Project Title:

Development of open source camera trap powered by a plant microbial fuel cell (pMFC)

Report Title:

Accomplishments and progress made by our awardee.

Summary
To further unlock the potential of utilising plant microbial fuel cell (pMFC) solutions, the Arribada Initiative teamed up with Open Plant to devise a specific challenge – develop a pMFC system to power a low-energy camera trap within the Peruvian Amazon. We offered an award of £10,000* to the most interesting and viable proposals so a prototype could be developed.

The pMFC will serve as an environmentally friendly power supply to power sensors and camera traps in remote field locations, such as tropical forests (**figure 1** shows an artistic view of this idea). Our aim is that these prototypes will contribute to the development of solutions that solve battery maintenance challenges associated with deployments of conservation technology.

Ultimately the use of pMFC solutions will enable researchers and conservationists to scale up the deployment of embedded sensors within the natural environment to gather evidential evidence of change over time by removing the need to have to use single use batteries or solar panels.

Figure 1. Artistic representation of the camera trap powered by a plant microbial fuel cell (pMFC)

Report and outcomes

With the support of Open Plant and the Arribada Initiative, we have:

- Created a competition called “The Plant Camera Trap Challenge”
- Advertised the competition via several national and international channels
- Attracted several proposals from multiple Universities and individuals
- Employed an independent panel of experts for screening the proposals
- Identified a single successful proposal and awarded them the cash prize.
- Secured a location for the developed prototypes ready to be displayed and tested.

*£5,000 provided by the Arribada Initiative and £4,000 + £1,000 provided by Open Plant.

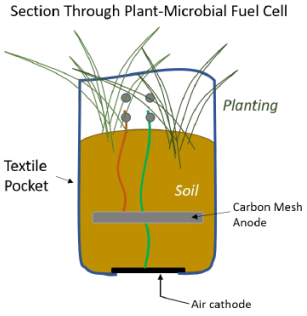
The development of the customised pMFC prototype has conducted by running a project competition. Teams formed by plant biologists, designers and electrical engineers were invited to design and build a robust, transportable prototype of a pMFC system that should be a low-cost, environmentally friendly power supply to operate sensors in remote field locations.

The prototypes built by the successful applicants would be expected to generate a minimum of 2500mC (@3.5V) per day – this is enough to “wake up” a device, take a single photo per day and return to a sleep mode. This energy should be able to be cumulatively stored by means of a non-toxic charge accumulator (e.g., capacitor). The designed solution must be able to work in areas beneath the canopy where conventional solar power generation is ineffective. The design will also need to use local, shade-loving vegetation to avoid the introduction of non-native species; be robust but as lightweight as possible (max 5kg per entire prototype – dry weight) and have dimensions conducive to being carried in a rucksack. All designs will be subject to open licenses.

The project completion was advertised via several media channels. The completion was named “The Plant Camera Trap Challenge”. The webpage on the popular platform Wildlabs.net provided all the required information to participate [1].

To enter the competition, applicants were invited to fill in an application form[2] (**attachment 1**). We received several applications, which were internally evaluated and generated a short list of three finalists (**figure 2**). The short list included three teams lead by:

- Daniel Adams (independent - **figure 2A**)
- Prof. Julea Butt (University of East Anglia, UK – **figure 2B**)
- Dr. Andres Riestra (Plant-e B.V., The Netherlands – **figure 2C).**



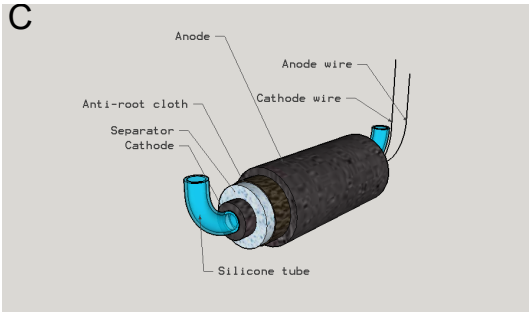


Figure 2. Submitted graphical material for the three finalist proposals.

The finalist teams were evaluated by an independent panel of referees through a Judge Form (**attachment 2**). The panel included:

- Prof. Ioannis Leropoulos (University of the West of England, UK)
- Dr. Stefano Freguia (University of Queensland, Australia)
- Dr. Ross Dennis (Australia National University, CSIRO, Australia).

The panel ranked the three finalists and awarded the team led by Dr. Riestra the winner of the challenge. Feedbacks were given to the runner-ups.

After communicating the outcome we negotiated with the winning team and established a "research contract" (**attached 3**) where the term and conditions were detailed. Finally, 50% of the financial award was paid to the winning team to begin work, and on delivery of the first prototypes, the remaining 50% will be released. Details describing the winning proposal are shown in **attachment 4**. The team led by Riestra has now built the prototypes (**figure 3**) which will be delivered to London Zoo during early February and installed in the Clore Rainforest exhibit. We have secured a protected enclosure (glass fronted) and daily access to monitor the system (**figure 4**).

Negotiating with the referees, devising the research contract, and finally, transferring the award, took much longer than we had expected. Having closed the Plant Camera Trap Challenge on the 4th of March 2018, the negotiation of the research contract and transfer of funding was completed in August 2018.

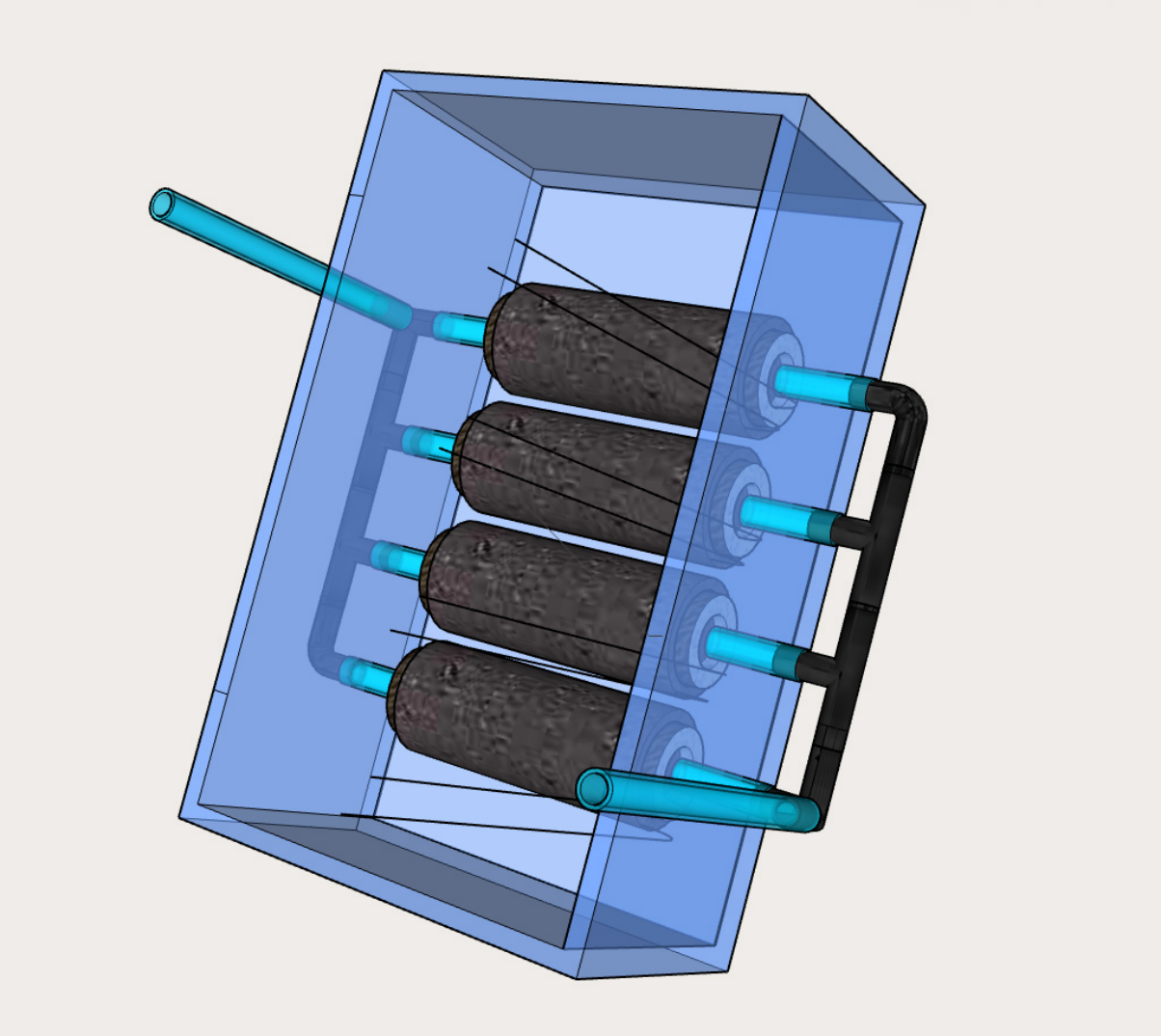


Figure 3 Prototypes built by the winning team

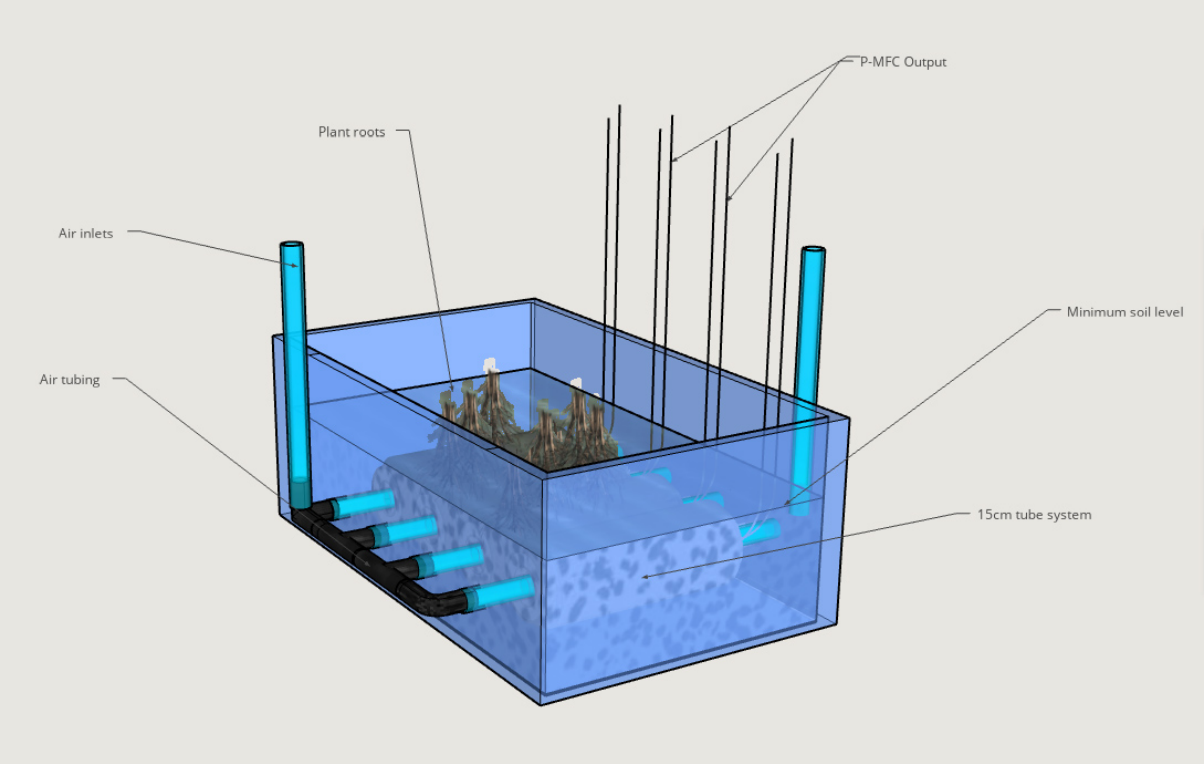


Figure 3 Prototypes built by the winning team

Figure 4 A) The Clore Rainforest exhibit at the London Zoo. **B**) The protected enclosure (glass fronted).

Changes to team

Our original team was formed by Dr Paolo Bombelli, Biochemistry, University of Cambridge, Ms. Rachael Kemp, Zoological Society of London (ZSL) and Alasdair Davies, Arribada Initiative. The team has not been changed.

Expenditure

The budget was spent as planed in our original proposal. £4,000 from Open Plant and £5,000 from the Arribada Initiative has been awarded to Dr. Andres Riestra (Plant-e B.V., The Netherlands). At present they have received 50% of the total amount, with the remaining funds transferred on delivery of the prototypes.

Would you like to claim the £1,000 follow-on fund?
In sympathy with our original proposal we would like to claim the £1,000 follow-on fund to fulfil the award granted to Plant-e, as at present we have £9,000 in total.

Follow on Plans
We have a clear plan for the follow on work.

- The prototype will be installed at London Zoo in late February 2019. Communication panels will be posted around the prototypes to promote the project to the Zoo's visitors.
- The electrical output of the prototypes will be followed for 6 months. Volunteers from UCL have been identify for performing routine checks on the installed prototype.
- The tested prototypes will be relocated in the Amazon tropical forest of Peru' (La Selva) by Alasdair Davies during his next expedition in late 2019 or early 2020 based on the success of the prototype.

The enclosure we have secured to install the prototype within can be seen in **figure 4B**. This space is on the first floor of the Clore Rainforest exhibit at ZSL London Zoo and is climate controlled. To the left is the main space that is also sprayed daily with misters to generate the required humidity (**figure 4A**).

Our prototype will be installed inside the enclosure and the aquarium filled with a mix of soil and water to keep the pMFC system wet. This will have to be replicated in the field (Peru), but this should be possible due to the average rainfall filling puddles and natural inclines. To maintain the system we will explore inviting students from local Universities to assess its performance and download logs. This will require a volunteer placement / pass to be generated by ZSL so the student can access the exhibit in their time. We are exploring this option and hope to develop a timeline with Plant-e (the award winner) to understand the effort needed and when we would need to assess the system to monitor its performance.

References

[1] https://www.wildlabs.net/resources/funding-opportunities/plant-powered-camera-trap-challenge

[2] http://arribada.org/plant-powered/view.php?id=10182