

# BLUGLASS (ASX:BLG)

## PATH TO COMMERCIALISATION

SEPTEMBER 2019

# FORWARD

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Information on Service Addressable Market (SAM) and Service Obtainable Market (SOM) is based on internal BluGlass modelling and assumptions, both of which depend on successful R&D outcomes and results achieved within estimated timetables. BluGlass recommends a cautious interpretation be taken by investors.

# CORPORATE OVERVIEW



# INVESTMENT AND CORPORATE SUMMARY

Leveraged to large and growing markets



BluGlass' proprietary RPCVD technology has **demonstrated performance advantages** in multiple high growth photonics markets

Including the high brightness **LED, microLED, laser diode** and **power electronics markets**

Strong patent portfolio



**68 International Patents** granted in key semi-conductor markets (including USA, Europe & Asia)

With a further **15 Applications**

Across **9 Patent Families**

Breakthrough Australian technology poised for global impact



**Demonstrated competitive advantages** with applications in multiple markets

Intensive R&D in Australia (**Over 12 years and \$90M invested**) to build strong commercial foundations

Now working with **a number of global partners & customers** to commercialise RPCVD

Several commercialisation paths



**BluGlass will go to market via a combination of:**

- Licensing fees / royalties
- Equipment sales with an equipment partner
- Equipment retrofit of installed base
- Wafer sales (through EpiBlu foundry)

Experienced Board and management team



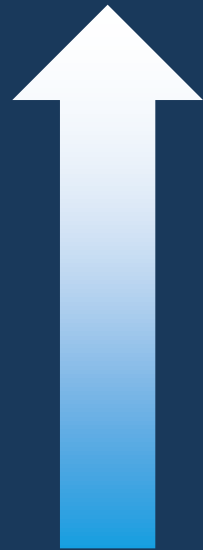
BluGlass has a **highly talented and expert team** including **7 PhDs**

Combines academic, industry and commercial expertise

We also work with world leading industry consultants to drive continuous innovation

# HIGH-GROWTH & LARGE END MARKETS

## Global LED market (packaged LEDs)



Global packaged LED market was worth **\$16.7B** in 2018

Source: Strategies Unlimited, \$US

## Global Laser Diode market



Global Laser Diode market is predicted to reach **\$14.6B** in 2019

Source: Strategies Unlimited, \$US

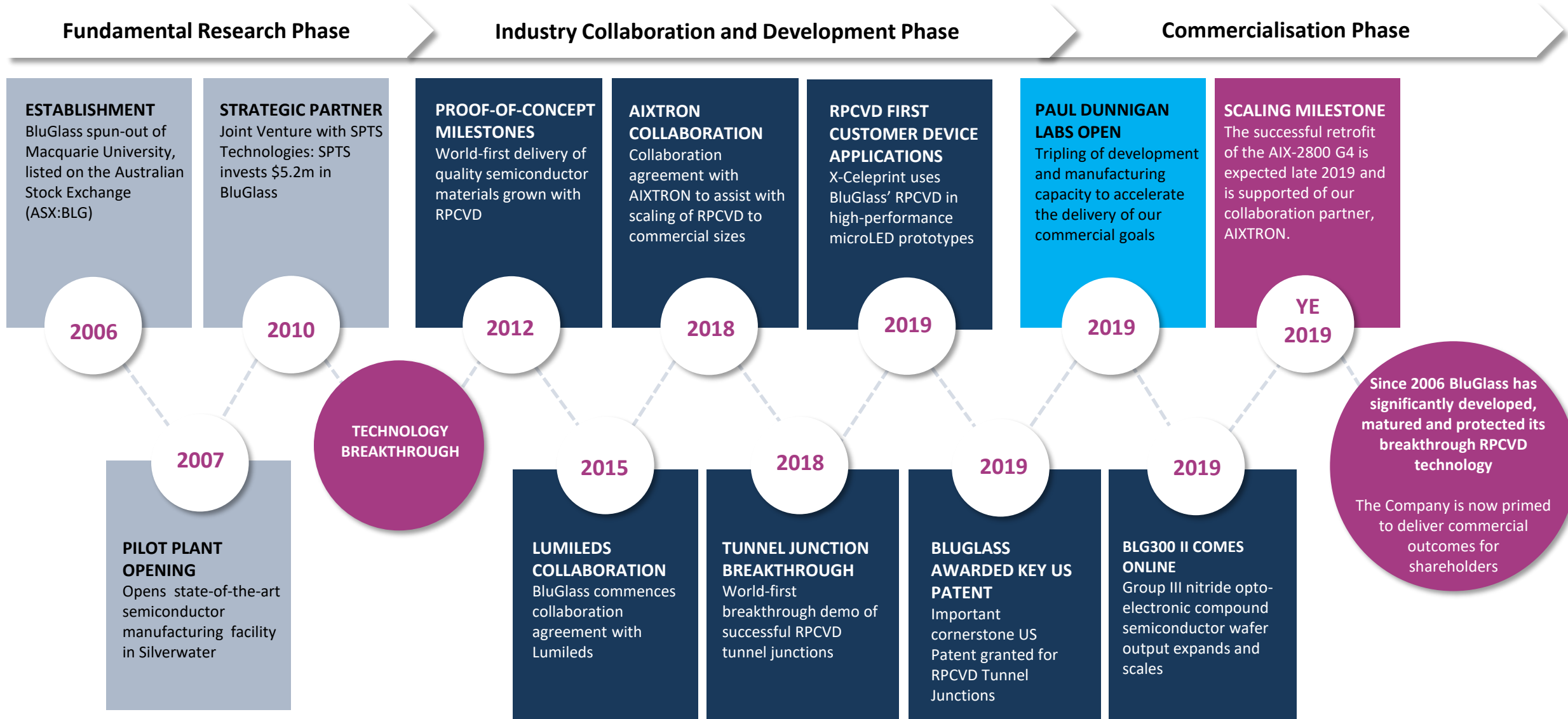
## Global Micro LED market



The emerging microLED market from near \$0 base is expected to reach **\$20.5B** by 2024

Source: Yole Development, and Markets and Markets, \$US

# COMPANY TIMELINE





SIGNIFICANT  
PROGRESS  
IN 2019 – RECENT  
NEWS

# BRIDGELUX JOINT VENTURE AGREEMENT

BluGlass and Bridgelux to co-develop RPCVD cascade LEDs for the general lighting market

## DEVELOPING OUR TUNNEL JUNCTION PROGRAM



Bridgelux is an international leader in the development of high-performing, energy-efficient, cost-effective LED solutions for the general lighting market, creating products for more than 2,500 customers around the globe



The JDA includes some foundry revenues to BluGlass while both partners jointly investigate new applications for RPCVD



Primary objective of the JDA is to establish a path to deliver cascade LEDs for mainstream applications



BluGlass and Bridgelux collaborating to combine their unique technologies in cascade LEDs for the rapidly growing general lighting market



**\$6.8B**

general lighting market  
in 2018  
(packaged LEDs)

Source: Strategies Unlimited



# BLUGLASS OPENS NEW MANUFACTURING LABORATORIES

BluGlass formally opens new laboratories to expand RPCVD development and commercialisation operations

## SIGNIFICANT INCREASE IN RPCVD MANUFACTURING CAPACITY AND CAPABILITY



New laboratories represent an investment of \$6 million in additional equipment and associated infrastructure



Semiconductor wafer growth already under way in the first of two additional semiconductor deposition systems, the BLG-300II



Second deposition system, the commercial scale AIX-G4, currently scheduled to start operations towards the end of calendar year 2019



Together, these two additional systems will triple BluGlass' RPCVD wafer capacity



# AIXTRON COLLABORATION & SCALING PROJECT

BluGlass is collaborating with global equipment leader, AIXTRON, to scale the technology and as a potential equipment partner

## DEVELOPING OUR TUNNEL JUNCTION PROGRAM



BluGlass has entered into a collaboration with global equipment leader, AIXTRON SE (FSE: AIXA)



AIXTRON is assisting in the scaling of RPCVD technology with the collaborative retrofit of the AIX 2800 G4 at BluGlass' facility



BluGlass has selected the AIX 2800 G4-HT system for the scaling of RPCVD to mass production capacities



AIXTRON is evaluating the performance potential of RPCVD and a possible equipment partnership for the delivery of RPCVD to market at scale



**\$1.4B**

Global MOCVD  
Equipment Market  
by 2025

Source: Market Study Report, LLC 2019

# X-CELEPRINT MANUFACTURES ACTIVE MATRIX MICROLED DISPLAY WITH RPCVD

Successful customer prototype of RPCVD p-GaN in high-performance microLED applications

X-CELEPRINT AN EARLY ADOPTER OF RPCVD FOR  
microLED DEMONSTRATIONS



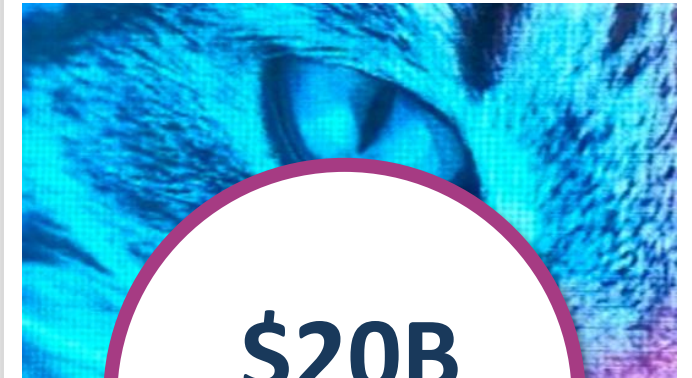
BluGlass' foundry customer X-Celeprint deploys RPCVD to deliver active matrix microLED display prototype (pictured), showing good colour uniformity, quantum efficiency and forward voltage, equalling existing high-performance commercial applications of 2,000 cd/m<sup>2</sup>



X-Celeprint is a world leader in micro-transfer printing ( $\mu$ TP) technology - a scalable manufacturing platform for integrating microscale devices such as lasers, LEDs and integrated circuits onto non-native substrates



microLEDs are an emerging display technology, predicted to become one of the fastest growing LED market segments, with applications in wearables (watches), mobile displays, next-generation TV displays, virtual reality (VR) and augmented reality (AR)



**\$20B**  
microLED market  
by 2024

Source: Yole Developpement, and Markets and Markets

# KEY TUNNEL JUNCTION PATENT AWARDED IN US – IP UPDATE

- Our Intellectual Property portfolio is a critical foundation for our future commercial success and underpins our licensing-based business model
- In July 2019 BluGlass was awarded a key US Patent for buried activated p-GaN in tunnel junctions
- This important patent brings our internationally granted patent portfolio to a total of **68 patents** in key semiconductor jurisdictions across **9** patent families



# TECHNOLOGY ADVANTAGE – HIGH-BRIGHTNESS LASER DIODES

RPCVD-grown Laser Diodes provide a pathway towards higher power, higher brightness and lower cost. Expansion of the GaN portion of the industrial cutting/welding, display, automotive and biotech market segments will hinge upon improvements in power output, brightness and beam quality, at lower costs. RPCVD-based Laser Diodes can offer performance advantages over traditional MOCVD-based manufacturing methods

## RPCVD-GROWN LASER DIODES: A NEW MARKET OPPORTUNITY



BluGlass' low-temperature growth RPCVD technology enables improved deposition control to enhance Laser Diode performance



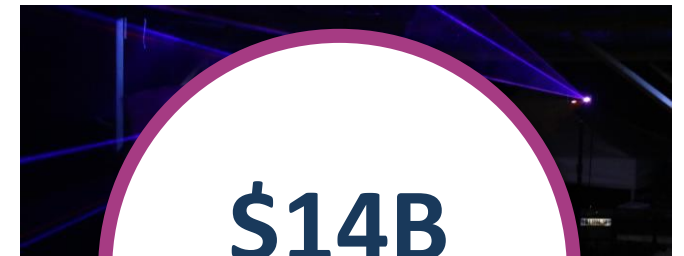
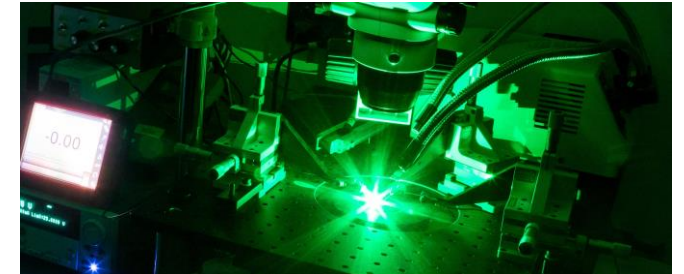
BluGlass' tunnel junction technology enables new design architectures that can increase power and brightness



RPCVD grown Laser Diodes can enhance the performance of GaN Laser Diodes at longer wavelengths



RPCVD growth enables new and unique processing steps for Laser Diodes, resulting in lower cost

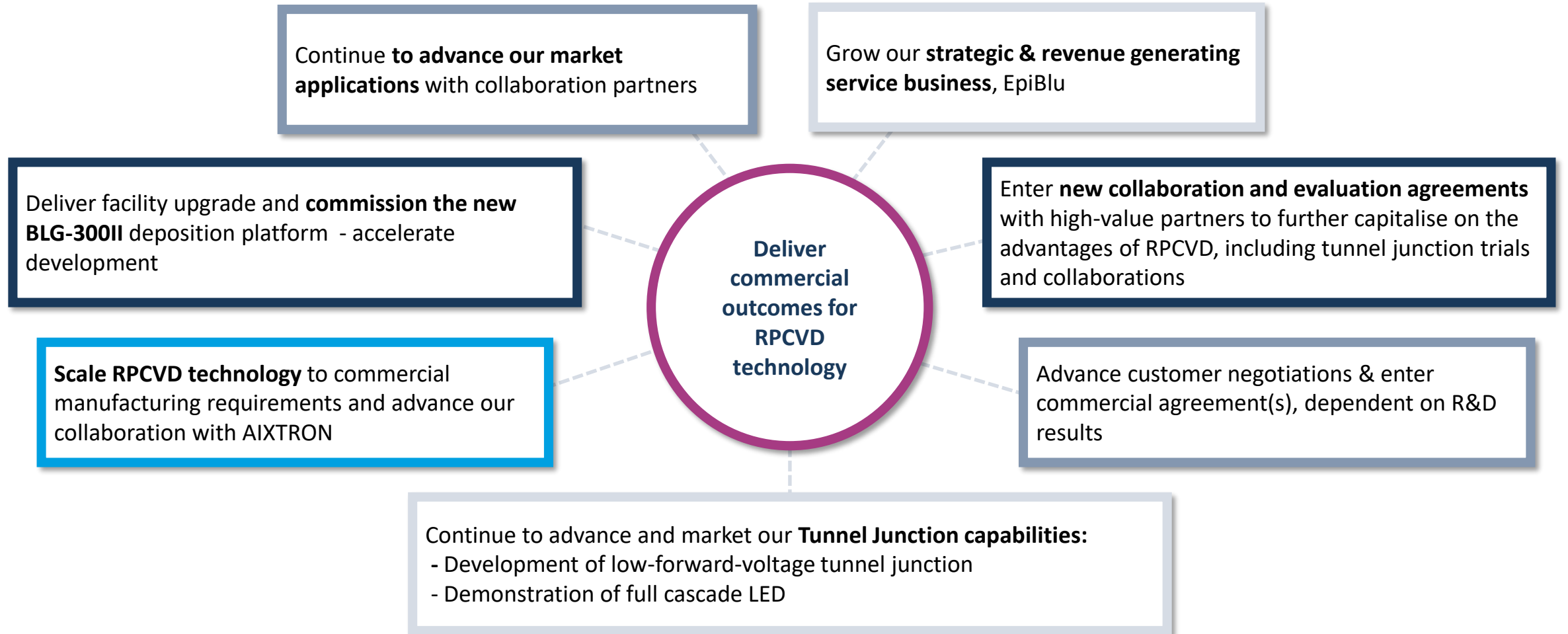


**\$14B**

Laser Diode markets  
in 2018

Source: Insert Source

# SIGNIFICANT PROGRESS ACROSS MILESTONES IN 2019



*Progress Key Since May 2019*

*Development and progress ongoing*

*Near-future*

*Complete*

# THE TECHNOLOGY



# BLUGLASS RPCVD TECHNOLOGY

RPCVD (Remote Plasma Chemical Vapour Deposition) – A Breakthrough Alternative for the Manufacture of Semiconductor Materials



Lower-temperature manufacturing processes, **several hundred degrees cooler** than the incumbent, MOCVD



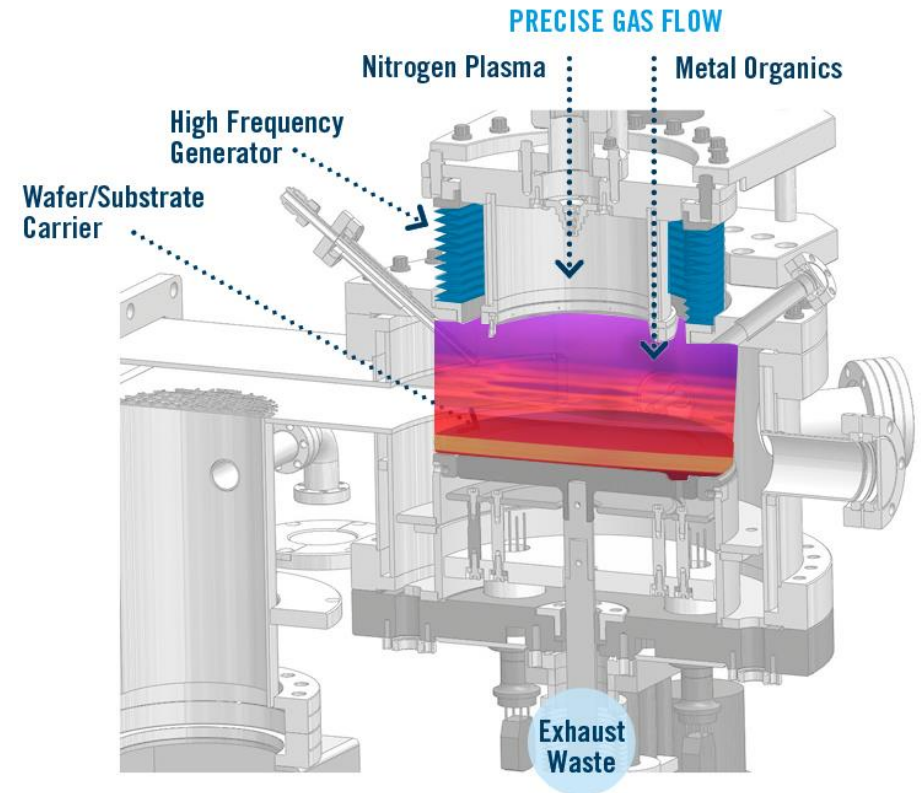
Higher-performing devices, **targeting greater than 10% improvement in light output**



**Lower cost inputs** replacing expensive ammonia with low cost nitrogen and low-cost substrates (silicon)



Active nitrogen density, from plasma source independent from **growth temperature**





# COMPETITIVE ADVANTAGE

RPCVD has the following advantages over the industry incumbent technology:

	Description	RPVCD	MOCVD
Lower cost inputs	RPVCD does not rely on high volume of expensive and toxic ammonia for nitrogen sources	✓	✗
Lower temperature	RPVCD has a lower temperature manufacturing process (several hundred degrees cooler) than high-temperature MOCVD. High-temperature process limits performances of the critical regions of the LED, microLED and power electronic devices	✓	✗
Higher performing devices	RPVCD technology has demonstrated a performance improvement in light output in green LEDs. BluGlass is targeting > 10% improvement in light output using its unique tunnel junction technology	✓	✗
Lower environmental impact	RPVCD does not use significant quantities of ammonia as its nitrogen source and does not result in environmental challenges in dealing with toxic waste	✓	✗
In-situ processing	Active nitrogen density from plasma source independent from growth temperature allows <i>in situ</i> processing to achieve required activation, called 'active as grown' tunnel junctions. MOCVD relies on time consuming <i>ex situ</i> processing for the growth of tunnel junctions	✓	✗

BluGlass' RPCVD technology potentially enables manufacturers to offer higher performing, lower cost and smaller devices

# TARGETING A PERFORMANCE IMPROVEMENT OF GREATER THAN 10%

LED industry competitiveness, market share and product innovation is largely driven by improving light performance (lumens) per dollar of cost:

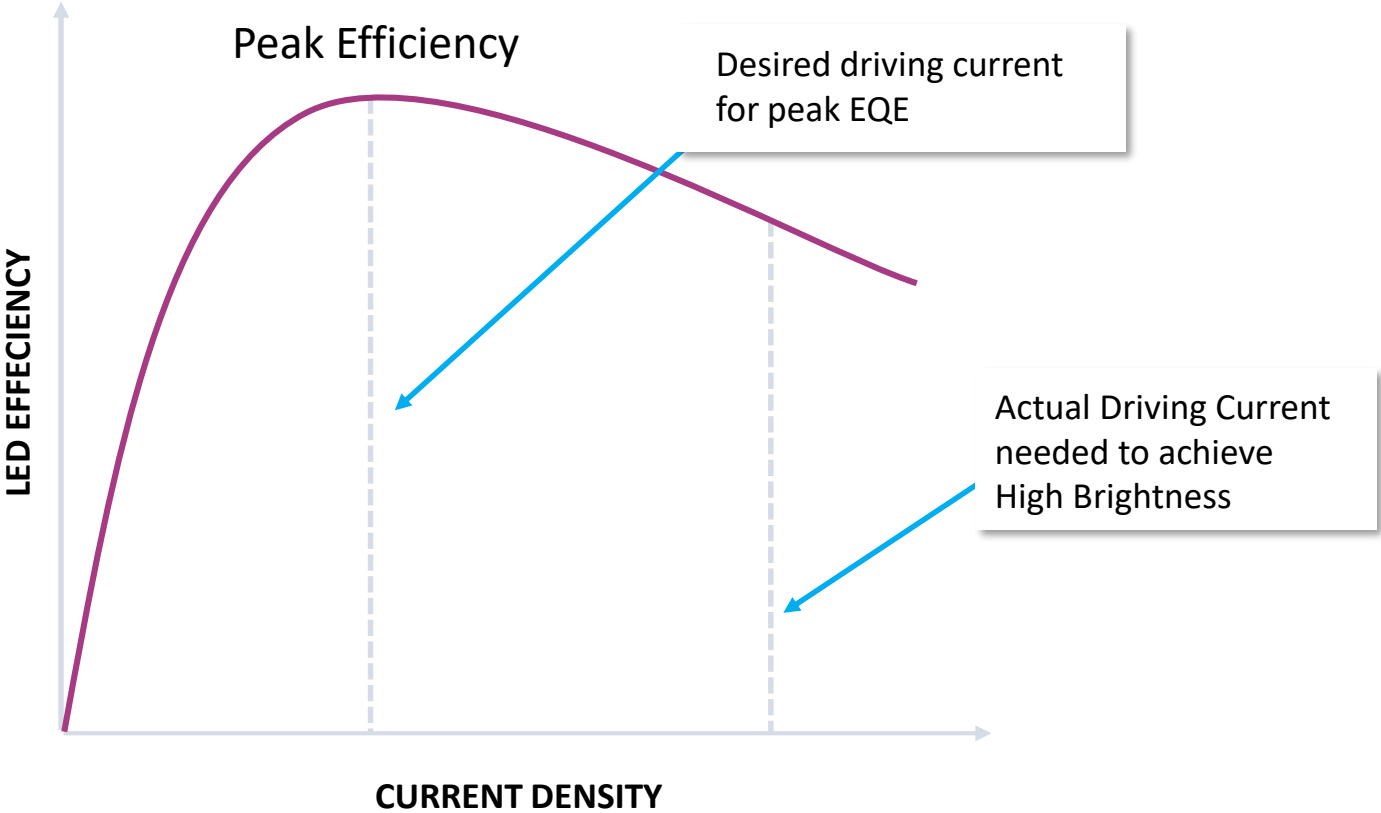


BluGlass' RPCVD breakthrough in tunnel junctions for cascade LEDs is targeting:  
**An improvement in light output of greater than 10%**

This would translate to a target of:  
**A reduction in processing costs of greater than 10%**

# ADDRESSING ONE OF THE BIGGEST LED INDUSTRY CHALLENGES

Efficiency droop is a major issue for High Brightness LED applications



RPCVD 'Active as-grown' (AAG) tunnel junctions are a potential solution to address efficiency droop in high-brightness LED applications

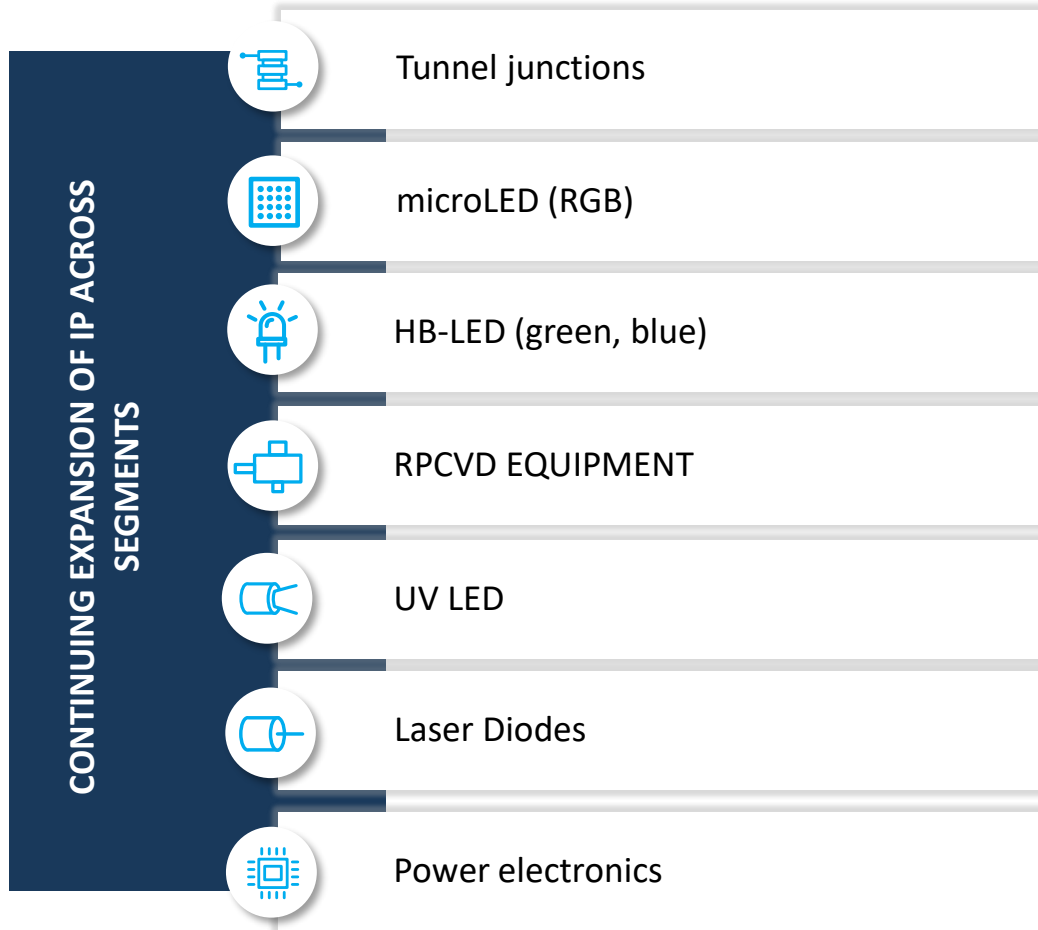
# PATH TO COMMERCIALISATION



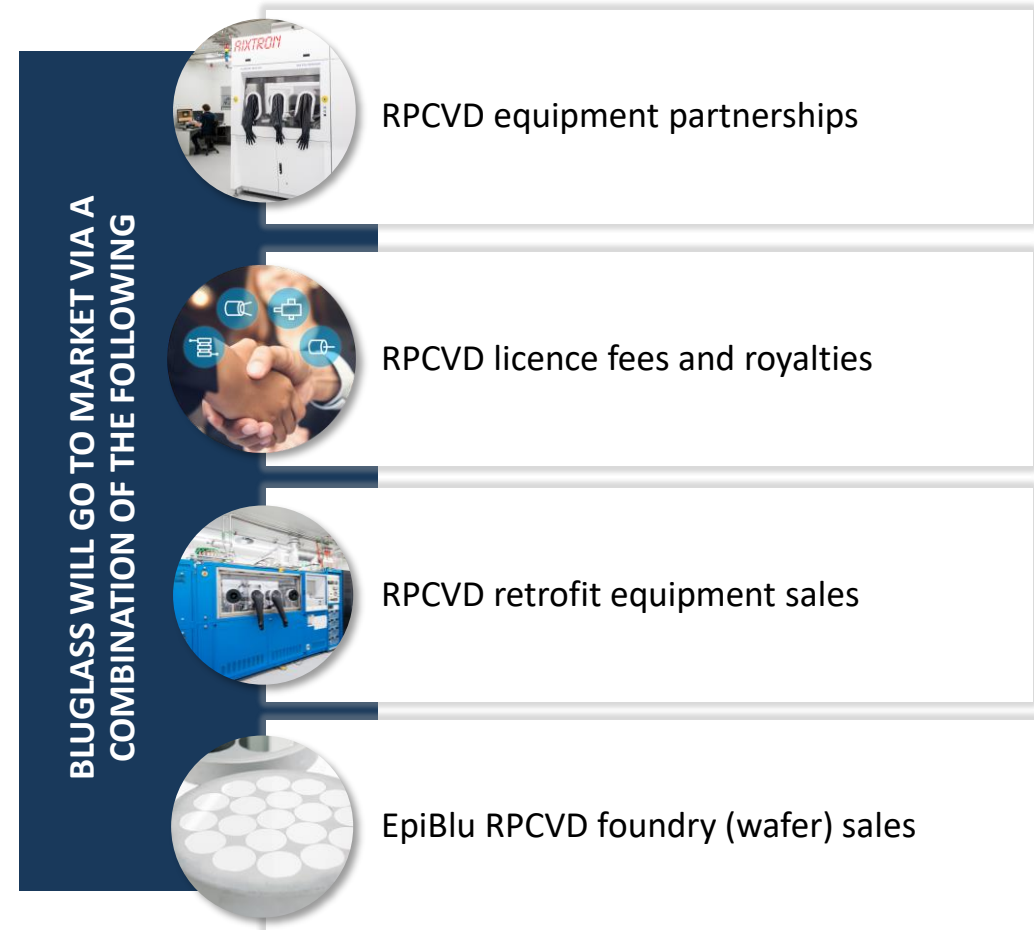
# A PLATFORM TECHNOLOGY WITH MULTIPLE MARKETS

BluGlass' patented RPCVD semiconductor manufacturing technology has demonstrated R&D results, showing competitive advantages with potential application in multiple high-growth LED market segments

## RPCVD TECHNOLOGY & APPLICATIONS



## MULTIPLE GO-TO-MARKET STRATEGY



# HOW BLUGLASS ADDRESSES THE MARKET

BluGlass will target business opportunities in the global photonics industries as follows:

## RPCVD licence fees and royalties



- Large opportunity: potential to negotiate multiple licensing **agreements** with a range of terms across a range of manufacturers
- Scalable: licence IP, complemented by support (consulting) and additional services

## EpiBlu RPCVD foundry (wafer) sales



- Higher margin, lower volume opportunity
- Ability to focus on high-value specialised opportunities and high-value prototyping and R&D services to customers
- Scalable business model, complemented by consulting and additional services

## RPCVD equipment partnership



- Higher-volume equipment production opportunity to provide RPCVD equipment to the market at scale with an equipment partner – e.g. with collaboration partner AIXTRON


## RPCVD retrofit equipment sales



- A preferred option for some manufacturers
- Smaller opportunity: limited number of companies will consider hardware retrofit
- Complementary revenue to licensing strategy to supply early equipment sales



BluGlass' target market focus remains the general lighting, automotive, microLED and laser diode market segments

# GO-TO-MARKET SUMMARY

Development Program	End Market	Evaluation	Joint Dev/Foundry Customers	Commercialisation & Manufacturing
 <b>RPCVD TUNNEL JUNCTION TECHNOLOGY</b>				
<b>Bridgelux Joint Development Agreement for General Lighting Market</b> <ul style="list-style-type: none"> <li>• Non-exclusive JDA</li> <li>• Development of RPCVD Cascade LEDs</li> <li>• Paid development program to cover BluGlass JDA costs</li> </ul>	US\$ 6.1B in 2018 <sup>1</sup>		✓	
<b>Continuing HB LED collaboration discussions in the industry</b>	Multiple high-growth market segments	✓		
<b>Laser Diode application opportunities</b> <ul style="list-style-type: none"> <li>• Development of Laser Diode device</li> <li>• Testing for cutting applications for difficult metals</li> </ul>	US\$ 14B in 2019 <sup>1</sup>	✓		
 <b>LED APPLICATIONS</b>				
<b>Continuing HB LED collaboration discussions in the industry</b>	Multiple high-growth market segments	✓		

Source: 1.Strategies in Light

# GO-TO-MARKET SUMMARY

Development Program	End Market	Evaluation	Joint Dev/Foundry Customers	Commercialisation & Manufacturing
 <b>RPCVD EQUIPMENT</b>				
<b>AIXTRON collaboration &amp; scaling project</b> <ul style="list-style-type: none"> <li>• EU-based leading global equipment manufacturer</li> <li>• Collaborating on scaling and evaluating performance of RPCVD</li> <li>• Potential to partner for new tool manufacture or retrofit existing tools to deliver RPCVD to market at scale</li> </ul>	MOCVD Market to grow to \$1.4B by 2025 <sup>1</sup>		✓	
<b>Other capital equipment manufacturers</b> <ul style="list-style-type: none"> <li>• Discussions with capital equipment providers (US and Asia) with the potential to retrofit or develop new RPCVD tools for market</li> </ul>		✓		
 <b>microLEDs</b>				
<b>X-Celeprint</b> <ul style="list-style-type: none"> <li>• Display applications in development for high-performance microLED</li> <li>• Foundry customer with ongoing revenues</li> </ul>	MicroLED market to grow to US\$20B by 2024 <sup>2</sup>		✓	
<b>EU LED display manufacturer</b> <ul style="list-style-type: none"> <li>• Testing technology in high-performance microLEDs</li> </ul>	Packaged LED market is \$16.7B in 2018 <sup>3</sup>		✓	

Source: 1. Market Study Report, LLC 2019 2. Yole Developpement, and Markets and Markets 3. Strategies in Light

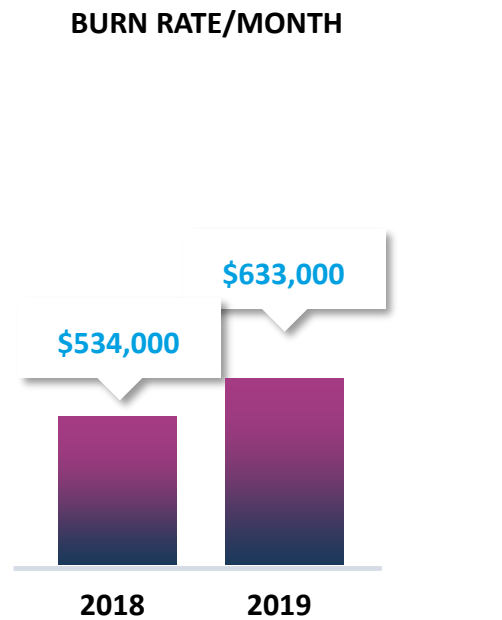
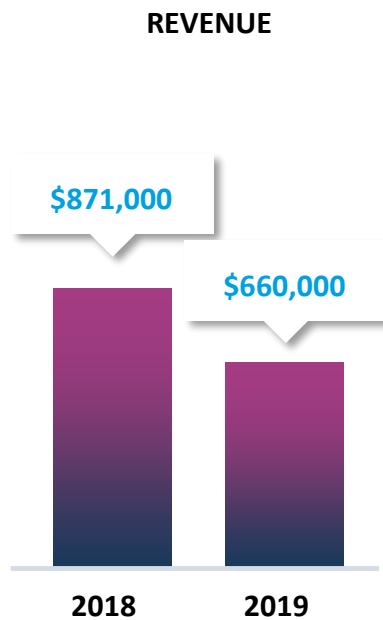


# GO-TO-MARKET SUMMARY

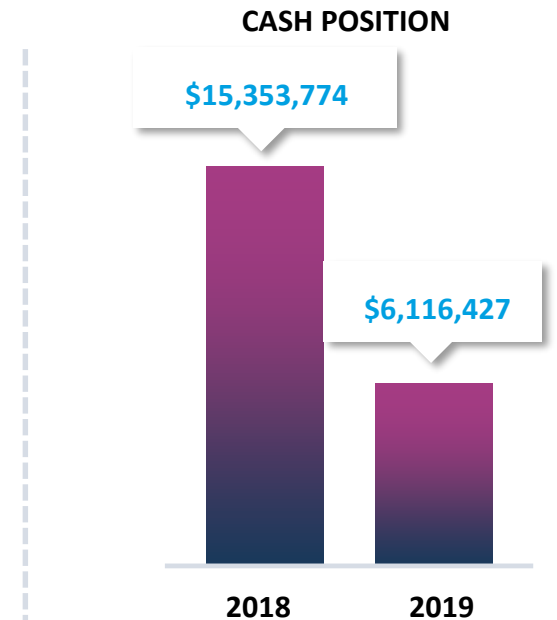
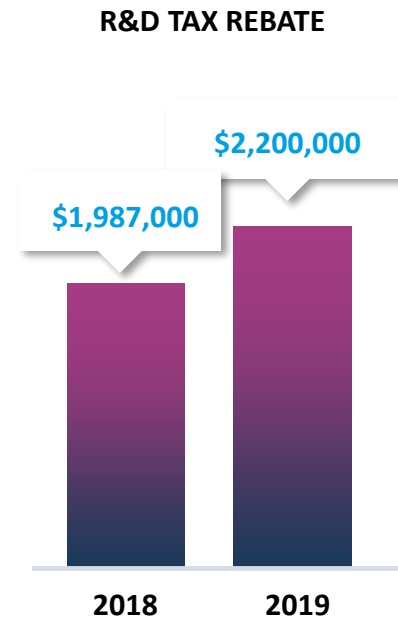
Development Program	End Market	Evaluation	Joint Dev/Foundry Customers	Commercialisation & Manufacturing
<div style="float: left; margin-right: 10px;">+</div> <b>OTHER APPLICATIONS</b>				
<b>IQE Foundry</b> <ul style="list-style-type: none"> <li>Continuing joint development</li> </ul>			✓	
<b>Leading Integrated Device Manufacturer (IDM)</b> <ul style="list-style-type: none"> <li>Testing technology in confidential application</li> </ul>		✓		

# FINANCIAL SUMMARY

- BluGlass is now primed to commercialise its patent-protected RPVCD technology, having built the required foundation for market entry
- Capital expenditure due to facility upgrade, increases in R&D, patent applications and trademark compliance costs led to an increase in burn-rate
- R&D investment took precedence over revenue-generating foundry work to June 2019, however the new facility is now online
- These investments combine to create an increased capacity to commercialise the R&D breakthroughs of the past 12-18 months



\*Burn rate increased in 2018 due to additional IP expenditure and technology staff



\*2018 cash position included monies raised for the facility upgrade and new equipment

# BLUGLASS NOW BENEFITS FROM EXPANDED FACILITY AND CAPACITY

## Existing RPCVD & MOCVD Labs (3 Prototyping Systems)

- 2 RPCVD system for process development
- 1 MOCVD system for custom epitaxy services and RPCVD support



### Output:

- IP generation
- RPCVD demonstrators
- Collaborations
- MOCVD custom epitaxial services

## New Production Bay 1 (1 x RPCVD System)

- Commissioned in July 2019
- RPCVD industry projects
- Support hardware and process development



### Output:

- Sell RPCVD wafers and epitaxial services directly to customers

## New Production Bay 2 (1 x Production Scale RPCVD)

- RPCVD scaling
- Demonstration of industry projects on production scale
- Expected to come online end of 2019



### Future Output:

- Design, build and sell retrofit RPCVD systems directly to customers

# SUMMARY: INVESTMENT HIGHLIGHTS

BluGlass' patented RPCVD semiconductor manufacturing technology has demonstrated R&D results, showing competitive advantages with potential application in multiple high-growth LED market segments:



High-brightness and  
general LED



Automotive



microLED



Laser diodes



UV LEDs



Power electronics

- The manufacturing and process advantages of RPCVD (lower-temperature, low hydrogen manufacturing process, ability to scale to commercial levels, use of molecular nitrogen over toxic and expensive ammonia) are established and protected with a strong patent portfolio
- Industry interest in RPCVD continues, in particular into our proven ability to manufacture tunnel junctions, an enabling technology for cascade LEDs using RPCVD, to help address the industry-wide challenge of efficiency droop, and improving the lumens/dollar ratio
- Multiple go-to-market options of IP licensing, equipment retrofit and contract manufacturing de-risk further the commercial deployment of RPCVD
- EpiBlu value-added epitaxy services and contract manufacturing subsidiary business well-placed to complement the mainstream BluGlass focus on RPCVD, continues to generate short-term revenue, positions the company in the industry as a global leader in compound semiconductor epitaxy R&D and commercialisation



THANK YOU

Giles Bourne, Managing Director  
BluGlass Limited (ASX:BLG)  
admin@bluglass.com.au

[www.bluglass.com.au](http://www.bluglass.com.au)