

## ASX Announcement

April 27, 2022

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### November Quarter Newsletter – Issue 41

**Sydney, Australia | April 27, 2022** – Multi-award-winning Australian technology company Calix Limited (ASX: CXL ‘Calix’ or ‘the Company’) is pleased to announce it has released a comprehensive update on activities across its business segments. The newsletter is attached overleaf.

This announcement has been authorised for release to the ASX by:-

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## About Calix

Calix is a team of dedicated people developing a unique, patented technology to provide industrial solutions that address global sustainability challenges.

The core technology is being used to develop more environmentally friendly solutions for advanced batteries, crop protection, aquaculture, wastewater and carbon reduction.

Calix develops its technology via a global network of research and development collaborations, including governments, research institutes and universities, some of world's largest companies, and a growing customer base and distributor network for its commercialised products and processes.

Because there's only one Earth – Mars is for Quitters.

**Website:** <https://www.calix.global/>  
**Twitter:** @CalixLimited  
**Youtube:** [CalixLimited](#)

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# Calix News

April 2022

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# Welcome to Issue 41 of the Calix Newsletter



**Phil Hodgson**  
CEO

In the recent quarter, Calix achieved a significant milestone with the LEILAC-2 Project for CO<sub>2</sub> mitigation in the cement and lime industries, passing its Financial Investment Decision with the full support of the project consortium. This achievement was even more significant given the significant supply chain and war risks that have added considerable uncertainty, but is a testament to the resolve of the consortium to push on with the project, given the pressures and commitments to CO<sub>2</sub> mitigation.

In this newsletter, we also explore the opportunity for the LEILAC technology in the lime industry, as well as the effort, and reasons, to develop electrification of the Calix technology. The Calix technology is being developed as a “future-proofing” option for industry. CO<sub>2</sub> capture is a primary goal for cement and lime, but also the ability to use renewable energy including electricity and waste fuels or biomass is becoming a central value proposition as energy prices soar, and is a subject of renewed focus and development of the technology for application across many other industries.

In our water business, we look at some recent customer case studies in the US for sewer treatment, and in Asia for aquaculture. We look forward to the recession of COVID-constraints to re-ignite our growth in both these industries, given the considerable market opportunity.

In our biotech business, we achieved a significant milestone with the approval of BOOSTER-Mag - our safe, environmentally friendly crop protection product - by the Australia Pesticide and Veterinary Medicines Authority (APVMA). This represents over two years of independent assessment of safety and efficacy of our unique product and market entry planning for the Australian 22/23 season is underway. We are very encouraged by this progress and while applications such as crop protection take time, the same environmental themes driving investment in CO<sub>2</sub> mitigation are also starting to focus on agriculture, where we have a unique product, uniquely positioned.

In this newsletter we also feature our first Communication on Progress (“COP” report) as members of the United Nations Global Compact, focussing on our efforts in Environment, Social and Governance improvement both externally, with our stakeholders and customers, and internally, with goals we are setting for ourselves as a company.

We also feature our new team members and also Doug Kelley - our US colleague leading the IER team - and his background, in our quarterly “meet the team” article. Despite a growing team, Calix remains very focussed on hiring the right people with not only excellent skills and competencies to grow our ambition, but also alignment with our corporate objectives. Both are equally important.

As always, we continue to very much appreciate the support of all our shareholders and stakeholders as we continue our journey and ambition, to help solve global challenges, using our unique technology and dedicated team.

## The Calix Team is Growing!



**Meet Tim Bartlett**  
Electrical & Control Systems  
Engineer

Tim has over twenty years of combined professional engineering experience in electronic and electrical fields associated with electrical power networks, process control, motor drives, SCADA, telemetry networks and electronic product design. The bulk of his career has been spent working in the mining and resources industry.

He started out with a trade in electronics and then followed up with a bachelor's degree in electronic and electrical engineering. He graduated with first class honours with awards from both Engineers Australia and The Institute of Electrical Engineers.

In recent years, Tim has become a Fellow of Engineers Australia (FIEAust), is a Chartered Practitioner of Engineering (CPEng), and is registered on the National Engineering Register (NER), the Asia-Pacific Economic Cooperation (APEC) Engineer Register, the International Professional Engineer Register and is a Registered Professional Engineer of Queensland (RPEQ).

Tim has joined Calix as an Electrical and Control Systems Engineer, assisting the team with electrical challenges on the development of the technology and its various applications.



**Meet Max Strokon**  
Technical Development Support  
Engineer

Max graduated from the University of Sydney with a bachelor's degree in Chemical and Biomolecular Engineering. His honours thesis focused on the effects of mechanical stress on 3D-printed plastics and how heat exposure affected the molecular structure printing filament.

Max's early career began with boutique prototyping consultation and technical advice regarding CAD-CAM systems. Most recently he worked in the medical device industry as a design engineer, specialising in primary packaging for high value sterilised devices.

Max has joined Calix as a Technical Development Support Engineer, with a view to leveraging his prototyping and production experience to assist with ongoing engineering projects. *“I care about implementing technology that is sustainable, to protect the environment of the planet we all share.”*



**Meet Shammi Ferdousi**  
Materials Engineer

Shammi is a material scientist with more than 12 years research experience as a laboratory researcher in nanomaterials, electrochemistry and surface science. She joined Calix in January 2022 as a Materials Engineer. Before joining, she was working as Associate Research Fellow at the Institute for Frontier Materials (IFM), Deakin University which was a collaborative project with Calix. Previously she worked on the project ‘moisture harvesting technology using metal doped nanotubes’ at The Hong Kong University of Science and Technology (HKUST), Hong Kong SAR. She finished her undergraduate (Hons) and master's (research based) degree in Chemical Engineering from Bangladesh University of Engineering and Technology (BUET), Bangladesh.

Her research interest is battery materials, electrode preparation, electrolyte development and optimisation from laboratory to pilot scale and battery fabrication.



**Meet Aqeel Mohaisen**  
CAD Technician

Aqeel Mohaisen is our new CAD technician. Because he has a strong interest for anything related to sustainability, Aqeel saw an opportunity to use his practical skills to solve environmental problems by joining Calix.

Aqeel graduated with a master's of Engineering-Research, a CERT IV in Engineering Drafting and a CERT III in Manufacturing Technology (CAD/Drafting) both from TAFE NSW.

He has also successfully completed courses in CAD for Building Design, TAFE NSW, Energy Auditing and Efficiency in Industrial Systems and Energy Auditing and De-carbonisation of the Built Environment, both from SBRC-UOW.

Outside of work, Aqeel loves reading, researching, continuing professional development and of course cooking.

### WE ARE HIRING

To learn more and apply, email: [hr@calix.global](mailto:hr@calix.global) or check out our LinkedIn page:  
<https://www.linkedin.com/company/calix-limited/>



# Calix's innovative project for capturing CO<sub>2</sub> emissions from the cement and lime sectors

“LEILAC-2” – passes Financial Investment Decision milestone

## Highlights

- The Calix lead LEILAC-2 project has passed its Financial Investment Decision (FID) to build a plant capable of capturing 20% of a cement plant's CO<sub>2</sub> at very low cost. It will be integrated into HeidelbergCement's operational plant in Hannover, Germany.
- Supported by the EU's Horizon 2020 scheme, the Calix design is for a new type of capture technology, designed as a retrofit, scalable module, that aims to use alternative and renewable fuels.
- This FID milestone has been achieved despite the complications arising from the global pandemic and the Russian invasion of Ukraine. We are now proceeding with detailed design, purchasing long-lead items, and expecting to commence construction in 2023. There remain key project risk flag points prior to purchasing major components, given the market situation.
- The LEILAC approach is designed to enable a green and just transition to a low-carbon future with the objective of strengthening local industry and maximising the use of local resources, whilst also addressing climate change.
- This first-of-a-kind modular retrofit, which addresses a cement plant's unavoidable emissions, is aiming to ultimately separate CO<sub>2</sub> for a cost of €20 to 25 per tonne of CO<sub>2</sub>.
- The LEILAC-2 plant is located in Hannover, providing a potential testing and backbone for future use and offshore storage options, and an excellent opportunity for decarbonising central European industry.
- The LEILAC-2 Project Consortium includes HeidelbergCement, Calix, CEMEX, Cimpor, Engie, IKN, Lhoist, and other global research and governmental partners.
- Critical global climate change targets have been committed to for 2050, with the Intergovernmental Panel on Climate Change (IPCC) assessment reports emphasising the need to accelerate the deployment of all CO<sub>2</sub> mitigation technologies, and it is hoped that LEILAC can play a key role.

LEILAC - Low Emissions Intensity Lime And Cement – aims to demonstrate, at industrial scale, a breakthrough technology that can capture a cement or lime plant's unavoidable process emissions for minimal cost, thereby providing a viable and effective decarbonisation solution. The LEILAC-2 plant is being designed to capture 100ktpa of CO<sub>2</sub>.

The cement and lime industries play a vital role in our society. Cement is used in our roads, buildings, homes, offices and almost all infrastructure. Lime is used in a variety of applications,

including the iron and steel, chemical, paper, pharmaceutical, drinking water, food, and farming industries. However, the cement industry alone is responsible for around 8% of global CO<sub>2</sub> emission, as most of its emissions are inherent to the production process and are therefore difficult to avoid.

Most cement associations and companies have committed to "net-zero" environmental processes, requiring the majority of cement plants to have carbon capture and storage solutions in place as quickly as possible.

The LEILAC Group, a subsidiary of Calix Limited, aims to apply a breakthrough in carbon capture technology that will enable the cement and lime industries to reduce their emissions dramatically - while retaining their international competitiveness - by capturing those process emissions at low cost. This is a completely new 'type' of carbon capture technology, which is a "process modification" approach, rather than requiring additional chemicals or processes, so CO<sub>2</sub> can be separated at very low cost. The technology can also be retrofitted in a modular form at any scale, and aims to use any fuel or energy source (such as biomass, hydrogen, or electricity) – providing a 'future proof' solution.

The LEILAC-2 project was established to: demonstrate that the Calix technology can be a retrofitted solution capable of capturing 20% of a plant's emissions; be integrated without causing issues or major interruptions to the host plant; investigate the use of alternative fuels; and, be a replicable module enabling significant scale up. Since the LEILAC-2 project commenced in 2020, as a global society we have faced significant challenges resulting in delays and price increases across the supply chain. Despite these challenges, the project teams – involving talented individuals from all of the project partners - have managed to progress, de-risk and develop a costed and technically viable design. The project successfully passed its FID decision milestone, and will now proceed into the detailed design phase through 2022, followed by procurement and construction of the plant itself. There will be risk related gateways throughout the coming months to assess and deal with various risks, particularly for purchasing long lead items, and to address the current market volatility.

Although there are considerable challenges ahead, LEILAC-2, despite being a first of a kind demonstration retrofit, has the potential to separate CO<sub>2</sub> at low cost at a commercial scale. Including expected compression, fees and, capex costs – this equates to an "abatement" (not just capture) cost of around €20-25 per tonne.

## SOLVING GLOBAL CHALLENGES

If the LEILAC-2 plant can reach its nameplate capacity, this EU funded plant may capture €7.5 - 9.5million worth (EU ETS - or European Union Emissions Trading System) of CO<sub>2</sub> annually for a total annual operating cost of €2million. The design is a replicable module, that can be duplicated to and scaled to capture 100% of a plant's process CO<sub>2</sub> emissions. The storage of the CO<sub>2</sub>, using well established, regulated and safe practices, would be required to ensure it does not reach the atmosphere, with a variety of options being put in place globally.

LEILAC-2 remains a research and development plant, with risks as noted above, but is designed to deliver a replicable module that will be a step change in capturing carbon emissions in the cement and lime sectors. To mark this success, there will be a new website, and logo for the LEILAC Group – underscoring the central vision of successfully and economically decarbonising hard-to-abate sectors. The LEILAC technology is unfolding as a practical and affordable pathway for local industries to thrive in a carbon-constrained future.



**Antonio Clausi**  
HeidelbergCement Group Director  
Competence Center Cement

**"At HeidelbergCement, we are testing a wide range of new technologies to decarbonise the cement production process. Our goal is to achieve these CO<sub>2</sub> reductions while minimising the need for additional resources, particularly fossil-based energy, and lowering costs. Maturing the LEILAC technology, steered by the highly committed Calix team, is therefore one of our priorities."**



**Phil Hodgson**  
Calix MD and CEO and Chairman of the LEILAC-2  
Executive Board commented

**"The positive FID decision marks a significant milestone and further demonstrates the momentum which is building around the LEILAC-2 project. The completion of the FEED\* has been achieved despite the challenging circumstances and is a testament to the strong level of collaboration which has been cultivated between the consortium partners, who have all worked together to make significant progress on this breakthrough project."**

The consortium is led by the LEILAC Group (technology provider Calix), and comprises HeidelbergCement, CEMEX, Cimpor, IKN GmbH, Lhoist, Port of Rotterdam, Federal Institute for Geosciences and Natural Resources (BGR), Geological Survey of Belgium (GSB), the Centre for Research and Technology-Hellas (CERTH), Polytechnic University of Milan (POLIMI), and Engie.

It is supported by the Global Cement and Concrete Association (GCCA), Global Carbon Capture and Storage Institute (GCCSI), CEMBUREAU, European Climate Research Alliance (ECRA), European Lime Association (EuLA). The project aims to apply and demonstrate a breakthrough technology that will enable the cement and lime industries to reduce their carbon footprint significantly.

\*FEED - Front End Engineering Design



A Virtual Tour of LEILAC with Adam Vincent at the Carbon Capture, Utilization & Storage Forum 2021

<https://www.youtube.com/watch?v=jto3r-3YxHQ&t=1s>



Podcast #4 – CO<sub>2</sub> Direct Separation for Cement Decarbonisation Feat. James O'Loughlin & Simon Thomsen

<https://www.youtube.com/watch?v=Pn6vMXUx-le4&t=254s>

**BRAND  
REFRESH!**



**Leilac  
Group**

Introducing the newly designed logo of the Leilac Group as part of the branding refresh.

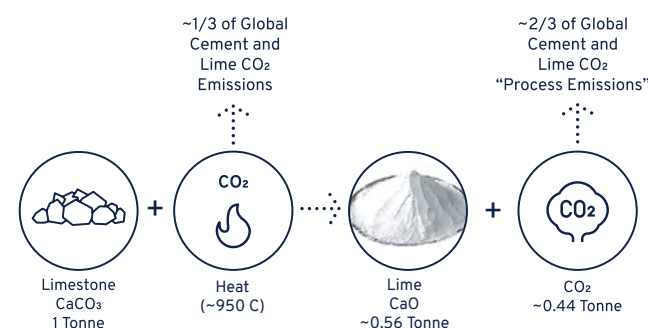


# Calcination process for lime decarbonisation

## Lime, one of the most vital minerals used on Earth

Lime is amongst the oldest and most important materials used on earth and an essential element in global civilisation, yet most of us don't know the vital role it plays in our day-to-day lives. With such ubiquitous usage, the global lime market reached a value of around \$US 41.93 billion in 2020 and is expected to reach \$US 51.04 billion by 2028. The high maturity markets, in terms of usage, include North America and Europe, while markets with high growth potential include South America, the Middle East, Africa and Asia Pacific.

Lime refers to products derived from burnt (calcined) limestone, such as quicklime and hydrated "slaked" lime. Limestone is nearly half CO<sub>2</sub> by weight. The CO<sub>2</sub>, which is trapped in the rock, is released when making lime.



Lhoist, a key partner in helping develop Calix's LEILAC technology, is the world leading supplier of high-quality lime, dolime and minerals, with a vast experience in material characterisation as well as the development of new products and processes. It serves industries like steel, environmental, building and civil engineering, pulp and paper, and agriculture.



**"Once tested and scaled up, Calix's LEILAC technology should reduce the cost of carbon capture considerably and accelerate the deployment in the lime industry – enabling society to continue to benefit from this vital product without negatively impacting the environment."**

Ziad Habib, Global Director – Manufacturing Process Innovation, Lhoist

## Lime production and the climate challenge

The latest Intergovernmental Panel on Climate Change (6th Assessment) Report stated that it is now unequivocal that human influence, primarily through the production of greenhouse gases such as carbon dioxide, is causing widespread and rapid changes to the climate.

To have the best chance of avoiding a two degree rise in global temperatures, the global average personal carbon footprint needs to reach zero by 2050. To achieve this, all sectors of society must deliver emission reductions and governments are taking actions to this effect.

**"By acting now," said European Commission President Ursula von der Leyen in mid-July, "we can ... choose a better, healthier and more prosperous way for the future."**

As environmental regulations toughen, and shareholders and stakeholders place increasing pressure on companies to reduce greenhouse gas emissions, lime producers need solutions quickly to help mitigate their CO<sub>2</sub> emissions.

Calix's LEILAC ("Low Emissions Intensity Lime and Cement") technology is available now to efficiently separate the CO<sub>2</sub> emitted in lime production.

Calix's LEILAC technology captures the process CO<sub>2</sub> emissions that are generated when limestone is heated (see graphics above). These emissions are unavoidable regardless of the fuel type and can constitute up to 75 per cent of CO<sub>2</sub> emissions from a lime plant. The remainder comes from burning fuel.

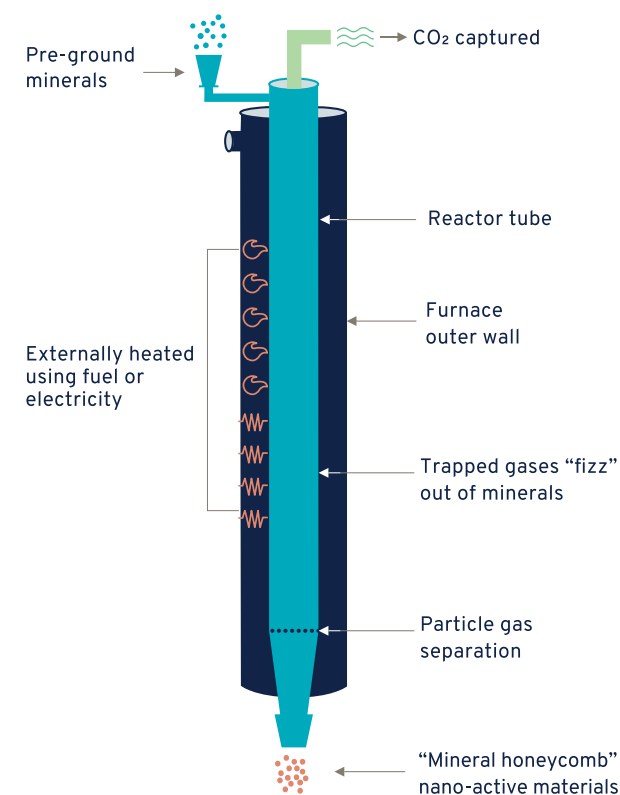
Further advances in Calix's LEILAC technology, such as the ability to electrify the whole of the heating requirement, and power it from renewable energy, means that zero-emissions lime manufacturing can be achieved.



**"The current objective facing the lime industry and governments is threefold: maintain economic prosperity, meet lime market demand, while dramatically lowering CO<sub>2</sub> emissions. Calix (LEILAC) aims to meet this global challenge as quickly as possible."**

Adam Vincent, General Manager  
Lime Decarbonisation

## SOLVING GLOBAL CHALLENGES



Calix's LEILAC technology involves grinding limestone to an average size of around 1/10th to 1/100th of a millimeter and then 'flash' heating the material in an externally heated reactor over a short period of time, thus converting the particles to lime. Specially selected steels allow the process temperature to reach in excess of 900 °C, which is required for the reaction. The evolved gas is high purity CO<sub>2</sub>, which can be captured and used or stored.

After the successful commissioning of a world-first pilot plant (LEILAC-1) in 2019, scale up of the technology will be demonstrated on LEILAC-2, where a 4-reactor module array is scheduled to be built by the end of early 2024, with the aim to capture the CO<sub>2</sub> from cement and lime processing in a suitable condition for storage.

The next stage of advancement for the processing of lime will focus on several key areas including maximising efficiency, scale up of throughput, testing of solid fuels, testing of alternate gaseous fuels such as hydrogen, scale up of Calix's electric calciner for lime, fuel side CO<sub>2</sub> capture options and optimising CO<sub>2</sub> clean-up and compression. The ultimate aim is the production of zero CO<sub>2</sub> lime.

More recently, and on the back of the knowledge built through years of research and development, Calix has teamed up with several companies to undergo feasibility and engineering studies for the development of Calix lime calciners with carbon dioxide capture capabilities.



Read more:

<https://www.calix.global/industries/industry-lime/>



Listen the Podcast here:

<https://youtu.be/HWMfLI0i7HQ>





# Electrification

To help mitigate greenhouse gas (GHG) emissions from minerals processing

## Minerals processing and synergies with carbon fuels

Carbon based fuels played a crucial role in the history and development of minerals processing technologies. As early as 1100BC pig iron was produced, where iron is blended with carbon in the form of charcoal and set alight to create a crude form of useful metal.

Carbon based fuels have historically been the best and often only option to achieve the required process temperatures to convert low grade ore into useful minerals and metals.

During the industrial revolution, carbon based fuel shifted from basic carbon, in the form of charcoal and coal, to more sophisticated and refined energy sources such as bunker fuel oil, refined oil and natural gas. Throughout the decades, these mineral liberation processes have been refined and improved to squeeze every last percentage of energy efficiency from this source of energy.

Throughout the entire industrial revolution however, the fuel has remained unchanged. Carbon based fuel was the only option for the high temperature reactions required for mineral refinement.

## Minerals processing and emissions

Using carbon fuels, the minerals industry has been hampered by the fundamental efficiency limits of a combustion process, where the energy losses through exhaust gas and thermal leakage has defined the limits.

The long carbon chains release energy as they break down in the fire, releasing smaller carbon molecules before finally emitting carbon dioxide as the final stage in the process.

The carbon dioxide emitted from the firing process needs to be exhausted to allow further fuel and oxygen to be introduced, but it carries with it some of the energy from the reaction. Thousands of different technologies have been invented, improved and optimised to minimise these energy losses, but there has never been the possibility of overcoming these fundamental limits of efficiency... until now.

## Introducing the Calix Electric Flash Calciner

Inspired by our purpose to solve Global Challenges, and a shift in the energy landscape, Calix has spent many years working on the development of a technology ready for the new energy paradigm - electricity.

The decision to develop a calciner that is dedicated to production using electricity as a fuel source has changed the game when it comes to energy efficiency.

Calix's indirect calciner design was the perfect candidate to take the next step into the age of electricity and benefit from the energy efficiency improvements and increased availability of renewable energy, made feasible thanks to global decarbonisation efforts.

In a recent Calix podcast with James O'Loughlin, Michael Wheatland explained that attempting to convert a direct fired fuel based calciner to use electricity as a fuel would be a bit like trying to bake a cake by dumping all of the ingredients into the oven and expecting a cake to emerge. It creates a huge mess on the heating elements as they are in direct contact with the product, and the resulting cake would be burned in the areas in contact with the elements and undercooked in other areas.

Michael explained that the Calix Technology is the equivalent of inventing a cake tin. It's a technology that keeps the ingredients clean and separate from the energy source, it enables good heat distribution throughout the process, and results in a high-quality product all whilst keeping your oven clean.



Podcast #7 - Electrification.. the future of the industry.

.....  
<https://youtu.be/L-a-fquJhXo>

## The wicked challenge of scale

One of the biggest challenges of climate change and elevated levels of CO<sub>2</sub> in the atmosphere is the scale of the problem. It seems insurmountable, as global industry has been developed around carbon based fuels for over a century.

While operating a large scale minerals production facility using solely electricity may seem impossible to some today, it is predicted that producing minerals using carbon based fuels in 20 years time will be uncompetitive, thanks to the global push for rapid decarbonisation of industry.

## Calix technology is renewable energy-ready

The Calix technology provides a unique solution to the problem of scale up due to the technology being modular. This means the integration of the technology within existing plants is possible, allowing for greater flexibility of production and a greater ability to adjust to energy cost fluctuations, with no detrimental impact on product quality or equipment longevity.

Traditional calcination technologies also have the challenge of needing to remain in operation around the clock, to avoid the possibility of degradation of the hard face refractory - the insulating layer that keeps the heat in the vessel, and protects the vessel's steel skin.

With the Calix technology, the mineral and process flow never come into contact with the hot face of the refractory. This allows use of a softer and more pliable refractory, more resilient to thermal cycles.

Combining the Calix technology to existing calcining technologies not only allows for energy fluctuations and production rate adjustments, but it could also generate revenue by providing stability to the local electricity grid.

The modular nature of the Calix technology allows the implementation during an expansion of production capacity at a low capital expense, while improving the flexibility of production rates and energy sourcing options as the world changes over the next 50 years.



**"The Calix Technology is a bit like a new kind of cake tin. It's a technology that keeps the ingredients clean and separate from the energy source, and enables good heat distribution throughout the process, resulting in a high quality product while keeping the oven clean."**

**Michael Wheatland, Business**  
Development Manager Sustainable Processing





WATER

SOLVING GLOBAL CHALLENGES



# Magnesium Hydroxide for Collection System Odour, Corrosion, and FOG Control

*Killing three birds with one stone.*



## Customer success story



### BACKGROUND

Birch Bay Water and Sewer District (BBWSD) located in Whatcom County, WA has been feeding BIOXIDE (calcium nitrate) for years, with limited success in controlling hydrogen sulfide (H<sub>2</sub>S) odour. Recently the state of Washington required a limit on the amount of nitrogen that can be discharged from the wastewater treatment plant (WWTP) into Puget Sound.

With these new limits, the Birch Bay staff started to look for ways to limit nitrate loads into the plant and increase their alkalinity in the plant to aid with the nitrification process.

### OBJECTIVES

- Manage H<sub>2</sub>S and odour levels.
- Eliminate excess nitrate loads into the treatment plant.
- Provide an increase in the treatment plants alkalinity.

### CHALLENGES

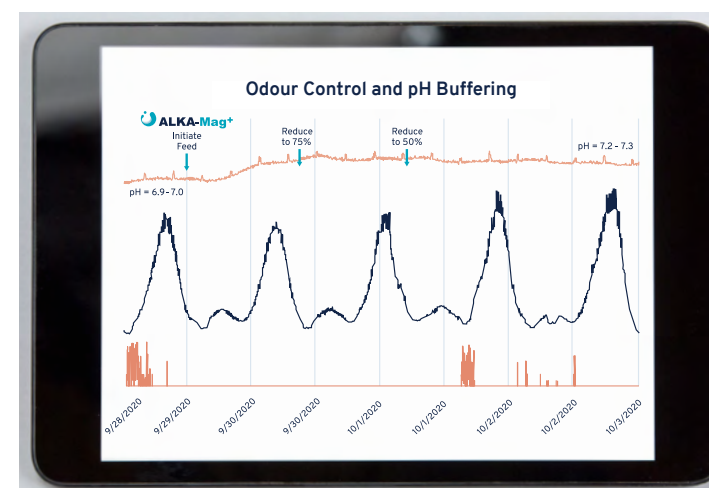
- Odour in collection system due to high H<sub>2</sub>S generation.
- Heavy build-up of fats, oils and greases (FOG's) in the network.
- Yearly cleaning off FOG's in collection system (pigging), leading to increased maintenance costs.
- A looming nitrogen limit requiring an increase in alkalinity in the treatment process.

### SOLUTION

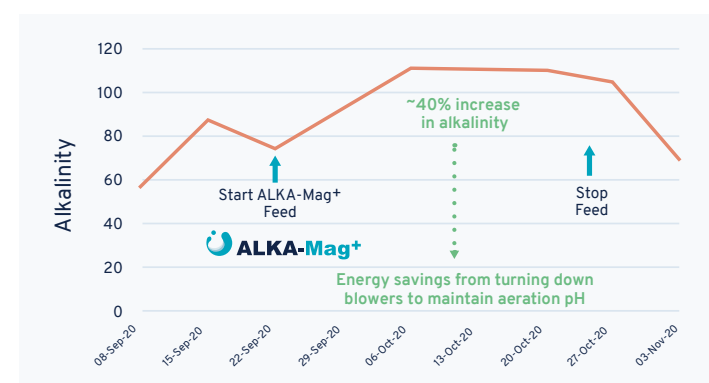
- Replace the feeding of BIOXIDE for odour control with IER's ALKA-Mag<sup>+</sup> (magnesium hydroxide), providing odour control protection whilst increasing the alkalinity in the treatment plant.

### BENEFITS

- A reduction in H<sub>2</sub>S generation.
- An increase in alkalinity throughout the treatment plant.
- A reduction in blower run time due to alkalinity increase.
- Significant FOG reduction within the collection system.



pH, H<sub>2</sub>S, and detention time with BIOXIDE and ALKA-Mag<sup>+</sup>



Alkalinity increase

## Conclusion

BBWSD was able to use one non-hazardous product, ALKA-Mag<sup>+</sup>, to replace two chemical products (one of which was highly hazardous), to effectively address two performance issues:

- Odour and corrosion control in the collection system
- Nitrification within the treatment plant

In the process they discovered a third benefit of switching from BIOXIDE to ALKA-Mag<sup>+</sup>. By replacing a chemical that fosters biomass growth (BIOXIDE) with one that breaks down insoluble organics (FOG and biomass), the main pipeline became clean - improving the pumping efficiency of the system.

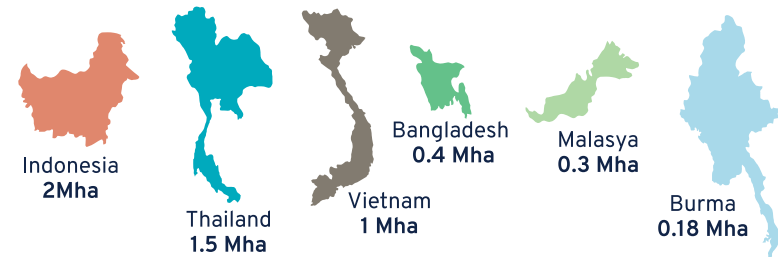
The performance benefits of ALKA-Mag<sup>+</sup> resulted in cost savings from reduced chemical usage, reduced aeration blower energy usage and reduced collection system line cleaning costs.





## Iron in Aquaculture Ponds

Iron is a major problem in Southeast Asia for aquaculture ponds in coastal areas. In Asia some 7 million hectares (Mha) are acid sulphate soils, heavy in iron.



The high iron concentrations come from either pyrites or accumulated iron in mangrove swamps. When the ground is disturbed with pond excavation, oxygen is introduced. This produces iron complexes and sulphuric acid ( $\text{H}_2\text{SO}_4$ ).

- Pyrites compete with aquatic life for more oxygen to oxidise and become ferric iron ( $\text{Fe}^{3+}$ ).
- Water and pond bottom becomes acidic, and iron is observed in the pond.

While some level of soluble iron is desirable in aquaculture ponds, medium to high levels cause problems:



- Beneficial algae growth is inhibited.



- pH is often acidic, which can cause stress in both fish and prawns.



- High iron levels can react with organics in the pond producing a colloidal iron complex, which reduces oxygen transfer and can cause suffocation of living organisms.



- High iron in water can cause stress on fish and prawns, which often results in a reduction in growth and in some cases the appearance of Early Mortality Syndrome (EMS) throughout the pond.

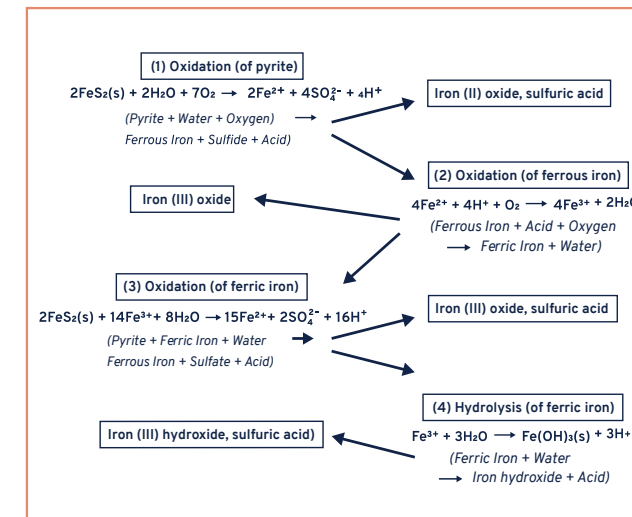


- Vibrio bacteria usually favours acidic conditions and feeds on soluble iron, which can prevent the viability of the whole pond.



### SOLVING GLOBAL CHALLENGES

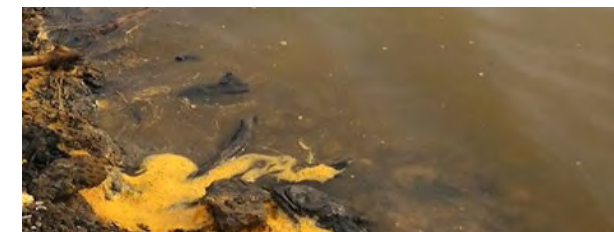
Farmers often complain of loss of crop after heavy rain events. When the sludge is not disturbed and no additional oxygen (other than that provided by paddle wheels) is introduced, the pond usually remains relatively healthy with beneficial algae being the dominant species. But if the vibrio load is high in the pond, the chances of getting EMS will greatly increase. Heavy rains can disturb acid sulphate soils, as pyrite releases hydrogen sulphide ( $\text{H}_2\text{S}$ ) and iron ( $\text{Fe}^{2+}$ ). This soluble  $\text{Fe}^{2+}$  increases oxygen demand to produce insoluble  $\text{Fe}^{3+}$ , while  $\text{H}_2\text{S}$  is toxic to shrimp. This explains why heavy rains can cause stress in aquaculture ponds.



Source

P. Byrne, P. J. Wood & I. Reid (2012): The Impairment of River Systems by Metal Mine Contamination: A Review Including Remediation Options, Critical Reviews in Environmental Science and Technology, 42:19, 2017-2077  
<http://dx.doi.org/10.1080/10643389.2011.574103>

### AQUA-Cal+ can flocculate iron



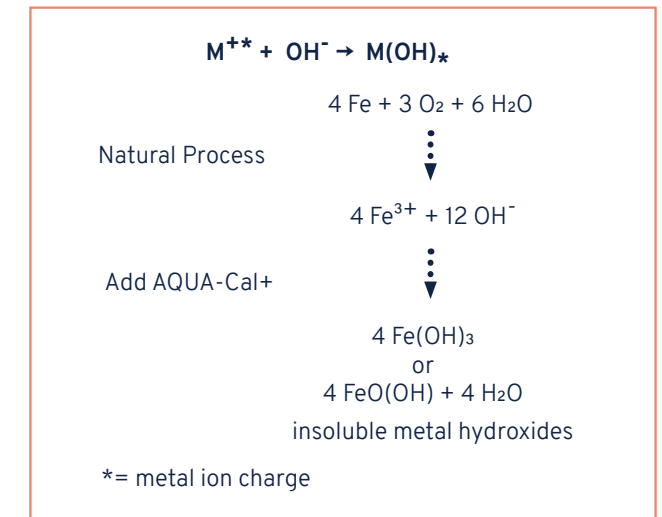
High Iron before treatment



2 Days after treatment

### Why AQUA-Cal+ is an ideal solution for the flocculation and removal of iron (and other heavy metals)

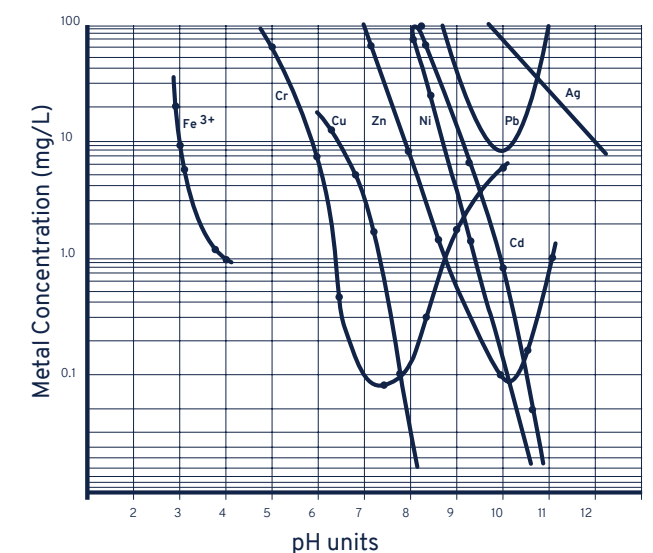
- The hydroxyl ions ( $\text{OH}^-$ ) in the magnesium hydroxide  $\text{Mg}(\text{OH})_2$  slurry react with the metal ions to form insoluble metal hydroxides.



### Cost comparison of AQUA-Cal+ with traditional treatments for iron

\* The cost of traditional treatments was provided by one of our Vietnamese customers. Costs may vary by region and situation.

Iron Treatment	Pond Size (m2)	Depth (m)	Cost (USD)
Traditional	1000	2.5	434
AQUA-Cal+	1000	2.5	300



Source

Hoffman Environmental Inc., 2002, Wastewater Treatment System, Texas, USA.





WATER

SOLVING GLOBAL CHALLENGES



## Reducing pollution while increasing yield at a shrimp farm pond liner, in Pahang, Malaysia



## Customer success story



### BACKGROUND

This farm had problems with reduced yields and deteriorating water quality. We suggested using AQUA-Cal+ standard protocol to improve water quality and in doing so de-stressing the shrimp and improving yield.

This customer is involved in a marine shrimp hatchery and grow out farm. Years of discharge of toxic sludge to the waterways in this area has resulted in deterioration of water quality and degradation of the habitat. This has resulted in reduced productivity and susceptibility to disease.

### CHALLENGES

- Low survival rates
- Poor water quality

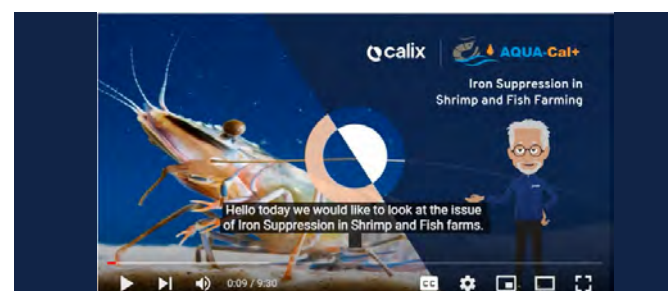
### SOLUTION

AQUA-Cal+ is a water conditioner, developed by Calix, that safely addresses disease and pollution, delivering improved feed performance and yield.

### BENEFITS

- Increased water quality
- Increased survival rates
- Increased harvest weights

AQUA-Cal+ has already begun to transform prawn and shrimp farming, as well as fin fish farming. It improves water condition, reduces stress on the animals and helps lead to increased harvest weight and survival rates, whilst protecting the environment.



IRON IN AQUACULTURE

.....  
<https://youtu.be/bFIgB13FH5I>

### Multiple benefits in a single solution:

#### Improved water quality

- AQUA-Cal+ works as a water and pond bottom conditioner, clarifying the water, controlling pH and releasing alkalinity as required to aid in the digestion of organic matter.

#### Less stress on prawn and shrimp

- With stabilised conditions in the pond, stress is reduced. When stress is reduced and water condition is improved, both fish and prawns become healthier and more productive.

#### Sludge volume reduced

- As AQUA-Cal+ neutralises the pond bottom sludge and accelerates its breakdown, pond bottom septicity is prevented. AQUA-Cal+ helps release organic material for the growth of phytoplankton (natural food for shrimp), while binding the toxic contaminants. Subsequently, the smell of the sludge is greatly reduced, with less toxic compounds in the water.

#### Iron suppression

- Conditioning with AQUA-Cal+ removes the iron by flocculation from the water, significantly reducing turbidity and toxicity. The stocking of the pond after the water is conditioned reduces the subsequent mortality of the post-larvae.

## Conclusion



**Wilson Lum**  
Applications Engineer  
Aquaculture

AQUA-Cal+ is a great alternative and a more sustainable approach to shrimp culture. Guided by our expertise and protocols, we help farmers reduce pollution while increasing their yield and revenue.

A more sustainable industry means aquaculture and shrimp farming can become a more efficient way of growing food and feed the protein needs of a growing human population.





## Calix receives regulatory approval for its safe, environmentally-friendly crop protection product BOOSTER-Mag in Australia

- In January 2020, Calix submitted an application to the APVMA (Australian Pesticides and Veterinary Medicines Authority) seeking registration for BOOSTER-Mag 609 SC as a non-lethal insecticide for the suppression of two-spotted mite (*Tetranychus urticae*) in tomatoes and cucurbits (field and protected crops).
- APVMA concluded its review this month and has approved the application.
- BOOSTER-Mag can now be supplied or sold and used safely according to the label directions by farmers (using the issue of product registration number #89101).
- BOOSTER-Mag aims to reduce farmer input costs and produce food more safely and sustainably.
- The initial registration has been approved without restriction on crop residue, reflecting intrinsic BOOSTER-Mag safety.
- Large-scale field trials indicate that regular foliar application of BOOSTER-Mag can allow for a material reduction in the use of conventional pesticides without compromising crop yield or yield quality.
- The initial label registration creates a Bioactive materials platform; establishing product safety and paves the way for expedited approval for use in more crops and more applications.

The registration of BOOSTER-Mag is the culmination of six years of scientifically rigorous product and application development and is a major milestone for Calix and its Biotech business. BOOSTER-Mag is the first registration of a magnesium hydroxide insecticide in the world.

This initial registration validates that the unique form of Calix materials can be safely applied to suppress a highly destructive crop pest. With suppression efficacy also apparent on additional crop pests and a variety of crop diseases, the initial registration provides a solid basis to expand the addressable market.



Robert van Merkestein about BOOSTER-Mag  
A sustainable alternative to conventional pesticides

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<https://youtu.be/jnPLTg5HEVA>

### BOOSTER-Mag description / history

Calix's core calcination technology enables the production of unique materials characterised by their high porosity and reactivity. Due to the intrinsic safety of produced materials, Calix has focused on the production of highly porous magnesium oxide and magnesium hydroxide products which are bioactive – early laboratory studies indicated that these materials were capable of suppressing common and highly destructive crop diseases.

BOOSTER-Mag is a suspension concentrate ("SC") of bioactive magnesium hydroxide, developed as a foliar treatment to suppress a variety of crop insect pests and diseases. Large-scale field trials have indicated that regular foliar application of BOOSTER-Mag reduces farmer reliance on conventional pesticides without compromising crop yield or yield quality.

The BOOSTER-Mag value proposition can be summarised as a means to reduce farmer input costs and produce food more safely and sustainably.

With the support of grant funding through the AusIndustry Accelerated Commercialisation programme, Calix completed a six-year development and testing programme, culminating in the January 2020 submission of a technical dossier to the APVMA.

In June 2021, it was announced that the Australian Government's Manufacturing Modernisation Fund ("MMF") would support Calix to develop and transform its Biotech manufacturing capability at its Bacchus Marsh facility in Victoria through the award of a grant of \$1.0m. The MMF grant is being used to transform the development of, and establish an advanced manufacturing capability for, bio-active materials for crop protection, marine coatings, and health and pharmaceutical applications.

International collaboration, supported by the Australian Government, with the Greek research organisation, CERTH, developed insights into the mode of action of BOOSTER-Mag on tomatoes by measuring the microbiological response of the sprayed plants. The published results support a view that BOOSTER-Mag may have a broad range of applications in agriculture.



### APVMA explained

In Australia, all agricultural and veterinary chemical products sold are required to be registered by APVMA.

APVMA acts as the Australian Government regulator of agricultural and veterinary ("Agvet") chemical products.

The registration process involves scientifically evaluating the safety and effectiveness of a product in order to protect the health and safety of people, animals, plants and the environment.

APVMA regulates Agvet products up to and including the point of retail sale. Once approved by APVMA, a product can be sold for the sole purposes and uses as stated on the product's label.

### Market size and need

The initial label in Australia allows BOOSTER-Mag to be applied for the suppression of two-spotted mite in tomato and cucurbit crops, which presents an addressable market opportunity estimated at 16,000 ha in Australia. Both tomato and cucurbit crops are vulnerable to insect pests and disease and, as such, conventional pesticides are critical.

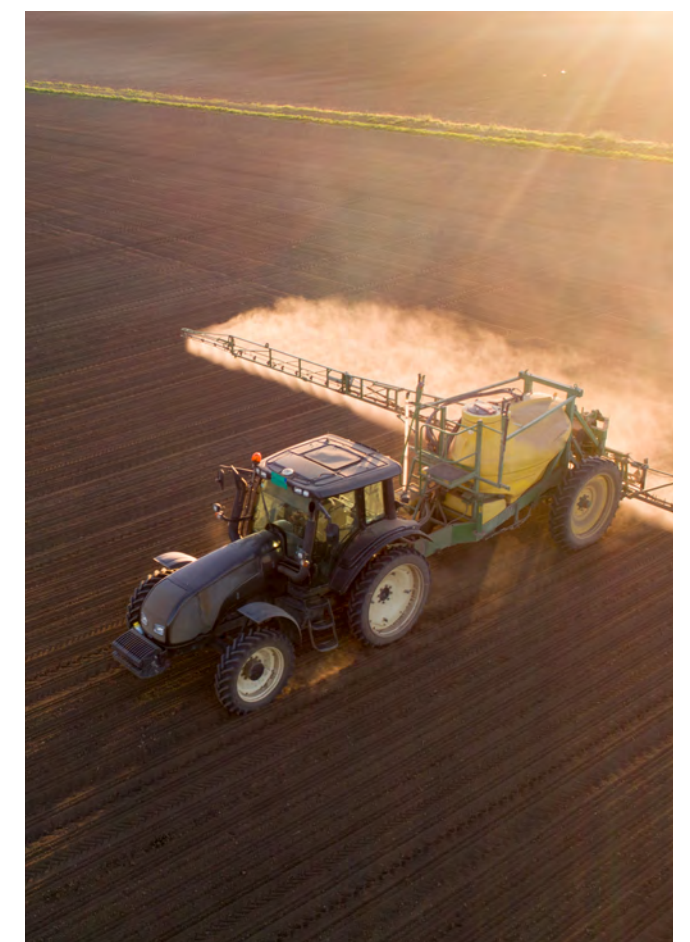
In addition, BOOSTER-Mag is a part of several larger field trials overseas where other types of crops and applications (e.g. anti-fungi) are being evaluated.

### Next Steps

Calix is developing commercial relationships with specialist global crop protection companies with the expertise and capability to fully utilise Calix's material bioactivity. BOOSTER-Mag field trials are currently underway to support initial market entry and extend the BOOSTER-Mag label, allowing for its use in major crops in Australia and internationally and increasing the addressable market, which conservatively is estimated at 500,000 ha.

Find out more about BOOSTER-Mag:

.....  
<https://www.calix.global/biotech-focus-area/making-crop-protection-safer/>







# Calix releases first Communication on Progress to UN Global Compact

Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. It is deeply embedded in our purpose, the reason we exist: “Because Mars is for Quitters.”

Sustainability is not just about environmentalism but adds social, governance and economic concerns to our organisation's business agenda. Since 2020, Calix has been a member of the United Nations Global Compact (UNGC), thus supporting its Ten founding Principles related to human rights, labour standards, environmental protection, and anti-corruption.

Between 2020 and 2021, a dedicated and cross-functional Sustainability Team conducted a review of all 17 Sustainable Development Goals (SDGs) with the aim to better understand our connection to the World's 2030 Agenda for Sustainable Development, identify associated risks, and define priority areas where we believe we can have the most meaningful impact.

This initial review has led to the publication of our very first Communication on Progress report. The team has recognised that Calix touches all 17 SDGs through innovation, development, and partnership initiatives, as well as in its day-to-day operations, business practices and investment opportunities.

Although this is the first step of a long journey, our annual Communication on Progress (COP) shares with you our company's status with regards to the Ten Principles set by the UN Global Compact, a high-level summary of our team's discussions, and the level of ambition we have set ourselves for each of the 17 SDGs.

In November 2021, Calix also enrolled in the "SDG Ambition Accelerator", a six-month program offered by the UNGC and Accenture (a global consultancy firm) that supports businesses in accelerating action to achieve the Sustainable Development Goals (SDGs).

We feel this program will empower and equip us to develop and implement innovative business strategies that significantly increase our impact on the SDGs. In simple terms, converting our ambitions into tangible and trackable actions.

By living our purpose and delivering on our strategy, we believe we can make a positive difference on society at large for the long-term and contribute to the 2030 Agenda, while maximising positive outcomes and growth for our customers and shareholders.



*“We are committed to make all of the UN Sustainability Development Goals (SDGs) part of our company culture and day-to-day operations, and we see the corporate social responsibility (CSR) as a journey towards long-term growth, competitiveness, big picture thinking, strong company culture, and a genuine team spirit. Because innovation in one area cannot make up for doing harm in another. We believe sustainability is about more than operating responsibly. It’s an opportunity to support the communities we’re a part of and make a positive impact on the world.”*

**Audrey Barucchi,**  
on behalf of Calix Sustainability Team.

More details and updates can be found on our website:  
.....  
<https://www.calix.global/sustainability>





We believe our people are key to achieving our purpose.



●  
**Introducing  
Doug Kelley**  
President of IER



Dr. Kelley is a Ph.D. chemist with 29 years of research & development experience in water and wastewater treatment technologies.

Doug graduated from Iowa State University in 1990 with a Doctorate in Inorganic Chemistry. He worked with Nalco for 14 years in basic research and new product development.

He is also the co-inventor on numerous patents related to scale and corrosion control in boiler and cooling water environments.

As President of Inland Environmental Resources (IER), Doug has spearheaded the development of proprietary, safe, environmentally-friendly and cost-effective chemical products based on magnesium hydroxide.

Dr. Kelley is a member of the American Chemical Society, American Society of Heating, Refrigeration and Air-Conditioning Engineers, and the Water Environment Federation.



*We greatly appreciate the opportunity we get everyday to work closely with our vendors to serve our customers' needs, helping their business run as smoothly as possible and keeping their wastewater system operating at peak performance.*



*IER offers more than 100 years of combined experience in the areas of municipal and industrial wastewater and process water treatment. IER shares Calix's passion to provide their uniquely stable and reactive magnesium hydroxide products for further growth into our primary North American markets, and to expand the applications of these high-quality, environmentally friendly technologies into new markets.*



# Giving back to the community

The pandemic has proven that people and businesses can overcome adversity and give back to their community even in the toughest of times, emerging as local heroes in their communities.

At Calix, we take our Corporate Social Responsibility (CSR) seriously, and we believe we can help create lasting social change that benefits the whole of society, while continuing to grow.

## Bacchus Marsh Football Team

Another initiative to support the local community is Calix's sponsorship of the Bacchus Marsh Senior Women's AFL football team, the Cobras. This partnership aligns with one of Calix's three core values – Positive Impact. While Calix has reached out across the globe with operations on four continents, it is proud of its roots and wants to continue to support the communities in which it operates.



Vincent Nguyen

**“It is a privilege to support the women’s football team,” said Vincent Nguyen, as Sustainable Development Goal 5: Gender equality (SDG5) – achieving gender equality and empowering all women and girls is also a big part of our sustainability agenda.**



To learn more about Calix technology, products, applications and services:  
[www.calix.global](http://www.calix.global)

Or call 1300 0 CALIX

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