

**RIDING  
SUNBEAMS**

*Before Dawn*

Progress Report  
February 2019

## Authors

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## 10:10 Climate Action

10:10 Climate Action is a registered charity on a mission to speed up action on climate change. Whether it's our world-leading Solar Schools campaign, research to generate low carbon heat from parks, or fighting the ban on onshore wind, everything we do is about inspiring more people to take more action on climate change. Charity no: 1157 363.

[www.1010uk.org](http://www.1010uk.org)

## Community Energy South

Community Energy South was established in 2013 as an umbrella organisation and regional hub enabling its members (local community energy groups and community organisations) to grow as sustainable low carbon businesses in the south east of England.

[www.communityenergysouth.org](http://www.communityenergysouth.org)

## The Rural Community Energy Fund

The Rural Community Energy Fund (RCEF) is a £15 million programme, jointly funded by the Department for Environment, Food and Rural Affairs (Defra) and the Department for Business, Energy & Industrial Strategy (DBEIS). It supports rural communities in England to develop renewable energy projects which provide economic and social benefits to the community.

Designed by Matt Bonner.

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## Executive summary



Our previous work showed that using solar to power trains on dc electrified railway lines should in principle be technically viable and commercially attractive.



The next phase of our research has established that this approach should work in practice as well as in principle.



Our consortium carried out six site-specific feasibility studies at real-world locations on behalf of local community energy groups in the south-east.



We found that all six potential pilot solar traction farms, with a combined generating capacity of 27.15 MWp, should be viable for development.



We examined the potential for long term contracts to procure traction power from the proposed lineside community solar farms. They appear to be capable of reducing rail operating costs and carbon emissions, at the same time as underwriting capital investment in new, unsubsidised renewable capacity. They will also generate revenue for local community benefit funds.



We can use existing equipment (repurposed from outside the rail sector) to connect solar to the high voltage ac feeder system that supplies dc rail traction substations with power from the grid. This greatly reduces development timescales compared to our earlier proposal for a dc-dc connection.



This approach also helps overcome the big technical challenge for rail renewable traction power: the intermittency of both the load and supply. Using this method, we will not usually need to integrate storage.



Our next step will be to show that the technical connection works safely and efficiently in the real world: on the operational railway. We have secured funding to design, build and connect a 'First Light' demonstrator solar traction unit to the Wessex Route during 2019.



Evidence from the trial will be used to inform a new rail industry code for the direct connection of renewable generators to rail traction systems.



If all goes well, the first community solar traction farms could connect to UK railways as soon as 2020.

## A word from our community energy partners

BHESCo are thrilled to be a partner in the revolutionary Riding Sunbeams project, working towards establishing a world first for renewable energy by powering our rail system with clean, solar power.

**Dan Curtis**

Brighton and Hove Energy Services Coop

At Repower Balcombe we have seen the Riding Sunbeams project grow from our initial idea to the detailed work needed to make it happen. It is great to see the enthusiasm from the rail industry for this groundbreaking use of solar power.

**Tom Parker**

Repower Balcombe

We have been really impressed with the innovation and collaboration that this project has produced. We have two sites that our feasibility studies have shown could generate over 5MW of electricity. These will generate clean energy and also provide significant financial benefits for communities in north west Hampshire.

**Andrew Thompson**

Hampshire Renewable Energy Cooperative

Hassocks village grew up around its railway station in the 1840s, later to be the first electrified line in the UK. It seems an appropriate place to test the feasibility of the next big technological leap: powering trains with solar power. HKD Energy is pleased to be part of the pioneering Riding Sunbeams project, working to make a significant contribution to reducing carbon emissions through community led renewable energy.

**Juliet Merrifield**

Hassocks, Hurstpierpoint, Keymer and Ditchling Transition (HKD)

British innovation and engineering has led the world since the start of the railways; this pioneering work is continuing to evolve by taking a huge leap into a world-changing renewable way to power transport. So it is wonderful to see our project, as part of a cluster of six, pushing forward this incredible world-leading innovation, raising the prospect of making not only our projects into catalysts for zero-carbon living in our communities, but opening the door for many more to follow by setting a precedent that can be replicated. This is a classic win-win-win-win-win for investors, local communities, Network Rail, cheaper travel and the global environment.

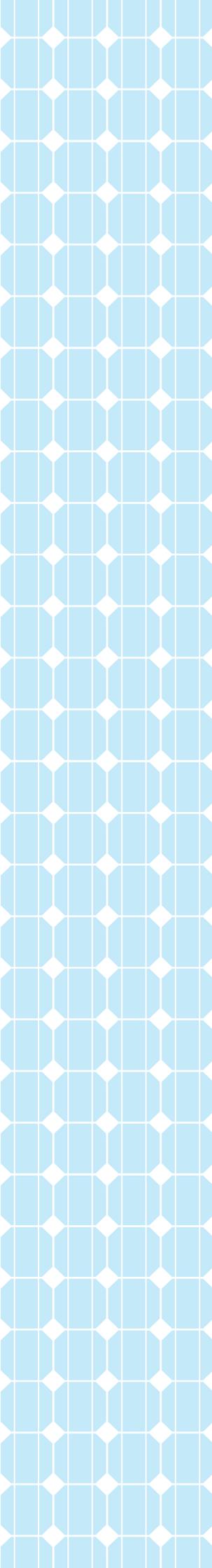
**Dr Alister Scott**

Cuckmere Community Solar

The Riding Sunbeams project is without doubt one of the most exciting opportunities to harness technical innovation and the creativity of social enterprise. We have a talented team and world class partners with whom we will deliver environmental, social and commercially sustainable solutions that will revolutionise our approach to powering the transport network.

**Ivan Stone**

Chair, Riding Sunbeams



## Introduction

In 2014, 10:10 was working with a community energy group in Balcombe, Sussex trying to find a grid connection for their community-owned solar farm. It set technical director Tom Parker wondering: why couldn't we plug the solar panels directly into the local electrified rail line?

Why not indeed? So in 2017, we carried out a preliminary, high level study to see if it would be possible to build small, community-owned solar farms alongside railways to supply renewable electricity directly to the tracks to power trains.

Direct supply of solar power to rail traction systems has still never been done anywhere in the world. Our study found that not only is solar traction power technically feasible, it also makes sense financially for solar generators and railway operators in today's market conditions. We also found that there is huge market potential for this idea in the UK and worldwide.

The obvious next step was to begin to take this concept off the drawing board and into the real world.

So at the start of 2018, we gathered a handful of established community energy groups in the south of England to develop the first ever portfolio bid to the government's Rural Community Energy Fund. With their support, we commissioned full, site-specific feasibility studies at six locations (identified in our previous study) for pilot solar traction farms. At the same time, we continued to work closely with Network Rail to find the best technical solution for safely and efficiently feeding intermittent renewable generation into the traction system.

This short report serves as a status update on our progress towards making the world's first community solar traction farms a reality.

Solar traction power solves two problems for decentralised renewable energy generation: it provides a new way to finance unsubsidised solar in the UK, and offers a way to circumvent grid capacity constraints. Meanwhile, it gives rail operators a chance to reduce traction electricity bills, cut carbon emissions and potentially to deliver completely new kinds of social benefits to lineside neighbours.

We want to lay the tracks for community- and commuter-financed solar traction power to be rapidly commercialised and deployed. Our mission is to make this happen for the benefit of railway routes and the communities that host them.

February 2019

# Community energy and the railways

From small beginnings back in 1996, today there are community energy groups across the UK. They do vital work supporting their communities to build locally owned renewable energy projects and providing much needed community led energy advice services.

In England, Wales and Northern Ireland there are over 230 groups, generating over 202 GWh of electricity each year, avoiding 71,000 tonnes of CO2 emissions and providing enough electricity to power 67,000 homes.

Our vision is for community energy groups to play a central role in connecting renewable energy to the railways – and become a catalyst for decarbonising rail travel in the UK and beyond. So during 2018, working closely with Network Rail and several community energy groups in the south-east, we examined the technical and commercial feasibility of six potential solar sites located close to railway lines.

By working with lineside communities and rail passengers, we will encourage local investment in these schemes – creating community benefit funds too. This will provide a social contract focused on local communities, supporting the vulnerable and promoting low carbon transport and energy.

The Riding Sunbeams project is truly a world first and it is amazing that some of the technology and thinking that will make it possible is being developed. This has the potential to power railways not just in the UK but across the globe. But Riding Sunbeams is not just about innovative technology; it is about developing equally innovative ways of owning and financing renewable energy. At the heart of the project is the building of community owned, decentralised renewable energy systems. This is as much the future as the technology is.

**Martin Heath**, from Basingstoke Energy Coop, who supported the 2018 feasibility study as a technical consultant.

## Technical challenges

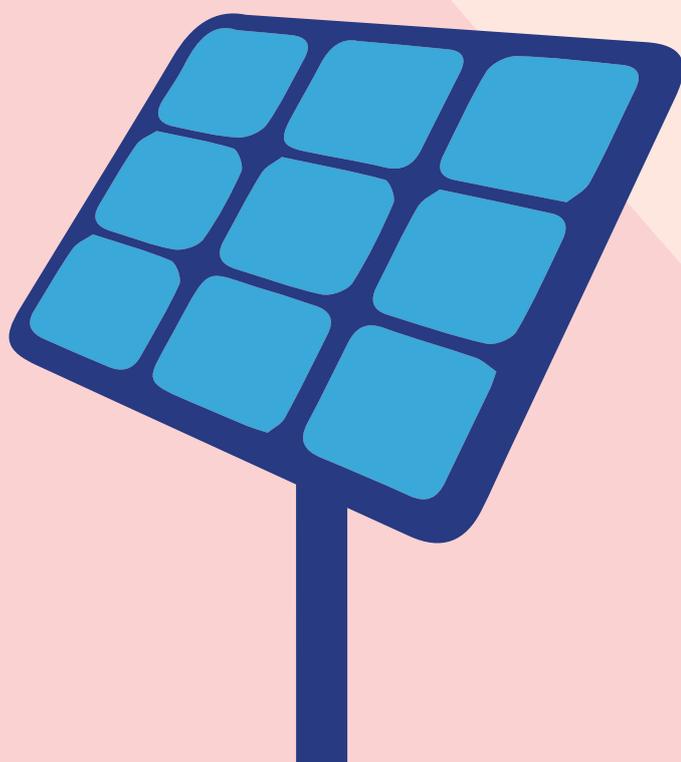
Our 2017 study produced a high level design specification for a dc-dc inverter to allow us to connect solar panels directly to traction substations on the dc rail network. In many ways this is the optimal engineering solution, but there are some major practical barriers. The central issue we faced was that this bespoke equipment simply does not exist on the mass market. Developing, testing and accrediting new equipment for use on the railway requires a multi-year, multi-million pound process in order to achieve the required Rail Industry Readiness Level (RIRL).

Our research also showed that in most practical applications of solar traction power direct to the substation, we would need to integrate some form of storage technology - due to the inherent intermittency of both the load and the generation. But storage technology is very immature in the rail sector, and is only now beginning to be written into rail codes. Moreover, to make the economic case for integrating storage, we would need to rely on value stacking across a range of other functions on the rail side, such as improving system receptiveness to regenerative braking. But it's not yet clear what the financial value of such functions would be to the rail network. We would need a large and detailed piece of analysis before we could even develop an outline business case for lineside storage on the traction system.

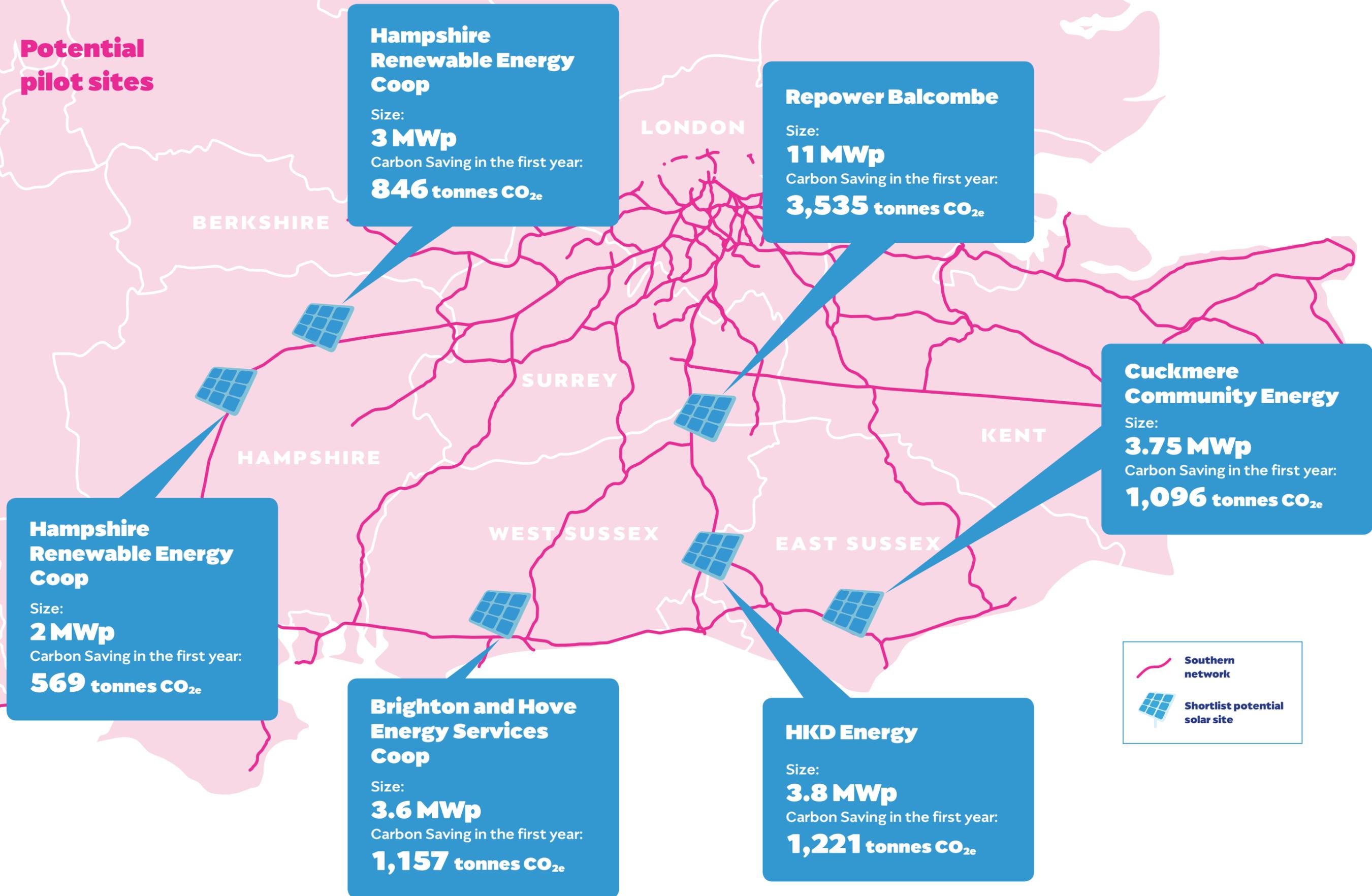
Thankfully, early in 2018 our technical team, working closely with Network Rail engineers, identified a pragmatic alternative solution. This was to connect into the 33kV ac feeder systems that carry power from the grid supply points (GSPs) to the substations. This approach will lead to some dc-ac-dc conversion losses, but it has a number of practical advantages over dc-dc supply to the substation:

1. Equipment for connecting solar farms to high voltage ac networks is very well established and widely available on the mass market. Therefore the task we face is to test and repurpose existing, highly mature technology (usually used for something else) for deployment on the railways. This avoids the need to develop a bespoke new power electronics interface from scratch.
2. Connecting to the feeders goes some way towards overcoming the major technical challenge for solar traction power: intermittency. This is because each GSP supplies around ten to fifteen substations, so the load that is being met is shared across all of these, making it much less peaky than it is at a single substation. It may also be possible to export small amounts of surplus power from the feeders back onto the grid via the GSP.
3. This approach should largely negate challenges around possible dc voltage range exceedances on the tracks, and negate the potential for power quality issues on the dc supplies, which would have substantially increased operational risk.

We can't reveal more about the technical solution we have arrived at now due to commercial considerations, but watch this space...



**Potential pilot sites**



 Southern network

 Shortlist potential solar site

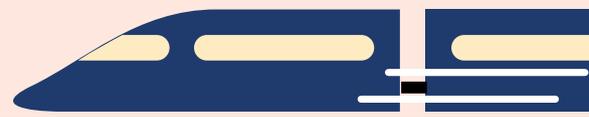
## Next Steps

In January 2019, the Riding Sunbeams consortium was lucky enough to win funding under the Department for Transport and Innovate UK's First of a Kind competition. The competition was for real-world demonstrations of innovations to help decarbonise the railways. With this funding we will be able to test our technical solutions in the real world – on an operational railway. We will also be able to finalise the innovative commercial delivery model and power purchase agreements which we will need to realise our vision.

All being well, in summer 2019 Riding Sunbeams will connect the first ever solar traction array to the railway line between London and Weymouth. Our 30kWp 'First Light' demonstrator PV array will connect to an ancillary transformer on the traction system to supply power to lights and signalling equipment. We will then use real world performance data from our test unit to build and validate sophisticated modelling for much larger volumes of solar power to be injected directly into the dc traction network.

If successful, this 'Riding Sunbeams: First Light' project will prove that direct solar PV supply can be successfully integrated into UK railways without negatively impacting on rail operations or safety. It will also establish the business case and contractual relationships needed to unlock the opportunities our work will create for community energy groups and other renewable generators. By 2020, we hope to be in a position to help build and connect the world's first ever full-scale, community- and commuter-owned solar traction farm to the railways.

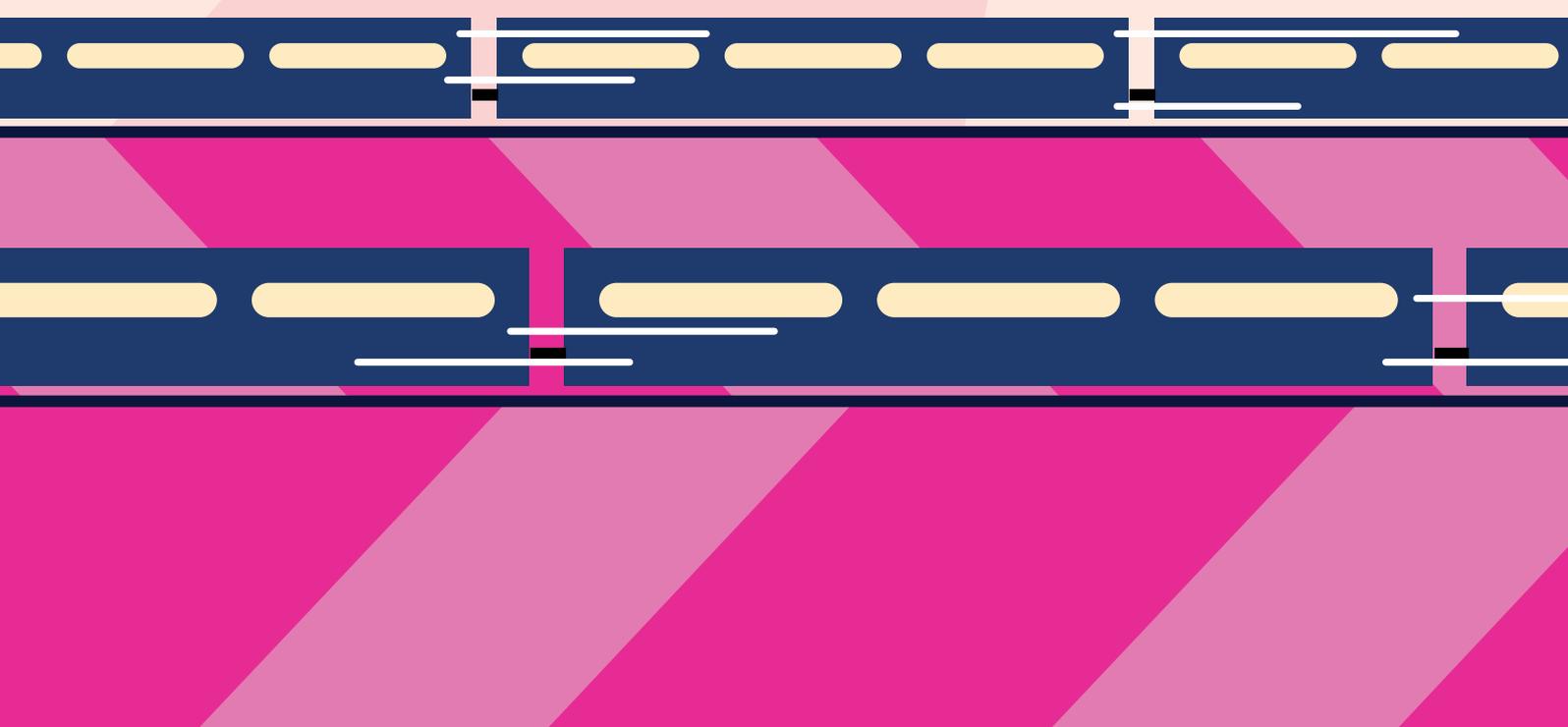
Get on board – here comes the sun!





## Acknowledgements

The authors would like to thank Wendi Wheeler, Alan Bullock and Michal Taratajcio in Network Rail's Safety, Technical and Engineering group; and Stuart Kistruck, Nigel Wheeler and Paul Richmond at Network Rail's Wessex Route for all the hard work, expertise and insights you have contributed to make this possible.



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