



## Report

# Technology and Market Potential Review

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## Technology and Market Potential Review

**BluGlass Ltd**  
**June 2010**

### Summary of Findings

**Significant Advantages** – BluGlass' Remote Plasma Chemical Vapour Deposition (RPCVD) equipment technology has significant advantages over competing technologies for both the manufacture of Light Emitting Diodes (LEDs) and high efficiency photovoltaic (PV) cells for use in Concentrating PV applications (utility scale solar).

**Cheaper and Environmentally Friendly** - The process is forecast to be more environmentally friendly and reduces costs for customers in both LED and CPV markets.

**World Leading Solar Efficiency** - In addition, the technology has the potential to produce the world's most efficient solar cell with solar conversion efficiencies of over 50% and one that is more durable than many of its less efficient competitors.

**LED Supply Constraints** - The LED market is forecast to grow at over 30% per year until 2014 and is served by two equipment suppliers that are struggling to meet the market demand.

**CPV Technologies Emerging** - The CPV market is also forecast to grow very quickly over the next ten years and there is no clear technology winners yet emerging. When proven, the RPCVD technology could be one of the key technologies underpinning both the LED and CPV industry growth.

**Strategic Options** – The company has a number of partnership options to help accelerate product commercialisation and to reduce the time to market.

**Key Valuation Triggers** – The key valuation triggers that may occur in the next 12-18 months are: the first orders for equipment, the announcement of a cornerstone investor or joint venture partner to accelerate commercialisation, the proving of commercial material quality and device performance. Any one of these events will greatly reduce the risks of BluGlass successfully commercialising the RPCVD technology and has the potential to significantly increase its market value. BluGlass is in a position to emerge as a key CVD equipment manufacturer comparable to Aixtron (NASDAQ: AIXG), a pure play CVD company, which has a current market capitalisation of over US\$3 billion.

### Comparative Technology Review

The only technology that is an effective and established competitor to the Remote Plasma Chemical Vapour Deposition (RPCVD) technology is the Metal-Organic Chemical Vapour Deposition (MOCVD) process. It is also possible to undertake many of the functions of these technologies using a Plasma Assisted Molecular Beam Epitaxy (PAMBE) process but this cannot be scaled up to meet the needs of large scale production.

The advantages that RPCVD has over MOCVD are as follows:

#### Concentrating Photovoltaic (CPV) Power

- **Significant Improvement in Solar Cell Efficiency** – The lower temperature of the RPCVD process enables it to incorporate indium-rich Indium Gallium Nitride (InGaN) into multi-junction solar cells, which may result in the production of the world's most efficient solar cells.
- **Improved Durability of Solar Cells** – In addition to being highly efficient, InGaN cells will also be more durable than competing technologies due to its radiation and heat tolerance and so is better adapted to CPV and space applications.

#### CPV and LED

- **Cost Savings** – Forecast reduced overall cost of production for customers using the RPCVD technology over those using MOCVD.
- **Improved Efficiency and Reduced Waste** - The MOCVD process uses thermal decomposition of toxic Ammonia (NH<sub>3</sub>) as its nitrogen source usually requiring very high process temperatures of over 1000°C. The RPCVD process instead uses non toxic and abundant nitrogen plasma to generate its active nitrogen species and can therefore operate at lower temperatures than MOCVD.
- **Increased Substrate Options** – Lower process temperature of RPCVD provides the option to use industry standard sapphire and potentially glass substrates which reduces costs and improves yield, particularly of larger substrate sizes, that improve the overall plant production levels.

Superior efficiency performance should drive demand from the CPV market. RPCVD equipment and assembly costs are forecast to be very similar to MOCVD equipment and so operational advantages should drive demand in LED sector.

The development of both LED and CPV applications is at about the same stage and the company is pursuing strategic partners for both. There may also be additional applications for the technology that have not yet been explored.

The RPCVD process is a platform technology that appears to have significant advantages in comparison to its major competitor technology, MOCVD, in the production of high quality LEDs. The advantages when looking at the CPV market appear to be even more compelling and this may be the biggest opportunity for this technology.

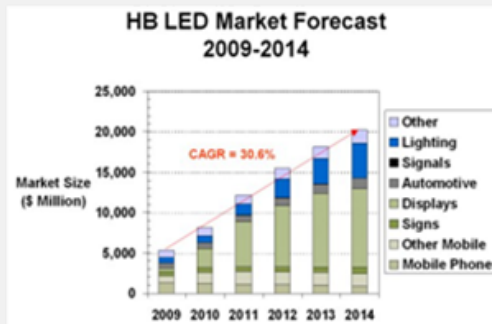
*Once the process demonstrates the ability to produce commercial quality material, we believe that there will be significant demand for the technology from current and emerging wafer and device manufacturers.*

Technology and Market Potential Review, June 2010

BluGlass Ltd

**LED Market Review**

The global LED market is set to grow significantly over the next five years and this will require significant increases in manufacturing capacity and the need for large numbers of new CVD equipment. The existing MOCVD equipment suppliers are in a strong position and are likely to see their equipment sales grow with this increased demand. It may also provide a market environment where a new entrant technology will have plenty of opportunities to soak up the additional demand without precipitating market share defence strategies by the incumbents.



**Market Growth** - A report by IMS Research published in January 2010 forecast that the demand for high brightness LEDs will 'grow by 61% in 2010 and supply is unlikely to keep up, creating an opportunity for new manufacturers and new tool makers.' The forecast total demand for MOCVD reactors in 2010 will be up to 588, which will be difficult for the current suppliers to fulfil. 'This potential shortfall in supply is putting pressure on both the tool suppliers and the LED manufacturers to improve yields (or reduce the binning specs), increase capacity and speed up tool production.'

**LED Equipment Suppliers** - The equipment supply market for MOCVD devices is dominated by only two suppliers: Aixtron and Veeco. Aixtron's 2009 results showed revenue of €303m with a Gross Profit of €135m (44%) and an EBIT of €63m (21%).

**Potential Customers** - There are over forty large scale global chip manufacturers located in Asia, North America and Europe who are the customers for Aixtron and Veeco. The five chip manufacturers that are seen as the leading 'high-end' providers are Toyoda Gosei, Nichia, Philips Lumileds, Cree and Osram.

*The LED equipment supply market is a highly concentrated market ready for a new entrant.*

**Concentrating PV Market Review**

The Concentrating Photovoltaic (CPV) market is at a much earlier stage than the LED market. Whereas the LED market has settled on a technical solution and is building significant capacity utilising that technology, the CPV market is still developing a number of different technical solutions.

CPV is only a small part of the overall photovoltaic (PV) market, which is currently dominated by flat plate PV modules that are installed on rooftops. CPV uses a lens or a mirror to concentrate the sun's rays so that a larger amount of radiation is focussed onto a smaller area. CPV cells with the greatest efficiency and durability will be the ones that will become the dominant market solution for utility scale solar power generation.

Globally, investment in solar companies and technologies, including concentrating solar, has grown exponentially over the last few years. CleanEdge forecast that in the U.S. alone, the installed capacity will increase from 419 MW in 2007 to over 16,000 MW in 2020. Similar levels of growth are forecast for Europe and North Africa.

**The Potential for Indium Gallium Nitride (InGaN) CPV Cells**

- Multi-junction (MJ) InGaN solar cells are expected to be over 50% efficient, and could be over 70% efficient, compared to 35%-37% efficiency for current commercial MJ cells.
- A lower temperature process is critical to increasing the proportion of indium in layers and achieving these efficiencies due to InGaN breaking down at high temperature during growth.
- It is expected that InGaN solar cells will be able to use sapphire as a substrate rather than germanium. Sapphire substrates are up to three times cheaper than germanium substrates and are available in larger diameters. Even greater cost advantages are possible if glass substrates can be used.
- InGaN has high radiation tolerance making it ideal for CPV and space applications.

*The greatest challenge preventing the wide-spread adoption of large scale solar is its current low efficiency and high cost compared to fossil fuel generation. InGaN CPV could potentially address these barriers and help solar energy achieve both grid parity and significant market penetration.*

*Aixtron, the world's leading maker of equipment used to produce LED lighting, rose as much as 11.7 per cent on Wednesday after it issued strong 2010 guidance on the back of improving demand in the sector. The German company has seen a near-450 per cent rise in its share price since January last year as the popularity of LED-backlit LCD televisions has risen.*

10 March 2010

*The high-brightness LED market will see greater than 50 percent growth in 2010, to reach \$8.2 billion in revenues. The report states that a major ramp-up in LED adoption for backlights for LCD TVs and monitors is driving this growth. It also forecasts that the growth should continue to average 30.6% a year through to 2014, creating a \$20.2 billion opportunity for the packaged semiconductor devices (see chart above left).*

Strategies Unlimited

*'In fact, this backlight-driven cycle will drive a 3X increase in capacity through 2012 to 2014, and accelerate the transition to 4-inch and then 6-inch wafers as producers scramble after better yields.'*

Canaccord Adams.

**Example CPV Concentration Method: the Solar Systems Parabolic Dish**



*The world's most efficient PV cells were reported in November 2009 in the NREL's 'Opportunities and Challenges for Development of a Mature Concentrating Photovoltaic Power Industry' report as follows:*

- CPV single crystal silicon from Amonix recorded 27.6% efficiency using a 92x concentration; and
- Three junction concentrators from Boeing Spectrolab recorded a 41.6% efficiency using a 364x concentration.

### Strategic Options

To build credibility in both the industry and investment markets, BluGlass needs to secure some key strategic relationships with major industry players. These relationships may also provide additional finance and skills to help accelerate the commercialisation of both the LED and solar applications of the company's platform technology.

Strategically, the company could consider creating partnerships at one or more levels. A partnership might take the form of a cornerstone investment in the parent company, BluGlass Ltd, or it could be in the form of a joint venture arrangement for individual technology applications or even geographies. A joint venture arrangement might be established as a 'farm-in' type of arrangement whereby the partner would progressively earn a greater share of the joint venture as they contributed funds to finalise demonstration and product development.

In the longer term, the company may have the opportunity to undertake a trade sale. It may even be that the strategic partner(s) may offer to acquire the company to provide them with a vertical integration opportunity. There have been a number of acquisitions in both the LED and CPV sectors that might provide insight into the nature of any exit opportunity that may emerge.

Date	Acquirer	Target	Deal Value
<b>LED Transactions</b>			
Oct'09	Sumitomo Precision Products	Aviza Technology	US \$57 million in cash and notes
Aug'07	Royal Philips Electronics	Color Kinetics Inc	€516 million
Apr'07	Cree Ltd	COTCO Luminant Device Ltd	US \$ 200 million
<b>CPV Transactions</b>			
Mar'10	Advanced Energy Industries	PV Powered	US \$90 to \$130 million
Dec'09	Amonix	Sunworks Solar	Not available
Dec'09	Soitec	Concentrix	€44 million for 80%

Strategically, the company may be able to take advantage of the market characteristics of the two primary industries that it is targeting:

- The LED equipment supply market in which BluGlass will compete is very constrained with only two major suppliers holding 90% of global market share. With significant increases in demand over the next few years, there may be options to either enter the market as third supplier with operational advantages or possibly to vertically integrate with a chip manufacturer to enable them to undercut their competitors and deny others access to the RPCVD technology.
- The CPV market is emerging and is forecast to grow extremely quickly. The potential advantages of the RPCVD formed multi-junction cells over all other CPV cells currently available, or in development, appears to present an enormous opportunity for the technology. The strategic options here are then also to be a cell supplier to all or to integrate with system developer to provide the most efficient installed systems available.

### Implementation Risks

- Technology Risk - Failure to demonstrate Material Quality or Device Performance (as discussed in the Valuation Triggers table) within the targeted timeframes or at all. The company's fifth generation tool appears to have improved versatility and reliability to help meet these performance objectives.
- Distribution Risk - Failure to access market even once the technology has been proven through poor commercial arrangements or through aggressive market defense by MOCVD suppliers. The Company has already secured a tier one distribution agent in the largest LED market in the world, Itochu Plastics (part of Itochu Corp.) of Japan.
- Raw Material Supply Risk – Failure to secure adequate supplies of key inputs such as Gallium and Indium. See Indium Corporation's comments at right.
- Capability Risk – Current executive team provides a strong basis for delivering the commercialisation program. This is enhanced through the supply chain and international connections of Chandra Kantamneni and Dr Alan Li, both of whom are Non-Executive Directors and have extensive experience in the semiconductor and LED sectors.
- Key Person Risk – There is a reliance on a few key individuals with highly specialised skills that are not readily available in Australia. There are however people available globally that could step into the process if required.

*'Soitec is entering the fast-growing solar industry; capturing value through the system level; and expanding its revenue base as worldwide demand for CPV systems is anticipated to ramp up strongly in the coming years. Soitec's technologies in engineered substrates are key to improving solar cell performance and therefore strongly complement Concentrix's expertise in high-efficiency CPV systems for solar power plants...Additionally, the transaction includes access to the high-efficiency concentrator solar cell technologies from Fraunhofer ISE'. Soitec also said they expect the CPV market to grow at a CAGR of >100 per cent from 2010-2015.*

*Soitec Press Release on the Acquisition of Concentrix, December 2009*

*"Indium- and Gallium-containing raw materials exist abundantly worldwide. The metals industry has been investing in process improvements and capacity over the last few years to bring more indium and gallium to the market. Suppliers can and will continue to do so if the demand continues"*

*Availability of Indium and Gallium, September 2009, Claire Mikolaczak, Director, Metals and Chemicals, Indium Corporation*

### Key Valuation Triggers

There are a number of specific 'Valuation Triggers' that will have the effect of significantly changing the company's risk profile and increase its likelihood of achieving its strategic goals. These are detailed in the table below.

Valuation Trigger	Detail	Consequence	Possible Timing
<b>Commercial Milestones</b>			
<b>Strategic Investor(s) into BluGlass</b>	This could be a cornerstone investor in BluGlass or a joint venture partner for one segment of the business.	This will provide capital injection, market credibility and maybe even additional required skillsets. Will also accelerate the commercialisation process and bring forward sales and cash flows.	Short Term
<b>First Equipment Order (Beta site)</b>	First order received for BluGlass RPCVD equipment or end product.	This will establish market credibility and will enable future equipment sales to be expedited.	Short Term
<b>Technology Milestones</b>			
<b>Commission new generation tool/reactor</b>	Commissioning of a fifth generation tool commissioned to encompass key performance criteria from previous tools.	Provides a more reliable and flexible platform to enable the acceleration of other technology milestones.	Short Term
<b>Demonstrate single crystal</b>	Demonstrate single crystal GaN and InGaN on newly commissioned tool.	This will provide confidence that the newly commissioned tool is operating effectively and will build a platform for further technology milestones	Short Term
<b>Production of Commercial Quality Material</b>	Producing repeatable high quality crystalline material with minimal defects. Achieving device quality doped material layers.	Should demonstrate to potential customers and partners that the technology is 'device ready'. It should effectively prove that the technology works.	Short Term
<b>Device Performance</b>	Demonstration of a single junction Indium-rich PV cell with high efficiency.	This should demonstrate that the device is working effectively and that it is possible to introduce Indium as required into the material. This may secure significant global coverage of a new way to do solar cells for CPV applications.	Medium Term
<b>Production of Quality Layers</b>	Demonstrations of a three junction cell including an Indium-rich layer.	This may trigger the start of large scale sales into the CPV sector.	Medium Term
<b>Scalability of Equipment</b>	Demonstrations of the potential and added advantages of using the RPCVD technology for larger diameter substrates with higher yield and reduced waste.	This should fully demonstrate the potential of the equipment to the LED sector and may provide a trigger for large scale sales into that sector.	Medium Term

We believe that each of these 'Valuation Triggers' once successfully met, will drive a significant increase in the value of the RPCVD technology and hence for the company. BluGlass could emerge with a similar business model to Aixtron: also a university spin-off that commercialised a disruptive technology to grow a company with 2010 forecast revenues of over €650 million.

The LED target market is highly concentrated and is prone to the entry of emerging and competing technologies. The CPV target market is seeking high efficiency solutions that, currently, only the RPCVD technology has the potential to provide.

Once the company has proved 'device quality material' the benefits that the RPCVD technology offers to manufacturers are compelling in both of the company's target markets. BluGlass could expect to gain market share by enabling significant cost savings, efficiency improvements, safety and throughput advantages to adopters of its RPCVD technology. To our knowledge, there are no other emerging technologies that have the same potential in either target market as the RPCVD technology.

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