**Australian Securities Exchange Announcement**

**15th July 2014**

# Outstanding Saccharification results provides additional commercialisation opportunity for Glycell™ process

## Highlights

- **99% saccharification of cellulose to sugars in 6 hours from Glycell™ pretreated sugar cane bagasse;**
- **"Clean" sugars produced with negligible degradation products produced;**
- **These results are commercially significant and open up a potential second income stream for the Glycell™ process, and;**
- **Patent applications finalised and lodged.**

Leaf Energy Ltd **(ASX: LER)** ("Leaf" or "the Company") is pleased to announce further outcomes from ongoing production trials of the Company's Glycell™ process.

## Testing at Andritz facility

Leaf has been conducting continuous production trials at the Andritz pilot plant facility in Springfield, Ohio (Andritz is a globally leading supplier of plant, equipment, and services for pulp and paper and other industries). The trials have focused on developing the Glycell™ process on industrially available equipment on several different biomass inputs.

Further to previous announcements regarding the successful application of the Glycell™ process in the production of cellulose and its derivatives at commercial scale, Leaf has now received the report from Andritz on the component testing and saccharification (conversion of cellulose to sugars) for the second set of trials which were run in late January 2014 at throughputs of approximately 5 tons (dry) per day.

The data obtained from the trial work continues to define the features and benefits of the Glycell™ process. In particular, the saccharification results were outstanding, and of a level that we believe sets a new benchmark for pretreatment and enzymatic hydrolysis of biomass as a commercial pathway to sugars.

These results are therefore of significance for the commercial utilisation of plant biomass as a replacement feedstock for many sustainable products currently derived from non-renewable oil. This potentially opens up licensing of the process for the production of cellulosic sugars as an additional commercial opportunity for the Glycell™ process in addition to the production of cellulose from plant biomass.

**Cellulose production and digestibility**

Producing cellulosic sugars from biomass is a two-part process:

1) the first step requires the production of cellulose, and;

2) the second step converts that cellulose to sugars using enzymes (enzymatic hydrolysis).

**Cellulose yield**

The results show that the Glycell™ process recovered approximately 94% of the available cellulose from both bagasse and Eucalyptus globulus[1] feedstocks.

By comparison, a dilute acid pretreatment resulted in a 10% lower cellulose yield than the Eucalyptus feedstock under the same conditions.

**Results of cellulose digestibility**

Two feed stocks that were pretreated with the Glycell™ process gave rapid saccharification, producing sugars at a faster rate and highlighting the adaptability of the Glycell™ process to both a woody feedstock (Eucalyptus globulus) and a non-woody feedstock (bagasse – sugar cane after processing). The results reported are for samples measured after 6 and 24 hours hydrolysis. However, samples were analysed out to 168 hrs and demonstrated consistent results.

Results are summarised in table 1 below:

[1] Eucalyptus globulus otherwise known as the Tasmanian Blue Gum, Southern Blue Gum or Blue Gum, is an evergreen hardwood tree, one of the most widely cultivated trees native to Australia.

**Table 1**

**Cellulose saccharification after enzymatic hydrolysis using the Glycell™ process**

| Pretreated Feed stock | Saccharification[2] (%) | Hydrolysis Time (hrs) |
|---|---|---|
| Bagasse | 99.4 | 6 |
| | 100 | 24 |
| Eucalyptus globulus | 80.3 | 6 |
| | 98.1 | 24 |

## "Clean" sugars produced

The Glycell™ process produced negligible degradation products during the Andritz trials.

This is commercially important because many downstream processes that use cellulosic sugars as an input require clean sugars i.e. sugars with negligible degradation products.

Due to the severe treatment conditions, competing pretreatment processes such as acid hydrolysis and/or steam explosion often produce degradation products that can inhibit further processing.

Pretreated materials produced during the trials with the Glycell™ process were analysed for a range of degradation products. The results showed negligible degradation products were produced with most below the limit of detection and those that could be detected, classified as low.

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[2] The saccarification (digestibility) procedure measures the efficacy of a given pretreatment based on a maximum enzyme loading and is reported as a percentage of the theoretical mass yield. Cellulase enzyme cocktail used was Cellic ® CTec3 (Cellic ® CTec3 is a registered trademark of Novozymes) at 20 FPU/g cellulose at 2% cellulose weight loading applied to all samples.

## Commercial significance – clean sugars faster

Based on the results above, Leaf Energy's Glycell™ process when compared to other pretreatment processes, such as acid hydrolysis and/or steam explosion:

- produces more cellulose with less degradation products;
- converts more cellulose to sugars;
- does it considerably quicker, and;
- produces clean sugars faster.

Whilst Leaf has further work planned as to the best way to capitalise on these results, it is anticipated that a short saccharification time and a high conversion rate to sugars improve the economics of the Glycell™ process significantly.

## Market potential

Around the world significant steps are being taken to move from today's fossil based economy to a more sustainable economy based on biomass. Globally companies world-wide are seeking a process that converts waste biomass into sugars cheaply and cleanly for input to their proprietary processes, for the production of green, renewable, sustainable products.

The total value of the bio-based chemical market is expected to grow by 20% per year between now and 2017 and exceed $500 billion by 2017[3]. Companies such as Toyota, Dow, Proctor and Gamble, Johnson and Johnson, Coca-Cola, Dulux and DuPont amongst many others are now using green, renewable products sourced from biomass.

As examples of the potential of this market, Table 2 highlights a number of companies which have processes making use of cellulosic sugars (sugars from biomass) as an input and progressed toward commercialisation.

[3] European Forum for Industrial Biotechnology, 2012.

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**Table 2**

**Examples of companies commercialising processes which use cellulosic sugars.**

| Company | Product | Potential uses |
|---|---|---|
| Zeachem | Acetic acid<br>Ethyl Acetate<br>Ethanol | Acetates, glues , fibres & fabrics 6.5 mt/pa<br>Solvent in paint, ink & pharmaceuticals - $2.2B<br>Biofuel |
| Myriant | Succinic Acid | Direct replacement - $4b market |
| Bioamber | Succinic Acid<br>1,4 Butanediol<br>Tetrahydrofuran (THF) | Direct replacement - $4b market<br>Direct replacement - $4.3b market<br>Direct replacement - $2b market |
| Avantium | PEF | Replaces Pet plastic (Coca-Cola an investor) |
| Segetis | Levulinic Acid | Plasticisers - $14b<br>Agrochemical - $3.5b<br>Household and Industrial cleaners - $2.5b<br>Acrylate polymers - $5b |
| OPX Biotechnologies | Bio-acrylic | Direct replacement for "petro" acrylic |
| Baskem | Polyethylene | Supplies Proctor and Gamble, Tetrapak and Johnson Johnson |
| Renovia | Adipic Acid<br>Lactic Acid | Nylons, Polyurethanes - $6.2B market |
| Poet,<br>Mascomo<br>Cofco | Ethanol | Biofuel - 70 Sugar plants in India have associated Ethanol plants |

## Commercialisation path

Leaf is now well positioned to provide a low cost, high value solution for companies requiring both cellulosic sugars and/or cellulose as inputs to their proprietary processes. Given the downstream proprietary process owned by these companies, Leaf believes that one strategy may be to license its Glycell™ process for specific applications or in certain geographies. Leaf may also selectively pursue alternative commercialisation strategies whereby the Company will fund the commercial application of the technology, either directly or in partnership. More work needs to be done on this potential and the company is now planning the next steps.

## Intellectual property

Leaf Energy has lodged two provisional patent applications for the Glycell™ process. The applications cover the conversion of plant biomass into cellulose for cellulose fibre and the conversion of plant biomass to cellulose and then hydrolysed to sugars. These patents are wholly owned by Leaf and will enable Leaf to commercialise the IP on a global basis.

The data shown within this release was withheld from public release until the patent applications were finalised and lodged so as not to invalidate the patent applications.

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## About Leaf Energy

In virtually every industry consumer demand for greener more natural products is fuelling a surge of interest in bio-based alternatives to replace oil based products.

Leaf Energy's Glycell™ process is a simple, innovative and effective process that uses a waste, biodegradable reagent, glycerol, to break down plant biomass into its constituent parts: cellulose, hemicellulose and lignin. Cellulose is a critical building block for many bio-based products.

The Glycell™ process has the following key features:

- Single stage continuous process with a short resonance time
- Low temperature and low pressure
- Low cost recyclable reagent
- Carbon friendly
- Can operate at any scale
- Operates on both non-woody and woody feed stocks

The operating conditions of the Glycell™ process means it has significantly lower capital costs and significantly lower operating costs than rival, currently used, processes such as steam explosion and can produce low cost cellulose at virtually any scale.

Leaf Energy's pathway to commercialisation is tangible and realisable and initially targets the production of cellulose derivatives that have applications in industrial, food, nutraceutical and pharmaceutical markets. We are currently planning the scale and location of our first demonstration plant.

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