Leaf Resources

Initiation of coverage

Game-changer technology for bio-based products

Alternative energy

Leaf Resources' (LER) Glycell technology dramatically cuts the cost of producing cellulosic sugar from biomass. It also produces 'clean' sugars, with low degradation, for higher-value bio-based chemicals and plastics manufacture. Its quality coproducts open up high-value global growth opportunities. The shares are trading well below our valuation range.

Year end	Revenue (A$m)	PBT* (A$m)	EPS* (c)	DPS (c)	P/E (x)	Yield (%)
06/14	0.0	(1.6)	(2.4)	0.0	N/A	N/A
06/15	0.0	(2.2)	(1.6)	0.0	N/A	N/A
06/16e	0.0	(2.0)	(1.5)	0.0	N/A	N/A
06/17e	0.0	(2.0)	(1.4)	0.0	N/A	N/A

Note: *PBT and EPS are normalised, excluding intangible amortisation, exceptional items and share-based payments.

Lower costs, unlocks high-value growth areas

LER's Glycell process is a disruptive technology that dramatically reduces the costs of bio-based chemicals, plastics and fuel produced from biomass. The process has the potential to change the face of global renewable production. The cost advantage is partly driven by higher process yields, the simplicity of the process and additional revenue from coproducts. The quality of its coproducts offers another dimension, unlocking high-value opportunities in new growth areas such as the renewable aromatic resource for the chemical industry offered by lignin.

Renewable target push by large chemical companies

LER's attention is focused on licensing its technology, joint ventures and collaborations. A target is renewable chemicals, where the large chemical companies have stated objectives to achieve 25% of their sales from renewable chemicals by 2020. Another target is the pulp and paper industry, which is strategically keen to embrace bio-based markets as it is a natural agglomerator of biomass. Glycell provides opportunities for revenue diversification, in part using existing pulp and paper plant and infrastructure. There are also opportunities utilising 'advantaged' biomass, which is essentially a waste product. As biomass is the largest cost in producing bio-based products, such opportunities can be very profitable. LER is also seeking licensing opportunities such as reequipping first generation ethanol sites, retrofitting existing second generation biofuel and biomaterials assets or new infrastructure.

Valuation: Substantial global potential

The Glycell process has enormous valuation upside because of its potential global application. Our valuations are based on access fees and royalties linked to gross profit. Significant extra value could be created through the potential for direct ownership of assets in joint ventures. In the mid-range of our royalty assumptions, we calculate a valuation of A$1.45 per share. Incorporating a lignin coproduct, the valuation rises to $4.95/share. If a glycerol coproduct is produced, the valuation is A$6.29. This demonstrates the upside of coproducts, some of which will provide feedstocks for the expansion of bio-based products into new growth areas.

9 September 2015

Price	**A$0.16**
Market cap	**A$18m**
	US$0.72/A$
Net cash (A$m) at 30 June 2015	0.7
Shares in issue	113.4m
Free float	68.6
Code	LER
Primary exchange	ASX
Secondary exchange	N/A

Share price performance

%	1m	3m	12m
Abs	(15.8)	18.5	116.2
Rel (local)	(10.2)	27.1	135.0
52-week high/low		A$0.22	A$0.07

Business description

The Glycell process, developed and owned by LER, is an intermediate-stage process in the conversion of biomass to bio-based chemicals, plastics and fuel. Advantages include lower capital and operating costs relative to alternative technologies and recovery and quality benefits.

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Analyst

Peter Chilton +44 (0)20 3077 5700

Roger Johnston +44 (0)20 3077 5722

industrials@edisongroup.com

Edison profile page

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Investment summary

Glycell cuts costs, unlocks high-value revenue opportunities

LER has developed and owns the Glycell process. Historically, converting lignocellulosic biomass to sugars, used as a feedstock for renewable bio-based chemicals, has been challenging. Glycell is an innovative and disruptive technology that breaks down plant biomass into cellulose, hemicellulose and lignin at low temperature and pressure. This is achieved at a substantially lower cost than existing processes, allowing bio-based chemicals to be competitive with those based on petroleum feedstocks. Its advantages go beyond cost. Rather than producing a combined product stream, it produces separate 'clean' sugar product streams and a high-quality lignin product. This facilitates entry into high-value growth opportunities and additional revenue streams.

Valuation: Premium to the share price, coproduct upside

We have calculated indicative valuations from royalty and access fee streams. The valuations assume LER's Glycell process achieves a 5% share of the global carbohydrate equivalents (CHEQ) market in 10 years. This is a reasonable target, but there are both upside and downside risks. In our base case, we use gross profit using revenue from cellulosic sugars only. In a second case, gross profit is based on both cellulosic sugars and a lignin coproduct. For a third case, gross profit is based on cellulosic sugars and two coproducts, lignin and glycerol. While coproducts have very positive valuation impacts, there is a risk the market for the coproducts may take a number of years to develop.

- **Base case:** valuation range is A$1.24-1.66/share.
- **Includes lignin coproduct:** valuation range is A$4.16-5.75/share.
- **Includes lignin and glycerol coproduct:** valuation range A$$5.27-7.31/share.

Financials: Actively involved in commercial discussions

LER has no current source of earnings or cash flow.

- LER is in active business development and commercial discussions with over 15 companies and is involved with three jointly-funded development and commercialisation projects.
- At June 30, 2015, LER had cash of A$0.7m and expected R&D tax refunds of over A$0.5m.

Sensitivities: Variability from feedstock costs and availability

Royalty and technology access fees received by LER for the Glycell process are sensitive to a range of factors including:

- **Biomass feedstock cost** – this is normally the single highest cost of the process. Feedstock may at times be affected by availability issues. The logistics of acquiring feedstock and associated transport costs are important as biomass is generally a low value material.
- **Relative price of competing feedstocks** – the Glycell process produces cellulosic sugars at a lower cost than existing processes that produce sugars from biomass. The relative competitiveness of these costs is sensitive to the price of petroleum-based feedstocks and first generation sugar sources such as sugar cane or beet, corn starch or starch from other grains. The decline in the oil price from levels of around US$100/bbl to current levels around US$45-60/bbl reduces the relative attractiveness of the Glycell process as a substitute for petroleum-based products, on purely cost grounds.
- **Market conditions** – supply and demand and prices for chemicals and plastics may fluctuate.
- **Technology** – demand for Glycell technology could be affected by competing technologies.
- **Exchange rates** – the financial outcomes of the process will be affected by changes in exchange rates as feedstocks, coproducts, chemicals and plastics are normally priced in US$.

Opportunities in chemicals, plastics and fuel

LER has opportunities in three global markets – chemicals, plastics and fuel. These markets are currently predominantly based on feedstocks derived from petroleum. LER's innovative Glycell technology substantially lowers the cost of producing cellulosic sugars, which can be used as a substitute feedstock for the production of a majority of the petroleum-based products.

Glycell places bio-based products on a much lower cost footing, making them competitive with petroleum-based products. The process provides a massive opportunity for substitution.

Chemicals

- **Market size** – US$2tn.
- **Potential** – virtually every petroleum-based chemical can be replaced by a bio-based product.
- **Trend** – existing participants in biomass chemicals include Dow, Dupont, Johnson & Johnson, Mitsui and Procter and Gamble. They have stated intentions to increase production of bio-based products. Dupont and Procter and Gamble have goals of achieving a biochemical share of 25% share of sales by 2020.
- **Market growth** – the biochemical markets are growing by approximately 20% per year and could achieve US$500bn sales by 2017.[1]

Plastics

- **Market size** – petroleum-based plastics constitute a 265Mt market. The bio-based plastics market was only a 3.5Mt, US$2m market in 2011.[2]
- **Potential** – 80-90% of plastics and polymers can be bio-based.[2]
- **Trend** – companies such as Coca Cola have stated they are working to completely eliminate the use of non-renewable fossil fuels in their plastic bottles.
- **Market growth** – potential for massive growth

Fuels

- **Market size** – global biofuels market was US$83bn in 2011.[3]
- **Potential** – has been projected to become a US$185bn market by 2021.[3]
- **Trend** – existing operators of plants in the US include Abengoa, Dupont and Poet DSM.
- **Growth** – cellulosic biofuels to grow at a CAGR of 50% over the 2014 to 2020 period.[4]

Exhibit 1: Proprietary technology owned by others converts sugars to renewable chemicals and products

Technology owner	Bio-based chemical examples	Used by companies such as
Zeachem	Acetic acid, ethyl acetate	Toyota
Bioamber	Succinic acid	Dow
Myriant	Succinic acid	Dupont
Avantium	PET replacement	Mitsui
Baskem	Polyethylene	Johnson and Johnson
Renovia	Adipic and lactic acid	Procter and Gamble
Multiple	Ethanol	Coca Cola
Others	Many uses	Many others

Source: Leaf Resources

[1] European Forum for Industrial Biotechnology.

[2] Deloitte & Corelli.

[3] Pike Research.

[4] Allied Market Research.

Why change to bioproducts?

Over the longer term, petroleum-based products are seen as unsustainable, both from a carbon footprint and supply perspective. In contrast, biomass is a sustainable product:

- **Carbon footprint** – products manufactured from biomass provide an approximate 70% carbon emissions saving when replacing petroleum-based products;
- **Feedstock supply security** –the biomass feedstock is renewable;
- **Geopolitical risk** – a large range of alternative biomass supply sources; and
- **Price volatility** – potential for greater price stability from biomass feedstocks. Some biomass feedstocks are waste products from primary production.

A major limitation to the expansion of bioproducts has been cost, with petroleum-based products generally having a cost advantage to most biomass derived feedstocks.

The Glycell process represents a major downward shift in the cost of producing bioproducts. Using Glycell, the cost of producing bioproducts can now be competitive with petroleum-based products. This provides the opportunity for massive substitution.

Biomass – source of sugars for chemicals and plastics

Biomass is a source of cellulosic sugars which is used as a feedstock to produce chemicals, plastics and fuel.

What is biomass?

Biomass is material of recent biological origin. It most often refers to plant dry matter, where it is specifically referred to as lignocellulosic biomass. This is the type of biomass used in LER's Glycell process.

The sources of biomass that are most relevant to LER are:

- **Wood based** – from hardwood, eucalyptus, hybrid poplar to softwood;
- **Non-wood based** – agricultural products such as grasses and crops and agricultural residue products such as corn stover, bagasse (from sugar cane or sorghum stalks), and empty fruit bunch from oil palms; and
- **Other** – can include some types of municipal waste.

Sugars are stored in the biomass

Solar energy enables plants to convert carbon dioxide and water to sugars. Generally through drying, these plants become biomass. In most biomass, sugars are stored as polymers of which there are three main types – starches, cellulose and hemicellulose.

A polymer is a chemical compound made up of small identical molecules called monomers. Some polymers, like cellulose, a polymer of glucose, occur naturally, while others are artificial. Polymers have extremely high molecular weights and make up many of the tissues of organisms.

The sugar polymers (cellulose and hemicellulose) typically account for 75-90% of the weight of the biomass. Lignin can comprise 10-25% of the weight. A 10-15% balance can comprise other components such as ash and protein.

Lignin is a more complex polymer than cellulose or hemicellulose. Nearly all of the lignin produced in the manufacture of pulp and paper is burnt as a fuel, with the balance used for low-value products. However, this could soon change. In the future, lignin could become the main renewable aromatic resource for the chemical industry for the production of speciality and fine chemicals. High-value lignin-based products in the aromatics group include benzene, toluene and xylene (BTX), phenol and vanillin. Another high-value lignin-based product is carbon fibre in the macromolecules group.

Pretreatment needed to break down biomass to produce sugars

To extract the sugars from the biomass, a pretreatment process is required to destructure the lignocellulose. There are a number of existing pretreatment processes, which generally use chemical or mechanical approaches.

While these sugar extractive processes have been technically successful, a key issue has been the cost of extraction, as these processes are often more expensive than the alternative of using petroleum-based feedstocks.

LER has developed the Glycell process, which has technical and cost advantages over existing technologies.

After the separation of the sugar streams, they are then used as a feedstock for later process stages that convert the sugars to building block chemicals that are used to produce bio-based chemicals, plastics and fuel. These stages involve proprietary technologies owned by others. They typically use microbial fermentation to produce alcohols, organic acids, alkenes, lipids and other chemicals. This conversion can use bacteria, fungi or yeast under a variety of process conditions.

Exhibit 2: Process flow from clean sugars to chemical markets

Source: Leaf Resources

Existing pretreatment processes

Traditional existing pretreatment processes incorporate mechanical elements to explode the fibre in lignocellulose biomass. The processes include:

- Dilute acid (Poet DSM);
- Steam explosion (Beta renewable, Abengoa);
- Ammonium fibre explosion (Dupont);
- Supercritical water (Renmatrix); and
- Concentrated acid (Virdia).

Other sources of sugar that compete with the Glycell process include:

- Sugar from a traditional cane and beet sugar process; and
- Sugar from corn starch.

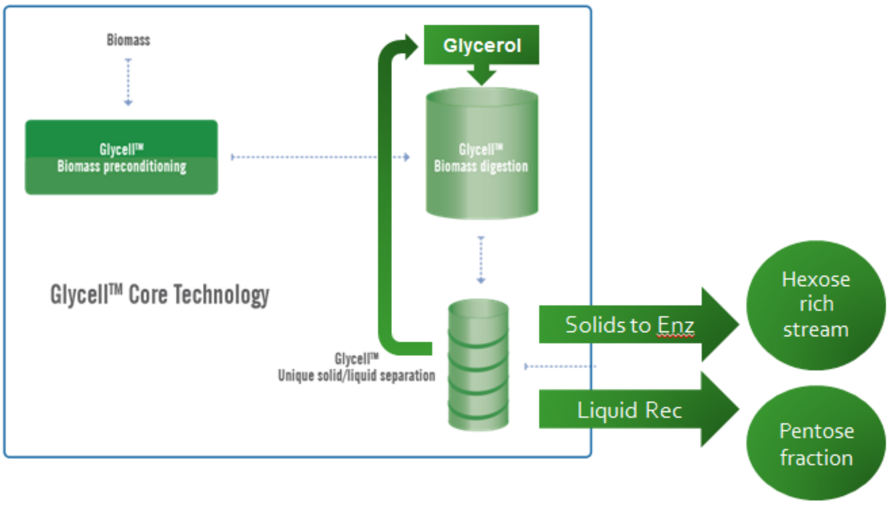
The Glycell process

The Glycell process represents a departure from the industry focus directed towards the mechanical explosion of fibres. Glycell is a low temperature and pressure process which uses a reagent to accomplish the breakdown of the fibres. Differentiating features include higher recoveries of cellulosic sugars, separate C6 and C5 sugar streams, which can assist value enhancement and more valuable coproducts because there has been less decomposition of the sugars. The lower capital cost of a Glycell installation increases its economic size range to smaller plants, where a biomass to sugar operation was not viable before.

Glycell reduces the cash operating costs of producing cellulosic sugars from biomass by over 20% compared to existing processes such as dilute acid. Cost reductions can exceed 60% if coproducts are included such as lignin at US$450/t.

The majority of the testwork for the Glycell process has been carried out at the Andritz facility in Springfield, Ohio in the US, providing offsite verification of the process. Andritz is a leading global supplier of plant equipment and services for the pulp and paper and other industries. Pilot scale data has been obtained at production rates of four to six dry tonnes biomass per day. There have been >40 independent pilot scale tests totalling over 20 dry tonnes biomass. As a sign of confidence in the process, Andritz have quoted on a commissioned basis for a plant with a capacity of 127,000 bone dry tonnes per annum biomass. In trials in August 2014, duration time in the main Andritz pretreatment reactor was cut from 30 minutes to 25 minutes with no significant reduction in results, increasing the throughput capacity.

Exhibit 3: Glycell process



Source: Leaf Resources

During CY 2015, testwork confirmed the range of biomass the Glycell process could work on. Work has now been done on eucalyptus globulus (hardwood), bagasse (waste sugar cane), empty fruit bunch (from palm oil), poplar (a hardwood common in North America) and corn stover.

- **Pretreatment** – in the Glycell process, the lignocellulosic biomass is impregnated with sulphuric acid and steam at atmospheric pressure for 10-20 minutes and then fed into a horizontal or vertical screw reactor where the reagent, crude glycerol, is added. The mixture is held in the reactor for 25 to 30 minutes at 160^{O}C. The solid and liquid components are then separated in a pressafiner (screw press). Glycell pretreatment produces a high yield cellulose with less degradation products.
- **Enzymatic conversion of cellulose to sugars** – the solid component is then washed with water and treated with a hydrolysing enzyme for enzymatic conversion of the cellulose to

sugars. Glycell pretreatment improves the enzyme kinetics for efficient sugar production. The cellulosic hexose sugar C6 (glucose) is recovered from the cellulose together with a lignin coproduct.

- **SMB to recover glycerol and separate C5 sugars from hemicellulose** – the purpose of the sulphuric acid is to selectively depolymerise the hemicellulose, so that it is in a soluble form and goes forward with the liquid streams. The liquid phase, which also contains glycerol, some dissolved lignin and acid is then processed by simulated moving bed chromatography (SMB). The cellulosic pentose sugar C5 (xylose) is recovered from the liquid phase. The C5 sugars can then be converted to higher value chemicals. Hemicellulose and the C5 sugars xylose and arabinose are important for next-generation technology and new developments.

Features of the Glycell process

The Glycell process conveys many productivity related, technological and revenue enhancement advantages over traditional methods of producing cellulosic sugars.

Productivity

- High recovery of cellulose and hemicellulose. For example cellulose yield of 94%.
- High conversion and rapid conversion of cellulose and hemicellulose to sugars. For example 99% conversion in six hours for C6 sugars using bagasse (sugarcane waste).
- Can potentially operate over a range of 100,000-700,000 tonnes feedstock per annum. Currently, the largest plants using existing technology have a capacity of 300,000 tonnes per annum. A decision on the scale of a new plant will be determined by the biomass available. LER currently favours a Glycell plant size of around 200,000 tonnes – plants at this scale have the potential to be very profitable if producing high-value products.
- Rapid processing time due to the effectiveness of glycerol as a reagent.
- Continuous process.

Technology

- Simple, innovative and effective.
- Operates at low temperature and pressure.
- Operates on all biomass including hard to softwoods, non-wood based and agricultural residue products.
- Uses ‘off-the-shelf’ standard industrial equipment.
- Simple technology and equipment allows more flexibility in plant scale, providing more opportunities for Glycell installations. This includes plant capacities of 200,000 tonnes per annum feedstock, where there is growing demand. At this scale, LER expects to achieve high recoveries of quality coproducts. Some existing technologies are normally not viable at this lower scale.
- Can be ‘bolted on’ to existing plants as an addition to the process or to replace technology that is already in place.
- Uses a low cost recoverable coproduct from biodiesel (glycerol) as the reagent.

Revenue

- Separate C5 and C6 sugar streams – the Glycell process produces separate C5 and C6 sugar streams. This is a massive advantage. C6 sugars are usually fermented into a range of chemicals and fuels. C5 sugars require novel organisms and can be used for higher-value applications. Other existing processes produce various cocktails, which then have to undergo separation, or are not suitable for some fermentation processes.

- Clean sugars – the Glycell process produces very 'clean' sugars. Mild temperature and pressure in the process combined with the glycerol solvent means there are less degradation products to contaminate the sugar. Clean sugars are essential for many renewable chemicals.
- Significant potential coproduct revenue from the sale of lignin and upgraded glycerol.
  - Lignin – the Glycell process produces a high-quality lignin coproduct, for which there is a higher-value opportunity and a growing market. Existing processes decompose the lignin structure so it becomes less useful and normally only good for combustion (heat value).
  - Glycerol – by upgrading the recovered glycerol to a higher specification by adding another simple process step, an additional coproduct is created.

High sugar yield drives operating costs down

The Glycell produces sugars from biomass at a significant cost advantage to existing processes, mainly due to:

- higher cellulose and hemicellulose yields;
- higher conversion rates to sugars;
- lower residence times during conversion;
- lower energy and maintenance costs due to low operating temperature and pressure; and
- use of low-cost reagent, glycerol, which can be recycled. This is a waste product of biodiesel production.

The high yields and conversion rates reduce costs because less biomass has to be purchased and processed for a given level of sugar output. The cost of biomass is the single highest cost item.

In existing processes such as a dilute acid process, typical industrial-scale cellulose yields and conversion efficiencies are both in the order of 80%, giving an overall efficiency of 64%. At a maximum where a cellulose yield of 85% is achieved, the overall efficiency is still only 68%.

In the Glycell process, significantly higher cellulose recoveries of 94% have been achieved. In the conversion from cellulose to sugars, a conversion rate of 99% has been achieved in six hours using bagasse biomass. This implies a potential total overall efficiency of >90% and is solids loading dependent.

Coproduct credits lower effective costs of production

An additional feature of the process is the ability to produce additional revenue from coproducts which, when offset against direct costs, further lowers the effective costs of production. These coproducts are:

- **Lignin** – existing processes such as dilute acid produce a waste lignin product, which is normally burnt for steam and electricity generation, as a replacement for coal or oil, for a nominal value of around US$70/t. The Glycell process produces a high-quality lignin coproduct stream. There is an emerging market for high-quality lignin feedstocks for the production of phenol derivatives or resins, carbon fibre or other products. We have assumed a lignin price of around US$450/t. Lignin is a valuable market with good opportunities. Higher prices may be possible, potentially up to US850/t, for lignin for some high specification applications.
- **Upgraded glycerol** – rather than recycle the glycerol reagent used in the process, testing at Amalgamated Research has confirmed that 95% of the glycerol is recoverable by SMB chromatography at a purity of 99.7%. The arbitrage between the 'waste' glycerol purchase price of around US$200/t and the assumed price of around US$500/t for the 99.7% grade glycerol sold, after taking into account the cost of upgrading the glycerol, represents an additional coproduct which effectively reduces the operating cost. The glycerol which is sold is replaced by waste glycerol.

'Off-the-shelf' components contribute to a lower capital cost

A higher sugar yield and faster processing times contribute to higher plant utilisation and a reduced capital cost for a Glycell plant at a given production rate.

Other factors that reduce capital expenditure include:

- the 'off-the-shelf' nature of all of the process components;
- the ability of the process to be bolted on to any existing plant; and
- its lower operating temperature and pressure and likely pacifying effect of the glycerol solvent results in savings in material costs (eg can use cheaper steel).

Unit costs

A cellulosic sugar stream is the feedstock for ongoing processing to chemicals, plastics or fuel. The price of this sugar stream has to be competitive. Competing feedstocks include first-generation sugars:

- sugar (sucrose) from sugar cane or sugar beet;
- sugar (glucose) produced from corn starch or starch from other grains; and
- petroleum feedstocks to produce the same or similar products in petrochemical plants.

We use the term minimum sugar selling price (MSSP) for the cost of cellulosic sugar production, which becomes the effective price of sugar for the next process stage downstream.

We have modelled pretreatment plants using existing industrial dilute acid technology and Glycell technology. We have used the models to calculate indicative unit operating costs, expressed as US$/t cellulosic sugar produced. These costs are subject to variation depending on the type and cost of the biomass used and the scale of plant. Smaller plants may have higher unit costs.

We have reviewed:

- **Cash costs** – the cost of feedstock and variable and fixed costs.
- **Coproduct revenue** – lignin and glycerol revenue, which cuts the effective cost of production.
- **Depreciation of plant** – assumes 15 years straight line (appropriate for a process plant).
  - For a plant using existing dilute acid technology, we have assumed a capital cost of US$272m. This is derived from the National Renewable Energy Laboratory (NREL) Technical Report (May 2011) which modelled a 700,000 dry tonnes per annum corn stover feedstock, which produced cellulosic sugars at a rate of 347,000 tonnes per annum. The capital cost in the report in 2007$ has been escalated to 2015$ using the Department of Labor CPI of 1.13.
  - For the Glycell sugar model, production has been scaled up to match the output of the NREL model. Throughput was approximately 428,000 dry tonnes per annum bagasse to produce 347,000 tonnes per annum cellulosic sugars. The scaled-up capital cost is US$203m.
  - Based on the capital costs and sugar production above, we have assumed a capital intensity of US$785/t sugar production for an NREL dilute acid plant based on existing technology and a capital intensity of US$585/t sugar for a Glycell plant.

Exhibit 4: Indicative costs of sugar production for existing and Glycell processes

Costs (US$/t sugar)	NREL dilute acid Coproduct – lignin as a fuel	Glycell No coproduct	Glycell Coproduct – lignin	Glycell Coproduct – lignin and glycerol
Feedstock	147	105	105	105
Processing costs				
Variable costs	99	90	90	222
Fixed costs	29	20	20	28
Subtotal	128	110	110	250
Costs before coproducts	276	215	215	355
Coproduct revenue				
Lignin	(7)		(120)	(120)
Glycerol				(322)
MSSP – cash	269	215	95	(87)
Depreciation	52	39	39	42
MSSP – after depreciation	321	253	134	(45)

Source: Leaf Resources, Edison Investment Research

In summary:

- **Before coproducts** – cash operating costs are lower than an existing dilute acid process by over 20%.
- **Including lignin coproduct** – cash operating costs with lignin at US$450/t are lower than an existing dilute acid process by over 60%.
- **Including lignin and glycerol coproducts** – cash operating costs with lignin at US$450/t and glycerol at US$522/t are effectively close to zero and estimated to be slightly negative.

Comparison with other sugar sources:

Exhibit 5: Cost comparisons of different sources of sugar

Sugar source	Cash MSSP (US$/t)	Comments
Biomass – dilute acid process	254	
Biomass – steam explosion process	287	
Raw sugar	280	
Corn starch sugars	280	Includes dextrose, glucose.
Corn syrup	220	Food syrup from starch of maize. Contains maltose and higher oliogosaccharides.
Biomass – Glycell - no coproduct credits	215	
– lignin credit	95	Lignin US$450/t.
– lignin and glycerol credit	(87)	Lignin US$450/t, glycerol US$522/t.

Source: Leaf Resources, Lux Research, Edison Investment Research

Royalty and access fee revenue

LER will target revenue via a number of ‘capital light’ licensing avenues through fees and royalties.

It will also investigate opportunities for direct equity in Glycell process operations, possibly through joint ventures. These have the potential to be the most remunerative.

The mechanisms for revenue are as follows:

- **Technology access fee** – set on a plant by plant basis. May only be charged in the first year of operation.
- **Tonnes based royalty** – based on throughput of cellulosic sugars.
- **Direct revenue share** – through a joint venture or similar arrangement.

The royalties and fees that can be charged will be influenced by the value added by the Glycell process. Cost savings and the ability to generate coproduct revenue may vary. There are a number of potential earnings models for revenue including those based on:

- **Direct cost savings only** – in certain cases, the location, ownership, complexity, size, age, type or scale of plant may reduce the scope for coproduct revenue.

- **Direct cost savings plus coproduct revenue** – where coproduct revenue streams are easy to define and market.
- **Joint venture** – where costs and revenues are shared with other parties.

Influencing the earnings model will be a range of factors:

- **Scale** – large scale to small scale.
- **Location** – located within an existing industrial precinct or in a remote location.
- **Geography** – located in a developed country or in a developing country.
- **New plant** – installation as part of a new purpose-built facility.
- **Retrofitted plant** – installation as an addition or modification to an existing plant.
- **Special purpose** – such as recycling, waste processing or revenue enhancement.

Business strategy

Over the next 12 months, LER's focus is on licensing, joint ventures and collaborations. There are four key targets:

- **Advantaged biomass** – this is biomass that can be sourced cheaply, such as a waste or discarded product. As biomass is the largest cost in producing cellulosic sugars, LER is seeking opportunities for project opportunities to process this type of material.
- **Renewable chemicals** – the large chemical companies have objectives to achieve 25% of sales from renewable chemicals by 2020. These companies are already active in the cellulosic area.
- **Pulp and paper market** – pulp and paper companies generally have access to biomass. They can be large aggregators of supply. They are keen to investigate bio-based markets because they provide diversification away from their traditional products, which may be cyclical. They understand the Glycell process because it utilises equipment they already use. The 'repurposing' of surplus newsprint mills is a large potential opportunity for LER, particularly as a lot of existing infrastructure can be used, resulting in savings in capital.
- **Licensing opportunities** – there are many situations where opportunities occur. These include brownfield sites (eg first-generation ethanol assets), greenfield sites (eg new infrastructure) and retrofitting to existing assets.

Intellectual property

LER is continuing to broaden its intellectual property (IP) portfolio. It has a focussed IP strategy in which it regularly reviews all of its research activities and is proactive in identifying new intellectual property and building strength around its ongoing IP assets.

The company's management have extensive IP experience and work closely with patent attorneys and lawyers in Australia and overseas to build and maintain the IP portfolio.

Over the past year, LER filed three patent applications:

- Methods for hydrolysing lignocellulosic material relating to the conversion of plant biomass to cellulose and then to cellulosic sugars;
- Methods for treating lignocellulosic material relating to the conversion of plant biomass into cellulose for cellulose fibre; and
- Apparatus system and method for treating lignocellulosic material relating to the Hybritech platform that enables the production of either pulp or cellulosic sugars from the same equipment line. This addresses a strategic focus of pulp and paper producers.

LER lodged the complete specifications for the first two patent applications and they will proceed along the International Patent Cooperation Treaty (PCT) leading to the examination of the patent applications commencing in 2016.

All three patent applications are wholly owned by LER. The company actively captures improvements to the core technologies and incorporates this data in the overall IP portfolio as appropriate.

Management

LER has a strong technical team with experience that is relevant to the company's activities.

Ken Richards – managing director: Ken has over 30 years' experience as a managing director of various listed and unlisted companies across agriculture and technology sectors. As a public company CEO, he has completed transactions (capital raisings, takeovers, asset sales) well in excess of A$200m. He holds an MBA and Batchelor of Commerce from the University of Western Australia. He is also a fellow of the Australian Institute of Company Directors.

Alex Baker – chief operating officer: Alex has over 20 years' industry experience in science and technology commercialisation including waste stream value creation. He has a focus on the industrialisation of innovation, broadly in the life sciences and renewables sector. He has worked in a range of company types including dual-listed Australia stock exchange (ASX)/OTCQX-listed companies. He has held senior management roles involving startup ventures or resetting companies by business transformation, including CEO of Maverick Biosciences. He has a BSc, Master of Technology Management and a graduate diploma in biotechnology. He is a member of the Australian Institute of Company Directors.

Dr Les Eyde – VP, R&D: Les joined LER in July 2014. He has a background in carbohydrate chemistry, expertise in biofuel production processes and sustainable biomass supply. He has research interests in the conversion of lignocellulosics to fuels and chemicals and biorefining for total biomass utilisation. He is recognised internationally and since 2007 has held the position of National Task Leader, International Energy Agency, Bioenergy Task 39 – Commercialising Advanced and Conventional Liquid Biofuels from Biomass. He is the author of more than 90 peer-reviewed journals, conference proceedings and book chapters and the inventor of three patents.

Dr Marc Sabourin – executive VP, business development (Americas): Mark is an experienced business development engineer, with over 28 years in the global pulp and fibre division of Andritz. Andritz is a leading global supplier of plant equipment and services for the pulp and paper and other industries. Marc has developed a large range of contacts in the pulp and paper industry and the emerging biorefinery space.

Sensitivities

The use of the Glycell process and the cost savings and advantages achieved and the extent to which the process is adopted globally are sensitive to a range of factors:

- **Feedstock cost** – the cost of the biomass feedstock. This is normally one of the largest costs in producing cellulosic sugars.
- **Feedstock supply** – availability of the biomass and logistics and transport factors. It is important there is consistency of supply. Biomass is a low-value product and there may be a limit to the distance it can be transported.
- **Oil price** – this affects the competitive position of bio-based products relative to the cost of competing petroleum-based feedstocks and end products.

- **Raw sugar price** – the differential between the cost of cane and beet sugar and corn-based sugar products and the MSSP derived from the Glycell process. This affects the relative competitiveness of the process.
- **Coproducts** – the market for coproducts and the price achieved for these products.
- **Competing technologies** – technological advances by others could affect the competitive position of the Glycell process.
- **Plant throughput and utilisation** – these can affect unit costs.
- **Capital cost** – the capital cost of the Glycell installation, retrofit or modification will affect rates of return, valuations, depreciation and financing.
- **Market conditions** – demand and supply conditions for the bio-based products.
- **Exchange rates** – many feedstocks and products are priced in US$.

Valuation

The valuation of the company is dependent on the acceptance and widespread adoption of the Glycell technology to produce cellulosic sugars and coproducts from biomass, and the successful negotiation of access fees and royalties for the technology at an appropriate level. The technology has high potential, but there are risks. The market share of the technology assumed in our valuations could be met, exceeded or not achieved.

Basis for the valuation

The global fermentation industry processes around 200 million tonnes of carbohydrate equivalents (CHEQ) per year from sugars, starches or material of cellulosic origin (Source: Opportunities for the fermentation-based chemical industry. Deloitte, September 2014). Around 94% of annual CHEQ is used for bioethanol production. The balance is used for bio-based chemicals, including plastics, which provide higher economic value add. Excluding alcohols, the annual growth rate for CHEQ is projected to be 6.5%, exceeding GDP growth.

For our valuation, we have projected the level of CHEQ processed after 10 years and assume LER has grown its share of the market using the Glycell technology from zero currently to 5% by year 10, which is around 1.2Mt. During this period, we assume capacity using the technology is added at a constant rate.

In the valuation, the cellulosic sugars produced by the process generate nominal revenue, which is based on the arm's length price of raw sugar. This revenue is used to calculate a gross profit, after subtraction of feedstock costs and direct and indirect operating costs. Assumed costs are based on our modelling. Royalties, payable to LER, are calculated from the gross profit. The level of royalty applied is based on standard royalty percentages of gross profit. Royalty rates are generally higher for value-adding technology. Access fees, also payable to LER, are received when new capacity is added. Our basic premise is that the royalty is based on the value add created by the Glycell technology. Royalty calculations and terms may vary, depending on the outcomes of individual negotiations.

Our valuation is the NPV[10] of the royalty and access fee stream over a total period of 15 years. In this valuation, revenues and costs are unescalated.

The valuation is intended to be indicative. If the Glycell technology is widely adopted, the expansion of capacity using this technology could be at a more rapid rate and 'lumpier'. This would lead to a higher valuation.

In Exhibit 6, we calculate valuations based on the gross profit created by the Glycell process without any allowance for coproduct revenue. This is a base case. A 1% +/- change in the discount rate would change the valuations by approximately +/- A$0.12/share.

Exhibit 6: Indicative valuation of Glycell process before coproduct credits (base case)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cellulosic sugars (kt)															
New capacity	65	73	82	91	102	115	128	144	161	180	202	226	253	284	318
Cumulative capacity	65	138	219	311	413	527	656	799	960	1,141	1,343	1,569	1,822	2,106	2,423
Growth in capacity		112%	59%	42%	33%	28%	24%	22%	20%	19%	18%	17%	16%	16%	15%
Revenue – sugars	18	39	61	87	116	148	184	224	269	319	376	439	510	590	678
Costs	14	30	47	67	89	113	141	172	206	245	289	337	392	453	521
Gross margin	4	9	14	20	27	34	43	52	62	74	87	102	118	137	158
Royalty @ 25%	2	3	5	6	8	10	13	15	18	21	25	29	33	38	44
@ 30%	2	4	6	7	10	12	15	18	21	25	29	34	39	45	52
@ 35%	2	4	6	8	11	14	17	20	24	29	34	39	45	52	60
		US$m	A$m	A$/sh	Royalty (%)										
	NPV^{10}	101.1	140.5	1.24	25%		Raw sugar		(US$/t)		280			A$/US$	0.72
	NPV^{10}	118.3	164.4	1.45	30%		Cash costs		(US$/t)	sugar	215			Shares	113.4m
	NPV^{10}	135.6	188.3	1.66	35%		Access fee		(US$/t)	capacity	15.0				

Source: Edison Investment Research

In Exhibit 7, our valuation includes coproduct revenue from lignin. The market for lignin, other than for combustion is relatively immature. However, this is unlikely to be the case for long, with a growing market expected for quality lignin for conversion to higher value-add products. The Glycell process is differentiated by its ability to produce a high-value coproduct. A 1% +/- change in the discount rate would change the valuations by approximately +/- A$0.40/share.

Exhibit 7: Indicative valuation of Glycell process after coproduct credits for lignin

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cellulosic sugars (kt)															
New capacity	65.0	72.8	81.5	91.3	102.3	114.6	128.3	143.7	160.9	180.3	201.9	226.1	253.2	283.6	317.7
Cumulative capacity	65.0	137.8	219.3	310.7	412.9	527.5	655.8	799.5	960.4	1,140.7	1,342.5	1,568.7	1,821.9	2,105.5	2,423.2
		112.0%	59.2%	41.6%	32.9%	27.7%	24.3%	21.9%	20.1%	18.8%	17.7%	16.8%	16.1%	15.6%	15.1%
Revenue - sugars	18.2	38.6	61.4	87.0	115.6	147.7	183.6	223.9	268.9	319.4	375.9	439.2	510.1	589.5	678.5
Costs	14.0	29.6	47.2	66.8	88.8	113.4	141.0	171.9	206.5	245.2	288.6	337.3	391.7	452.7	521.0
+ Lignin revenue	11.7	24.8	39.5	55.9	74.3	94.9	118.0	143.9	172.9	205.3	241.7	282.4	327.9	379.0	436.2
Gross margin	15.9	33.8	53.7	76.1	101.2	129.2	160.7	195.9	235.3	279.5	328.9	384.3	446.4	515.9	593.7
Royalty @ 25%	5.0	9.5	14.7	20.4	26.8	34.0	42.1	51.1	61.2	72.6	85.3	99.5	115.4	133.2	153.2
@ 30%	5.8	11.2	17.3	24.2	31.9	40.5	50.1	60.9	73.0	86.5	101.7	118.7	137.7	159.0	182.9
@ 35%	6.5	12.9	20.0	28.0	36.9	47.0	58.2	70.7	84.8	100.5	118.2	137.9	160.0	184.8	212.6
		US$m	A$m	A$/sh	Royalty (%)										
	NPV^{10}	339.3	471.3	4.16	25%	Raw sugar		(US$/t)		280			Lignin	(US$/t)	450.0
	NPV^{10}	404.2	561.4	4.95	30%	Cash costs		(US$/t)	sugar	215			A$/US$		0.72
	NPV^{10}	469.0	651.4	5.75	35%	Access fee		(US$/t)	capacity	15.0			Shares		113.4m

Source: Edison Investment Research

In Exhibit 8, our valuation includes coproduct revenue from both lignin and glycerol. Some processing plants, particularly smaller or isolated plants, may not wish to install the additional plant required to upgrade the glycerol for sale as an additional coproduct. For larger plants with good logistics, there are strong arguments for upgrading glycerol to create an additional value add revenue stream. A 1% +/- change in the discount rate would change the valuations by approximately +/- A$0.50/share.

Exhibit 8: Indicative valuation of Glycell process after coproduct credits for lignin and glycerol

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cellulosic sugars (kt)															
New capacity	65.0	72.8	81.5	91.3	102.3	114.6	128.3	143.7	160.9	180.3	201.9	226.1	253.2	283.6	317.7
Cumulative capacity	65.0	137.8	219.3	310.7	412.9	527.5	655.8	799.5	960.4	1,140.7	1,342.5	1,568.7	1,821.9	2,105.5	2,423.2
		112.0%	59.2%	41.6%	32.9%	27.7%	24.3%	21.9%	20.1%	18.8%	17.7%	16.8%	16.1%	15.6%	15.1%
Revenue – sugars	18.2	38.6	61.4	87.0	115.6	147.7	183.6	223.9	268.9	319.4	375.9	439.2	510.1	589.5	678.5
Costs inc glycerol u/g	23.1	48.9	77.9	110.3	146.6	187.3	232.8	283.8	340.9	404.9	476.6	556.9	646.8	747.5	860.2
+Lignin revenue	11.7	24.8	39.5	55.9	74.3	94.9	118.0	143.9	172.9	205.3	241.7	282.4	327.9	379.0	436.2
+Glycerol revenue	13.6	28.8	45.8	64.9	86.2	110.1	136.9	166.9	200.5	238.2	280.3	327.5	380.4	439.6	506.0
Gross margin	20.4	43.2	68.8	97.5	129.6	165.5	205.8	250.9	301.4	357.9	421.3	492.2	571.7	660.7	760.4
Royalty @ 25%	6.1	11.9	18.4	25.7	33.9	43.1	53.4	64.9	77.8	92.2	108.4	126.5	146.7	169.4	194.9
@ 30%	7.1	14.1	21.9	30.6	40.4	51.4	63.7	77.4	92.8	110.1	129.4	151.1	175.3	202.5	232.9
@ 35%	8.1	16.2	25.3	35.5	46.9	59.7	73.9	90.0	107.9	128.0	150.5	175.7	203.9	235.5	270.9
		US$m	A$m	A$/sh	Royalty (%)										
	NPV^{10}	430.4	597.8	5.27	25%		Raw sugar	(US$/t)	280				Lignin	US$/t	450.0
	NPV^{10}	513.4	713.1	6.29	30%		Cash costs	(US$/t)	355				Glycerol	US$/t	522
	NPV^{10}	596.5	828.5	7.31	35%		Access fee	(US$/t)	15.0				A$/US$		0.72
													Shares		113.4m

Source: Edison Investment Research

Financials

LER has developed the Glycell process and is now at the stage of commercial discussions with a growing number of parties to license this technology. This will potentially lead to receipt of income from fees, royalties and potential direct equity in process operations where the technology is used.

Earnings

LER has no current source of earnings.

Having developed and advanced the Glycell process, LER has been involved in targeted business development and commercial discussions with over 15 companies. Some discussions have led to the supply of pretreated biomass and/or sugar samples. Many of these companies have signed introductory agreements to protect LER's intellectual property. Discussions have been held with large chemical companies, large consumer goods companies, large alternative fuels companies, pulp and paper companies and companies that require sugars as a feedstock for their proprietary microbial processes.

LER has also been involved with jointly-funded development and commercialisation projects with three companies (as of August 2015), which explore the use of forestry and agricultural waste and radiata pine.

LER will derive earnings from its technology through technology access fees, tonnes-based royalty agreements and potential direct equity through possible joint ventures. Because of the uncertainty of making forecasts of fees and royalties, both from a timing and value perspective, they are not currently incorporated into our financial projections.

Cash flow

The company has annual costs of A$1.5-2.0M for research and development (R&D), employee and director costs, professional fees and administration costs. At the current time, LER does not have a source of cash flow from operations. During FY15, LER raised additional equity of A$2.25m including A$1.7m at A$0.15 in October 2014.

LER has estimated that it is entitled to claim in excess of A$500,000 from R&D tax incentive refundable tax offsets and an Export Market Development Grant (EMDG). LER expects the R&D claim to result in a refund exceeding A$400,000 and its EMDG provisional grant entitlement to exceed A$100,000, of which A$40,000 will be received as an initial payment and the balance received in a second tranche.

To provide additional funding prior to the commencement of technology access fees and royalty payments, we believe it is likely LER will raise more equity capital in 2015/16. In our forecasts, we have assumed LER raises A$2m (before costs) in each of 2015/16 and 2016/17 for the issue of 12.5m shares in each year at a notional A$0.16. In practice, the outcomes from current business development and commercial discussions could significantly change this scenario.

Balance sheet

As at June 30 2015, LER had cash of A$699,000 and no debt. It is expecting to receive in excess of A$500,000 from an R&D tax incentive and EMDG. Further equity capital is expected to be raised over the next 12 months.

Exhibit 9: Financial summary

A$000s	2013	2014	2015	2016e	2017e
30-June	IFRS	IFRS	IFRS	IFRS	IFRS
PROFIT & LOSS					
Revenue	718	1	11	8	8
Cost of Sales	(1,316)	(1,478)	(1,871)	(1,730)	(1,730)
Gross Profit	(598)	(1,477)	(1,860)	(1,722)	(1,722)
EBITDA	(673)	(1,615)	(2,201)	(2,042)	(2,042)
Operating Profit (before amort. and except.)	(675)	(1,617)	(2,204)	(2,045)	(2,045)
Intangible Amortisation	0	0	0	0	0
Exceptionals	3	0	0	0	0
Share based payments	(8)	(16)	(241)	0	0
Operating Profit	(680)	(1,633)	(2,445)	(2,045)	(2,045)
Net Interest	23	14	13	17	31
Profit Before Tax (norm)	(652)	(1,603)	(2,191)	(2,027)	(2,014)
Profit Before Tax (FRS 3)	(657)	(1,619)	(2,432)	(2,027)	(2,014)
Tax	299	91	519	203	201
Profit After Tax (norm)	(354)	(1,512)	(1,672)	(1,824)	(1,812)
Profit After Tax (FRS 3)	(359)	(1,528)	(1,913)	(1,824)	(1,812)
Minorities	0	0	0	0	0
Associated company income	0	0	0	0	0
Net income (norm)	(354)	(1,512)	(1,672)	(1,824)	(1,812)
Net income (FRS 3)	(359)	(1,528)	(1,913)	(1,824)	(1,812)
Average Number of Shares Outstanding (m)	49.8	62.4	106.5	119.6	132.1
EPS - normalised (c)	(0.7)	(2.4)	(1.6)	(1.5)	(1.4)
EPS - normalised and fully diluted (c)	(0.7)	(2.4)	(1.6)	(1.5)	(1.4)
EPS - (IFRS) (c)	(0.7)	(2.5)	(1.8)	(1.5)	(1.4)
Dividend per share (c)	0.0	0.0	0.0	0.0	0.0
Gross Margin (%)	N/A	N/A	N/A	N/A	N/A
EBITDA Margin (%)	N/A	N/A	N/A	N/A	N/A
Operating Margin (before GW and except.) (%)	N/A	N/A	N/A	N/A	N/A
BALANCE SHEET					
Fixed Assets	87	4	46	21	21
Intangible Assets	0	0	0	0	0
Tangible Assets	87	4	46	21	21
Investments	0	0	0	0	0
Current Assets	536	528	765	1,303	1,353
Stocks	0	0	0	0	0
Debtors	58	53	66	66	66
Cash	478	475	699	1,237	1,287
Other	0	0	0	0	0
Current Liabilities	(218)	(541)	(454)	(454)	(454)
Creditors	(218)	(541)	(454)	(454)	(454)
Short term borrowings	0	0	0	0	0
Long Term Liabilities	0	0	0	0	0
Long term borrowings	0	0	0	0	0
Other long term liabilities	0	0	0	0	0
Net Assets	405	(9)	356	870	920
CASH FLOW					
Operating Cash Flow	(408)	(1,258)	(2,204)	(1,542)	(2,042)
Net Interest	23	15	13	17	31
Tax	200	271	204	203	201
Capex	(2)	(3)	(20)	0	0
Acquisitions/disposals	3	84	(25)	0	0
Equity financing, other	(7)	888	2,257	1,860	1,860
Dividends	0	0	0	0	0
Net Cash Flow	(192)	(2)	224	538	50
Opening net debt/(cash)	(669)	(478)	(475)	(699)	(1,237)
HP finance leases initiated	0	0	0	0	0
Other	0	0	0	(0)	0
Closing net debt/(cash)	(478)	(475)	(699)	(1,237)	(1,287)

Source: Leaf Resources, Edison Investment Research

EDISON

Contact details	Revenue by geography
88 Brandl Street Eight Mile Plains Queensland 4113 Australia +61 7 3188 9087 www leafresources.com.au	N/A

Management team	
Managing director: Ken Richards	**Chief operating officer: Alex Baker**
Ken has a track record in managing, growing and transitioning high-growth ASX and private companies. As CEO of Norgard Clohessy Equity, he took the company from a startup with a capitalisation of A$60,000 to a company with a market capitalisation of A$50m.	Alex is BSc and MSc qualified in science, biotechnology and technology management. He has over 20 years' industry experience in science and technology commercialisation including waste stream value creation. Alex was CEO of Maverick Biosciences, leading that company into the biomedical field.
Executive VP – business development (Americas): Dr Marc Sabourin	**VP, R&D: Dr Les Eyde**
Marc is BSc and MSc-qualified in chemical engineering and has a PhD. He has research and development, process engineering and project execution experience spanning 29 years. Marc has held positions in process and research engineering in the pulp and paper industry, including senior roles at Andritz.	Les has a PhD in carbohydrate chemistry, with expertise in biofuels production processes and sustainable biomass supply and 25 years' experience in R&D. He has been internationally recognised, since 2007, as National Task Leader, International Energy Agency, BioEnergy Task 39 – Commercialising Advanced and Conventional Liquid Biofuels from Biomass.

Principal shareholders	(%)
Ken Richards	11.2
Russell Charles Wilson	8.0
Alan Omacini	7.1
UBS Wealth Management Australia Nominees	5.1

Companies named in this report
Avantium, Baskem, Bioamber, Coca Cola, Dow Chemical, Dupont, Johnson &Johnson, Mitsui, Myriant, Procter & Gamble, Renovia, Toyota, Zeachem