15 DEMONSTRATION FARM

NFUScotland

Over Rankeilour Farms Wind Turbine, Heat pump and biomass

Over Rankeilour Farms, (West Hall Farm)
West Hall,
Cupar,
Fife,
KY15 4NA
Farmer – Ian Crombie
Date of Farm Visit – 23rd February 2015

Background

Over Rankeilour Farms is a 1,450 acre farm with 1,150 acres of arable land growing wheat, barley, oats, potatoes, broccoli, and includes 250 acres of woodland. Over the last four years Ian Crombie and the Partners have invested in a 225kW wind turbine, a 155kW biomass boiler and a 24kW air source heat pump.

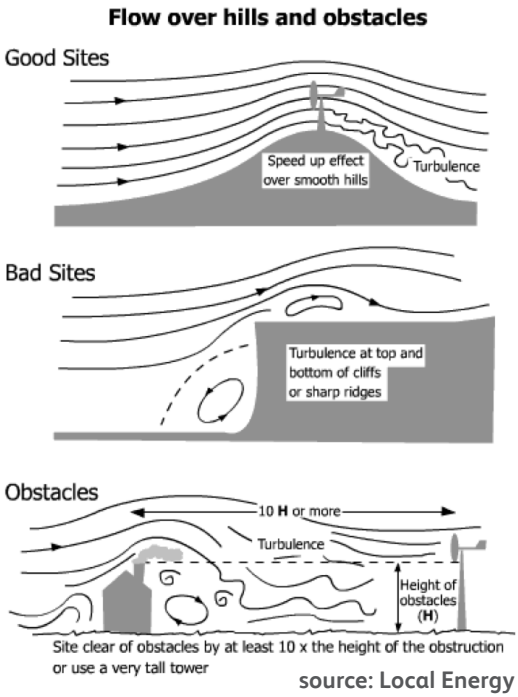
Wind Turbine (ACSA A27/225kW)

Hub height: 32m • Rotor diameter: 27m • Height to blade tip: 45.5m • Swept area: 573 m^2 • start up wind speed 3.5 m/s • cut out wind speed 25 m/s

Following a consultation with the local planning authority over the siting of the turbine, they elected to site the turbine at the bottom of the hill in order to reduce the landscape and visual impact, making it more likely to secure planning consent quickly and secure a higher feed-in-tariff, but also to be close enough to the farm steading to be able to utilise the power generated on the farm first before exporting the surplus. The final location came with the compromise of lower wind speeds compared to an elevated site. The turbines output can be described as 'spikey', which is normally a sign of turbulent air flow. Figure 1 shows how surrounding obstacles can affect the flow of air around a turbine.

The turbine was erected in April 2012, but did not produce energy until January 2013 due to a wiring issue in the turbine. The wiring issue however was not discovered until after the grid connection was upgraded to a larger cable and a new ground mounted transformer and substation were added at a significant additional cost. The original estimate for the project was £550,000 and in total £700,000 was spent.

Figure 1



source: Local Energy Scotland

The 11kVa distribution line that the wind turbine is connected to emanates from Cupar but it only had 150kW of export capacity, which was secured by this project. This has prevented any other farms on the line from exporting renewable energy. Despite the turbine having a peak capacity of 225kW, the spare energy is either used on site or diverted into the wood chip dryer.

This style of arrangement is becoming more common as the power network in rural areas is becoming increasingly limited in terms of what power it can accept. District Network operators are also becoming more adept at finding ways to connect distributed generation, for example Scottish Power are announcing extensions to their Accelerated Renewables Connections (ARC) initiative in the summer of 2015.

The Scottish Government
The European Agricultural Fund for Rural Development: Europe investing in rural areas
savills

Biomass (155kW)

The capital cost of the biomass boiler and district heating network was £80,000. The boiler is a 155kW Herz and was installed by the Wood Heating Company. The boiler serves the office, the farm house and two properties for seasonal farm workers. The boiler was not connected to the grain dryer as it was felt that this would have oversized the boiler for 11 months of the year. The hopper is off the ground allowing for the augers to be horizontal. The advantages of this are that there is no 'dead space' where the wood chip never moves and that as the floor of the fuel store is raised above ground level, if maintenance is required then the auger can be easily removed.

The boiler installed cost includes a two year free maintenance package. This is will help ensure the boiler is working at its best efficiency. One sign a boiler is not working properly is when clinkers are found in the ash bin and combustion chamber.

Clinkers

Clinkers are formed by normally occurring ash being raised above its' melting temperature in the combustion area.

They are common in pellet boilers but less so in wood chip boilers, mainly because it is easier to spot contamination in wood chip (contaminated ash often has a lower melting point) and wood chip generally has a higher moisture content that suppresses fire bed temperature.

For the last quarter (October to January) the boiler produced 74.4MWh, of which 55.8MWh was eligible for RHI. In other words 25% of the heat produced was lost in the boiler room and heat transport piping. The boiler was installed in early 2014, and as such receives the higher RHI rate of 8.8 p/kWh. The data for the October to January period is shown on Table 1 and we have also provided an estimate for the annual heat generation and RHI payments of the boiler.

Table 1

155 kW herz	Oct-Jan quarter	Annual estimate
Capital cost	£80,000	
Heat produced	74.4 MWh	230 MWh
Eligible Heat*	55.8 MWh	172MWh
RHI tier one payments**	£4,910	£15,140
RHI tier two payments***	£0	£0
Previous fuel costs****	£2,790	£ 8,600
Wood chip (25%MC)*****	23 tonnes	76 tonnes

*Assumes that heat loss in pipes has a linear relationship throughout the year
**Tier one rate of 8.8p/kWh
***Tier two rate of 2.2 p/kWh
****Assumes the previous fuel cost 5p/kWh
***** Assumes calorific value of 3,790 kWh per tonne and a boiler efficiency of 80%

Eligible Heat

OFGEM will only pay RHI on heat that they deem is eligible. This typically means a wholly enclosed indoor climate.

For more information on RHI eligibility visit: https://www.ofgem.gov.uk/publications-and-updates/guidance-volume-one-two-and-fuel-measurement-and-sampling-guidance

Fuel Supply

The wood fuel for the biomass boiler has so far been supplied from wind blow around the farm. The farm has 400 tonnes of green wood stored (approx. 270 tonnes at 25% MC once dried), enough timber to keep the boiler running for about three years.

In order to process the wood a tractor towed chipper is hired in periodically, this machine is able to access the logs which have been stockpiled in the woodland which simplifies the management of the chipping process. As it is just supplying one boiler and there is only storage capacity for approximately 60 tonnes of wood chip, a large chipper is not practical.

Wood Chip Dryer

Due to the limited grid connection Ian's farm manager John Wilson came up with a bespoke design to use the electricity to heat a wood chip drying system. When the turbine is producing more than 150kW of electricity, the excess electricity is diverted in to two 10kW fans and 65x1kW heating elements. This helps to ensure that the moisture content of the woodchip is less than 30% (improving boiler efficiency) but more importantly it protects the G59 grid connection with SP Energy networks and allows the wind turbine to continue operating at over 150kW. Before the dryer was installed the turbine was limited to 150kW (as to not trip the G59 connection). This reduced its operational efficiency and energy generation.

Air Source Heat Pump

A Daikin Altherma 24kW air source heat pump system was installed in September 2010 at Ian's newly built house which is on Westhall Farm. The system has two 300 litre hot water tanks and is designed to operate with a low temperature underfloor heating system. As such the heating system operates at 25 to 40°C while the hot water temperature is set at 50°C (scalding temp is 48°C). The system is designed to have a Seasonal Performance Factor (SPF) of 3.6.

SPF is a measure of the operating performance of an electric heat pump heating system over a year. It is the ratio of the heat delivered to the total electrical energy supplied over the year.

> The African hard wood doors on the electric substation were a surprise and a huge additional cost to the project
>
> *Ian Crombie, February 2015*