

# BLUGLASS (ASX: BLG) INVESTOR UPDATE, Q1 2019

# 2019

February, 2019

GILES BOURNE  
Managing Director



This document has been prepared by BluGlass Limited to provide readers with a summary of the Company and the Company's technology



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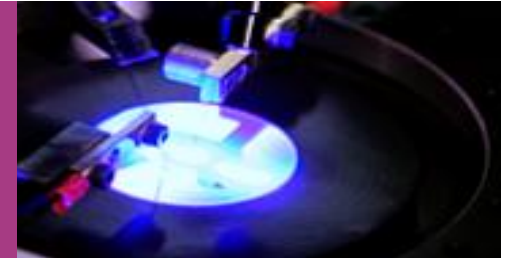
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## OUR VISION



Position BluGlass as a leading force in the rapidly growing global opto-electronics industry, by delivering RPCVD as a key enabling compound semiconductor deposition technology

## OUR OBJECTIVE



Our objective is to deliver high-growth commercial outcomes for the RPCVD technology in the LED, microLED and power electronics industries, using a diverse range of go-to-market options

BluGlass has a diversified development strategy designed to address opportunities in a number of high-performance device categories

## ESTABLISHED COMPANY



### ASX: BLG

Listed on the Australian Stock Exchange since 2006

**AU \$125 M**

Market Cap as at 14 February 2019

## UNIQUE TECHNOLOGY



BluGlass' unique **RPCVD technology** has demonstrated performance potential in rapidly growing markets

Commercialising low temperature deposition technology for compound semiconductors

## STRONG IP PORTFOLIO

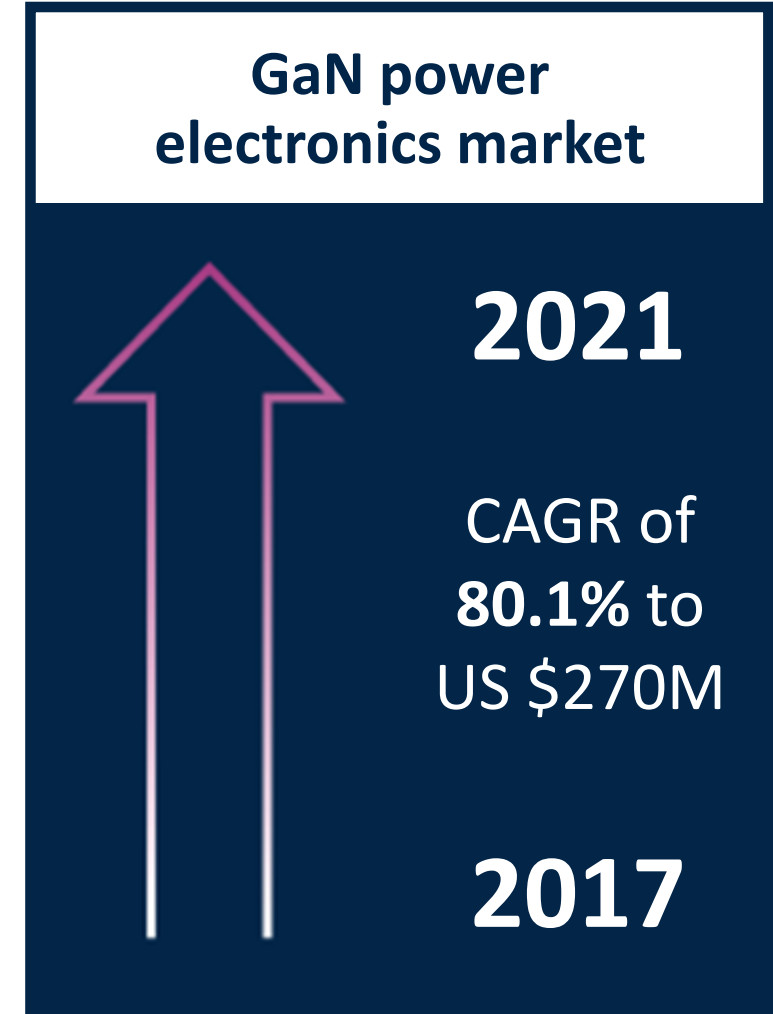
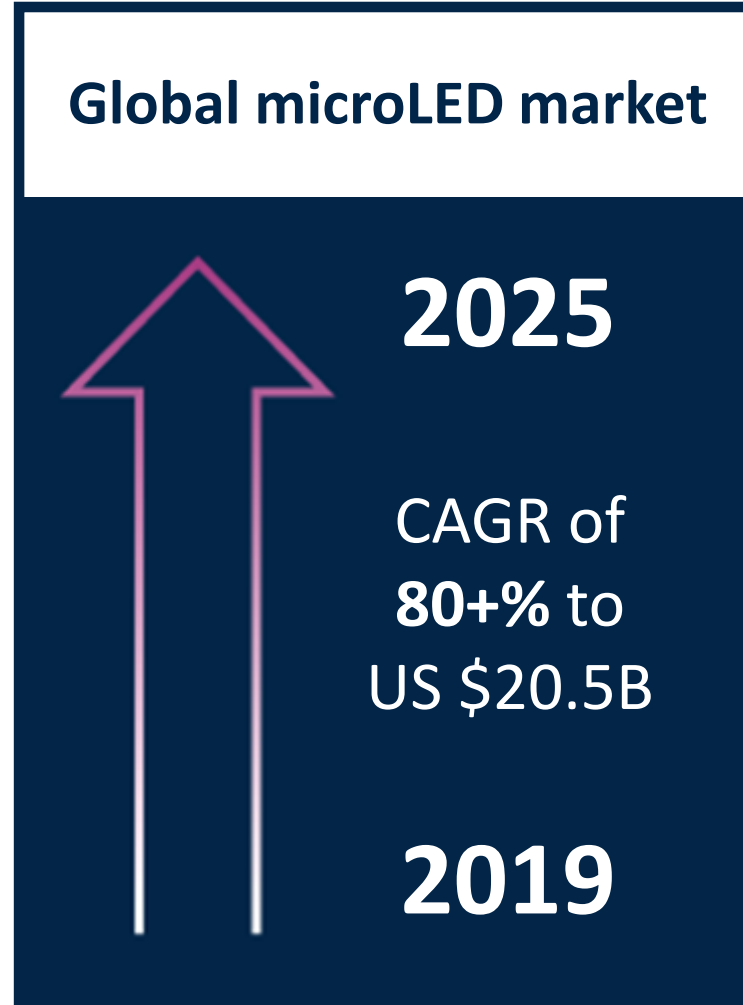
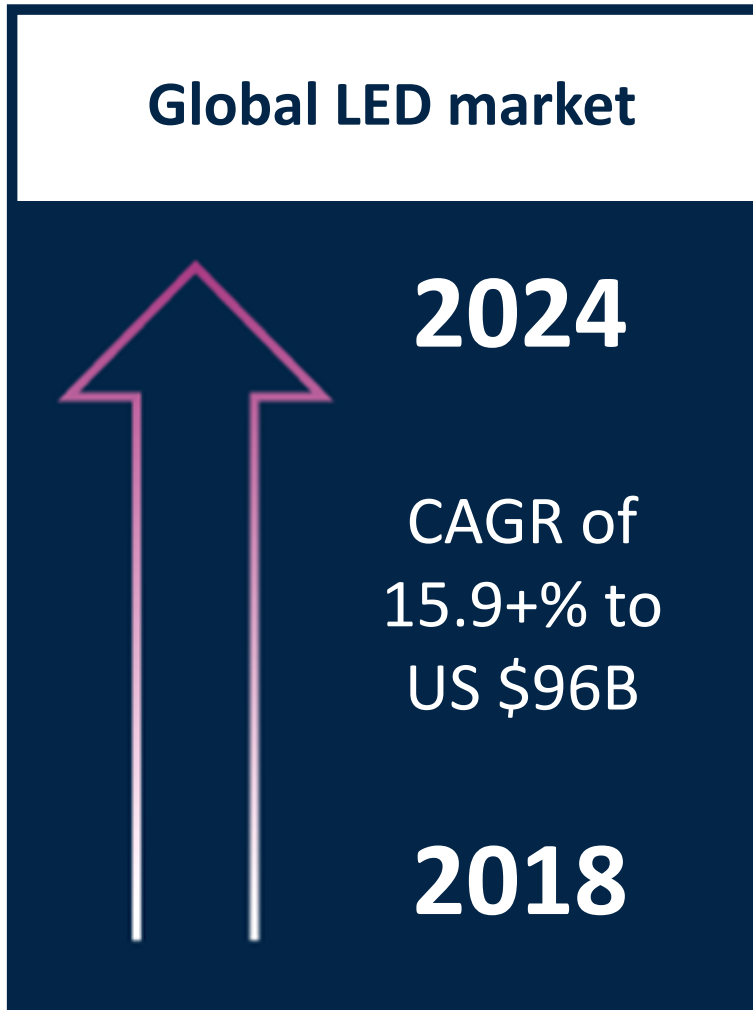


### 63 Patents

Granted in Key Semiconductor Markets

Licensing, Equipment & Contract Manufacturing Business Model

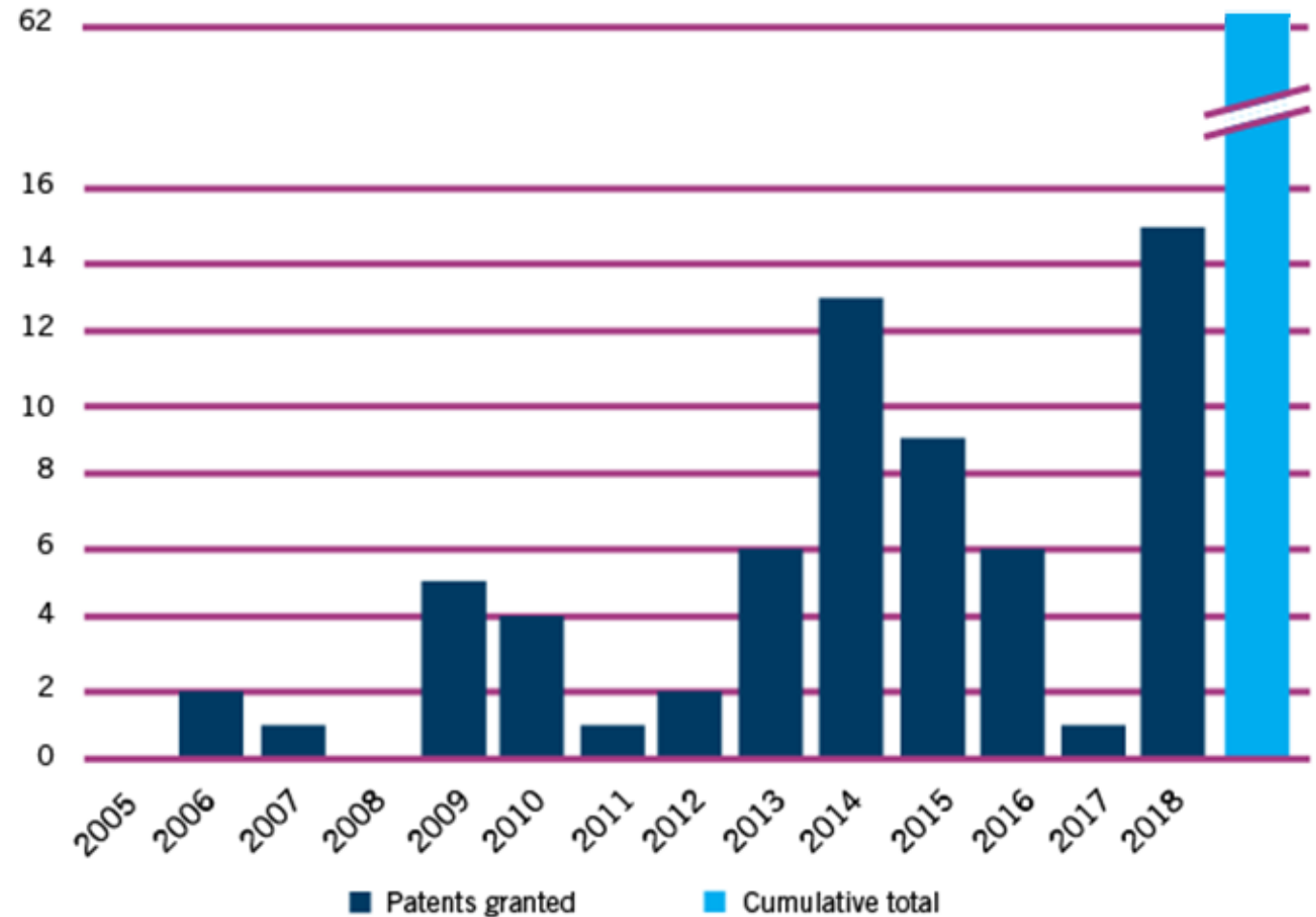




Sources: LED: Allied Market Research, microLED: Yol  Development and Markets and Markets, Power: Yol  Development

Our Intellectual Property portfolio is a critical foundation for our future commercial success and underpins our licensing-based business model

- During 2018 significant investment was made to further expand and strengthen our portfolio
- In 2018 16 patents granted bringing our internationally granted patent portfolio to a total of **63 patents** in key semiconductor jurisdictions
- With a further **15** applications
- Across **8** patent families





**GILES BOURNE**  
Managing Director &  
Chief Executive Officer

Appointed to Board in 2014, CEO in 2008. Twenty years experience in cleantech & manufacturing. Business development & commercialisation specialist.



**DR IAN MANN**  
Chief Operations &  
Technology Officer

Appointed in 2009. Twenty years experience in product development, tech team management, materials sciences and photonics. Former CEO of Bandwidth Foundry.



**DR MARIE  
WINTREBERT**  
Chief Scientist

Founding scientist and co-inventor of the BluGlass RPCVD process. Device design, fabrication, modeling and measurement expert.



**BRAD SISKAVICH**  
Vice President of Business  
Development

Appointed in 2018. Twenty years experience in developing and commercialising new technologies in start-up and high-growth companies in the compound semiconductor, PV and opto-electronics industries.



**STEFANIE WINWOOD**  
Corporate Comms &  
Investor Relations Manager

Appointed in 2009. Strategic marketing and communications professional. Fifteen years experience in technical & strategic communications & brand management.



**WILLIAM JOHNSON**  
Chairman

Appointed to Chair in 2017, Board in 2010. Deep global industry experience in the high-technology and semiconductor manufacturing sectors, covering M&A, operations. Former President & CEO, SPTS Technologies.



**GILES BOURNE**  
Managing Director & CEO

Appointed to Board in 2014, CEO in 2008. Twenty years experience in cleantech & manufacturing. Business development & commercialisation specialist.



**VIVEK RAO**  
Non-Executive Director

Appointed in 2016. Semiconductor capital equipment specialist with more than 23 years experience in the global industry. Technology leadership specialist. President and COO of SPT Microtechnologies.



**JAMES WALKER**  
Non-Executive Director

Appointed in 2017. Experienced executive with track record in successfully commercialising cutting-edge technology in emerging global markets. Finance, M&A, IPO and strategic management specialist.






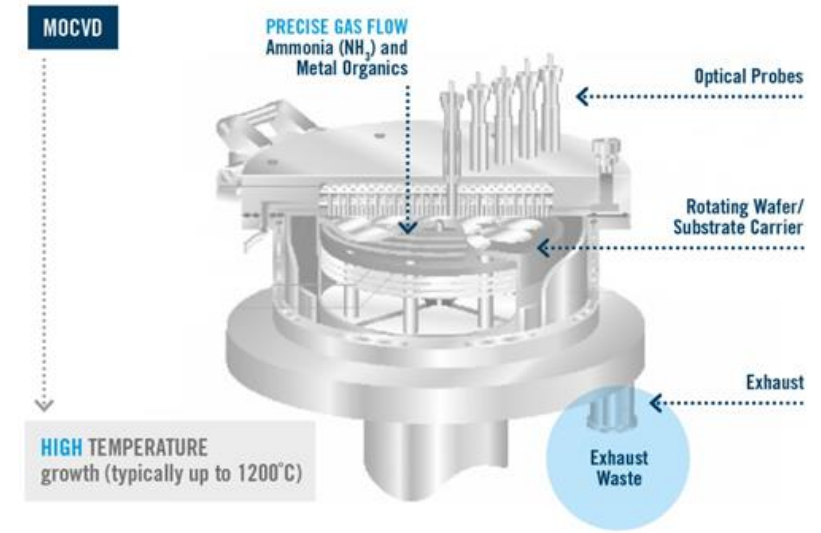
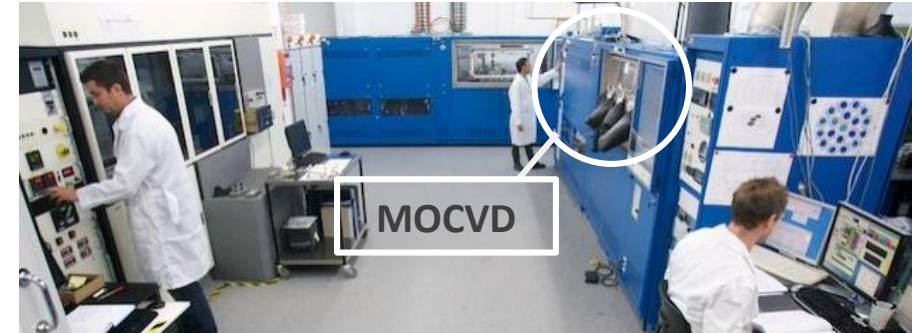
**STEPHE WILKS**  
Non-Executive Director

Appointed in 2018. Professional company director and executive. Led successful global technology companies in high growth and disruptive industries. Extensive tech leadership, strategic finance, M&A and governance expertise.



## MOCVD (Metal Organic Chemical Vapour Deposition) – The Industry Incumbent Technology

CHALLENGES	
	High temperature processes <b>limits performance</b> of the critical regions of the LED, microLED and power electronics devices
	Relies on high volume of <b>expensive &amp; toxic ammonia</b> for its nitrogen source, produces toxic waste, more-difficult and costly to manage
	<b>High temperature</b> limits the choice of low-cost, larger silicon wafers for power electronics, microLEDs and LEDs



## RPCVD (Remote Plasma Chemical Vapour Deposition) – A Breakthrough Alternative

### OUR SOLUTION



**Lower**-temperature manufacturing processes



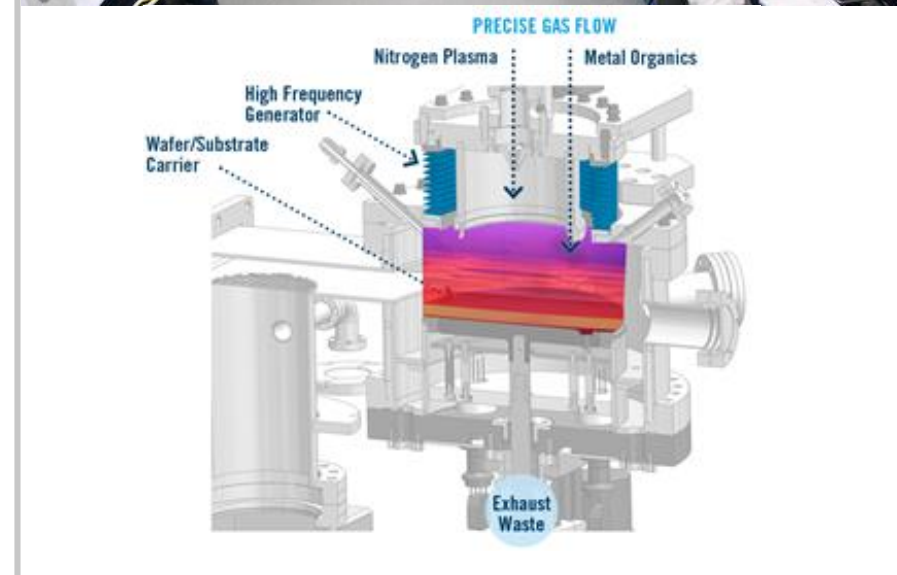
**Lower cost** inputs



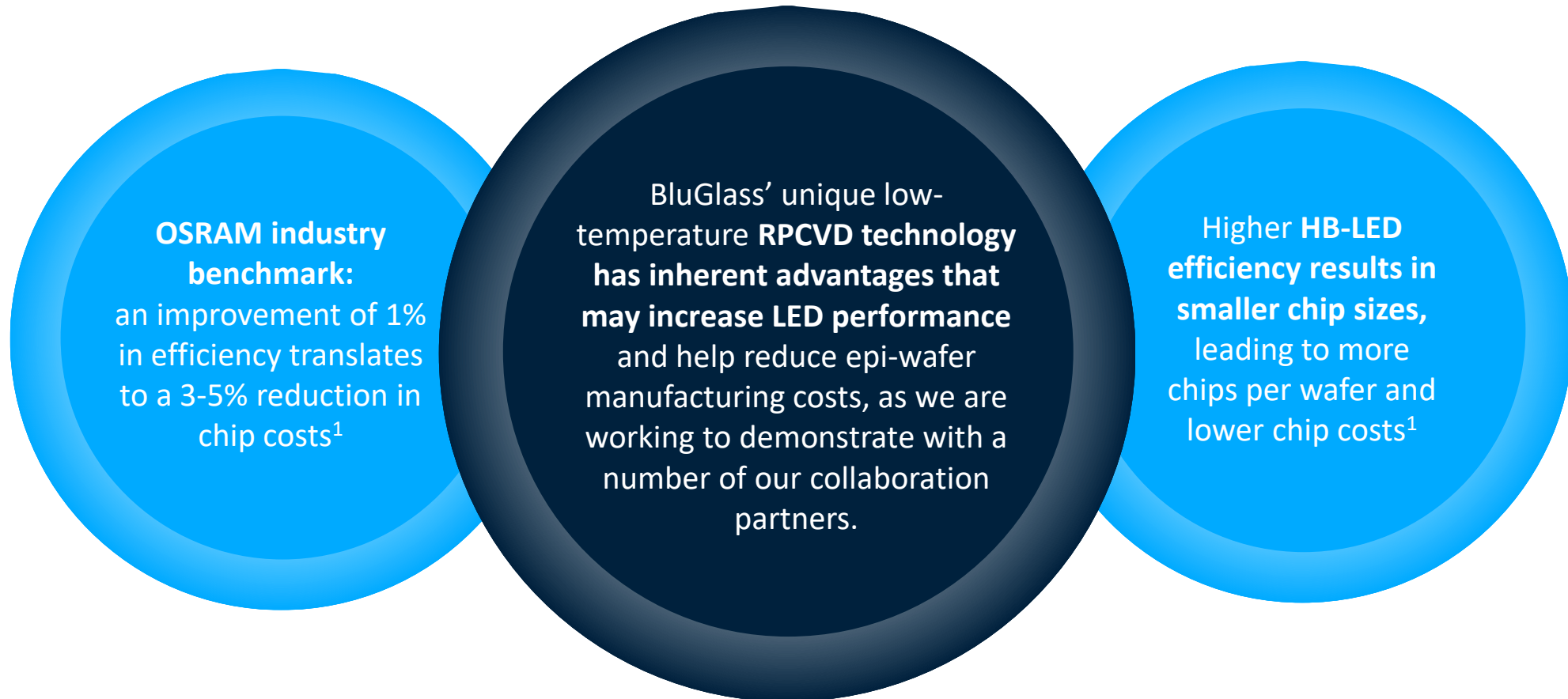
Higher-**performing** devices



**Environmentally** friendlier & more-sensitive

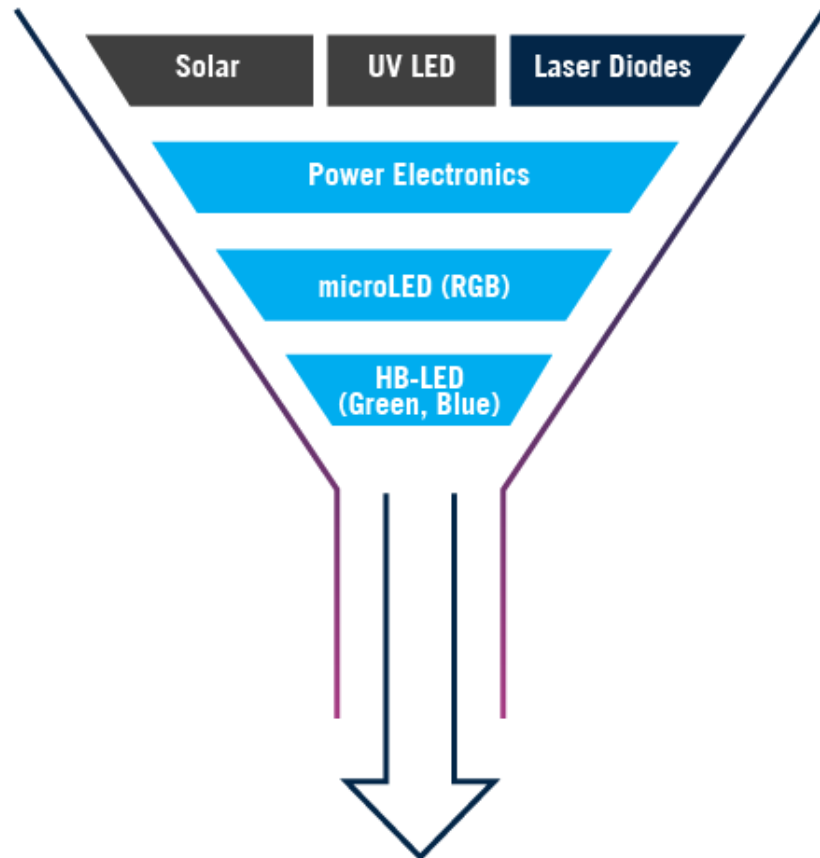


Competitiveness in the HB-LED industry is largely driven by efficiency (light-output) and manufacturing costs. Efficiency improvements can also lower cost



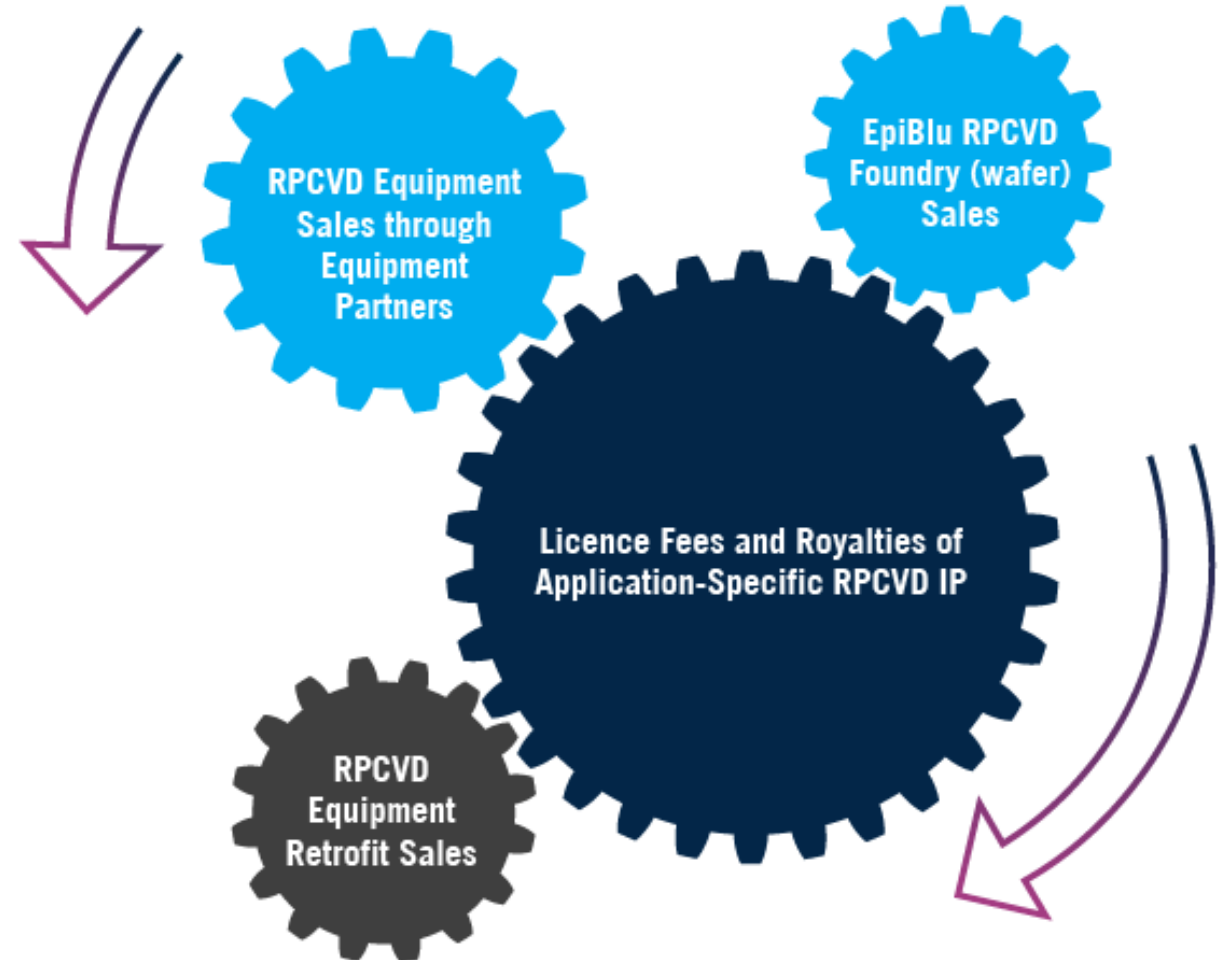
Sources: 1. OSRAM Analyst Day 2016 Presentation, January 2016.

## Applied Development of RPCVD



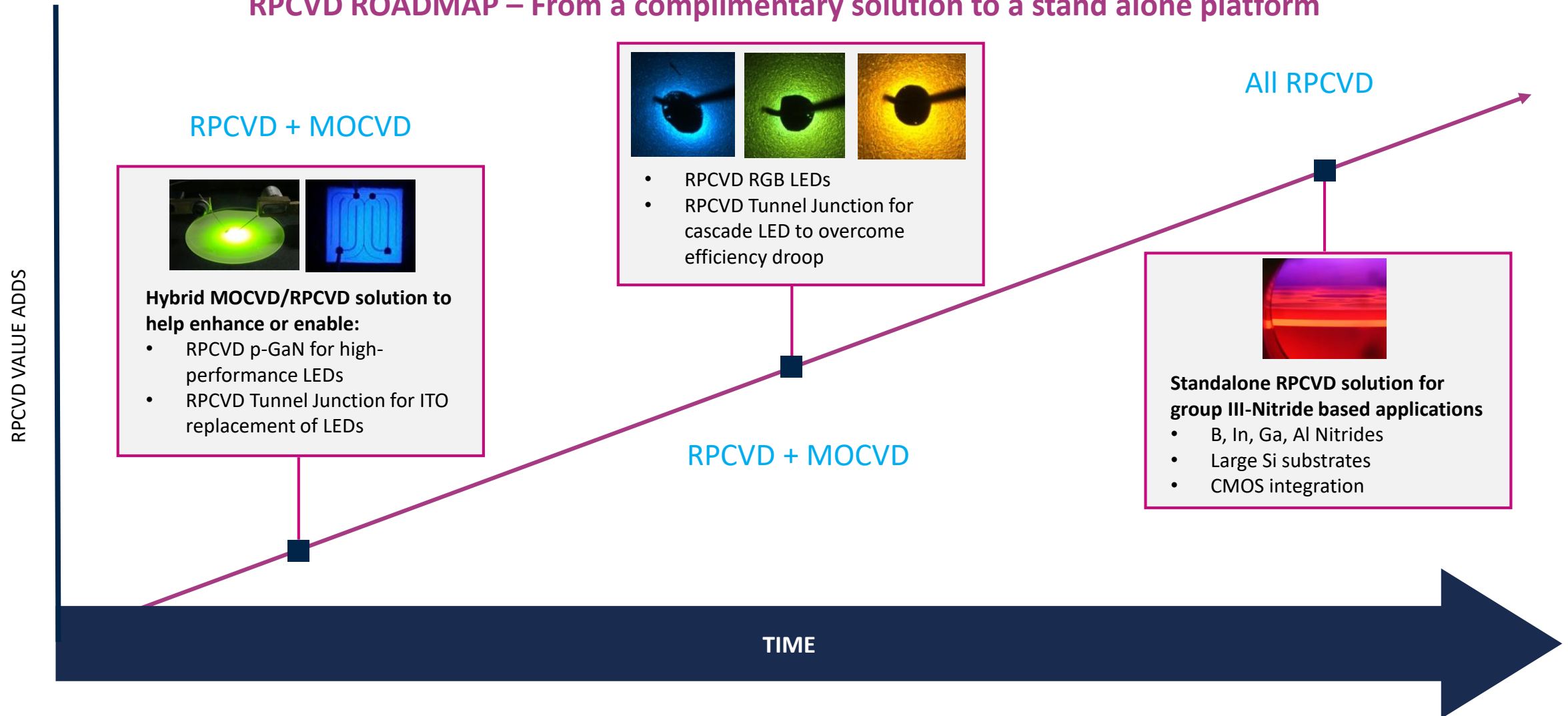
Pipeline of RPCVD IP

BluGlass will generate RPCVD revenues through a combination of the following:





## RPCVD ROADMAP – From a complimentary solution to a stand alone platform



# SIGNIFICANT COLLABORATIONS & PARTNERSHIPS



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

- AIXTRON will evaluate the performance potential of BluGlass' *RPCVD technology* for commercial applications
- BluGlass has selected the AIX 2800G4-HT system for the scaling of RPCVD to mass production capacities
- AIXTRON will provide assistance to expedite and support the successful RPCVD retrofit of the AIX G4
- They have a strong R&D focus and are constantly striving to bring novel technologies onto their platforms
- AIXTRON could become an equipment partner for the delivery of RPCVD to market



## Commercial negotiations with Lumileds continue

- BluGlass is no longer encumbered by exclusivity arrangements with Lumileds in relation to the RPCVD field of use being developed by the parties
- We will provide the market with further details on the outcome of this negotiation
- BluGlass is pleased with the results of the project to date which has shown clear promise that our proprietary technology could substantially improve LED efficiency for high powered LED applications





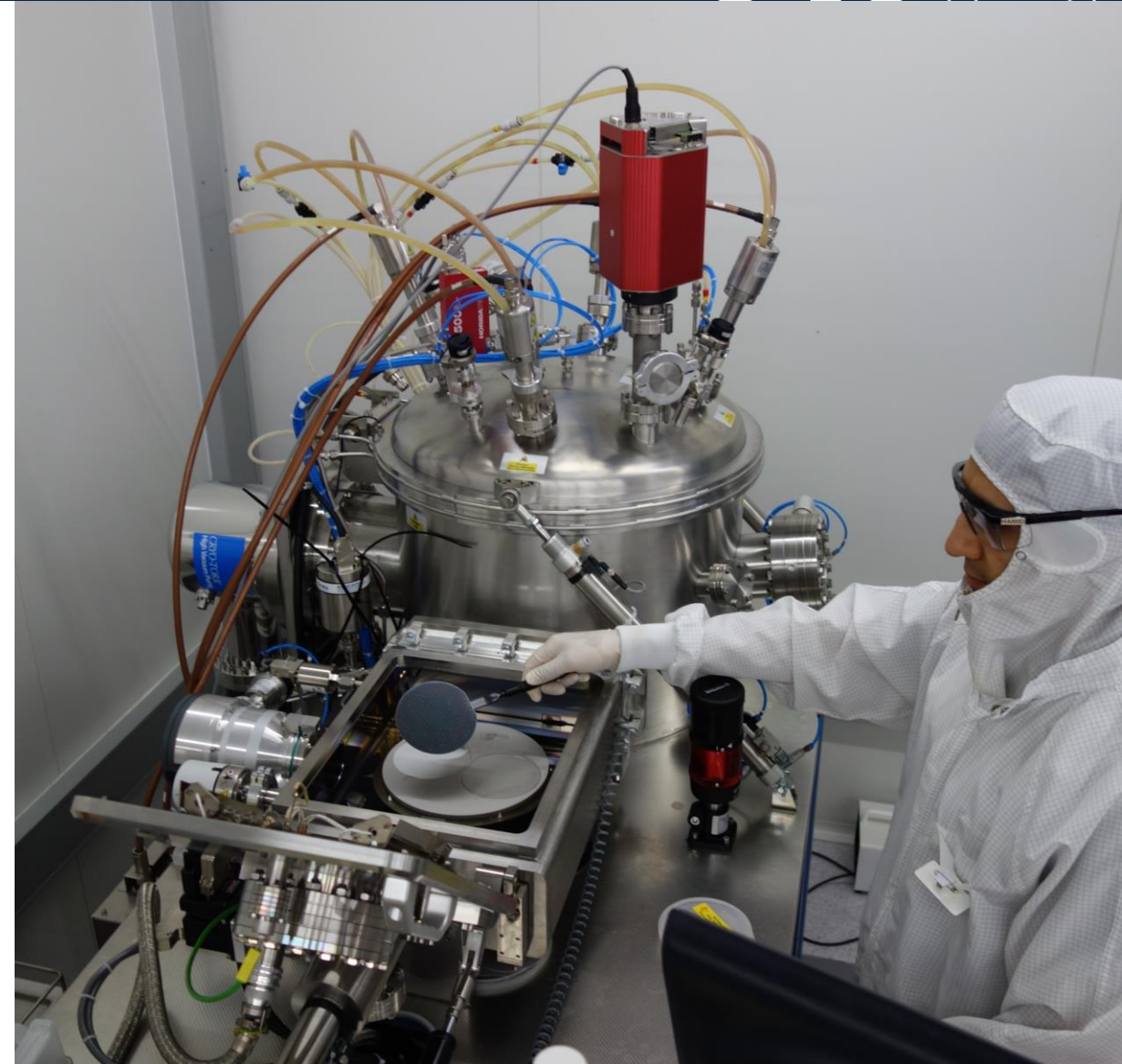
microLED players have shown interest in RPCVD's unique advantages for blue, green, yellow and red LEDs for display and other applications - these longer-wave lengths are very difficult for MOCVD

- microLEDs present a compelling opportunity for the competitive advantages of RPCVD
- RPCVD's lower deposition temperature allows for the growth of indium rich InGaN, the key performance material and ingredient required for longer wave-length LEDs including green, yellow and red colours
- BluGlass RPCVD technology has demonstrated a performance improvement in light output in green & blue LEDs
- BluGlass is working with **multiple microLED customers on novel applications, including an RPCVD collaboration** with a leading European developer



## Partnership with Griffith University and the Innovative Manufacturing Cooperative Research Centre (IMCRC) to develop next-generation GaN transistors

- Objective is to develop commercial-spec devices for product demonstration as a commercial proposition for the transistor market
- Focus is on specialised switches called High Performance Normally-Off GaN High Electron Mobility Transistors (HEMTs) used in high-reliability, low-temperature applications (e.g. electronics equipment, cellular telecommunications, radio & RADAR)
- Exploits inherent advantages of lower temperature RPCVD



BluGlass continues to engage in collaborations, evaluations and prototyping with a number of industry leading partners in specialised, high-value technologies including:

**Global Foundry:  
IQE**

*Applications on silicon wafers and specially-engineered substrates using crystalline rare earth oxide (cREO™)*

**microLED and Power Electronics Collaborations**

*Exploring unique advantages of RPCVD for novel applications*

**LED Manufacturer:  
HC SEMITEK**

*Multiple LED applications under evaluation*

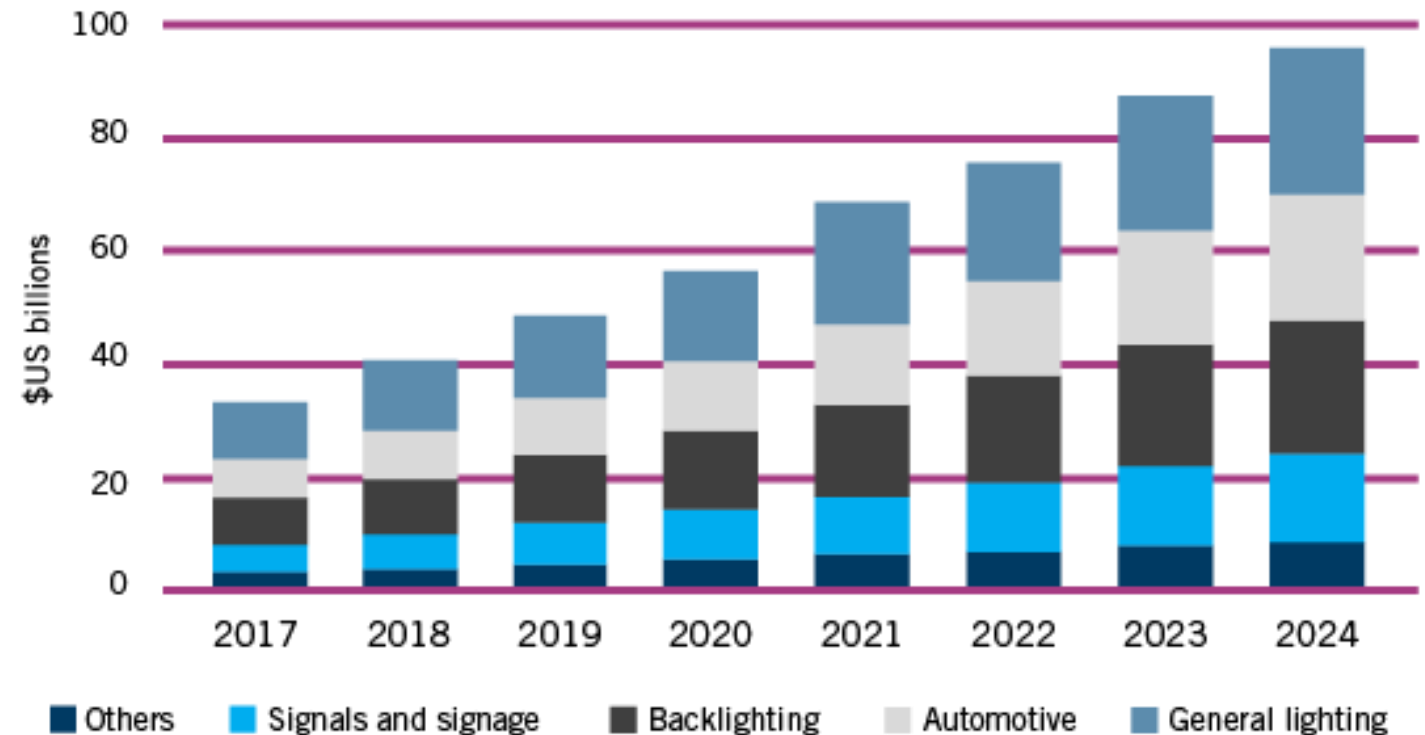


# THE MARKET OPPORTUNITY

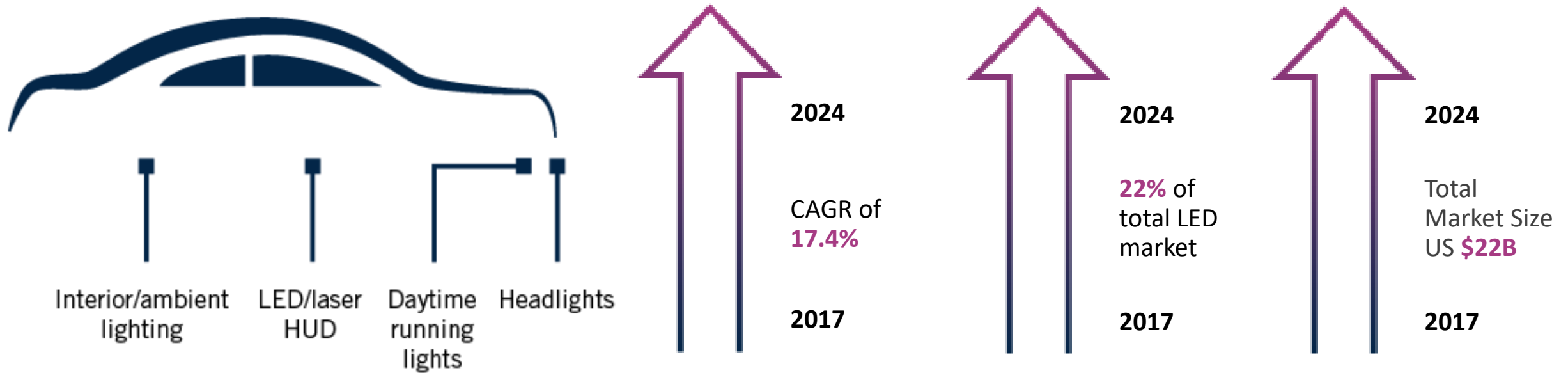


- The Global LED market is expected to grow from **US \$33.1B** in 2017 to US **\$96.71B** in 2024
- With a CAGR of **15.9%**
- BluGlass is interested in the high-brightness segment of the LED market
- The biggest gains will be in automotive, displays and general lighting

Global LED Market by Application, 2018-2024



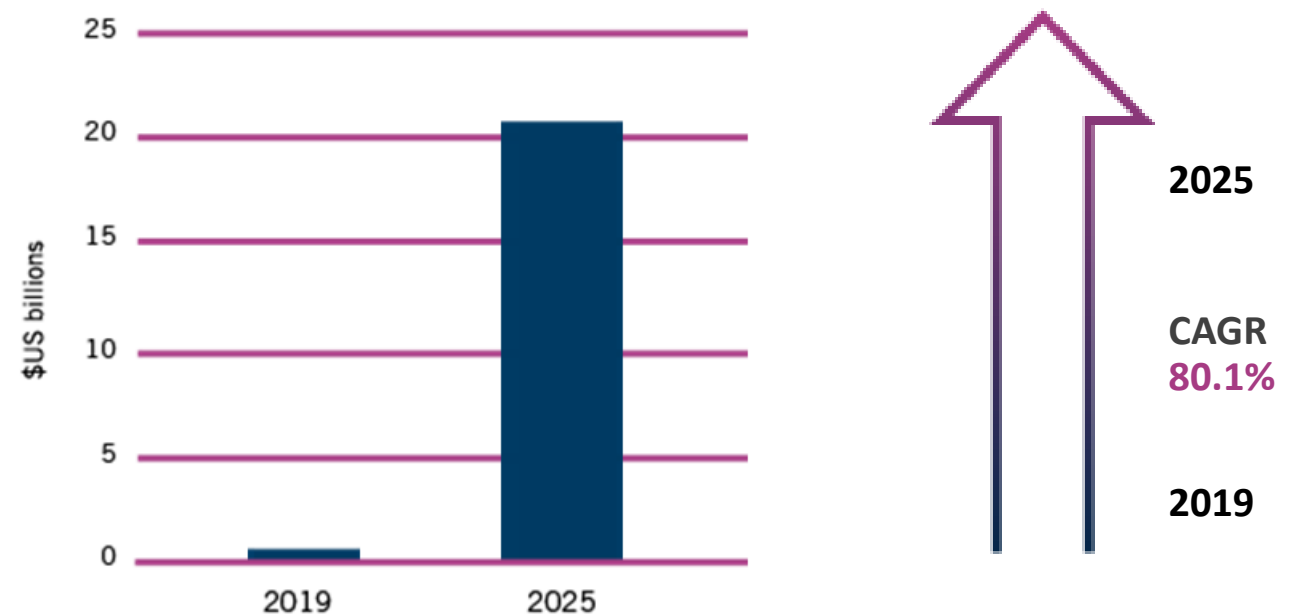
Sources: Allied Market Research, Global LED Market Report 2018



Sources: Applied Market Research, Global LED Market Report 2018

- microLEDs represent a potential game changer on the way for displays
- Predicted to become a **US \$20.5B** market by 2025
- Superior display performance for fraction of the power consumption of LCD and OLED
- Application from smartphones, wearables, AR/VR and potential for transparent displays
- Both emerging and major global players are investing significantly in this market

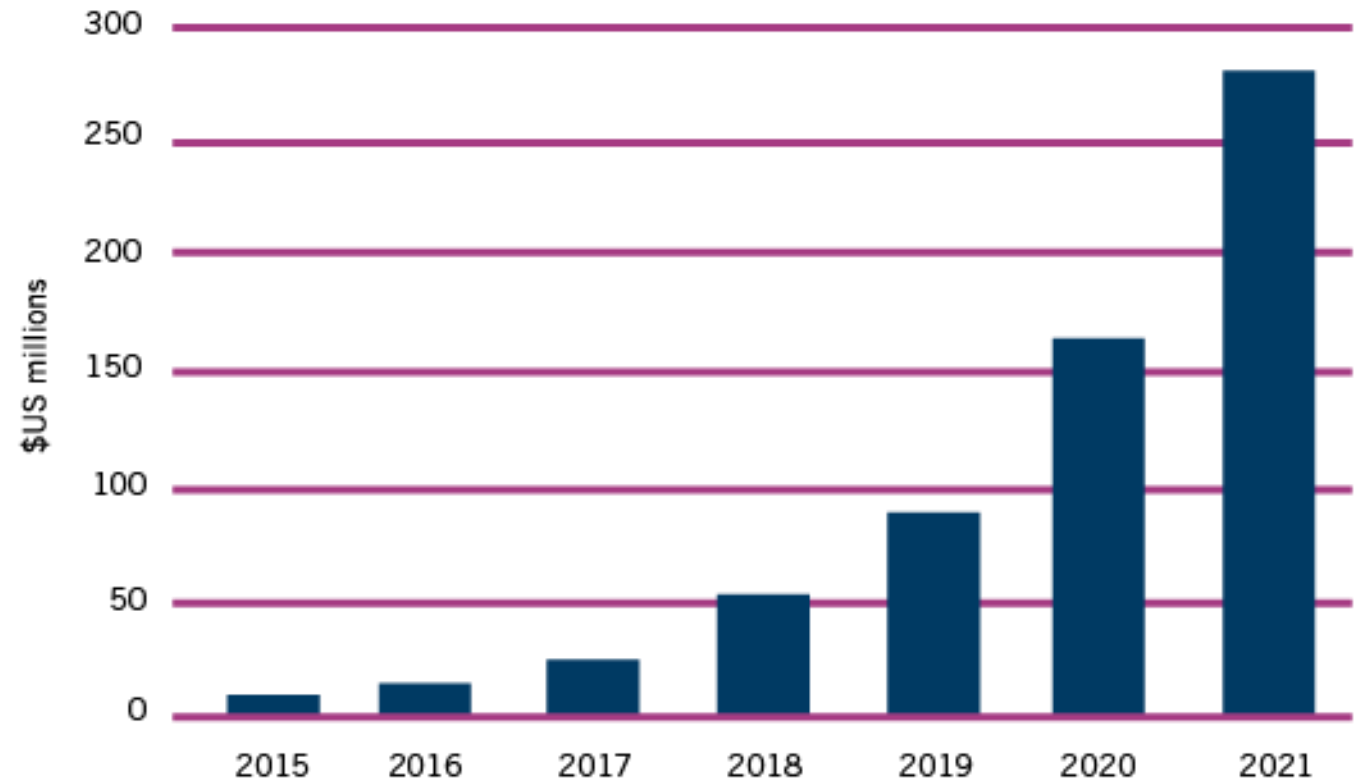
Global microLED Market, 2019-2025



Source: microLED Market by Application (Display (Smartwatch, NTE Devices (AR, VR), Smartphone, Television, HUD, Digital Signage, Laptop & Monitor) and Lighting (General, Automotive)), Display Panel Size, Vertical, and Geography - Global Forecast to 2025 by Markets and Markets May 2018

- Major applications in power supply (laptop, mobile, USB chargers, large-scale server data centres), electric vehicles & hybrid electric vehicles and inverters
- GaN on Si for power electronics is preferred choice for high frequency applications
- Emerging GaN power segment has strong growth potential with estimated **+80% CAGR** to reach **US \$270M** from \$0.6m in 2017

## GaN Power Electronics Market



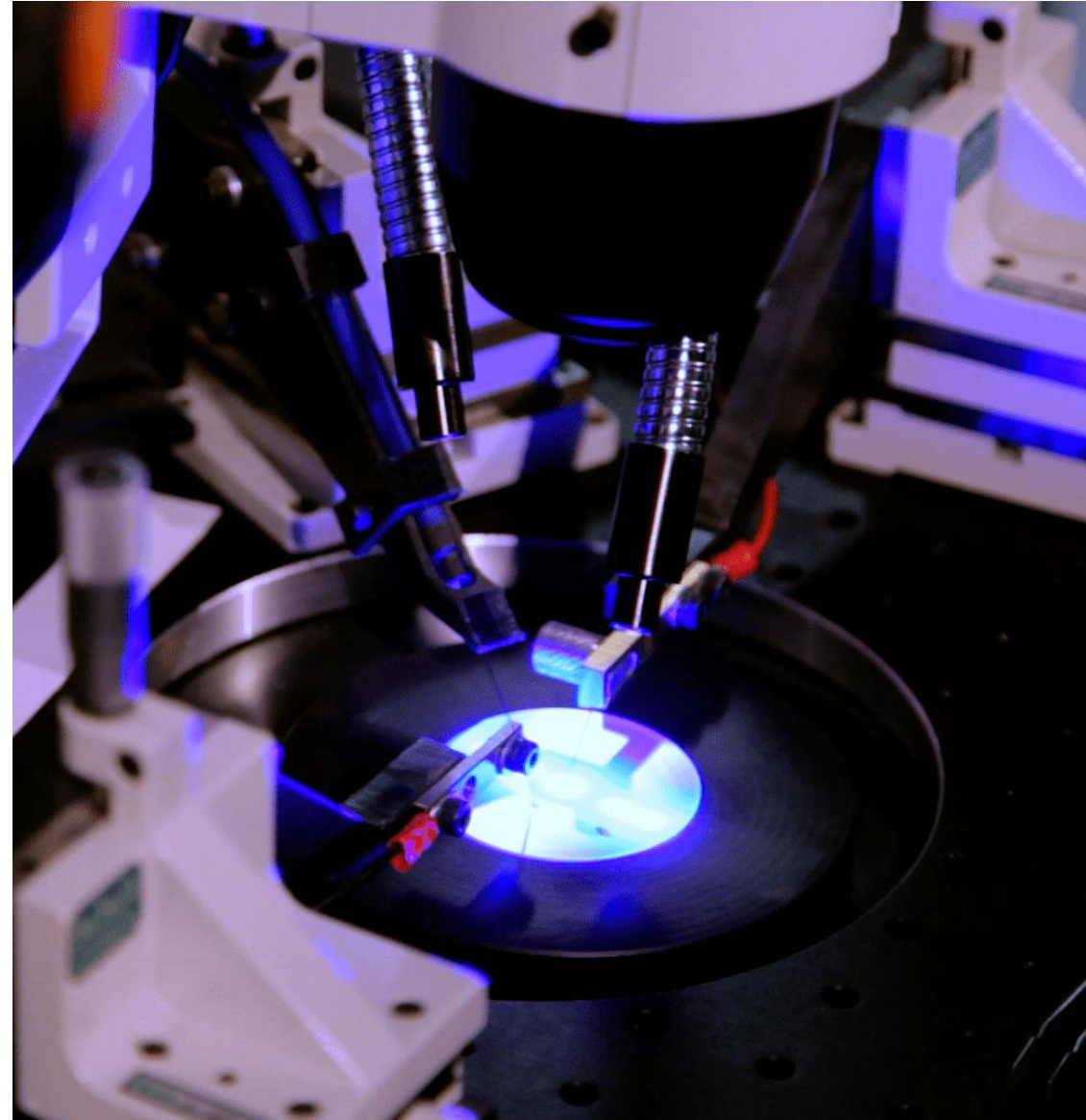
Source of GaN power electronics market stats and chart: Yole Developpement, SiC and GaN devices for the power electronics webcast, Dec 5, 2017. See also market overview at <https://www.google.com/url?q=https://www.youtube.com/watch?v%3DS1FQoK8QHAw&sa=D&ust=1541585860045000&usg=AFQjCNGn9jqM2FPiaAHdG9hv51QVVWXvfA>





## Strategic vehicle for RPCVD industry acceptance

- Specialised GaN foundry and epitaxial wafer growth services
- High value, low volume services
- Custom & contract R&D
- RPCVD and MOCVD services available
- Epitaxial characterisation services

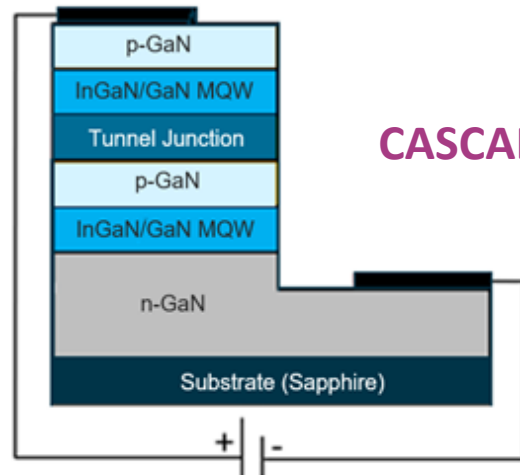
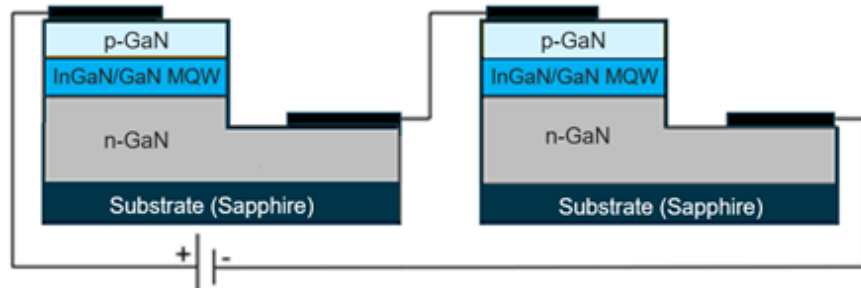


# TECHNOLOGY UPDATE



## BluGlass has demonstrated successful RPCVD tunnel junctions to enable cascaded LEDs

### SIDE-BY-SIDE LEDs

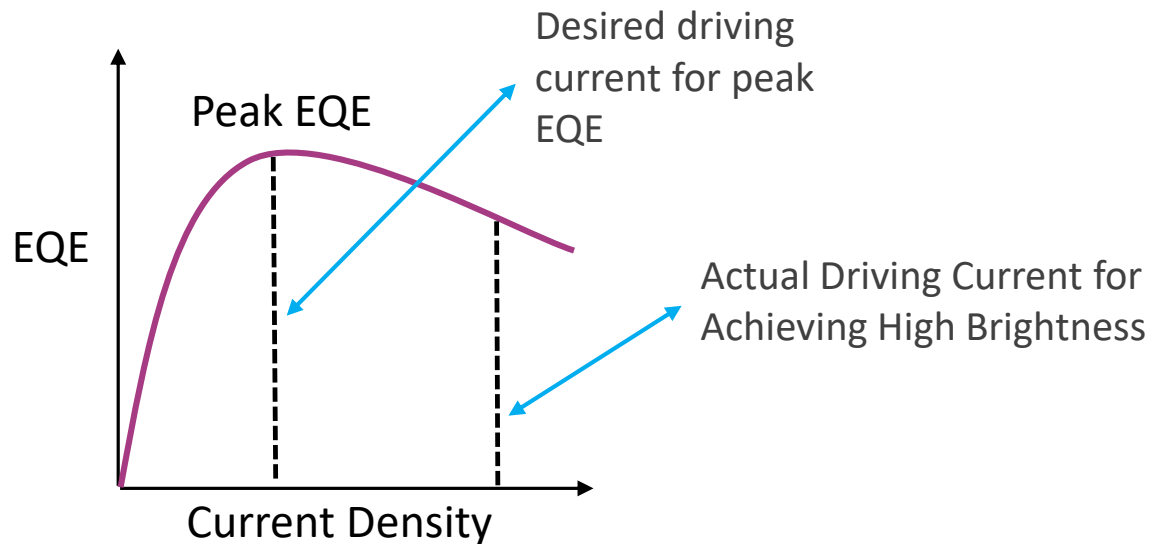


### CASCADED LED

- A cascaded LED is a device where two or more LEDs are grown in a continuous vertical stack using a tunnel junction to interconnect the multiple LEDs in a single chip – *offering the advantages of multiple LEDs in a single higher performing, lower cost and smaller package*
- A cascaded LED addresses the fundamental challenge of ‘efficiency droop’ in GaN-based LEDs by decreasing the required electric current while increasing the emitted light power density
- Cascaded LEDs are not commercially available to date
- *Significant commercial potential for automotive lighting, UV LEDs for water purification, high power laser diodes and high efficiency multi-junction solar cells*

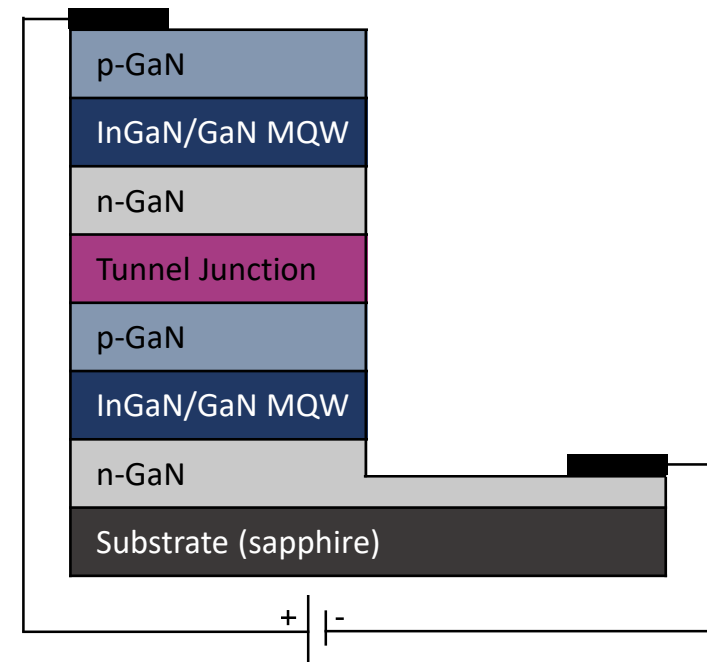
## Efficiency droop is a major issue for High Brightness LED applications

- Cascade LEDs are expected to **enable smaller, cheaper and higher performing LEDs** – the three key interest areas of the LED industry



## Cascade LEDs:

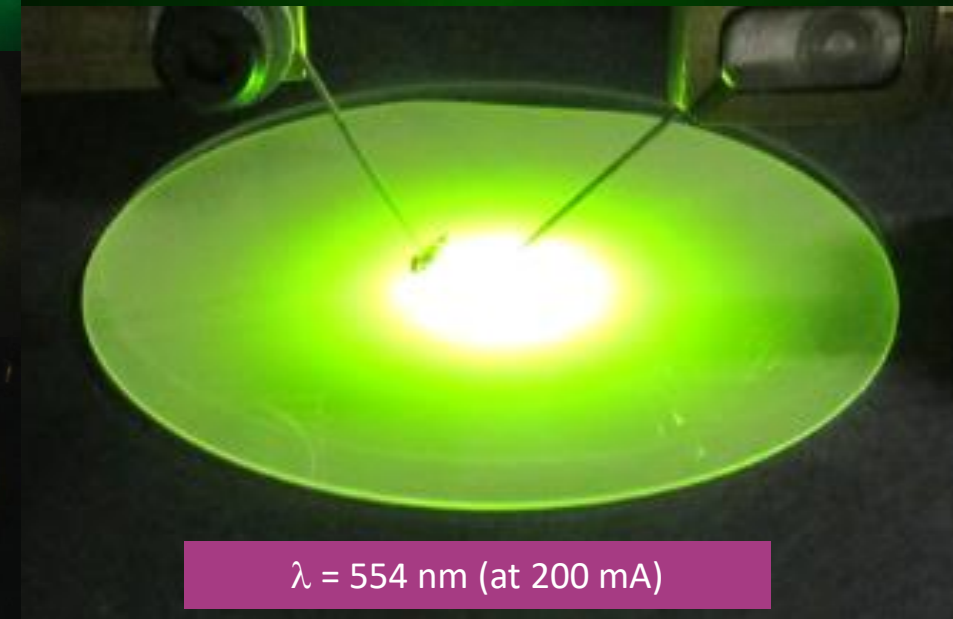
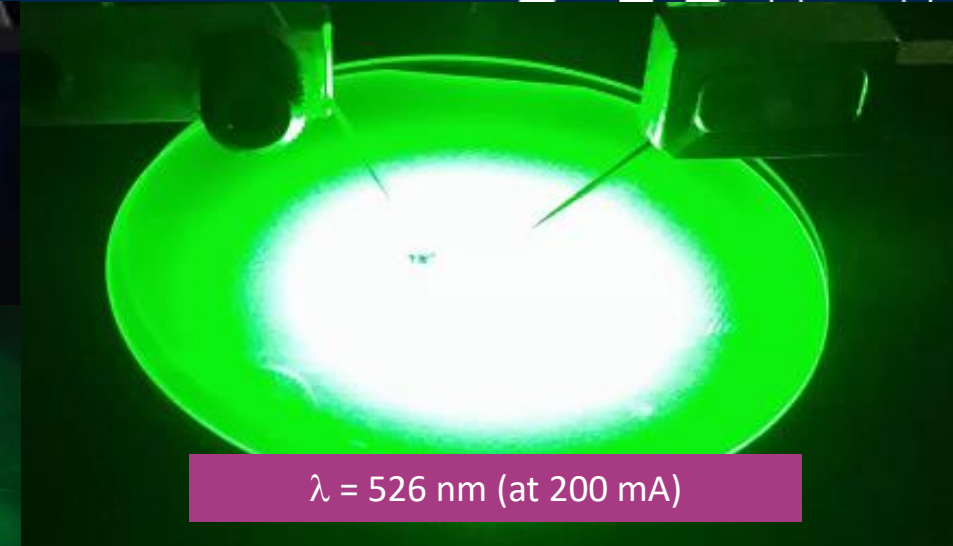
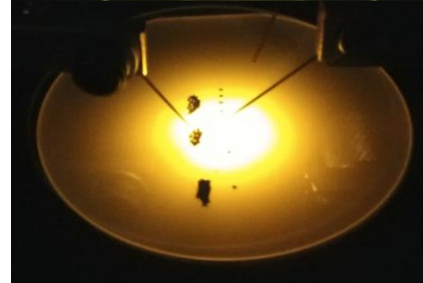
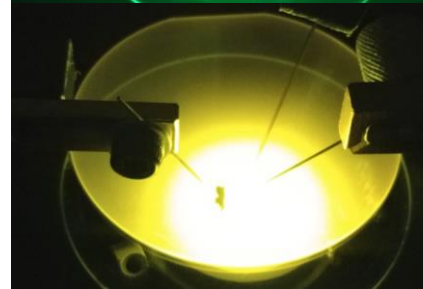
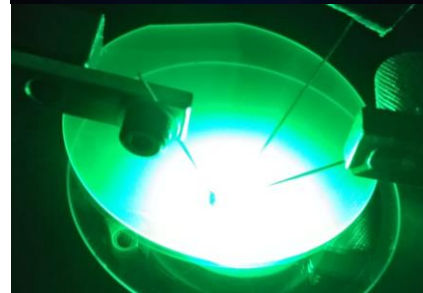
- Compact size & lower cost due to more LEDs grown in a single wafer – high brightness in a small area
- Good candidate for automotive lighting application where strict size and performance requirements exist





BluGlass continues to improve performance of its longer wavelength LEDs – Critical for RGB microLED demonstrations for customers

- Low temperature RPCVD p-GaN has **significant potential to improve device performance in long wavelength LEDs** – by overgrowing RPCVD p-GaN on indium-rich InGaN multi-quantum wells (MQWs)
- BluGlass is now developing capabilities and validating the **RPCVD performance potential in multiple building blocks of the LED device**, including the critical light emitting layers, the multi-quantum wells



# THE YEAR AHEAD

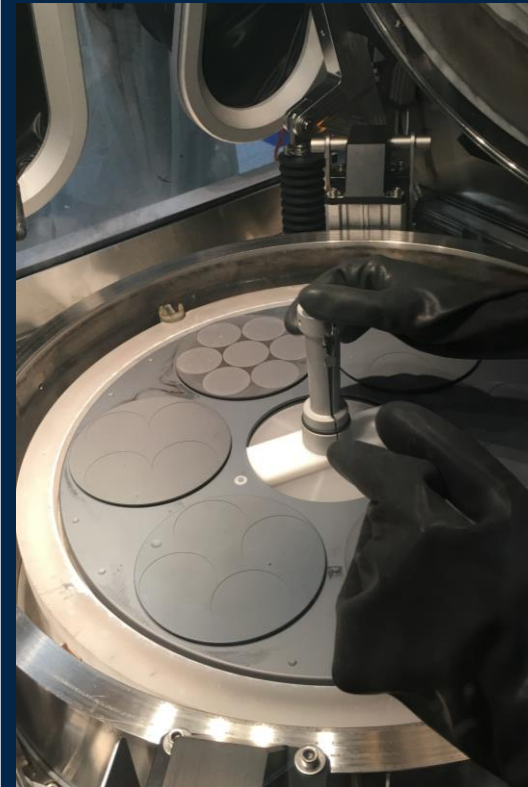


## New Production Bay 1



- New BLG-300™ RPCVD system (19x2")
- Increase RPCVD industry project capacity
- RPCVD foundry services
- **Operational Q2 2019**

## New Production Bay 2



- Installation and retrofit of commercial scale Aixtron G4 Planetary Reactor (capable of 6x6" or 42x2")
- Next generation of RPCVD retrofit – larger area and improved uniformity
- Suitable for LED production for select customers
- **Facility operational Q2 2019**, with AIX-G4 expected online Q4 2019

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

**USE:** 2 RPCVD system for process development  
1 MOCVD system for custom epi services and RPCVD support



### OUTPUT

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

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

**USE:** RPCVD industry projects  
Support hardware and process development



### FUTURE OUTPUT

- Sell RPCVD wafers and epitaxial services directly to customers

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

**USE:** RPCVD scaling  
Demonstration of industry projects on production scale



### FUTURE OUTPUT

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



BluGlass continues to seek commercialisation opportunities for our unique technology platform

Scale the **RPCVD technology** to commercial manufacturing requirements and advance our collaboration with AIXTRON

Continue to **advance our market applications** with our collaboration partners

Grow our **strategic & revenue generating service business**, EpiBlu

## 2019 – THE YEAR AHEAD

Deliver the facility upgrade and **install two new RPCVD deposition systems**

Continue to advance and market our **Tunnel Junction capabilities** with the view to licensing the technology

Enter into **new collaboration and evaluation agreements** with high value partners to further capitalise on the advantages of RPCVD

Delivering our vision of positioning BluGlass as a leading force in the rapidly growing global opto-electronics industry



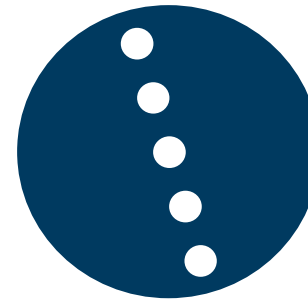
Disruptive  
**Platform**  
**Technology** with  
demonstrated  
Value Propositions



Multiple,  
**Growing End**  
**Markets**



**Healthy balance**  
**sheet** as the  
Company  
approaches  
commercialisation



High end foundry  
& service  
capability -  
**revenue**  
**generating**  
business



World leading  
scientific team  
with **8 PhDs** &  
global expertise in  
semiconductors



Recipient of  
multiple  
**Awards & Grants**

# THANK-YOU