ASLEE – Information and Innovation

Scotland has some of the best renewable energy potential in Europe but that potential is severely constrained by local capacity issues of the National Grid - particularly in our remote and rural areas. This is a barrier to development, with many otherwise viable energy projects being delayed or scrapped due to grid constraint issues. If more electricity could be used close to the sites of electricity generation then it would be possible to overcome grid constraints thus allowing more renewable generation, resulting in economic and social benefits to vulnerable areas. This project will look at the technical and economic viability of using renewable energy as the basis of a new bio-manufacturing industry for Scotland. Microalgae are already used to produce a wide variety of products with a value estimated at $4bn *per annum*. Microalgae represent the ideal candidate for a renewable energy-based bio-industry for the following reasons:

1: Microalgae are already used in Scotland's aquaculture industry and demand will rise.

2: The products are high value and low volume, making them easy to transport. Technical risk associated with growing them is low.

3: The major feedstock for the production of microalgae is light. Electricity is the major feedstock cost for producing algae in photobioreactors.

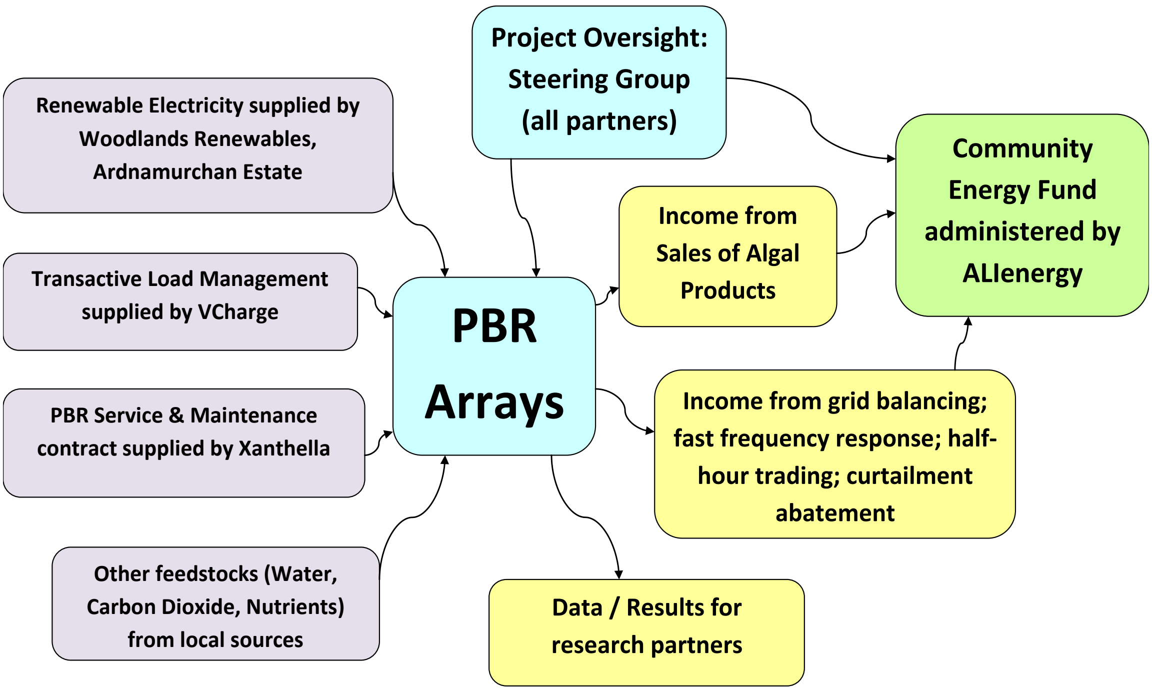
4: Algae production can be scaled to fit local resources and the algae are tolerant of light intermittency. This means that algal production can provide a base demand justifying additional renewable generation while also acting as a transactive load for grid balancing.

In the first and smaller project stage technical feasibility and planning for the second stage will be tackled. The second stage will see the deployment of industrial scale arrays that will be used to investigate the economic viability of the approach. The project will be led by Xanthella and jointly managed between Xanthella and ALIenergy.

In stage one, two small arrays consisting of 4 x 1000l PBRs will be manufactured by Xanthella working with VCharge to develop software and interface systems allowing VCharge's technology to be used in the project. The two arrays will be installed at FAI Aquaculture, Ardtoe and at Xanthella. The Ardtoe array will be used to determine the volume and quality of algae produced by the PBRs operating under optimal conditions. This will use several commercial species of interest and can be compared with the results obtained from the "bag" reactors that are currently in use The EMSP array will be used to investigate the effects of intermittency on the quality and quantity of algae produced. This array will include integration of VCharge's technology that allows demand side management for grid balancing and a reduction in the cost of electricity. The intermittency effects will include test patterns based on likely grid balancing requirements (as previously determined by VCharge) and patterns of intermittency based on wind availability (using data obtained for the 300kW turbine at Ardnamurchan). The data obtained will be used to produce operational models that predict optimal solutions depending on whether the priority is to accommodate renewable intermittency, grid balancing or algal output. The data will also be used by UWS to inform a more detailed business model, looking at the cost benefits. Studies will be made, on the Ardnamurchan Estate, to determine the best operational embedding of the Stage 2 arrays. This will include a technical analysis undertaken by Sgurr and the Ardnamurchan estate to develop an integration and renewables plan for the Estate.

In Stage 2, an array of 32 1000l PBRs will be deployed. This will be the largest system of its type in the UK. The array will demonstrate the technical and economic feasibility of algal biomanufacturing under real conditions of intermittency and at industrial scale. The algae will be evaluated for its suitability to displace imports of algae for the aquaculture industry. The value of the array in grid balancing and renewable curtailment will be determined. The potential social and economic impact of this approach will be studied by UWS who will also study questions around upscaling potential.

The study will conclude with a detailed report on the opportunity algal biomanufacturing presents in removing grid constraint in rural areas and on improving the rural economy. Bottlenecks and barriers to expansion will be identified and remedial actions proposed. Interactions with major stakeholders will inform legacy planning for the project with the aim of establishing algal biomanufacturing as a viable industry in Scotland.



Innovation

The ASLEE project is highly innovative, demonstrating firsts at national, UK, EU and global levels. As production of microalgae is unfamiliar in Scotland it might be thought that much of the innovation is tied to the microalgae. The project will indeed establish the largest internally lit photobioreactor system in the UK but the production of microalgae is a well-developed industry globally, including the production of aquaculture feeds and a demonstrated ability to produce biofuels. The Pandora PBR design is novel and will be a class leader in the production of very high light levels but it is based on tested technologies. Thus while there is a degree of technical innovation in growing the algae and the scale of the proposed facility is innovative for Scotland, growing microalgae is not novel and the technical risk associated with this aspect of the project is correspondingly low. There is more significant technical innovation in marrying VCharge's transactive load management with Xanthella's Zeus control system but again the level of technical risk here is only moderate.

The truly innovative aspects of the project lie firmly in the application of the mutual support between using algal PBRs as a transactive load to reduce the cost of producing the algae whilst using this new industrial manufacturing capability to reduce the impact of grid constraint and curtailment on the deployment of renewables in rural Scotland. To our knowledge, this is a global first and our results will be of great interest to communities everywhere who face similar problems. The central question to be addressed in the project is around the opportunity and the limitations of light intermittency. Algae have evolved in a world where light is intermittent at seasonal and diurnal periodicities but also at much shorter time scales due to cloud cover, water depth and obstructions. The effects of day/night cycles has been well studied and there is also much (but rather contradictory) research on the effects of high flash rates on microalgal production. We know that algae can thrive in intermittent light environments and indeed degrees of intermittency may actually benefit algal growth in high light environments as it allows the algae to recover from photo-inhibition. The ability to alter electrical load is essential for transactive load management but few industrial processes are suited for intermittency of energy supply and fewer still that can cope with intermittency over the ranges that transactive load management and renewable supply demands (ranging from seconds to hours). What is unknown are the limits to which we can exploit the resilience of algae to intermittency of light in transactive load management and the potential scale of algal manufacturing that could be exploited in Scotland to allow an expansion of renewable production in otherwise grid constrained areas. Answering these questions is a main goal of the project and will place Scotland firmly at the front of industrial research in this area.