



BANK TOP FARM, LITTLEBOROUGH SUSTAINABILITY AND ENERGY EFFICIENCY REPORT

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REPORT AMENDMENT RECORD SHEET

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P2	03.08.2022	Updated following planners' comments	Various		LD
P3	22.08.2022	Updated for final comments prior to issue to planning		3.0 and 5.0	LD
P4	24.08.2022	Updated following planners' comments		3.0	LD

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1.0 GENERAL

Bank Top Farm is located in a countryside location just beyond edge of Littleborough and Smithy Bridge/ Hollingworth. It is an existing livestock holding (primarily cattle and sheep) and extends to c 14ha (with additional land rented). The land is classified as severely disadvantaged as a result of its type, location and topography.

The proposed site area within the farm is a highly sloping site that is West facing and comprises rough grazing land with rock outcrops and lies to the north of a small copse of trees. There are no watercourses in the immediate vicinity.

The site fronts and is directly accessible to Hollingworth Road. It is therefore visible in its immediate setting and Hollingworth Road frontage (with full details provided in the Landscape and Visual Assessment Report).

As a result of the site location and context there are potential considerations/ constraints to energy efficiency and sustainability measures that could be considered for the site, as assessed later in this report.

The family owners of the farm operate a small business selling farm produced meat products and eggs. However, it is highly constrained as set out in other supporting documentation.

The proposal is for a new farm shop with butchery, café and community room, supported by parking and associated infrastructure.

The aim of the building is to be as self sufficient as possible given the constraints of the site in terms of energy and to include sustainable materials and measures in its construction where they are feasible in terms of the building, surroundings, functional requirements and cost.

The aim of this report is to provide the options to be considered during the later design stages of the project to ensure that compliance with standards / regulations, energy consumption during building use, sustainable materials and use of renewable energy form part of the initial briefing and are fully reviewed as part of the design process.

2.0 RELEVANT PLANNING POLICY / DOCUMENTS / BUILDING CONTROL

The building fabric and building services systems at Bank Top Farm, Littleborough will be subject to the requirements of the current building regulations relating to new commercial buildings. We expect that the client will appoint an approved inspector to advise on the requirements and validate the works in terms of building control approval for any works that the client intends to undertake.

Rochdale Borough Council have an adopted core strategy and the following areas of this document relate to the consideration / option appraisal for this development in terms of renewables and sustainability.

10.3 To help tackle climate change and its impacts, as well as addressing fuel security and fuel poverty issues, our policies seek to:

- *Promote sustainable patterns of development and sustainable construction and design;*
- *Encourage renewable energy developments;*
- *Safeguard natural resources which help to tackle climate change and its impacts, such as urban greenspace, waterways and the peatlands;*
- *Help achieve national goals for zero carbon development; and*
- *Ensure the co-ordinated delivery of key infrastructure with the delivery of development.*

10.4 To protect and enhance our natural environment and resources our policies seek to:

- *Protect the Green Belt and other countryside;*
- *Protect and enhance biodiversity;*
- *Manage water resources and flood risk;*
- *Reduce the impact of pollution; and*
- *Manage minerals and waste in a sustainable manner.*

New developments will be expected to:

- a) *Be zero carbon in line with national targets and definitions;*
- b) *Adhere to the 'energy hierarchy' as outlined in policy G2, being designed in such a way that ensures that buildings require the minimum amount of energy to function over their lifetime;*
- c) *Reduce CO2 emissions through the use of renewable and low carbon decentralised energy technologies and networks. This will be through both on-site provision in new developments and through connection to local networks;*
- d) *Address the impacts of climate change by incorporating comprehensive adaptation measures, including: suitable measures, such as urban greening, for tackling the 'urban heat island' effect; ii. where possible, the opening up of covered and culverted sections of waterways and provision of new water features, to help cooling and provide biodiversity, landscape and flood prevention benefits; iii. the incorporation of appropriate water conservation and management measures, such as Sustainable Drainage Systems (SuDS), including ensuring that the rate of run-off on 'greenfield' sites is not increased and on 'brownfield' sites is significantly reduced, and avoiding the use of impermeable surfaces; iv. the retention of existing trees wherever possible and the taking of all appropriate opportunities to plant trees and other suitable vegetation on site; and v. the incorporation of 'green roofs' wherever possible, such as with flat roofs*

10.11 Allowable solutions may include:

- *On site measures such as heat networks*
- *Retrofitting existing buildings*

- Contributions towards strategic infrastructure projects via a Greater Manchester fund.
- Contributions towards connecting existing buildings to district heating networks (network development areas)
- Contributions towards tree planting or other measures to reduce CO2 through natural systems

The information in the following sections seeks to demonstrate how the design of this development will seek to support this strategy, where appropriate to the development.

The following details from the current building regulations identifies the consideration of high-efficiency alternative systems that will be reviewed in the following sections of this report.

This section deals with the requirements of regulation 25A of the Building Regulations 2010.

Regulation

Consideration of high-efficiency alternative systems for new buildings

- 25A.** (1) Before construction of a new building starts, the person who is to carry out the work must analyse and take into account the technical, environmental and economic feasibility of using high-efficiency alternative systems (such as the following systems) in the construction, if available—
- decentralised energy supply systems based on energy from renewable sources;
 - cogeneration;
 - district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources; and
 - heat pumps.
- (2) The person carrying out the work must—
- not later than the beginning of the day before the day on which the work starts, give the local authority a notice which states that the analysis referred to in paragraph (1)—
 - has been undertaken;
 - is documented; and
 - the documentation is available to the authority for verification purposes; and
 - ensure that a copy of the analysis is available for inspection at all reasonable times upon request by an officer of the local authority.
- (3) An authorised officer of the local authority may require production of the documentation in order to verify that this regulation has been complied with.
- (4) The analysis referred to in paragraph (1)—
- may be carried out for individual buildings or for groups of similar buildings or for common typologies of buildings in the same area; and
 - in so far as it relates to collective heating and cooling systems, may be carried out for all buildings connected to the system in the same area.

Regulation continued

- (5) In this regulation—
- "cogeneration" means simultaneous generation in one process of thermal energy and one or both of the following—
 - electrical energy;
 - mechanical energy;
 - "district or block heating or cooling" means the distribution of thermal energy in the form of steam, hot water or chilled liquids, from a central source of production through a network of multiple buildings or sites, for the use of space or process heating or cooling;
 - "energy from renewable sources" means energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases; and
 - "heat pump" means a machine, a device or installation that transfers heat from natural surroundings such as air, water or ground to buildings or industrial applications by reversing the natural flow of heat such that it flows from a lower to a higher temperature. (For reversible heat pumps, it may also move heat from the building to the natural surroundings.)

The following section from the current building regulations identifies the minimum fabric requirements for the building which will be considered as part of the building design moving forward.

The later stages of design will use these figures as a minimum standards for the new build construction and the overall compliance of the building will be demonstrated via calculation and drawings in conjunction with advise from building control / approved inspector.

Table 4.1 Limiting U-values for new or replacement elements in new and existing buildings and air permeability in new buildings

Element type	Maximum U-value ⁽¹⁾ W/(m ² ·K) or air permeability
Roof (flat roof) ⁽²⁾	0.18
Roof (pitched roof) ⁽³⁾	0.16
Wall ⁽⁴⁾⁽⁵⁾	0.26
Floor ⁽⁶⁾⁽⁵⁾	0.18
Swimming pool basin ⁽⁶⁾	0.25
Windows in buildings similar to dwellings ⁽⁷⁾⁽⁸⁾	1.6 or Window Energy Rating ⁽⁹⁾ Band B
All other windows, ⁽¹⁰⁾⁽¹¹⁾ roof windows, curtain walling	1.6
Rooflights ⁽¹²⁾⁽¹³⁾	2.2
Pedestrian doors (including glazed doors) ⁽¹⁴⁾	1.6
Vehicle access and similar large doors	1.3
High-usage entrance doors	3.0
Roof ventilators (including smoke vents)	3.0
Air permeability (for new buildings)	8.0m ³ /(h·m ²) @ 50Pa

NOTES:

- Area-weighted average values, except for new windows, rooflights and doors in existing buildings.
- For dormer windows, 'roof' includes the roof parts of the windows and 'wall' includes the wall parts (cheeks).
- If meeting such a standard in an existing building would reduce by more than 5% the internal floor area of the room bounded by the wall, a lesser provision may be appropriate.
- The U-value of the floor of an extension may be calculated using the exposed perimeter and floor area of either the whole enlarged building or the extension alone.
- If meeting such a standard in an existing building, would create significant problems in relation to adjoining floor levels, a lesser provision may be appropriate.
- The U-value of a swimming pool basin (walls and floor) calculated according to **BS EN ISO 13370**.
- For example, student accommodation, care homes and similar uses where the occupancy levels and internal heat gains are essentially domestic in character.
- If other performance (e.g. wind load, safety, security or acoustic attenuation) requires thicker glass to be used, an equivalent window unit with standard thickness glazing should be shown to meet the required standard.
- The methods for calculating Window Energy Rating are set out in the Glass and Glazing Federation's Glazing Manual Data Sheet 2.3, Guide to the Calculation of Energy Ratings for Windows, Roof Windows and Doors.
- No maximum U-value is set for display windows and similar glazing. There are no limits on the design of display windows and similar glazing, but for new buildings their impact must be taken into account in the calculation of primary energy and CO₂ emissions.
- In buildings with high internal heat gains, the average U-value for windows can be relaxed from the values given above if this can be shown to be an appropriate way of reducing overall CO₂ emissions and primary energy. However, values should be no higher than 2.7W/(m²·K).
- U-values for rooflights or rooflight-and-kerb assemblies should be based on the developed surface area of the rooflight (U_d values), which is often greater than the area of the roof opening. Further guidance on U_d-values is given in the Building Research Establishment's BR 443 and the National Association of Rooflight Manufacturers' Technical Document NTD02.
- The limiting value for rooflights also applies to kerbs that are supplied as part of a single rooflight-and-kerb assembly sourced from the same supplier and for which the supplier can provide a combined U_d-value for the assembly. An upstand built on site should have a maximum U-value of 0.35W/m²·K.
- For external fire doorsets, as defined in Appendix A of Approved Document B, Volume 2, in new and existing non-domestic buildings, a maximum U-value of 1.8W/(m²·K) is permissible.

3.0 SUSTAINABILITY and ENERGY EFFICIENCY

The following areas are key to the developing building services engineering design and the building sustainability and energy strategy:

- Operational performance
- Health and wellbeing
- Energy use and CO2 emissions
- Managing pollution from building services
- Adapting to climate change
- Water use
- Materials and resource use

The following publications can inform the clients decision making in terms of building improvements and sustainability:

- Sustainability CIBSE guide L: 2020
- RIBA plan of work 2020
- RIBA sustainable outcomes guide 2019

The following table taken from the CIBSE Guide L reviews the items identified in the above list and shows how these elements can be reviewed and demonstrated.

This is to be considered by the client and design team in relation to options for the site and potential energy efficiency, sustainability matters for the development.

Issue	Typical design and construction objective	Example indicators	Example performance standards
Health and wellbeing	Provide a safer, more accessible, healthy and comfortable environment	Air quality (e.g. PPM) Acoustic performance (NR and dB LAeqt) Lighting, daylight and views	Maintain Carbon dioxide levels in the space below 900 ppm. Set suitable acoustic performance standards at later design stages. Include control system to modify lighting with external conditions.
Energy and CO ₂	Reduce predicted CO ₂ emissions by applying passive design and energy efficient design principles and utilizing low or zero carbon technologies. Operational energy use assessment undertaken (based on CIBSE TM54 (CIBSE, 2013))	Total CO ₂ emissions: kgCO ₂ /m ² per year Energy use: kW·h/m ² per year for electricity, fossil fuels and other energy sources Air permeability index: m ³ /h per m ² at 50 Pa	Target on total energy use, EPC A Rating AND Target on space heating demand: e.g. below 15 kW·h/year per m ² AND Heat to be supplied from low-carbon sources, aiming for no fossil fuel combustion on site Air permeability: 3 m ³ /h per m ² at 50 Pa or less
Transport	Increase the use of sustainable modes of transport when the building is in use. Accessibility by a range of means. Joint use – range of uses to cater for multi-purpose. Refer to transport statement	Percentage of trips by each mode of transport (%)	Site location and design measures equivalent to credits in BREEAM, LEED or other schemes, which take account of a range of factors including public transport accessibility, cycling and walking facilities etc.

Issue	Typical design and construction objective	Example indicators	Example performance standards
Water	Reduce predicted water use by integrating water efficient plant, appliances, and fittings	Non-domestic: m ³ /person per year or litre/person per day Dwellings: m ³ /bedspace per year or litre/person per day	Non-domestic: operational use of less than 0.5 m ³ /m ² per year or less than 4 m ³ /FTE (full time equivalent)
Materials	Reduce the embodied lifetime environmental impacts by selecting on the basis of environmental preference, e.g. recycled content	Percentage achieving preference criteria (%) Embodied carbon target (kgCO ₂ eq/m ²)	Recycled content greater than 10% (claims must comply with BS EN ISO 14021 (BSI, 2016) Type II Self-declared Environmental Claims) RIBA 2030 Climate Challenge for new buildings and major refurbishments: embodied carbon target of 300 kgCO ₂ eq/m ² (domestic buildings) or 500 kgCO ₂ eq/m ² (dwellings), measured according to the RICS methodology, modules A–C
Waste	Reduce construction and demolition waste to landfill and enable in use recycling by following the waste hierarchy	Habitat losses and gains Losses and gains of features used by priority species	Achieve total waste arising targets less than or equal to 13.3 m ³ per 100 m ² (gross internal floor area) Diversion of 95% of (non-hazardous) construction waste and 100% of demolition waste from landfill
Ecology and biodiversity	Protect existing ecology on site and enhance the ecological value and biodiversity of the site by protecting existing assets and by introducing local new habitats and/or species Aim for a net-positive impact on biodiversity Compensate for any unavoidable loss of biodiversity	Habitat losses and gains Losses and gains of features used by priority species	Ecologist to undertake a desk-based biodiversity assessment before site is cleared and ensure existing ecology is protected Enhancement of ecology potential on site to achieve 10% BNG.

Issue	Typical design and construction objective	Example indicators	Example performance standards
Pollution	Reduce unavoidable building related emissions and the risk of accidental pollution	Global warming potential (GWP) of refrigerant or whole life mgNO _x /kW·h of delivered energy	Assess viability of using refrigerants with GWP <10 in all systems over 6 kg charge. Target for whole life warming potential, taking account of emissions in operation (including leakage rate and cooling system operational efficiency as well as the refrigerant GWP itself)
Flood risk	Mitigate the risk of flooding (and design for flood resilience)	Where at risk of flooding, use appropriate flood resistant and resilient construction techniques	Follow BS 85500 (BSI, 2015)
Sustainable Drainage	Reduce run-off from the site	Run-off rate (peak and volume) Sustainable drainage systems can provide multiple benefits so, ideally, this should complemented with other indicators, especially as ecology/biodiversity	Achieve greenfield run-off rate
Adapting to climate change	Improve the capacity of the building to operate successfully under the different and demanding conditions predicted in future	CIBSE overheating criteria Flooding resilience and resistance criteria to take account of climate change	Review overheating during later design stages and provide systems that are future proofed
Social issues	Reduce crime and adverse effects on neighbours throughout the lifetime of the development through design and practice in construction and operation	Accessibility Considerate construction Opportunities for apprenticeships and training Creation of local jobs	Achieve Secured by Design 'Developer's Award' Consider opportunities for local employment during construction and operation. 'Considerate Contractor' score of at least 32

3.1 LOW CARBON TECHNOLOGY OPTIONS FOR BANK TOP FARM

The table below provides an overview of the renewable options reviewed and the viability of each for this development.

Technology	Technical Feasibility	Carbon Savings
Solar photovoltaics	The use of solar photovoltaic panels at this site would be technically feasible either roof or ground mounted. In terms of planning and architecture there are further reviews to be undertaken regarding the proposed form of the building and site and how panels could be suitable integrated into the scheme. The system would be sized to offset energy used and provide a saving on carbon use and energy bills. The system would be grid connected to export only when there is energy produced when it is not needed. The use of battery storage would also be considered.	If sufficient area for panels can be made available, it would be possible to offset a significant amount of the electrical energy use of the building, with associated savings of carbon in use. The amount of saving will be determined at a later stage once available area for panels can be determined. Initial studies have identified between 40 and 90 panels with an area between 80 and 180m ² .
Wind	Location of building and planning may be an issue on this part of the site. The predicted wind speed at 25m above ground in this location is 4.2m/s, which is slightly lower than optimum for wind turbine installations.	A significant amount of the energy use for the building with associated carbon savings could be achieved with the use of a wind turbine. A turbine at 18-27m with a 4.5m blade would offer 18kw of energy to the site.
Micro Hydro	There is no capacity for micro hydro on this site since there are no local water courses available.	N/A
District Heating	Not currently available	N/A
Solar Hot Water	Limited space. Efficiency improvements for existing plant sizes not considered to be sufficient for the capital cost.	N/A
CHP	Demand for this building is too low for this option to be feasible in comparison to other options available.	N/A
Air Source Heat Pumps	ASHP is technically feasible for heating and hot water for this development. System sizing between 11 and 15KW	When used in conjunction with a thermally efficient building construction ASHP provides significant improvement in use of energy and carbon when compared with traditional methods.
Ground source heat pumps	GSHP is technically feasible for heating and hot water for this development. System sizing between 11 and 15kw. Area for ground loops between 700m ² and 1000m ² dependant on ground conditions. Potentially half of the ground loops under the new parking areas and the remainder either by rods or under the surrounding grassed or pathway areas. Vertical driven rods also an option.	When used in conjunction with a thermally efficient building construction ASHP provides significant improvement in use of energy and carbon when compared with traditional methods
Biomass	Not considered to be suitable for this location.	N/A
Rainwater Harvesting	Collection of rainwater from the building to utilise for wc flushing in the building would improve water consumption. Below ground tank and pump arrangement would be required. Dependant on eventual use of the water a minimum tank size of 3000l would be suitable, or larger if water is also to be used for irrigation of the site. The use of sedum roof to part of the building will assist with reusing rainfall to the site.	N/A

Passive ventilation systems	Option to replace mechanical ventilation if acceptable in terms of elevational / roof treatment and planning. If an on site electricity generation option is taken forward to design the use of mechanical ventilation may be preferred as the energy use of the fans will be offset.	Small reduction in energy use in comparison to using fan assisted ventilation.
Low energy lighting systems	Adoption of LED based lighting system with suitable controls that can include timeclock, daylight linking and presence detection can assist in reducing energy and carbon in use. External lighting can be considered with integral photovoltaic panels to support the site renewable objectives.	The use of LED lighting is considered to be essential for this scheme to keep the overall energy use of the building at optimum levels.
Control systems	The mechanical and electrical systems can be provided with suitable automatic controls to ensure that systems only run when needed and therefore keep energy and carbon use to minimum levels.	The use of mechanical services heating and ventilation controls on a zoned basis to suit occupancy and use requirements will be included

Based on the above assessment, the technically feasible technologies for this project to take forward for further review are:

a) Solar photovoltaics for offsetting electrical energy use combined with storage battery

Options for the PV scheme have been reviewed as identified in the previous table. The report in the appendices provides further detail.

b) Air source or Ground Source heat pumps

An initial review of sizes of required equipment to take forward to the next design stage for review has been undertaken as identified in the previous table.

c) Rainwater harvesting

An initial review of tank size has been undertaken and identified in the previous table. The intended use for the rainwater to be reviewed at a later design stage to firm up on tank requirements and any greywater provision within the in the building.

d) Passive ventilation systems

There is an option to provide minimum mechanical ventilation levels to the community room, shop and café with suitable systems with appropriate filtration to the food preparation areas in line with the requirements of DW 172, which identifies the standards required for systems that ventilate food preparation and serving areas. This method of ventilation will provide staff and visitors with adequate ventilation levels for the activities undertaken in the building whilst ensuring good air quality and acoustic properties as required. This option also has the least impact on the building fabric in terms of louvres / vents. Although some interventions will be required as well as some specific extract ventilation requirements for the food prep areas once the full details of the requirements for these are known.

Passive measures for ventilation is an option for this scheme, but they may require ventilation systems that provide interventions with the external fabric of the building and may alter the elevations of the building as currently shown. These options would be more energy efficient and sustainable than the mechanical ventilation systems

noted above and the use of either system should be carefully considered in line with the planning requirements for the scheme and the aspirations for the scheme to be low energy and with low carbon emissions over its lifetime.

e) Low energy lighting

The building will be provided with suitable control system to monitor and reduce energy use wherever possible along with low energy LED lighting systems. Consideration for providing external lighting with good quality integral photovoltaics will also be considered moving forward.

4.0 ELECTRIC VEHICLE CHARGE POINTS

It is expected that there will be a requirement for EVC's as part of the planning conditions for this project and this will be reviewed as part of the servicing distribution for the site.

All EVC's will be specified as load balancing.

Dependant on electrical supply arrangements these may be provided as electrically separate from the building.

5.0 CONCLUSION

This study and report has been conducted to clarify the client's intentions to consider and deliver a system of renewable energy technologies to support a proposed new building which are both sensitive to their impact on the site and will also deliver real operational benefits in terms of their use.

A number of technologies have been reviewed, however only some of them can be considered moving forward given the context of the architecture and the wider site aspects.

The renewable technologies that the client is interested in pursuing have been identified as being the following;

1. Solar Photovoltaic Panels
2. Battery Energy Storage System
3. Air Source Heat Pump

Each of these renewable energy systems will need to be further developed at RIBA Stage 3 and 4 to ratify the technical and operational details necessary to install them, however this list comprises the technology that is considered appropriate.

If designed well, these systems will remove the majority of the lifetime operational Carbon Emissions and deliver a facility that aims for essentially Net Carbon Zero and powered by sustainable and renewable energy.

The predicted energy use and carbon emissions will be determined by as designed SBEM calculations at a later design stage to confirm the agreed design intent meets the current regulation requirements. With the combination of the systems and fabric performance that are being reviewed the building could aim to achieve a minimum A EPC rating and the client could move forward with a clear roadmap for the building to aim to achieve net zero carbon in the next 10 years of the building use.

6.0 APPENDIX A

6.1 PV SIMULATION REPORT



Version 7.2.16

PVsyst - Simulation report

Grid-Connected System

Project: Bank Top Farm

Variant: New simulation variant

Sheds, single array

System power: 32.4 kWp

Littleborough - United Kingdom

Author



PVsyst V7.2.16

VC0, Simulation date:
20/06/22 14:45
with v7.2.16

Project: Bank Top Farm
Variant: New simulation variant

Project summary

Geographical Site Littleborough United Kingdom	Situation		Project settings	
	Latitude	53.64 °N	Albedo	0.20
	Longitude	-2.10 °W		
	Altitude	154 m		
	Time zone	UTC		
Meteo data Littleborough Meteonorm 8.0 (2004-2013), Sat=100% - Synthetic				

System summary

Grid-Connected System Simulation for year no 10		Sheds, single array	
PV Field Orientation Fixed plane Tilt/Azimuth 18 / 9 °		Near Shadings Linear shadings	
System information PV Array Nb. of modules 90 units Pnom total 32.4 kWp		User's needs Daily household consumers Seasonal modulation Average 17.1 kWh/Day	
		Inverters Nb. of units 2 units Pnom total 30.0 kWac Pnom ratio 1.080	

Results summary

Produced Energy	25.32 MWh/year	Specific production	781 kWh/kWp/year	Perf. Ratio PR	69.25 %
Used Energy	6.23 MWh/year			Solar Fraction SF	70.92 %

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PVsyst V7.2.16

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Project: Bank Top Farm

Variant: New simulation variant

General parameters			
Grid-Connected System		Sheds, single array	
PV Field Orientation		Sheds configuration	
Orientation		Nb. of sheds	3 units
Fixed plane		Single array	
Tilt/Azimuth	18 / 9 °	Sizes	
		Sheds spacing	5.00 m
		Collector width	5.91 m
		Ground Cov. Ratio (GCR)	118.2 %
		Top inactive band	0.02 m
		Bottom inactive band	0.02 m
		Shading limit angle	
		Limit profile angle	109.2 °
Horizon		User's needs	
Free Horizon		Daily household consumers	
		Seasonal modulation	
		Average	17.1 kWh/Day

PV Array Characteristics			
PV module		Inverter	
Manufacturer	Generic	Manufacturer	Generic
Model	RCM-360-6MA- 15S (1500V)	Model	SUN2000-15KTL-M2
(Original PVsyst database)		(Original PVsyst database)	
Unit Nom. Power	360 Wp	Unit Nom. Power	15.0 kWac
Number of PV modules	90 units	Number of inverters	2 units
Nominal (STC)	32.4 kWp	Total power	30.0 kWac
Modules	6 Strings x 15 in series	Operating voltage	160-950 V
At operating cond. (50°C)		Max. power (>=55°C)	16.5 kWac
Pmpp	29.20 kWp	Pnom ratio (DC:AC)	1.08
U mpp	527 V		
I mpp	55 A		
Total PV power		Total inverter power	
Nominal (STC)	32 kWp	Total power	30 kWac
Total	90 modules	Number of inverters	2 units
Module area	175 m²	Pnom ratio	1.08
Cell area	157 m²		

Array losses			
Thermal Loss factor		DC wiring losses	
Module temperature according to irradiance		Global array res.	160 mΩ
Uc (const)	29.0 W/m²K	Loss Fraction	1.5 % at STC
Uv (wind)	0.0 W/m²K/m/s		
Module Quality Loss		Module mismatch losses	
Loss Fraction	-0.5 %	Loss Fraction	2.0 % at MPP
Module average degradation		Strings Mismatch loss	
Year no	10	Loss Fraction	0.1 %
Loss factor	0.4 %/year		
Mismatch due to degradation			
Imp RMS dispersion	0.4 %/year		
Vmp RMS dispersion	0.4 %/year		

20/06/22

PVsyst Evaluation mode

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Array losses

IAM loss factor

Incidence effect (IAM): Fresnel smooth glass, $n = 1.526$

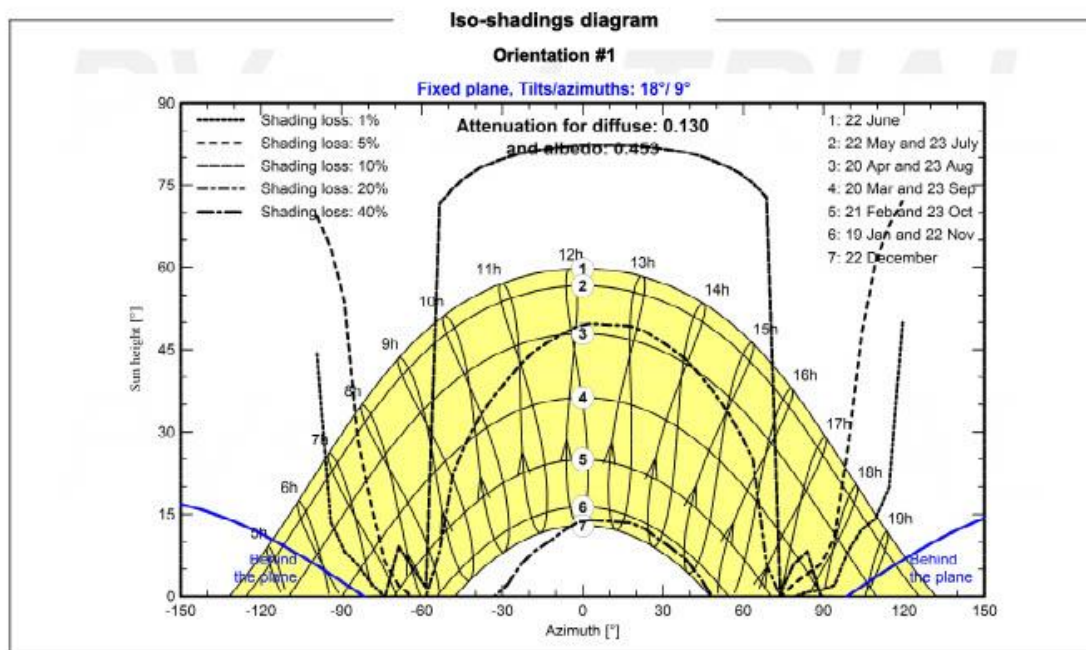
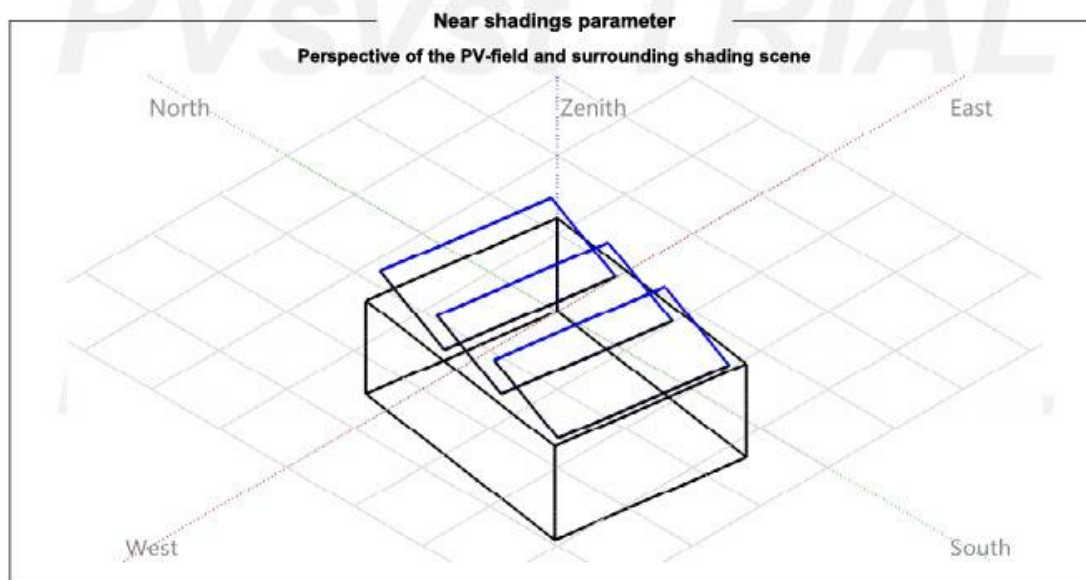
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.998	0.981	0.948	0.862	0.776	0.636	0.403	0.000



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Detailed User's needs

Daily household consumers, Seasonal modulation, average = 17.1 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	20	10W/lamp	8.5	1700
TV / PC / Mobile	2	100W/app	7.0	1400
Domestic appliances	3	1000W/app	5.0	15000
Fridge / Deep-freeze	4		24	3197
Dish- & Cloth-washers	1		2	4000
Ventilation	1	100W tot	24.0	2400
Air conditioning	2	1000W tot	4.5	9000
Stand-by consumers			24.0	144
Total daily energy				36841Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	10	10W/lamp	5.0	500
TV / PC / Mobile	2	100W/app	5.0	1000
Domestic appliances	1	500W/app	5.0	2500
Fridge / Deep-freeze	2		24	1598
Dish- & Cloth-washers	1		2	2000
Ventilation	1	100W tot	24.0	2400
Stand-by consumers			24.0	144
Total daily energy				10142Wh/day

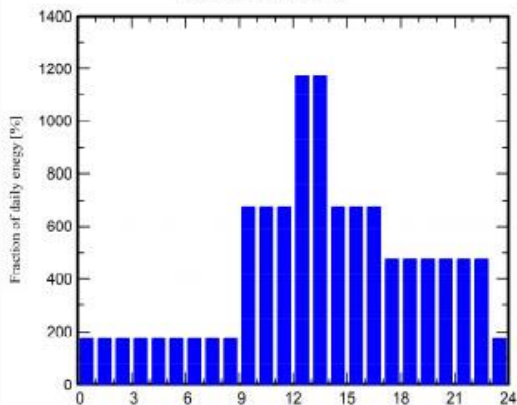
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	10	10W/lamp	6.0	600
TV / PC / Mobile	2	100W/app	6.0	1200
Domestic appliances	1	500W/app	6.0	3000
Fridge / Deep-freeze	2		24	1598
Dish- & Cloth-washers	1		2	2000
Ventilation	1	100W tot	24.0	2400
Stand-by consumers			24.0	144
Total daily energy				10942Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	10	10W/lamp	5.0	500
TV / PC / Mobile	2	100W/app	5.0	1000
Domestic appliances	1	500W/app	5.0	2500
Fridge / Deep-freeze	2		24	1598
Dish- & Cloth-washers	1		2	2000
Ventilation	1	100W tot	24.0	2400
Stand-by consumers			24.0	144
Total daily energy				10142Wh/day

Hourly distribution





PVsyst V7.2.16

VC0, Simulation date:
20/06/22 14:45
with v7.2.16

Project: Bank Top Farm

Variant: New simulation variant

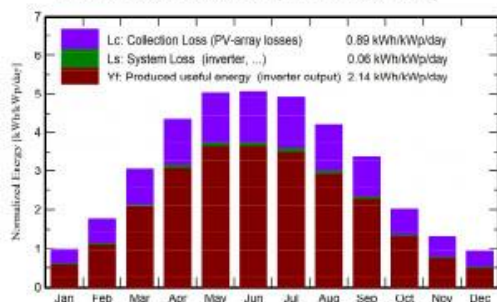
Main results

System Production

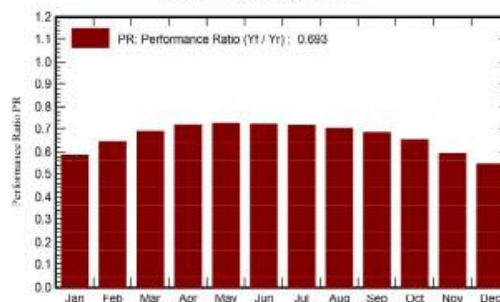
Produced Energy 25.32 MWh/year
Used Energy 6.23 MWh/year

Specific production 781 kWh/kWp/year
Performance Ratio PR 69.25 %
Solar Fraction SF 70.92 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_User	E_Solar	E_Grid	EfrGrid
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	MWh	MWh	MWh	MWh	MWh
January	20.0	13.04	3.95	30.9	20.8	0.617	0.339	0.155	0.433	0.184
February	35.5	20.58	3.89	48.7	35.3	1.057	0.306	0.165	0.858	0.142
March	75.9	37.42	5.37	94.5	72.4	2.163	0.314	0.197	1.913	0.118
April	115.8	56.76	7.60	130.2	104.8	3.087	0.304	0.207	2.810	0.097
May	148.8	82.23	10.82	155.9	129.2	3.760	0.314	0.231	3.444	0.083
June	149.0	71.60	13.79	152.0	127.4	3.641	1.105	0.934	2.619	0.172
July	147.2	75.87	16.14	152.8	127.2	3.623	1.142	0.969	2.564	0.173
August	120.1	58.73	15.55	129.7	105.9	3.018	1.142	0.897	2.044	0.245
September	87.0	50.07	13.01	101.4	79.7	2.306	0.304	0.195	2.052	0.109
October	49.1	30.81	9.95	62.4	46.7	1.366	0.314	0.185	1.139	0.129
November	25.1	14.70	6.38	38.7	26.3	0.777	0.304	0.155	0.590	0.149
December	16.1	8.85	4.42	28.7	18.0	0.535	0.339	0.128	0.379	0.211
Year	989.5	520.66	9.27	1126.0	893.7	25.950	6.230	4.418	20.845	1.812

Legends

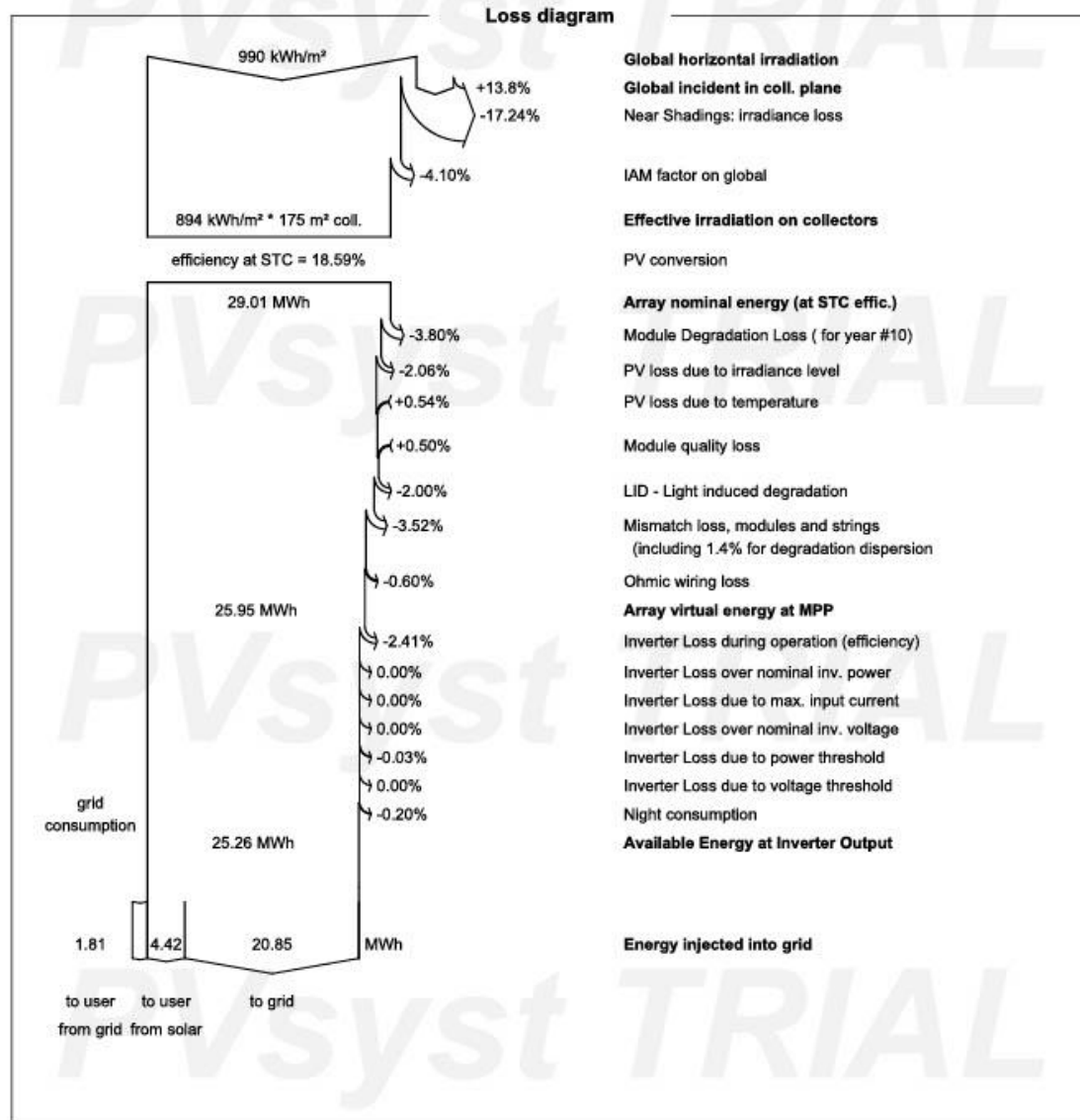
GlobHor Global horizontal irradiation
DiffHor Horizontal diffuse irradiation
T_Amb Ambient Temperature
GlobInc Global incident in coll. plane
GlobEff Effective Global, corr. for IAM and shadings

EArray Effective energy at the output of the array
E_User Energy supplied to the user
E_Solar Energy from the sun
E_Grid Energy injected into grid
EfrGrid Energy from the grid



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Project: Bank Top Farm
Variant: New simulation variant

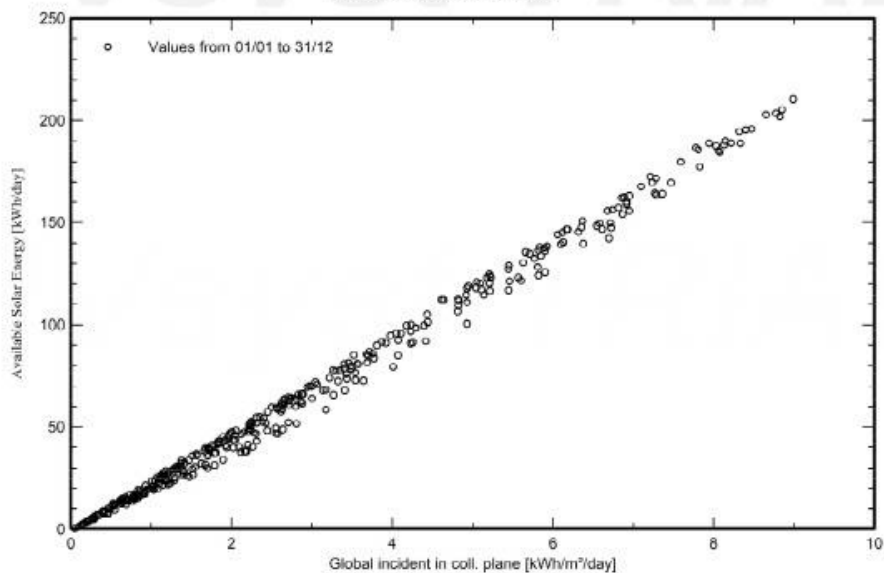




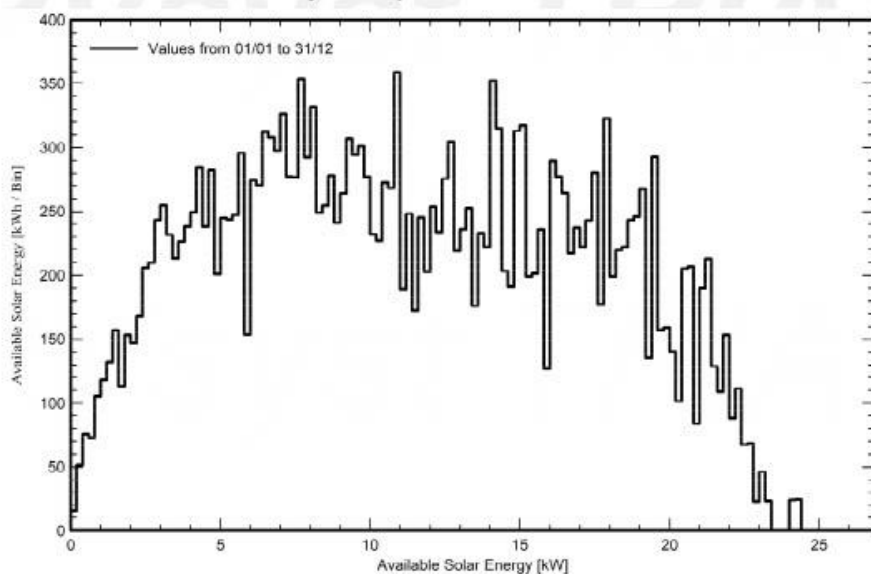
PVsyst V7.2.16
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Project: Bank Top Farm
Variant: New simulation variant

Special graphs
Daily Input/Output diagram



System Output Power Distribution





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with v7.2.16

Project: Bank Top Farm

Variant: New simulation variant

P50 - P90 evaluation

Meteo data

Source Meteonorm 8.0 (2004-2013), Sat=100%
Kind Not defined
Year-to-year variability(Variance) 0.0 %

Specified Deviation

Global variability (meteo + system)

Variability (Quadratic sum) 1.8 %

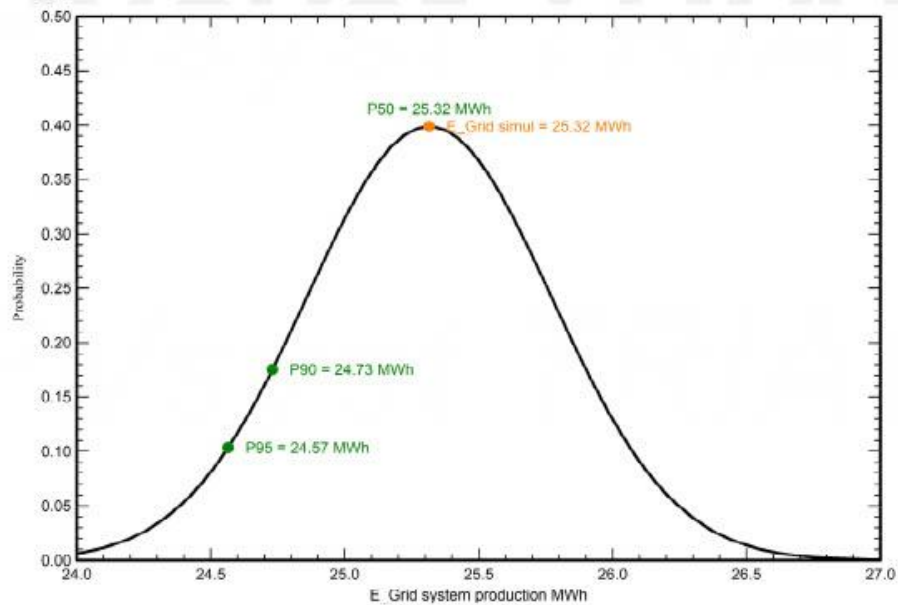
Simulation and parameters uncertainties

PV module modelling/parameters 1.0 %
Inverter efficiency uncertainty 0.5 %
Soiling and mismatch uncertainties 1.0 %
Degradation uncertainty 1.0 %

Annual production probability

Variability 0.46 MWh
P50 25.32 MWh
P90 24.73 MWh
P95 24.57 MWh

Probability distribution





PVsyst V7.2.16

VC0, Simulation date:
20/06/22 14:45
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Project: Bank Top Farm

Variant: New simulation variant

P50 - P90 evaluation

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Year-to-year variability(Variance) 0.0 %

Specified Deviation

Global variability (meteo + system)

Variability (Quadratic sum) 1.8 %

Simulation and parameters uncertainties

PV module modelling/parameters 1.0 %
Inverter efficiency uncertainty 0.5 %
Soiling and mismatch uncertainties 1.0 %
Degradation uncertainty 1.0 %

Annual production probability

Variability 0.46 MWh
P50 25.32 MWh
P90 24.73 MWh
P95 24.57 MWh

Probability distribution

