

## Crichton Castle PV Panels

### **History & Context**

Due to its isolated location, Crichton Castle is not connected to mains utilities. Despite this, our site staff need a source of warmth and light in order to be safe, healthy and efficient in their work. They also need a telephone and fax machine so that they can stay connected to the rest of the organisation. Therefore we have to generate electrical power on site. In this past, a petrol generator was used to supply this power, but this is not ideal because the noise from the generator disturbs what is otherwise a tranquil and picturesque site. The generator also puts more carbon into the atmosphere than other sources of electricity, and means that staff regularly have to handle flammable substances.

In 2005, an array of solar panels was installed on the roof of the castle in a way that was unobtrusive and respectful to the aesthetic values of the monument. These were able to provide power for the lighting, card reader and fax machine, which meant that the generator was only required to supply the heating during cold weather, or as a backup when there is not enough sunlight striking the solar panels. This was a great benefit for us, because it reduced both our carbon footprint and the amount of money we need to spend on fuel – the sunlight is free, after all!

HES's *Carbon Management Plan 2020* identifies "the introduction of low-carbon and renewable technologies" and an area of "primary focus" that will enable us to hit our target of a 69% carbon reduction by 2050 (from the 2015 baseline), in line with the framework set out by the Scottish Government. At present, Crichton Castle is the only ancient monument in our estate that is fitted with solar panels. Since we have made it an explicit goal to get more of our energy from renewables, Crichton Castle represents a vital proof-of-concept that will hopefully serve as a model for other sites, so that these carbon savings can be replicated elsewhere.

### **2019 Upgrade**

In the years between 2005 and 2019, solar technology has improved significantly. The panels installed in 2005 converted 15% of the solar energy that hit them into usable power – but the new ones achieve a market-leading 22.2%. Combined with a slight increase in the total area of the array, we have been able to increase the power output to almost double what it was before.

As part of the upgrade project, we have also installed new batteries with a larger capacity. This means more power can be stored for longer, and the extra output from the new panels won't be wasted.

Thanks to this extra power, we now have several options that we didn't have before. We could:

- Use the extra power to run the heating system, which would mean much less reliance on the petrol generator\*. We are planning to make some changes to the heating system that will enable us to keep our staff warm without using so much energy; these would synergise well with the upgraded solar installation.
- Keep the current lights on for longer without having to run the generator, even when it's too dark to get any solar power.
- Install additional lighting across the site to improve the visitor experience and bring more of the building to life.
- Provide power to a computer or electrical cash register in the office.

And, of course, the new panels will last much longer than the old ones. Even after 25 years (in 2044!), the panels we have installed today should still be producing 87% of their nominal output\*\*.

### **Reduce, Reuse, Recycle**

The old panels, which have been at Crichton Castle for 14 years, and the old batteries, which are around 4 years old, are still in good working order. We are going to keep hold of them and, if possible, re-install them at another HES site. The roof space at Crichton Castle is very limited, and the lack of mains supply means that every kilowatt-hour we can squeeze out of the solar array is one we don't have to get from the petrol generator. At other sites, with more roof space and pre-existing mains connections, this is less of a concern, so the old panels can still make a useful contribution.

We've also taken steps to minimise the amount of waste produced by the upgrade project. For example, we modified and re-used the old battery cabinet, and kept most of the existing electrical cables between the roof and the batteries. These items were still in perfectly good condition, so it would not make sense to throw them away now.

### **Stats for Geeks**

At present, the castle's power consumption is dominated by heating and lighting. The card reader and fax machine are active for brief periods only, so they will be excluded from the following calculations.

The old panels generate a maximum of 1,000W when the sunlight is at its brightest. The less sunshine falls on them, the less power they will generate. By comparison, the new panels generate a maximum of 1,800W.

At present, the heating for the site uses 2,000W, and the lighting uses 330W.

The new batteries can store 290Ah at 48V – that's a total of 13.9kWh. This means that, if we were running all 2,330W of heating and lighting off the batteries without any input from the solar panels or petrol generator, they would be empty after 6 hours (note that in practice, we wouldn't allow the batteries to drain completely). If the panels were producing their full 1,800W, you could run the whole site for over 26 hours before the lights went out! That is a significant improvement over the old system, and easily enough to cover the site's opening hours.