NEWS

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Calix

HIGHLIGHTS

Advanced Manufacturing Growth Fund grant to build a battery materials processing facility

Pilot to develop ThermoChemical Energy Storage for grid-scale batteries

More than 30 sewer pump stations now coated with PROTECTA-Mag across Australia and New Zealand

BOOSTER-Mag confirmed as providing quantifiable control of a number of destructive crop insect pests and disease

Calix part of the EU H2020 SOCRATCES consortium for development of Thermochemical Energy Storage

EDITORIAL

Welcome to Issue 24 of the Calix newsletter.

Phil Hodgson
CEO

We are pleased to report some great progress since our last newsletter.

Calix is very proud to receive an Advanced Manufacturing Growth Fund grant to build a battery materials processing facility at Bacchus Marsh. Our last newsletter featured our battery material development for manganese oxide cathode materials for use in rechargeable Lithium Ion batteries. Our progress from our initial patent application to R&D test results to being awarded a grant to help develop a production facility over the next two years, has taken just over 12 months. It is testament to the strength and versatility of the core Calix technology and the many potential industries to which it can be applied. Stay tuned for our next development!

Continuing on our battery theme, our R&D section in this newsletter outlines the €5m SOCRATCES project; our latest European research and development pilot to develop ThermoChemical Energy Storage for grid-scale batteries, with Calix technology at its core. This exciting, three-year project kicks off in January 2018.

Our BOOSTER-Mag agricultural crop protection product also continues strongly on its development pathway, with increased media attention to the unique value proposition of a fertiliser and crop protection product, all-in-one, over the last couple of months. Read about our latest BOOSTER-Mag developments in this newsletter.

Our commercial business continues to do well also, with more than 30 sewer pump stations now coated with PROTECTA-Mag across Australia and New Zealand. Read about this critical piece of sewer infrastructure and our solution to its protection from deterioration in this newsletter also.

As the year draws to a close, the Calix team would like to take this opportunity to wish you all a very safe and enjoyable Christmas and New Year. We made great progress in 2017, and we look forward to achieving even more in 2018…

RECENT MILESTONES

CALIX ENTERS THE RACE FOR GRID-SCALE STORAGE BATTERIES

The world-wide transition from fossil-fuel power stations to renewable sources of power generation is occurring rapidly, with large investments in renewable energy delivering impressive results.

However, one of the great challenges facing a system with a high share of renewable energy is that supply does not always match demand. The inherent variability of large-scale deployment of renewables can be addressed by grid-scale batteries: energy storage systems that supply power when required, and store energy when it is not. Such systems need to be reliable and cost-effective to support the new situation facing electricity grids across the world.

Calix's technology is uniquely placed to provide unique solutions for energy storage because:

1. Calix recently won an Australian Manufacturing Growth Fund award to develop a production facility for Lithium battery materials at Bacchus Marsh, exploiting the unique nano-active properties of manganese oxides produced from our technology, and featured in our last newsletter.

2. And now, in support of large-scale renewable energy storage, Calix will use and adapt its patented Calix Flash Calciner (CFC) Technology for Thermochemical Energy Storage (TCES) under a new three-year project called SOCRATCES, recently awarded €5m in funding from the EU Horizon 2020 scheme.

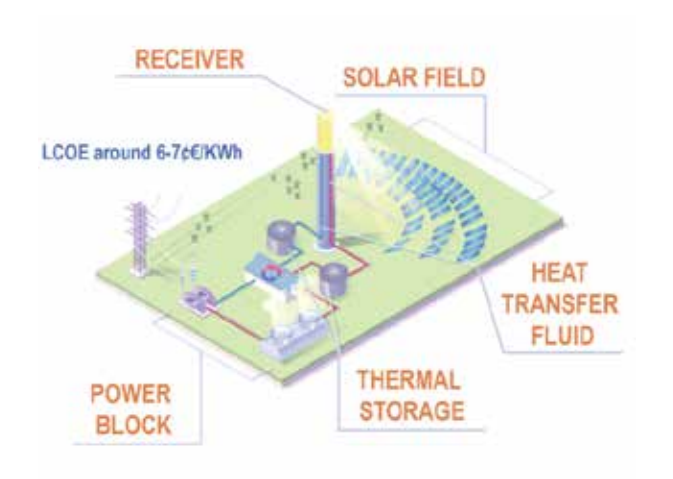
TCES is a means of storing energy by using a chemical process (such as using heat to break limestone into lime and CO_2), and regenerating the energy later by the reverse process (such as re-combining lime and CO_2 to produce heat). The demand for TCES is to balance power grids so that the excess energy production from renewable energy sources, such as solar, can be stored and later released to grid when required.

The SOCRATCES (SOlar Calcium-looping integRAtion for ThermoChemical Energy Storage) project will commence in January 2018 to develop a TCES prototype plant using its CFC technology. Calix is one of 15 participants in the SOCRATCES consortium, led by the University of Seville, that brings together organisations in Spain, Portugal, France, UK, Italy, Greece, and Germany.

The project will demonstrate the use of solar energy to convert limestone into lime and CO_2 in a CFC reactor, and then generate power from the heat released by the reverse process. This reaction uses limestone, a very common, low-cost mineral, and has close to the highest thermal energy storage capacity known (in GJ/tonne).

The application of the CFC to lime and cement is being demonstrated in Calix's LEILAC project, and the primary task of the Consortium is to integrate the CFC reactor into a TCES plant.

A small-scale prototype plant will be built to demonstrate the system in 2019. This will be used to validate this method of energy storage, reduce the core risks, understand and optimise the system, assess the efficiencies that may be obtained at scale, undertake a lifecycle cost analysis, and provide learnings for a rapid scale-up of the technology.



Calix's contribution to TCES should prove to be an economical and reliable method of supporting widespread renewable deployment. Ultimately, it could improve the way we generate, use, and deliver electricity.

PROTECTA-Mag

PREVENTING PUMP STATION CORROSION

Pump stations are a key asset in transporting sewage to the treatment plant. Failure of this asset means wide-ranging disruption to the sewer network. The wet wells in pump stations have the highest probability of severe corrosion because the conditions are perfect for acid corrosion. These include:

- high H_2S levels due to flow turbulence
- high humidity levels from stored sewage
- large surface area that does not see any flushing or contact with the sewage flow, thus allowing colonies of acid producing bacteria to grow.

Asset managers are aware of these corrosion issues on this vital asset. It is common practice that, when substantial corrosion is observed and the asset is structurally compromised, it is flagged for rehabilitation (Fig 1). Another common issue to prompt rehabilitation is when existing coatings like epoxy, CAC, etc. have failed (Fig 2), leaving the asset unprotected and prone to corrosion.

Fig 1 - Corroded asset

Fig 2 - Epoxy peeling off asset walls

Water authorities have also been taking a proactive approach by applying coatings like epoxy on new pump stations before commissioning. While this is a good approach, the coatings are seen not to pass the test of time. It is very common to see epoxy coatings fail, peeling off within three to four years of application. We have seen cases where such coatings have failed within four months of application.

A pump station is a live asset with equipment and structures built into it. Coating technologies like epoxy or CAC need entry in the asset. It is therefore essential for the asset to be taken offline and the equipment, structures etc. inside it removed before carrying out any corrosion protection. This is very disruptive to the sewer network, with high costs, and is a logistical and planning nightmare. The problem is worse when rehabilitating assets with peeled or failed coatings.

Calix PROTECTA-Mag technology provides a very simple, cost-effective, robust, non-disruptive, long-lasting, proven, and safe solution for pump station corrosion protection. The Calix technology can be applied to the asset when new or later in its lifecycle. The main advantages are:

- the asset does not need to be taken offline. The asset continues to operate during coating operation preventing bypass or stopping of the asset, as well as eliminating the need to remove any equipment in the asset
- entry isn't required to the confined space, increasing safety
- before coating, the water cleaning of the asset walls is carried out a low pressure, preventing the already-fragile concrete from being weakened any further
- the coating does not peel and, after the end of its life, a new layer (1mm) is applied after cleaning the walls
- the affinity of the fat layers sticking to the walls is greatly reduced, decreasing fat cleaning frequency.

Calix, along with its partners, has coated and protected more than 30 pump stations across Australia and New Zealand over the last six months. Some of these included the walls and roofs of "walk-in" pump stations.

Original wet wall

Post coating

BOOSTER-Mag

BOOSTER-MAG PROVIDES QUANTIFIABLE CONTROL OF A NUMBER OF DESTRUCTIVE CROP AND INSECT PESTS AND DISEASE

Experimental trials undertaken over the previous 2016/2017 season have now confirmed BOOSTER-Mag treatment provides quantifiable control of a number of destructive crop insect pests and disease. This outcome is a critical development milestone.

Our work with growers has also been remarkable, with controlled hectare-scale trials demonstrating BOOSTER-Mag can either substantially reduce, or even eliminate, conventional insecticide and fungicide use. These outcomes provide real context for the pest and disease control observed in experimental trials; BOOSTER-Mag is likely to provide material benefits in commercial agriculture including significantly enhanced grower productivity, safety, and sustainability.

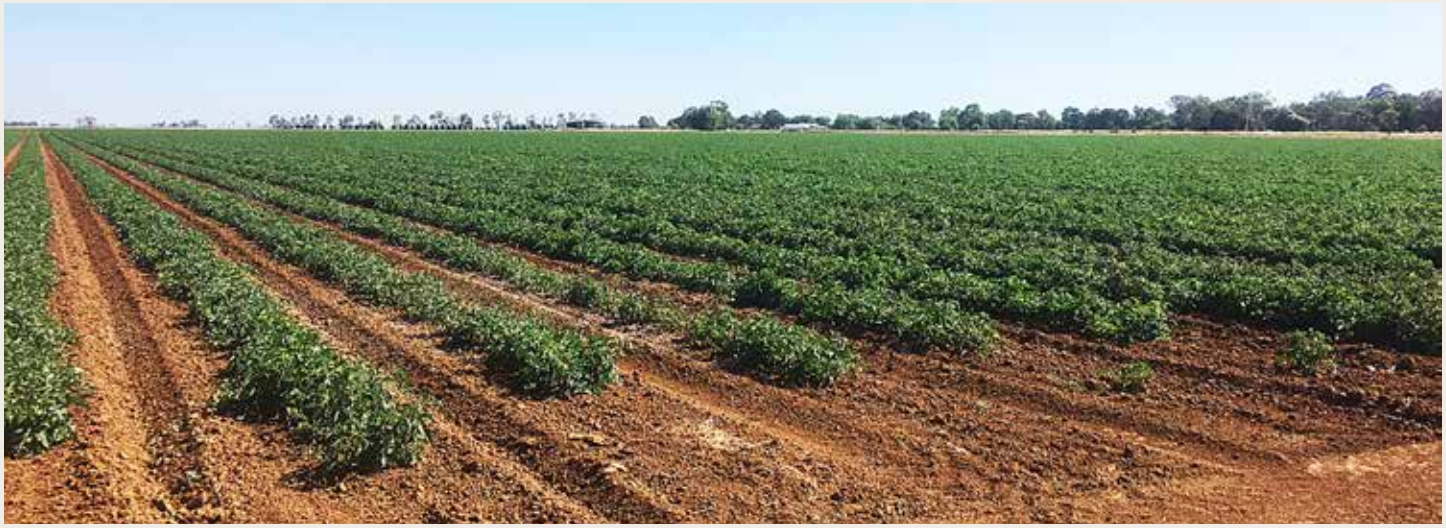
A comprehensive BOOSTER-Mag field trial program is planned for the 2017/2018 season to generate the consecutive years' data required to support registration as a crop protection product in major and minor crops. This will take place for:

- Botrytis – grape, WA & Tas
- Powdery mildew – grape, SA & Tas
- Powdery mildew – cucurbits, Qld & Tas
- Insects – cucurbits, Qld
- Insects – field tomato, Vic & Qld.

In parallel, the decision by a leading commercial Victorian field tomato grower to adopt BOOSTER-Mag as a base treatment at a full, 40-hectare farm is another major step forward. The grower's confidence is based on outcomes of the work undertaken over the previous two seasons. His objective is to reduce and, if possible, eliminate the use of hard conventional pesticides for improved safety and sustainability, which are core BOOSTER-Mag benefits.

Finally, a full acute toxicological assessment of BOOSTER-Mag is underway. Although not complete yet, the test subjects have shown no adverse effects or reactions following dermal, oral, and inhalation exposure. This work is required to support the registration program.

Treatment	Sprays	Pesticide Sprays	Payable Fruit. (Tne. / ha)	Total Cost (chemical & application) ($/ha)
Conventional	9	8	89	$ 509
BOOSTER-Mag	10	4 (reduced by 50%)	89 (no compromise in payable yield)	$ 315 (reduced by 38%)



INTRODUCING

MATTHEW GILL
PROJECT ENGINEER

Matthew graduated with a degree in mechanical engineering from UNSW. His study focused on the automotive engineering industry. However, in early 2012 Matthew came across Calix, and, while it wasn't in his plans to work for a small technology company, the company's profile and promise were extremely alluring. The cutting-edge, innovative, and dynamic approach of the company was unlike any other he had seen before and Matthew instantly knew he needed to work for Calix.

On starting with Calix in 2012, Matthew's role was the mechanical engineer for the Calix Flash Calciner (CFC), from the conceptual process design through to the commissioning and first production runs.

Following the CFC's completion, Matthew was involved in the development of the ACTI-Mag product, spending many hours helping to develop the production process and first manufacturing plant at Calix's main production site located in Bacchus Marsh, Victoria.

Having gained experience developing the process for the ACTI-Mag product, Matthew was then put in charge of developing and delivering a high-volume output ACTI-Mag production facility in Queensland. The project was developed under budget and ahead of schedule.

Matthew was then placed in charge of developing the PROTECTA-Mag application technology for Calix, which has proven to be a success across Australia.

At the end of 2016, Matthew was seconded to the European branch of Calix to work on the LEILAC project. Matthew was placed in charge of delivering the Calix component of the FEED stage and developing the budget for the project. With the consortium approving the budget and the project moving into the detailed design and procurement stage, Matthew was placed in charge of delivering the mechanical components of the project, which will begin construction in mid-2018.

Outside of Calix, Matthew hasn't lost his passion for automotive engineering, and is currently working on restoring a series 2 Fiat X1/9.