

November 11, 2020

Calix | Solving global challenges

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Recap: Business Overview & YTD FY21 Progress



Solving global challenges

# Calix Limited is using its core mineral processing platform technology to grow multiple global businesses





#### **Growing Sales** Revenues

generated from water treatment products, with growing exports and recent US acquisition



#### **Control of Supply Chain**

from mine, to manufacturing facility, to local mixing plants, to customer / distributor



## **Quickly scalable**

for minimal (organically funded) capex



#### **Robust business** model

with existing commercialised markets in "essential services" waste water and food, largely unaffected by COVID-19



#### **Funded Development**

in Australia (\$5m for agriculture, advanced batteries) and Europe (€28m for CO<sub>2</sub> capture for cement and lime)



#### **Multinational Partners HEIDELBERG**CEMENT







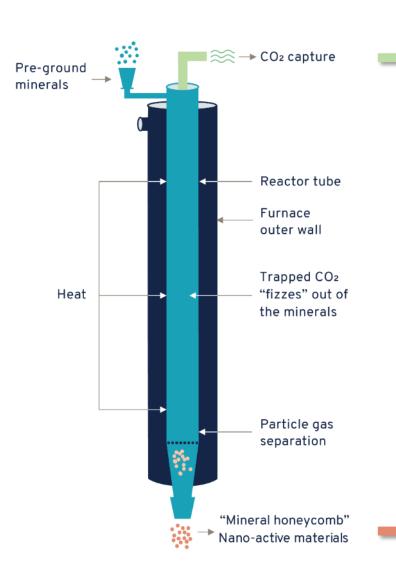


Cash-positive and with no debt, growing revenues, secure supply chain, readily scalable and with a funded development pipeline.



# **Calix's Core Technology**

A PATENTED PLATFORM TECHNOLOGY WITH 2 KEY FEATURES

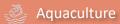


CO<sub>2</sub> Capture

When processing limestone, cement meal, or magnesite, gas exhaust is pure CO<sub>2</sub>

Low Cost, Safe + Very High Surface Area (Reactive) Products

( ) Wastewater



Lake remediation

Crop protection

Advanced batteries

A New Type of Kiln...

The "Calix Flash Calciner" or CFC



27 patent families covering core technology and applications

**O**calix



>\$60m has been invested to date in developing the technology.

## **Calix Limited FY20 Results Summary**

A TRANSFORMATIONAL YEAR





operating cash profit

up 224% to \$1.5m



major new project

\$57m LEILAC-2 launched April 2020



net assets \$26m

Zero Debt



new funding

\$30m in AU and **EU Grants** secured \$15.3m in new capital secured



5 new patents

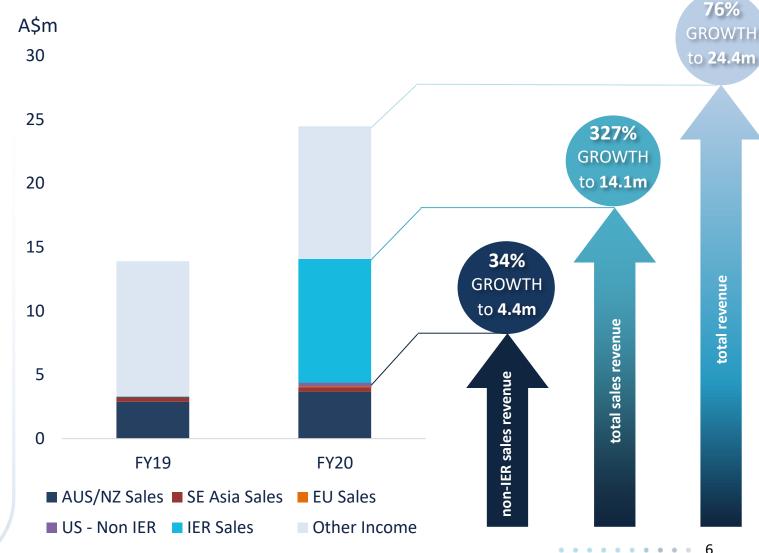
covering core technology and applications



1,334 shareholders\*

\* As of June 2020

**REVENUE GROWTH** Both organic, and through the acquisition of IER



# In Summary: Our Priorities for FY21

NWR Update Webinar 6/11 **O**calix

Today

	IN-MARKET  WATER	AQUACULTURE & FRESH	OMMERCIAL  AGRICULTURE	CO <sub>2</sub> MITIGATION	ADVANCED			
	& WASTE WATER	WATER REMEDIATION	CROP PROTECTION	LIME & CEMENT	BATTERIES			
Success in 12 months looks	US: 4 site upgrades, 1 new manufacturing site supporting new market growth	Re-establish Asian growth esp. China	First European summer sales leads to strong initial orders for next EU summer	Successful completion – LEILAC-1 test phase	Pouch cell prototypes tested –			
like?	European market entry and growth	Successful market entries – Indonesia, Vietnam, India	APVMA Approval – Australia Another commercial license	Successful Basis of Design milestone – LEILAC-2	high prospective performance and/or economics			
Strategic Options	Partnering / port	folio potential	License and possible spin-out play to crop majors	License and possible spin- out play to engineering / technology companies	License and possible spin-out play to battery / EV companies			
Priorities	Equal highest priority – grown revenues and leverage technology into new market opportunities	Medium priority – huge potential and high growth but off small base via distributors, + COVID	High priority – good European and global tailwinds, but subject to COVID issues wrt market entry	Equal highest priority – grow value through de- risking – look for early value inflexion point	High priority – good global tailwinds, will take time			
	Focus remains on growing organic revenue base whilst strategically realising value in other R&D verticals							

## **Wastewater Treatment**

A RAPIDLY GROWING BUSINESS

#### **Key Milestones Targeted FY21**

- Complete 3 more US plant upgrades stable MHL technology
- Complete 1 new US plant
- Pursue revenue and gross margin growth
- Pursue European market entry and growth

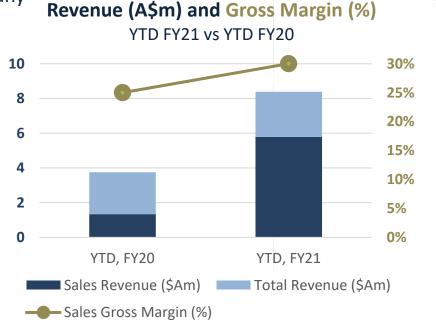
#### **FY21 YTD Key Achievements**

• Completed 1 plant upgrade – 2 more upgrades and 1 new plant to go this FY

• First EU paid trial achieved - Germany

#### YTD FY21 vs YTD FY20...\*

- Total revenue up 124% to \$8.38m
- Sales Revenue up 333% to \$5.78m
- IER Revenue up ~6% on preacquisition period (in \$US)
- Gross Margin up 5% to 30%





**Business Model / Strategy** 

Direct sales model

Near Term: Roll-out and exploit technical advantages – US + grow margins and revenues

Medium Term: New Calix Calciner -Americas

Replicate US Market Entry - EU

# CO<sub>2</sub> Mitigation

RAPID PROGRESS CONTINUES TOWARD COMMERCIALISATION

#### **Key Milestones Targeted FY21**

- Successful LEILAC-1 test campaign conclusion
- Successful Basis of Design milestone LEILAC-2
- Continue to pursue licensing opportunities, and other CO<sub>2</sub> verticals (lime, refractories, etc)

#### **FY21 YTD Key Achievements**

- EU Approval LEILAC-1 test campaign extended to mid-2021
- LEILAC-2 BOD on track

Coy's	Scope	Status	Targeted Next Steps – FY21
"A"	Refractories	Successful phase 1 test program complete Commercial T&C's under discussion	Phase 2 targeted from January 2021 Project / License Agreement covering first full-scale plant
"B", "C", "D", "E"	Compant	"LEILAC" 3 Concept under discussion for EU Innovation, and/or Country-Level funding	
"F", "G"	Cement	Full Scale cement plants outside of EU – Feasibility projects – discussions	At least 1 Project / License Heads of Agreement + Commence Feasibility – full-scale plant
"H", "I", "J", "K"	Lime	Application-specific concepts under discussion	



Theoretically the lowest cost solution to CO<sub>2</sub>
mitigation for cement and lime

- 2018 EU ratifies phase 4 of the Emissions Trading Scheme, CO<sub>2</sub> permit price jumps from €5 to over € 25, where it has remained
- 2019 HeidelbergCement pledges net zero CO<sub>2</sub> by 2050, and a 30% reduction by 2030
- 2020 EU legislates net zero CO<sub>2</sub>
   by 2050. Several countries follow.

#### **Business** model

- Capital light / low risk
- Engineering services and license / royalty fees
  - Consider equity interest to accelerate commercialisation

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Update: Advanced Battery
Materials Development
Program



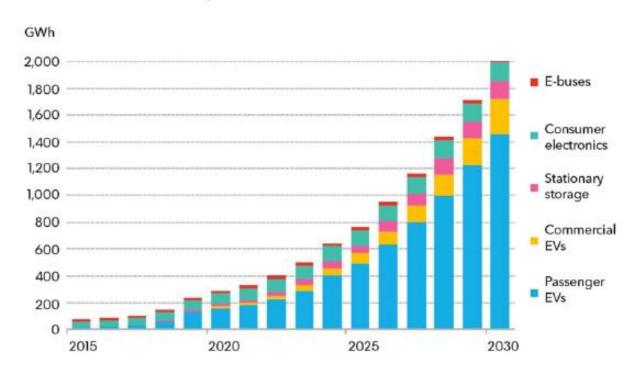


## Market opportunity – why are Li-Ion batteries of interest?



The Li Ion battery market has grown very quickly, and is predicted to accelerate further...

#### Annual lithium-ion battery demand



Source: BloombergNEF 2019

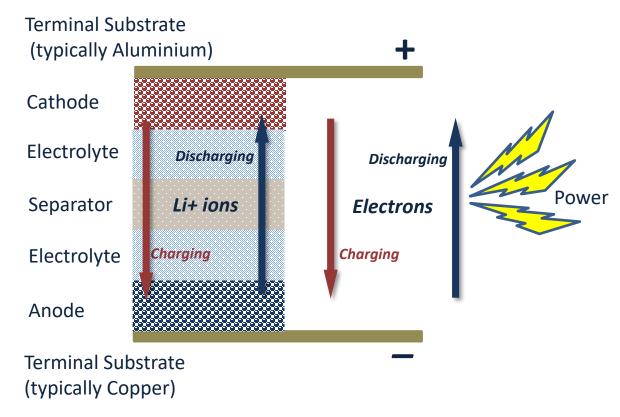
While there are varying predictions as to the growth of Li-Ion battery demand, there is consensus on two things...

- Growth will be driven by electric vehicles, with significant growing contribution from stationary storage
- Growth will be very fast over the next decade

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## How do lithium ion batteries work?

And why is the cathode so important?



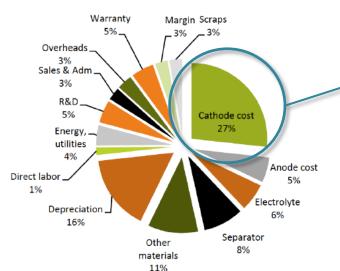
The cathode, as the source of Li+ ions, is the main determiner of the capacity and voltage of the battery



During **charging**, lithium (Li) ions flow from the cathode to the anode via an electrolyte, through a separator

During **discharge**, they flow back to the cathode, generating a flow of electrons from the anode into the external circuit (eg your phone, or car !) and back to the cathode also

#### Average cost structure of Li-ion cell



The cathode is also the most expensive component of a Lithium Ion battery

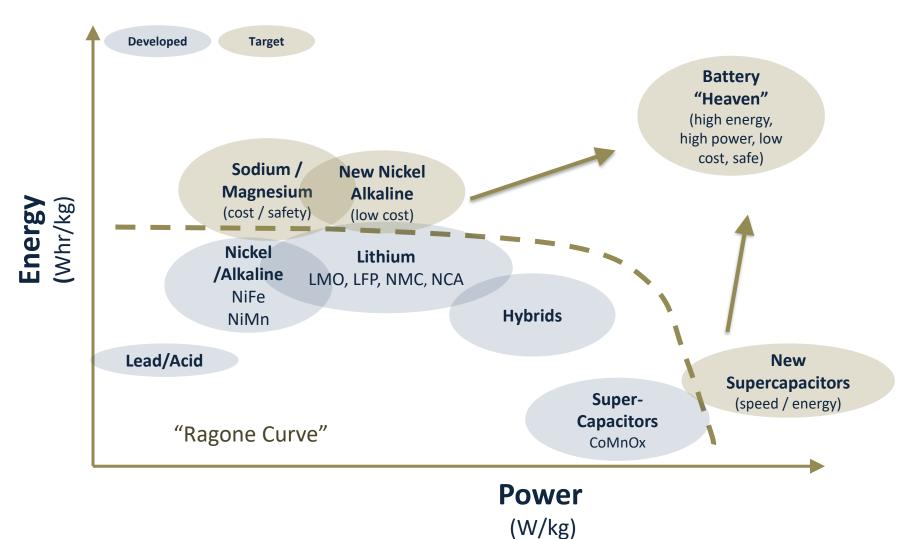
- over ¼ of the cost !
- due to...
  - 1.Materials
  - 2. Energy
  - 3. Capital

Source: Avicenne 2018

## What are the key operating properties of Li-Ion batteries?



So far (!) has been a trade-off between energy and power...



- "energy" defines how much "fuel" is in the tank
- "power" defines how quickly the energy can be used, and replenished
- EV's are driving development to push the Ragone Curve outward!
- But energy and power are not the only parameters of interest...

## Energy and power important, but so is cost and safety...



How the top 4 chemistries stack up, and recent trends towards cost and safety...

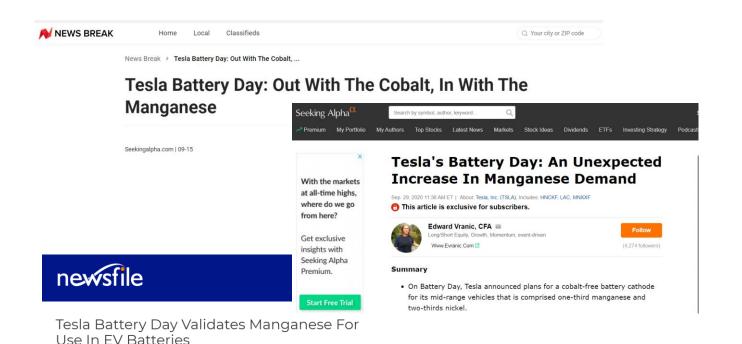
Cathode Chemistry	Key Elements	Stability	Voltage (V, vs Lithium)	Specific Energy ( (Wh/kg)	Typical Cost (\$/kg)	Cost / Energy (\$/kWh)	Safety <sup>1</sup>
NMC or NCM	Ni, Mn, Co	Good	3.8	140-180	20 – 28	30 – 43	0
NCA	Ni, Co, Al	Poor	3.8	80-220	23 – 30	30 – 40	
LFP	Fe, P	Excellent	3.4	80-130	10 – 12	18 – 22	•
LMO	Mn	Poor	4.1	105-120	8 - 15	16 - 30	•

- ry Safe Unsafe
- The first modern electric cars such as the first generation Nissan Leaf, used **Lithium Manganese Oxide** (LMO) cathodes because of low cost and good intrinsic safety, at the expense of lower capacity and lifetime (stability)
- > And Li-Ion stationary energy storage systems are less interested in energy density, and more in cost, safety and stability
- > Tesla has used **Nickel Cobalt Aluminium** (NCA) and a lot of other car-makers use **Nickel Manganese Cobalt** (NMC) due to higher energy densities, albeit at higher cost and safety concerns
- ➤ However, Tesla has stated it will move to **Lithium Iron Phosphate** (LFP) chemistry for its Model 3 cars for the Chinese market, mainly driven by safety, cost and longevity, and....

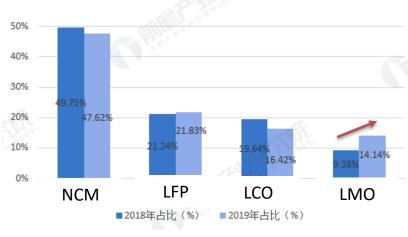
## Manganese – back with a vengeance ?!



Tesla is now targeting lower cost, safer, more environmentally acceptable chemistries, switching to Manganese...



2018-2019 Cathode Active Material market in China



- In an effort to reduce costs and increase safety further, Tesla announced at the recent "Battery Day" in September 2020, that it will be pivoting battery strategic development back toward Manganese, along with Nickel, and move away from Cobalt.
- ➤ In China over 2018-2019, LMO was the fastest growing cathode chemistry, and is being used to blend into NCM and LCO chemistries to reduce cost, and is also being driven by e-Bike growth

## Why might Calix's technology be suited to battery materials?

We make nano-porous particles, cheaply, and already at scale...





## Calix route







Current Manufacturing and Most R&D routes



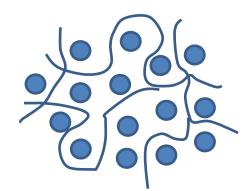


- **Exotic Chemistries**
- High purity pre-cursors

Ag-grade Manganese Carbonate microparticles



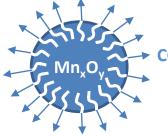


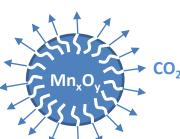


- Micro- and Nanoparticles
- Multiple spacing / *layering techniques* 
  - Waste materials!

Calix BATMn Reactor Controlled flash heating, oxidation

No waste









Controlled nano-porosity, strong flexible micro-crystals



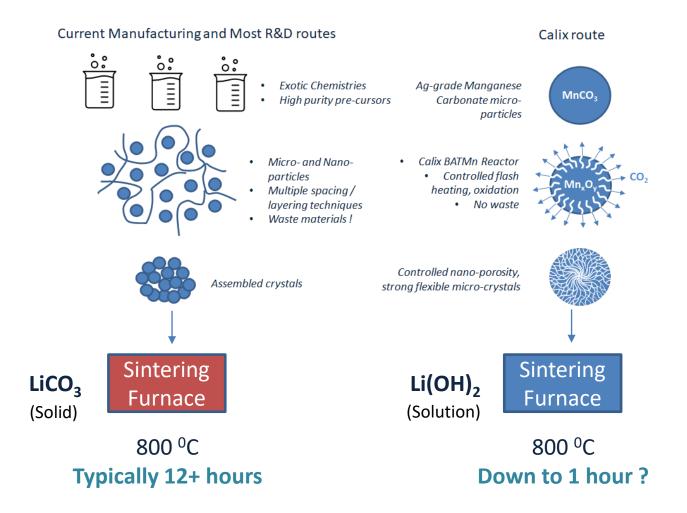
The more exotic, the harder + \$\$ to scale!

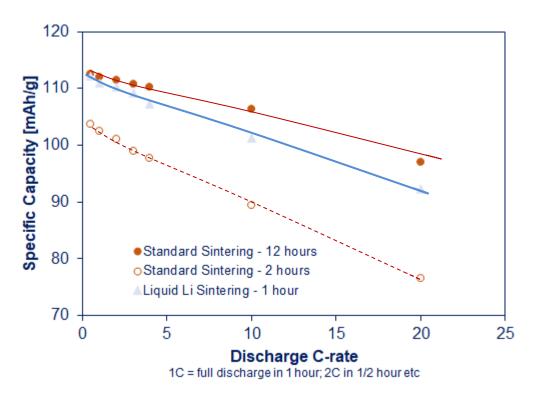
Already at Commercial Scale 2000 Tpa, ~A\$2m

## Why might Calix's technology be suited to battery materials?



Could the Calix technology also result in a cheaper way to add lithium?





- ➤ Our battery performance¹ for a Li solutionsoaked 1-hour sintering process is nearly as good as the 12-hour solid state sintering process
- > These are early results and more testing is required, however more optimisation may also be possible!

## Can we use cheaper, less pure materials?



Our early test work has concentrated on cheap, agricultural, non-battery grade manganese...

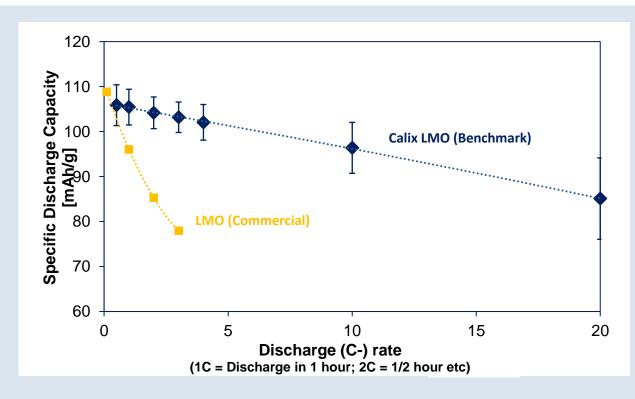
Chemical Composition (weight %)		Standards		Commercial LMO	Calix LMO	
		High Capacity <sup>1</sup>	High Power <sup>1</sup>	As tested	(washed)	(unwashed)
Main alamants	Mn	58.0 <u>+</u> 2.0	57.5 <u>+</u> 2.0	59.5	58.2	56.3
Main elements	Li	4.2 + 0.4	4.1 + 4.0	3.97	3.84	3.76
	K	< 0.05	< 0.01	0.01	< 0.01	0.03
	Na	< 0.3	< 0.1	0.3	0.05	0.27
	Ca	< 0.03	< 0.03	0.02	0.32	0.78
Impurities	Fe	< 0.01	< 0.01	0.01	0.02	0.02
	Cu	< 0.005	< 0.005	0.0002	0.0018	0.0017
	S	-	< 0.167	0.5	0.31	0.91
	Mg	-	-	0.02	0.6	0.6

- > Commercial LMO, and Chinese LMO Standards, show much lower concentrations in Ca, Fe, Cu and Mg impurities
- > Simply washing with water lowered some of the impurities (K, Na, Ca and S)
- ➤ And the performance ?....see next few slides!

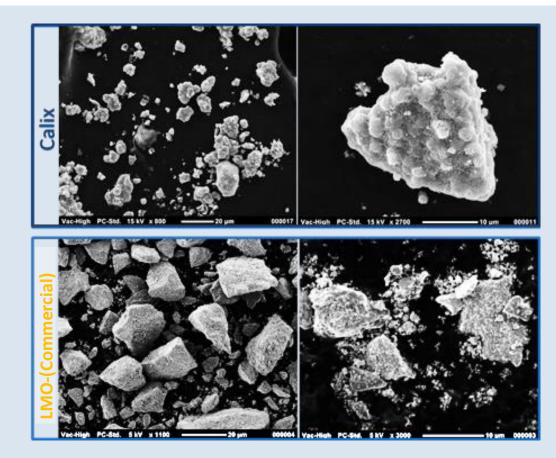
## **Despite lower purity – some encouraging performance...**



Firstly – charge rate performance versus a commercial LMO appears very different...



➤ As the **discharge rate** increases, puts more strain on the cathode material – our early materials are already showing good stability at higher charge rates, above commercially available LMO¹



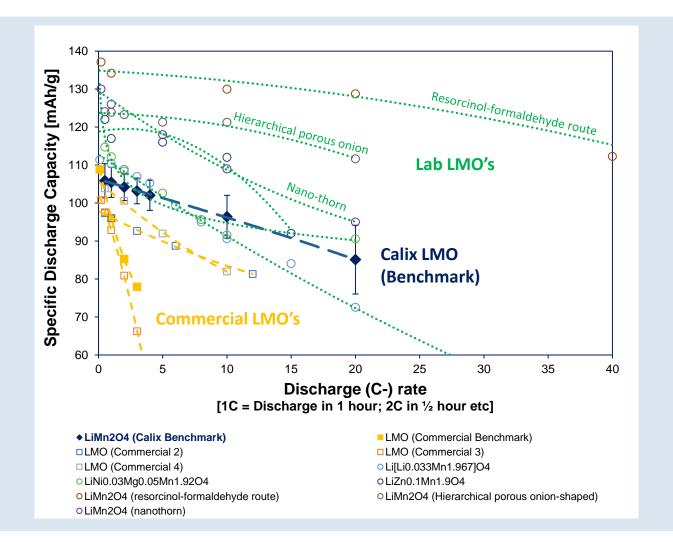
High magnification images clearly show our material has a different structure

<sup>1.</sup> All materials were tested under identical conditions in ½ cells

## How do we stack up compared to "the best" LMO's in R&D?



We've pushed some of our materials to very high discharge rates to see...



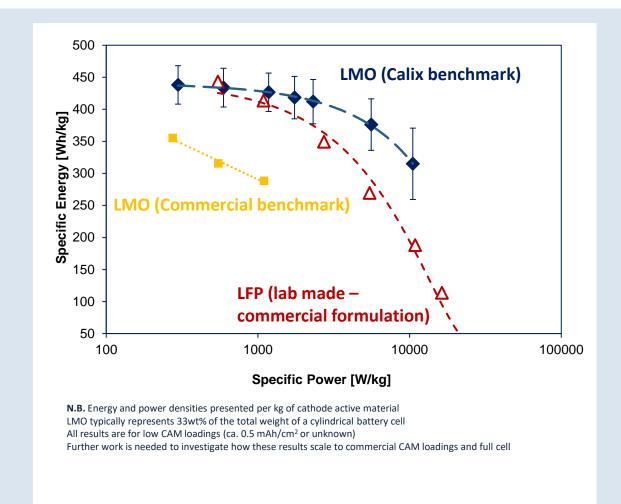
- Calix LMO was superior to the electrochemical performance data as reported from the top global LMO manufacturers \*
- Calix LMO also compared favourably to the best performing exotic lab-produced LMOs as presented in the open literature
- EARLY DAYS but very encouraging !

<sup>\*</sup> Test methods may be different between the different results, and we have tried to compare under as similar conditions as possible

## How do we stack up compared to other Li-ion chemistries?



We've compared results against literature for LFP's...



- Calix LMO materials (to date) also compare favourably to best performing LFP cathode materials as presented in the open literature\*
  - ➤ LFP market expected CAGR of 8% between 2015-2025¹
  - Uses include power tools, transit EV, xEV, e-bikes and stationary applications
  - ➤ The Chinese-made Tesla Model 3 will feature a Cofree LFP battery chemistry<sup>2</sup>
- **→** Can Calix LMOs compete for the LFP market????
- ➤ Early results promising but more work is needed to investigate how these results scale

<sup>\*</sup> Test methods may be different between the different results, and we have tried to compare under as similar conditions as possible

<sup>[1]</sup> http://www.avicenne.com/pdf/Lithium-Ion%20Battery%20Raw%20Material%20Supply%20and%20Demand%202016-2025%20C.%20Pillot%20-%20M.%20Sanders%20Presentation%20at%20AABCUS%20San%20Francisco%20June%202017.pdf

## We've just started our journey...



We are year 1 into a multi-year, multi-program development, but very encouraged already...







High capacity

alloying anodes



Nano-active LMO cathode













High Voltage Mn and Ni cathodes

& LTO anode Pouch cell

> Tailored electrolytes for nano-active electrodes

integration

Electrode formulation and casting development

Cell scale-up and pack integration

NMC Cathode pilot plant





We create chemistry



**Australian Government** 

**Australian Research Council** 







talga







Sodium and postlithium ion chemistry Nano-active catholytes & anolytes

Spodumene processing Li beneficiation

> **Next generation** graphite anodes

Nano-active separator technology

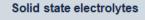














EU H2020 Training Network - Solid State Batteries















# We do have quite a bit of work to do...



The next stages of our program are critical to achieving commerciality...

Key Challenge	Description	2021	2022	2023
LMO Full Cell Performance	<ol> <li>Commercially-relevant loadings of Cathode Active Material<sup>1</sup></li> <li>Long term 500-1000+ charge-discharge cycling performance</li> </ol>		·	
Field Trials	Demonstration of the technology in a commercially relevant format at real world/application specific conditions <sup>2</sup>			
Scale-Up	Demonstrate electrochemical performance of materials produced in commercially relevant quantities (grams → kgs → tonnes)	Stage 1		
	<ol> <li>Stage 1: Lab (grams) → pilot production (kgs) - underway</li> <li>Stage 2: Pilot production (kgs) → Commercial demonstration (tonnes)</li> </ol>		Stage 2	
Optimised / Combined / New Chemistries	<ol> <li>Optimise LMO</li> <li>Test new materials / chemistries</li> </ol>	Iterative / On-going		
Electrode / Electrolyte Optimisation	Experiment with different combinations to maximise cycling stability	Iterative / On-going		

## **However - Early results are very promising!**

LMO is just the start, even LMO has great potential...



## Potentially far lower costs:

 The Calix process represents a potentially far lower cost material, and manufacturing process, to conventional and exotic processes

## Strong early performance results:

 Half-cell tests of Calix LMOs at Deakin University have outperformed commercial benchmark LMO and LFP's and is in the mix of some of the high performing lab LMOs reported in the open literature

## Highly prospective markets:

- Manganese "re-growing" in importance
- Other chemistries still to be tested...(Ni etc)





# MARS IS FOR QUITTERS

We believe our responsibility starts at home. That's why we're driven to use our unique skills to repair, preserve and prevent future harm to it.

Because there's only one Earth, and it's already ours.



# Because there's only one Earth...



# ... Mars is for quitters

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