 7-8 m/s, regardless of the method considered, and at the heights of turbines that were under consideration (30-80 meters), despite the local constraints (e.g. roughness, valleys, wind orientation etc).

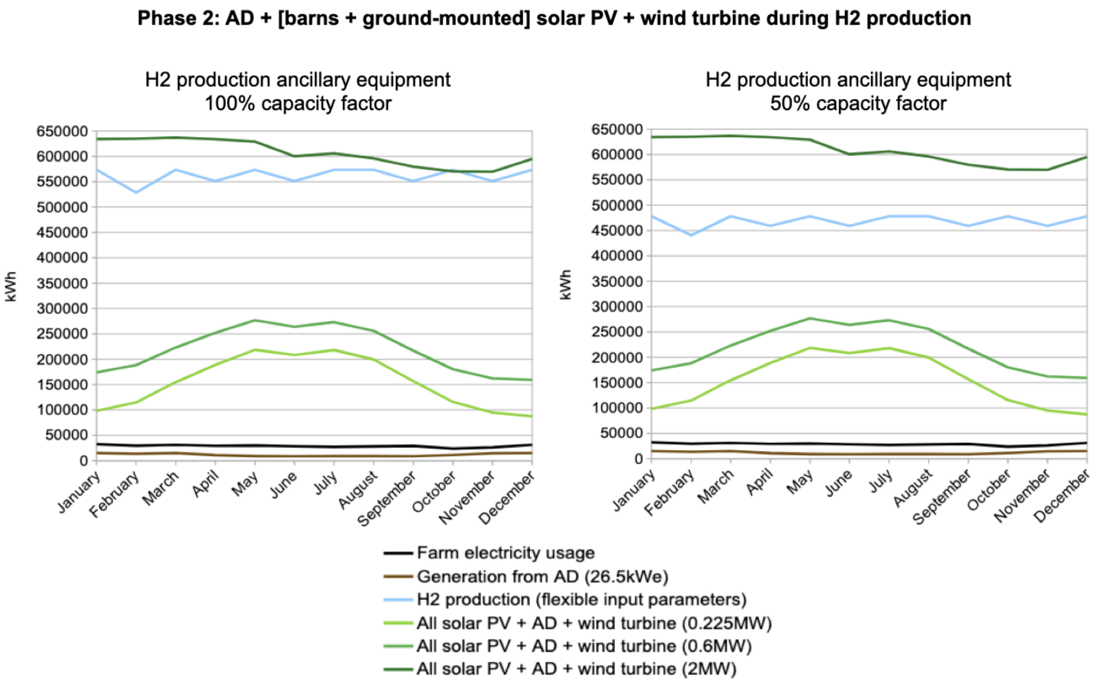
In order to derive monthly generation patterns, we harvested historical wind speed data for Sheffield (1991-2020) (Stannington or Dungworth were not available) and determined the monthly fold change of wind speed from those data. We then spread the annual generation output planned for location A for each turbine size (i.e. V29: 0.543GWh, V44: 1.314GWh, V80: 5.974GWh) to a monthly output and modulated this according to the calculated historical wind speed fold change for Sheffield. This led to the monthly generation models below.





Interestingly, all these figures suggest that the smaller turbines V29-V44 (av. power 62-150kW, ~540-1314MWh annually) would be largely sufficient to power the entire farm (average daily load 30kW, peaks of 80-120kW, monthly demand ~30MWh, annual demand ~400MWh), especially when combined with rooftop solar PV on site.

Finally, we modelled the cumulative monthly electricity generation of the anaerobic digester, barns and ground-mounted solar PV alongside various sizes of wind turbines (even though only turbines up to 600kW could be transported to site) while SYEcofit's 1.5MW hydrogen (H_2) production facility would be operating 15 hours/day, 300 days/year, with 500MW of ancillary equipment either constantly in operation or only 50% of the time (see picture below).



All solar PV (1.56MWp) + 33kW AD + wind turbine (0.225MW)	All solar PV (1.56MWp) + 33kW AD + wind turbine (0.6MW)	All solar PV (1.56MWp) + 33kW AD + wind turbine (2MW)	
1855921	2626801	7287121	kWh
1.86	2.63	7.3	GWh

These results show that only a large 2MW wind turbine combined with barns and ground-mounted solar PV and the AD would be able to generate enough electricity during the year to produce green hydrogen with a 1.5MW electrolyser. Solar PV and AD would only marginally contribute by compensating for the summer decrease in wind generation.

However, when combined together, all the renewables considered (all solar PV, 0.350MW-0.65MW daily electrical power and a 2MW wind turbine with 0.625MW of average power) would together only provide 0.98MW-1.3MW of average power for 8.5 hours April-September and still fall short of the 1-1.5MW required by the green hydrogen production facility for > 10-15 hours/days 300 days/year. These results also show that during "phase 2" the hydrogen facility's demand (4.5GWh-6.75GWh) would be such that all renewable electricity (2.63GWh annually when realistically using a 0.6MW wind turbine) would have to be redirected away from the farm (demand 0.35-0.4GWh) and therefore not contribute to its decarbonisation.

To be thorough, we also engaged with suppliers of new (Supporting doc 8) or second-hand wind turbines (Supporting doc 9). This was a valuable experience and we learned that transporting wind turbine components by air is prohibitively expensive and therefore would not apply for a single turbine at this site.

All these analyses allow us to conclude "phase 2" would face the significant technical and financial challenges of:

- the immediate high distribution and possibly transmission grid connection costs
- the inability to deploy sufficient capacity of renewables on site to meet the electricity demand and load of a 1.5MW green hydrogen production plant for an economically viable period of time annually.
- the inability to bring to site components of the only renewables that could make "phase 2" possible (i.e. large wind turbines 1.5-2MW).
- the capacity and electricity costs of relying on the grid when onsite renewables would not be able to generate sufficient power: advised against by Northern Powergrid, the hydrogen consultancy Logan Energy and The University of Sheffield. It would also mean the hydrogen produced would lose its "green" label.
- the depletion of all renewable electricity that would be directed away from the farm towards hydrogen production and therefore would not contribute to Our Cow Molly decarbonisation and energy resilience.

Additional financial and planning permission issues of "phase 2" are discussed further in Section 4 and 7.

On the contrary, we believe that our investigations have lowered the development costs of phase 1 (200kWp of rooftop solar PV on the barns and a 33kW anaerobic digester) and demonstrated that it can be immediately delivered through community investment and would decarbonise the farm's electricity supply, making it more resilient to energy price fluctuations and contribute to reduce its methane emissions. It would also increase the financial sustainability of the farm in the long term.

Alternative versions of "phase 1" could involve the farmer capitalising on biogas production from the AD instead of generating electricity (e.g. on site use, sales), and deploying a small 225kW wind turbine at location B, close to the Our Cow Molly, provided that Sheffield Honey ("house H0" located north east of the farm) was supportive and on board with this solution, possibly through incentives/participations. Planning opportunities for smaller wind turbines associated with agriculture may also open up as onshore wind policy develops. This option would potentially increase the percentage of electricity used by the farm as well as providing onsite fuel for farm vehicles.

4 Land Rights, Connection, Planning, Permits and Consents

This section is only relevant to Type A Projects dealing with energy generation or heat network systems.

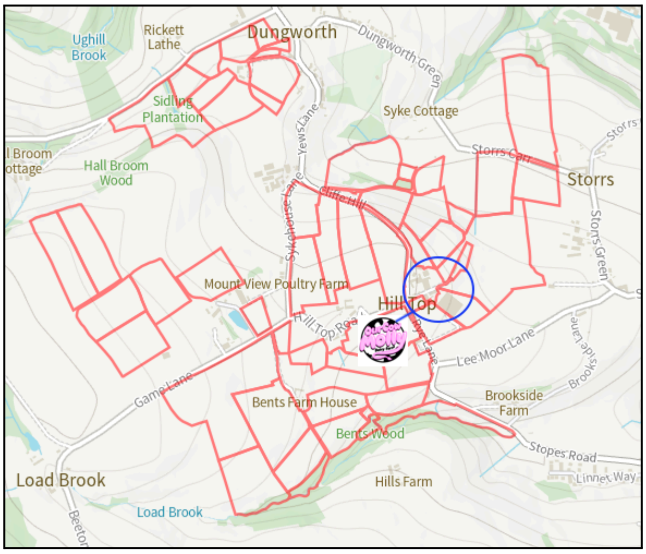
Please provide details of any requirements to obtain land rights to deliver the proposed scheme. This may include leasing land for installation of equipment or wayleaves to connect across third party land. Please provide information on the status in each case (for example exclusivity agreement or draft lease).

Please provide details of the grid connection that the Scheme will require. Provide evidence of consultation with the relevant Distribution Network Operator to establish the budget cost for the connection required and the timescales to achieve this connection.

Please give details of required planning and permitting for the installation as well as a view on the likelihood of achieving planning permission. This is of particular concern when the project involves wind turbines, large solar arrays or hydro installations. We expect that, as part of the feasibility report, discussions take place with the Local Planning Authority and any stakeholders who have the power to influence the outcome of planning applications. Your report should include screening for local constraints, information on any relevant local precedents and an assessment of the likelihood of receiving planning consent.

If the proposed installation will require Environment Agency permits, we expect to see evidence of consultation with them.

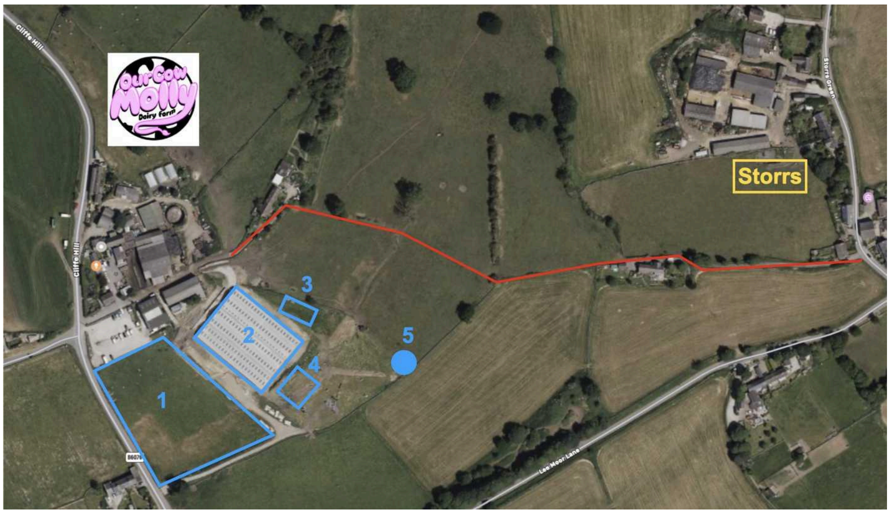
As mentioned previously in Sections 1.1, 2 and 3, this project takes place at Cliffe House Farm (a.k.a. Our Cow Molly), located near Dungworth, Sheffield, and was initiated when its owner Edward Andrew approached Sheffield Renewables. Since Our Cow Molly owns most of the surrounding land (see picture below), no land rights are needed to deploy renewables on site.



Land parcels owned by Our Cow Molly (circled in blue)

The farm and its accesses border the road B6076 and no crossing of third party land is required. Our consultant Pure Leapfrog has not identified any existing wayleaves or easements in the specific locations where assets will be sited and there will be no oversailing required. Moreover, they have established that no wayleaves or easements need to be negotiated with any third party.

There is a footpath that runs from the road, through the farm and leads to the neighbouring village of Storrs (see picture below). The farm has lived and worked with this right of way over generations, careful to keep it well-signed, maintained and clearly separate from other areas of the farm.



Public footpath, Location of planned assets: 1. ground-mounted solar PV, 2: barns, 3: AD, 4: Hydrogen production facility, 5:wind turbine site B

In addition to the Memorandum of Understanding that we had signed at the start of this project, we have obtained a letter of authority from Edward Andrew to conduct all our investigations on his behalf (Supporting doc 10).

We contacted Sheffield City Council planning authorities. They confirmed that solar PV on the barns would fall within permitted development (see Supporting doc 11), provided that the installation follows planning conditions for non-domestic buildings (e.g. 1m from edges of the roofs), which we took into account in our simulations. As a reminder, the farm has already secured planning permission for an anaerobic digester.

As mentioned in Section 3, we have engaged with the local DNO/DSO Northern Powergrid (NPg) early on (Supporting doc 1) and throughout this feasibility study. Our case handler James Nunns from NPg was very helpful and supported us with email and telephone communications, online and in person meetings and a site visit. To understand the generation capacity headroom available on the local distribution network, we filed a "budget estimate" with NPg (Supporting doc 2) to seek guidance on the process of connecting substantial renewable generators at Our Cow Molly and anticipate associated costs. As described in Section 3, the projected costs of connecting more than 1MW of renewables (£370k-£380k) and associated lead times led to splitting the project into "phase 1" (farm decarbonisation) and "phase 2" (hydrogen production). Once the scope of technologies for "phase 1" was more defined, we were advised by James Nunns to file a G99 application describing the connection of 209kWp rooftop solar PV and a 33kW anaerobic digester (Supporting doc 12). We were told that the detailed study that it would trigger (including a site visit) would help refine the generation capacity headroom available on site (initially 270kW).

We received a Connection Offer on July 7th 2025 from Northern Powergrid (Supporting doc 13) priced at £1440.35 for the works (+£840 of connection offer expenses) providing a maximum import capacity of 200kVA (“as existing”, even though the on site transformer is 315kVA) and a **maximum export capacity of 257kW including existing generation**. This means:

257kW - 33kW AD - 14kWp (dairy solar PV) - 9kWp (Corrie Energy temp solar trackers) = 200kW

Therefore **200kWp** are actually available for solar PV on the barns.

This is a good outcome that remains within 6% of our own solar PV predictions (205kWp) and the quote we had received from our installer HomeEco Energy (209kWp, Supporting doc 3).

At the start of this project, SYEcofit filed a pre-application enquiry to Sheffield City Council planning authorities on behalf of all the partners involved to understand the process required to obtain permission to deploy a ground-mounted solar PV farm, a hydrogen production plant and possibly a wind turbine at Our Cow Molly (Supporting doc 14). While the feedback received raised no objection for rooftop solar PV (Supporting doc 15), it nevertheless highlighted the planning issues that the development of “phase 2” assets would face:

- ground-mounted solar PV: potential impact on the openness of the Green Belt where the site lies
- hydrogen plant: perceived as erection of new building with associated infrastructure (e.g. rain water collection, storage facilities) and increased vehicular movements
- wind turbine: may not be supported due to its effect on the wider landscape, potential disturbance to neighbouring properties through noise, flicker etc.

This feedback also listed the investigations needed to accompany any potential planning application in relation to the deployment of “phase 2” assets:

- Detailed design and access statement/planning statement with a strong justification for the location of the development
- Landscape visual impact assessment
- Preliminary ecological appraisal of the site with information on Bio-Diversity Net Gain
- Coal mining risk assessment, due to the grounds of the locality
- Noise impact assessment, linked to wind turbine and hydrogen plant operations.
- Highways information: level of information required would depend on anticipated traffic generation.

During this project, we were supported by planning consultant Paul Bedwell during site visits and meetings with project partners and local community representatives (Bradfield parish council). Our interactions have culminated with his planning appraisal of the project (see Supporting doc 16) which very much underscores again that:

"Phase 1" solutions would face no obstacle:

- Rooftop solar PV on the farm's barns would certainly be acceptable.
- Anaerobic digester (AD) has already secured planning permission but Paul Bedwell made the important remark that this is on the condition that only slurry from Our Cow Molly would be used as feed-stock. This means that the AD's energy output and financial projections can only rely on manure from the farm.

"Phase 2" solutions would require considerable investment and face considerable risks without any guarantee of securing planning permission:

- Ground-mounted solar PV, wind turbine and a hydrogen production facility would all represent inappropriate development and would impact adversely on the openness of Sheffield's Green Belt.
- Development of a wind turbine would require prior confirmation of performance by installation of an anemometer which itself would also require planning permission.
- The site is close to the boundary with the Peak District National Park with the potential for intervisibility and resultant visual impact and, despite its rural location, has several residential properties within 500 metres of the site.
- Planning application would require comprehensive assessments of all these environmental effects amongst which: consideration of noise (particularly at nighttime), landscape, ecological and visual impacts, potential to secure biodiversity net gain and potential impact of wind turbine shadow flicker upon residents.
- Community engagement would need to be widened to all surrounding houses and local environmental charities to reach the largest consensus and strong local support.

Finally, in his report (Supporting doc 6), our wind power consultant Simon Tilley (Hockerton Housing Project) also highlighted that the deployment of a wind turbine in "phase 2" would also require to:

- assess impacts on local wildlife (e.g. bird and bat populations)
- assess potential electromagnetic disturbance on mobile phone transmission
- contact Civil Aviation and Ministry of Defence authorities to seek their views on the installation of a 0.225-0.6MW wind turbine at Our Cow Molly (maximum size that can be transported to site).

5 Community Engagement

Community Engagement is a vital part of the Feasibility Study and it is expected that significant effort will have been put into building awareness and support for the proposed Scheme within your community.

Please detail the engagement work undertaken and the numbers of committed supporters. Please provide a description of the level of support for the project in the community more generally. This will help determine some key aspects of project feasibility such as the likelihood of obtaining planning permission, opportunities for income generation and the required scale of installation. Key things to cover:

- How much support is there for the proposed installation within the community?
- How many members of the community have indicated that they would invest in, purchase energy from or otherwise support the proposed installation?
- What methods of community engagement have been undertaken? Please attach minutes of community meetings, surveys, petitions etc.
- Have there been any strong objections raised, either by members of the community or those outside of it?
- Have you identified the key stakeholders within the community (for example, the local authority, adjacent land or building owners, etc.)? If so, please list them here.
- How have you engaged with local stakeholders and what support do you have?

The communications strategy that we devised (Supporting doc 17) was to firstly raise the profile of the project by announcing its scope and scale. Following the decision to phase the project, more emphasis was given to raising investor potential and stakeholder support.

This was done mainly through social media posts and adverts and existing communication channels directed to distinct constituent communities, leaflets and engagement at conferences and events, reaching ~8000 people between October 2024 (beginning of this feasibility study 2024) and its completion (July 2025):

1. the local community of Dungworth and surrounding postcodes
2. renewable energy and environmental communities in Sheffield and beyond.
3. institutions and stakeholders in the statutory and institutional arena
4. potential investors

1. Existing social media channels of Sheffield Renewables (website, Facebook, etc) and LinkedIn posts were used to gain visibility for the project. New Facebook and website pages were established to test opinion and feedback on the project as a whole, before the phasing of the project was established. The Facebook page received several thousand views and paid Facebook ads were targeted at the area within a 10 mile radius of the farm using local postcodes. Online responses were overwhelmingly positive. Few negative comments were received but these were mainly following anti-Net Zero campaigns from outside the local area generally, rather than against the project itself.

Local newspapers (Sheffield Star & Telegraph) featured articles on the grant award and the scope of the project. “Sheff News”, run by journalism students from The University of Sheffield, featured an article for the project.

2. The project was featured at two Community Energy Conferences with over 100 attendees (National Community Energy Event 19/03/2025 and North East & Yorkshire Net Zero Hub Community Energy Event 27/03/2025), once as a keynote presentation, and at the South Yorkshire Sustainability Centre annual event 2025 (03/03/2025). Sheffield Renewables has been part of a regular meeting of a new community energy group, Sheffield Community Energy, and reporting on the project has been part of the regular meeting agenda. The group also contains members of South Yorkshire Climate Alliance, The South Yorkshire Sustainability Centre (The University of Sheffield) and the Sheffield City Council sustainability team.

We set up contact with Community Energy England regarding a learning package we are developing and publicity around the project.

As mentioned in Section 3, a local resident and environment/sustainability activist Mark Woodward, was engaged to share data on his wind installation and to gain support for the project.

Existing Sheffield Renewables supporters (approximately 1000) were informed of the project through our newsletter.

A leaflet presenting the project was distributed at all those events (Supporting doc 18).

3. Local Parish and City Councillors were invited to the launch event at the farm (15/11/2024) and a presentation was given to Bradfield Parish Council in the presence of our planning consultant Paul Bedwell (Supporting doc 19). Our Cow Molly was also visited by the local MP Olivia Blake at the project launch event.

Meetings were held with Will Stewart, Director of Regeneration at Sheffield City Council and we engaged in the Local Area Energy Plan consultation.

4. Existing shareholders (approximately 200) in Sheffield Renewables (Community Benefit Society) were engaged through our newsletter and at our AGM, and an in-principle decision to launch a share offer was received from the members.

We engaged with Co-ops UK and the Social Investment Business over both revenue support for share offer and equity support for phase 1 of the project.

For “phase 1” of the project (200kWp of rooftop solar PV on barns and Anaerobic Digester (AD)), statutory consultation on the AD has taken place as part of the planning process and the solar PV is covered by permitted development (see Section 4).

Further community engagement with all houses surrounding Our Cow Molly, Dunworth and local environmental charities would only be needed for “phase 2” to reach the largest consensus and a strong local support.

6 Community Benefits

Please detail the type and scale of benefits to the community that the Scheme will provide. This needs to cover both the general benefits (e.g. jobs created, reduction in local pollution) as well as the specific financial benefits and identify exactly who within the community will receive these benefits.

Phase 1 of the project will in effect decarbonise the farm, make it more resilient to energy price fluctuations and provide a long term financial saving for the operation. Any future business expansion of Our Cow Molly will also benefit from the decarbonisation of the farm's infrastructure. This will allow the farm to continue as an agricultural operation but also as a visitor, educational and environmental attraction for the local community. All these elements will also increase employment opportunities for the local community at the farm and make Our Cow Molly an exemplar for local decarbonisation in other agricultural settings.

200kWp of rooftop solar PV on the barns of Our Cow Molly would represent the largest renewable energy scheme that Sheffield Renewables would have ever deployed. It would embody the type of projects that our community of shareholders have been asking for at the last few AGMs to ensure that their investments have a stronger impact on Sheffield's decarbonisation. Since Our Cow Molly is well-known, this large project would also reinforce Sheffield Renewables visibility within the Sheffield region and would increase our reach and likelihood of new project development for the benefit of Sheffield communities.

Currently, Sheffield Renewables contributes 10% of its annual revenue as a Community Benefit Fund towards environmental projects in South Yorkshire (80%) and internationally (20%). This scheme could become more focussed locally or make up part of the existing arrangement with more local initiatives from the Dungworth/Stannington area benefiting. This would be decided in conjunction with Sheffield Renewables members and the site owner.

Use of the digestate from the anaerobic digester will reduce transport needs of the farm and reliance on artificial fertilisers, which are very carbon-intensive, and potentially reduce nitrate runoffs to local water courses. In "phase 2" the same would apply but money gained through the planning process would be spent locally through the Planning Gain process.

Since "phase 2" would require a net gain in biodiversity, the environment assessments and subsequent improvements could contribute to an increase in local sustainability.

7 Financial Projections

Please outline the financial model for the installation. It is important to get an idea of the financial viability of the project as far as possible at this early stage. This will be a key consideration in the decision to advance further funds.

For Type A Projects, the financial model needs to include:

- Forecast development costs to bring the scheme to investment readiness (including planning and permitting costs and grid connection deposit)
- Forecast capital expenditure to build and commission the scheme
- Forecast operating costs of the scheme
- Forecast income from the scheme
- Resultant margin and any community share

Type B Projects will need to provide a higher level indication of the financial aspects of the work.

Based on this financial information, the report should summarise the planned route to raise funding for the Scheme.

As explained in Sections 1.2, 2, 3 and 4, this project originally aimed at assessing the feasibility of deploying a range of renewable electricity generators to decarbonise the dairy farm Our Cow Molly and provide power to SYEcofit's 1.5MW hydrogen production facility on site. However, a budget estimate we commissioned from the DNO/DSO Northern Powergrid and our communications with them made it clear that substantial costs (£350k-£400k) would be incurred to overcome local electricity distribution constraints and potential transmission grid improvements. The identification of these constraints led to the decision to split the project into:

- Phase 1: logically focused on decarbonising the farm's activities, we have now received a connection offer from Northern Powergrid following our G99 application to connect 200kWp of rooftop solar PV on the barns and a 33kW anaerobic digester. In section 3, we have shown that these assets could cover most of the farm's current electricity demand when combined with load shifting, thereby supporting its decarbonisation while allowing it to reduce its energy costs.

- Phase 2: deployment of more renewables to try to power a green hydrogen production facility aimed at diversifying revenue for the farm and generating income for SYEcofit.

However, our investigations in Section 3 and 4 have shown that the total capacity of renewables that can realistically be deployed at Our Cow Molly (~2.16MW) would not be able to generate enough electricity to power the 1-1.5MW hydrogen facility continuously. Finally, it is important to note that the electricity costs of producing green hydrogen are not included in the calculations presented on Section 3 page 22 of this report and were not considered in Supporting doc 4. Adding them to that formula alongside OPEX (i.e. 4.5GWh/year for 1MW to 6.75GWh/year for 1.5MW), even with electricity tariffs as low as £0.1/kWh (i.e. £450k-£675k), exacerbate the challenges of "phase 2".

On the contrary, since "phase 1" does not require new planning permissions or grid improvements, we believe that it could be delivered relatively quickly through community investment (12-18 months). It would lead to rapid environmental and financial benefits for

Our Cow Molly and our investigations during this feasibility study have lowered its development costs.

For over ten years, Sheffield Renewables have been developing and operating solar PV schemes successfully for organisations, schools and businesses throughout Sheffield. Our Community Benefit Society has managed to meet its two original share offer proposals of 3% interest and capital re-payments to members through conservative but robust governance and rigorous technical and financial assessments of our projects. Our sound finances and positive balance sheet vouch for these facts.

For phase 1, our regular contractor Home Eco Energy provided us with a quote of £110k (ex. VAT) for 209kWp of rooftop solar PV (Supporting doc 3) for the barns of Our Cow Molly. We ran these figures (and those obtained in Section 3) in our in-house financial model which has allowed us to operate our five solar PV schemes successfully for over ten years:

Cost of installation: £110k

Size of scheme: 209kWp → £526/kWp

Annual generation: ~154MWh (conservative) to ~175MWh (historical data from Sheffield Renewables) → 735kWh/kWp - 838kWh/kWp

% on-site usage: 75% (conservative for Our Cow Molly, higher with load-shifting)

Current Our Cow Molly's tariff: £0.22/kWh

Organisation costs/Project contingency/Overheads: 5% of capital

Project on-going costs: 15% of revenue

Community Benefit Fund: 10% of annual revenue

Share Interest: 3%

Inflation: 2%

These parameters led to the following figures depending on contract duration:

- 15 year: tariff 15.4p/kWh, savings for partner ~£9k/year on average.
- 20 year tariff: 13.6p/kWh, savings for partner ~£11k/year on average.

and details of these financial modellings are presented in Supporting doc 20.

We believe that Sheffield Renewables' model provides the incentive for the farmer to proceed with the project (i.e. lower unit price, shorter contract terms). We believe that from experience of running two previous share offers that the capital for the solar PV element of "phase 1" could be raised through a community share offer.

For completeness and in order to share experience with other community energy groups, we are presenting below figures we obtained from wind turbine suppliers with the support of our wind consultant Hockerton Housing Project.

For new wind turbines, we interacted with Leitwind UK (Supporting doc 8). While it has been difficult to obtain clear figures from them despite signing NDAs, we nevertheless learned some interesting points. For example, it is usually costlier to have 2 wind turbines rather than one large wind turbine offering similar power, because such a case tends to multiply costs (installation and maintenance). It only makes sense as part of a wind farm, in order to gain resilience, should one turbine fail. For example, a 3MW turbine can cost 5 million euros compared to two 1.5MW turbines costing 7 million euros.

We were informed that a LWT42 turbine (500kW, ~ maximum size that could be installed at Our Cow Molly) would cost £700k-£800k, not including transportation, installation or commissioning. A LWT80 (2MW) would cost £2 millions and again not including transportation installation or commissioning.

For second-hand wind turbines, we interacted several times with Scott Warren, from Spectrum Wind Services (Supporting doc 9), who was very helpful and provided detailed cost estimates for Vestas wind turbines that could be installed at Our Cow Molly (e.g. V29 and V44), subject to market prices and availability.

Vestas V2X (e.g. Vestas V29 225kW): £295,000

- £120,000: procurement of a second-hand machine, including a 30-meter tower
- £75,000: refurbishment performed in Denmark (either by Vestas or an approved partner)
- £15,000: ancillary parts (new tower cables, tower bolts)
- £30,000: transportation from Denmark to the UK (note: this does not include transport from the original purchase location to Denmark)
- £25,000: transformer (basic specifications: 11 kV to 400/690 V)
- £30,000: installation (technical build & commissioning on-site, including cranes and equipment)

Vestas V4X (e.g. Vestas V44 600kW): £435,000

- £145,000: procurement of a second-hand machine, including a 40-meter tower
- £160,000: refurbishment performed in Denmark (either by Vestas or an approved partner)
- £25,000: ancillary parts (new tower cables, tower bolts)
- £30,000: transportation from Denmark to the UK (note: this does not include transport from the original purchase location to Denmark)
- £35,000: transformer (basic specifications: 11 kV to 400/690 V)
- £40,000: installation (technical build & commissioning on-site, including cranes and equipment)

8 Operation, Legal Structures and Governance

Please provide details of who will be responsible for overseeing the delivery and ongoing management of the project. For Type A Projects, this will be a key consideration of banks and other investors in making funding decisions about the project.

The proposed legal structures should be explained which may include Power Purchase Agreements, Heat Supply Agreements etc. and also the overall ownership structure for the scheme.

With respect to the key people involved, provide information on their relevant skills and experience. It is also helpful to have a succession plan in place to ensure the Scheme remains actively managed over its lifetime.

During this feasibility study, the investigations led by Sheffield Renewables presented throughout this report (notably Sections 3, 4 and 7) have acknowledged that the site of Our Cow Molly presents a number of features that make it ideal for the deployment of renewable electricity generators.

However, we have concluded that the farm's location in Sheffield's green belt, its proximity to the Peak District national park, the presence of multiple nearby houses and road access all limit the capacity of generators that could actually be installed on site. We found that trying to pursue "phase 2" of the project (ground-mounted solar PV, wind turbine(s) and hydrogen production) would face substantial fund-raising, community engagement and planning hurdles. Moreover, we have also found that even this "phase 2" level of renewables would not be sufficient to power a 1.5MW green hydrogen production plant and were told by several experts involved in this project (see Section 3 and 4) that relying on grid electricity at times was a non-starter and would make the farm an importer of electricity rather than add to self sufficiency.

We believe that the best social, economic and environmental outcome for the farm and the local community would be "phase 1", that is the delivery of 200kWp of rooftop solar PV on the barns and a 33kW anaerobic digester (AD) which would make the farm more energy resilient and reduce both its emissions and energy costs.

We were advised by Pure Leapfrog consultancy that "phase 1" will require a clear integration of both solar PV and AD, both from a technical and governance point of view. We have not been able to develop a working relationship with our partner SYEcofit (in charge of the AD side) to define this integration. Moreover, Edward Andrew, landowner, has expressed an interest in seeing a hydrogen production/economy develop at Our Cow Molly, which we believe would not be viable.

Due to these constraints it was felt that a single organisation taking it forward would be best to secure a positive outcome for the landowner and the community. Despite believing that "phase 1" would deliver the prime aim of decarbonising the farm Sheffield Renewables isn't comfortable with the level of risk required for "phase 2" so we have stepped back to let SYEcofit take the project forward.

9 Scheduling

Please provide an overall schedule for the next stage in the development or implementation of the project. This should include the meeting of project milestones such as delivery of technical reports, the gaining of planning, gaining of permits, identification of contractors, start of construction phase. This will be contingent on timing of receipt of finance but should offer a realistic forward forecast to include any lead times such as provision of a grid connection, grant of planning or completion of fundraising.

Our feasibility study has clearly demonstrated the short-term deliverables to decarbonise the farm at low cost, low risk and immediacy, a part of the project termed "phase 1". We believe "phase 2" increases all three factors in terms of delivery and effect on farm decarbonisation.

<u>Phase 1: SolarPV</u>

The regulatory and technical elements for the 200kWp of solar are currently in place with:

- Permitted development right for 200kWp of solar PV to the barn's roofs
- DNO connection offer in place for up to 257kW of generation capacity to existing dairy MPAN valid until end of September 2025
- Sheffield Renewables existing lease document for community-owned solar PV schemes available based on our previous developments
- Excellent quote from contractor with proven track record

The business case and our fund raising capability are available and offer:

- low risk to returns for community shareholders
- interest from social funders for revenue support for share offer and equity
- support from our existing community of ~200 shareholders and ~1000 supporters.
- a business model that offers a range of lease lengths/electricity tariffs to farmer (see section 7)
- generation patterns that offer maximum electricity onsite usage

Solar PV deployment for phase 1 could begin immediately supported by bridging finance or following a short community share offer of 6-8 weeks.

Phase 1: Anaerobic Digestion

Our work shows that a 33kW anaerobic digester would be complementary to the initial solar deployment in terms of load balancing across seasonal and day/night profiles and an alternative to battery storage that we had initially envisaged in our stage 1 CEF application.

The regulatory and technical elements for the 33kW of AD are currently in place with:

- planning permission for installation and on-site usage
- quote from supplier with track record (Supporting doc 21)
- financial model supplied by Pure Leapfrog

See SYEcofit's stage 1 CEF feasibility report for full output and details about costs and financial projections.

Phase 2: Wind power

Our work has shown that the longer term delivery of large scale wind power projects (>1MW) has a number of technical and regulatory barriers that affect its deployment on a site like Our Cow Molly:

- The existing Local Plan in place until July 2026 makes early planning applications challenging.

- Local distribution and possibly transmission grid reinforcement works and associated costs for projects above 1MW: despite the recent ceiling for statement of works raised to 5MW, we were told by Northern Powergrid that connecting such levels of generation would still remain under intense scrutiny for the time being.

- New Local Plan will identify wind sites in alternative locations around Sheffield which may mitigate against this site in a sensitive location

10 Conclusions and Next Steps

Following the feasibility study, what are your next steps. Bear in mind that if your proposed Scheme was found to have feasibility issues, this may involve a change of direction or even going back to the drawing board.

If your Scheme is broadly feasible, what is required to progress to Stage 2 (i.e. receiving CEF funds successfully) and to develop the Scheme through to completion, i.e. a fully operational renewable energy installation?

Alongside the on site work we have tried to evaluate the political and market risks associated with "phase 1 and 2" of the project.

The volatility of electricity prices, planning hurdles and uncertainties around energy policies all increase risk. This context has to shape decision-making so that community energy groups develop technically and financially realistic projects, grounded in experience and proven technologies (e.g. solar PV, small wind turbines, anaerobic digesters, batteries), to minimise risks and ensure clear and tangible environmental and economical benefits for partners and local communities. It also underscores the importance of onsite renewable electricity generation with high self-consumption rates to increase resilience in the face of market volatility.

Our feasibility study has demonstrated that the dairy farm Our Cow Molly can be most efficiently decarbonised and supported in its efforts towards sustainability and energy resilience by the sole deployment of rooftop solar PV and an anaerobic digester. This can be achieved with little or no disturbance both to the farmer's activities and the local community of Hill Top/Dungworth where the farm lies. Sheffield Renewables has a long experience of delivering and operating community-owned solar PV schemes. As such, we know that the solar PV element of "phase 1" of this project is financially sound, achievable and that the farm would greatly benefit from it.

According to our own financial modelling, funding a farm's anaerobic digester with community shares by an organisation such as Sheffield Renewables would require a more complex agreement with the landowner in order to offer a reasonable electricity tariff while recuperating the high initial capital cost invested (~£300k including installation) and cover for asset on-going maintenance and contingencies. This could involve selling the digestate to the farmer, selling the excess of unused biogas (would require purification, compression and storage), government grants from DEFRA as incentives for agriculture decarbonisation (e.g. transition away from artificial fertilisers) or community energy grants to reduce capital cost.

In our initial stage 1 CEF application, we had considered battery storage. However, our investigations in Section 3 of this report have since shown that a combination of load shifting and an AD would easily support a large proportion of the farm's daily and annual electricity demand, while also contributing to its decarbonisation. Therefore we believe that battery storage would not be required for phase 1 at present. Moreover, a grid-scale 5MWh battery storage solution (size of a shipping container) able to deliver 1MW for 4 hours to support a 1.5MW hydrogen production plant during low renewable electricity generation would cost at least ~£1 million.

As stated, “phase 1” of the project has the benefit of an onsite customer with matched demand, low development costs and no regulatory barriers and therefore represents a low risk project.

With “phase 2”, the development of stand alone large scale renewables for the production of hydrogen ties the project to an as yet undeveloped market with unknown customer and price base over a long term. This leaves the danger of a stranded asset for the community-owned entity. An alternative market to sell such large electricity production would require significant cost and timescale to establish a larger scale grid connection. This significantly raises the risk profile of the project also.

As mentioned, Sheffield Renewables will not be taking this project forward. However, it has been an extremely valuable learning experience both for our project workers and our organisation as a whole. We now feel a lot more confident in attempting similar larger projects in the future and we are again grateful for this opportunity that this stage 1 CEF grant gave us.