HKD Energy

Solar Traction Project:

Using Solar Energy to Power our Railways

Feasibility Study Summary

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The Solar Traction Project

While solar PV is an increasingly important part of the energy system, there are no examples of solar systems directly supplying railways anywhere in the world. In 2017 the Riding Sunbeams study investigated the potential for connecting solar PV to Network Rail's third rail system in the South East.

In 2018 HKD Energy Ltd applied for and received funding through the government's Rural Community Energy Fund to test the feasibility of a Hassocks site for the Solar Traction project. Five other pilot sites were proposed by other community energy groups under the umbrella of Community Energy South (CES). Following a competitive tender, Ricardo Energy and Environment were commissioned to undertake the Hassocks study and two others; Basingstoke Energy Co-op conducted the other studies. CES led the commercial work.

As with any world firsts, there are issues to be resolved, especially on innovative aspects of the technical and commercial arrangements. As well as exploring potential sites, an important focus of this initial work has been engagement with Network Rail. The potential for community investment rests on negotiating an agreement to buy renewable electricity over the lifespan of the solar panels. Network Rail have several important motivations for collaboration:

- Increased electrification, higher service frequency and higher power trains all increase traction power demand;
- Regulatory pressure to decarbonise the rail network;
- A longer term aim to remove diesel traction by 2040;
- A requirement to engage with communities along the railway.

Ricardo, Basingstoke Energy Co-op and Community Energy South have worked together with Network Rail to clarify and resolve key issues including:

- Technical Aspects: The method of connection to the electricity network that Network Rail own and operate, compliance with Rail industry standards, risks to electrical supply, export of surplus solar generation to the National Grid;
- Commercial Aspects: The proposals for price and duration of the Power Purchase Agreement (PPA) with community owned solar PV, conditions that Network Rail might place on the PPA provider, the ability to sign a PPA alongside Network Rail's long-term electricity purchase contract etc.
- Railway System Impacts: Network Rail sells electricity to the Train Operating Companies (TOCs), and problems with electricity supply could lead to cancellations or delays which have financial consequences.

Solar power

Solar PV is a proven renewable energy technology which has gained a significant global market share. The solar PV technology proposed is conventional, with arrays of panels mounted on metal frames, facing south and angled to maximise generation and minimise shading. Although costs are falling, without subsidies, future solar projects have to find new ways to offer an attractive investment.

Grid connection

The sites considered in this report are all near the London to Brighton Mainline. This uses a 750 V DC third rail traction system to supply power to the trains, fed from substations approximately 3-5 km apart. These are on a Network Rail owned and managed 33 kV network that connects to the national grid. Analysis suggests that this network is likely to have capacity for connecting 5 MW of generation subject to approval from UK Power Network.

Several connection options were analysed. Based on the solar PV capacity, distances and costs, two connection options were selected for Hassocks sites: one for sites with 3 to 5 MW capacity, and another for 0.77 MW capacity.

Site selection

The search for a suitable site for a ground-mounted solar array close to the railway near Hassocks focused on a corridor along the railway line north of the village. It was felt there was little point in proposing a scheme inside the South Downs National Park, because of concerns over the impact on landscape.

Two main search areas were analysed, one near Burgess Hill Track Paralleling Hut (TPH) just south of Burgess Hill and the second area near Folly Hill TPH just south of Haywards Heath. Seven possible sites were assessed for suitable area, size of solar PV system and grid connection cost.

Number	Search area	Site Area (Ha)	Site Generation (MW)	Approximate Connection Cost
1a	Burgess Hill TPH	5.6	3.76	£445 k
1b	Burgess Hill TPH	5.6	3.76	£445 k
2a	Folly Hill TPH	5.6	3.9	£445 k
2b	Folly Hill TPH	3.19	2.24	£445 k
2c	Folly Hill TPH	1.1	0.77	£420 k
2d+e	Folly Hill TPH	7.05	4.9	£445 k
2f	Folly Hill TPH	3.1	2.99	£445 k

An initial constraint analysis of all the sites was undertaken using available desktop materials and the results of a site visit. Analysis included: ability to connect to the grid; visibility; Accessibility for construction phase; shading; land ownership; listed buildings; flood risk.

Several site assessments showed potential for 3-5MW of solar PV capacity, but a number have high risk constraints that would be expensive or impossible to overcome. Two sites were identified as the least constrained. The best for a 5MW scheme is site 1b. A 0.77 MW scheme at site 2c was assessed as an opportunity for a smaller scheme (which might be viable in the future as a DC scheme connecting direct to the Network Rail DC system).

Further discussion with landowners and the local planning authority is required in the next stages of the project. The next stage should also include an ecological assessment.

Power purchase agreement[1]

With government subsidies for solar no longer in place, a long-term Power Purchase Agreement (PPA) with the right pricing structure and a financially strong customer such as Network Rail is an essential component for achieving a 'bankable' or 'investable' project.

Several key principles were identified to shape a PPA with Network Rail:

- Once a scheme is designed around a connection to the railway it is unlikely it can later be connected direct to the national grid. Thus any agreement with Network Rail has to be for the lifetime of the asset (assumed to be 25-30 years);
- Over this timeframe, power prices are expected to rise significantly (given the evidence of recent trends and projections of price), so an agreement must set out not only the starting price, but a revision mechanism for price into the future;
- There has to be a reason for Network Rail to agree to a long-term arrangement and the obvious mechanism is for a guaranteed saving compared to grid supplied electricity;
- The price mechanism may also include a floor price below which prices may not fall (to protect a minimum return to an investor), and a ceiling above which prices will not go (as an added incentive to Network Rail).

Financial projections

Costs, revenues and potential generation were analysed for a 3.8 MW scheme (suitable for site 1b) and a 0.77 MW scheme (for site 2c). Inputs for the analysis included Network Rail electricity demands, electricity prices, solar PV system generation profiles, and costs including development, grid connection and build costs. At this early stage cost and revenue figures are broad estimates, and more detailed financial projections will follow later.

The two schemes were compared to a 'base case' of a conventional 5MW solar farm connected to the national grid and exporting electricity at normal wholesale power prices. The comparator scenarios indicate that:

- The 'base case' scenario provides the community with a poor return on investment with a lengthy payback period and low internal rate of return (IRR). This shows the rationale for seeking a PPA with Network Rail.

[1] The commercial section of the report was developed in conjunction with Community Energy South.

- Hassocks site 1b, a 3.5MW scheme selling energy, via a PPA, to Network Rail, as well as exporting energy to the grid has a payback period of less than 10 years and a project IRR of above 10%.
- Hassocks site 2c, due to its small size and high connection cost has a low IRR (3.57%) with a long payback period at 19.2 years.

At this early stage Hassocks 1b shows indications of a potentially bankable solar PV project; in the next stages more accurate financial data will be gathered to improve the accuracy of the model.

Risks

While it is not within the scope of an initial feasibility to develop a fully comprehensive risk register and mitigation strategy, the study did identify key risks at each of the five stages of development: planning, design, installation, operations and de-commissioning. Four risk categories relevant here are legal/regulatory, construction/technical design, operational and financial. The full report identifies the major risks by category and development stage and how these may be mitigated.

Community benefits

The financial projections in this report indicate community benefits are likely to be substantial. It is important to recognise the variety of 'communities' that may benefit from the project. There is the local community in the area where the solar installation is placed, but also rail-users, a community of interest, but not a community of geography. A rail-user might live in Brighton, but benefit from (and wish to invest in), a solar farm in Hassocks or Haywards Heath.

We expect that the main way for a successful solar traction project to benefit our local community will be through a fund for community projects created from surplus income from the project (income is left after running expenses and members' interest has been paid). Alternative ways of funding community benefits for the rail-user community will also be considered.

Next steps

The Riding Sunbeams consortium (which includes 10:10, Community Energy South and others) has received a First of a Kind (FOAK) grant from the Department of Transport and Innovate UK to test technical solutions, and finalise the commercial delivery model and PPA. Meanwhile, HKD Energy will continue to explore site options identified in this study. We will share information via our website as it becomes available.