

# ASX Announcement

22 November 2010

## Wasabi Energy Limited subsidiary, secures two new contracts for the innovative adoption of the Kalina Cycle®.



- Increasing global interest in the adoption of the Kalina Cycle®
- Secures contract to design a 6,000kW Ocean Thermal Kalina Cycle® power plant
- Secures order for second Eco-Gen Kalina Cycle® power plant for Japanese Geothermal Market
- In advanced negotiations with a number of leading multinational organisations

Wasabi Energy (ASX: WAS) is pleased to announce its Global Geothermal Limited<sup>1</sup> subsidiary has recently secured two new contracts relating to its patented and thermodynamically efficient power cycle technology, the Kalina Cycle®<sup>2</sup>.

The first contract awarded to Global Geothermal Limited is from OCEES<sup>3</sup>, a leading ocean thermal energy conversion (OTEC) company, for the design of the world's first OTEC Kalina Cycle® power plant. OCEES has been reviewing the Kalina Cycle® technology for a number of years and the ultimate selection of the Kalina Cycle® for this proposed large scale (6,000kW) power generation project, provides strong endorsement of the advantages of the technology.

The second contract awarded to Global Geothermal Limited is for the engineering, procurement and assembly of an additional Eco-Gen Kalina Cycle® power plant for the Japanese geothermal market. This second order is for a substantially similar Eco-Gen unit to the previously announced GERD<sup>4</sup> order, although it is expected to be constructed by an alternative technology partner.

These new contracts are important steps in the ongoing commercialisation of the Kalina Cycle® as they entrench the technology in an existing market segment and introduce the technology to additional markets, with experienced partners.

In the case of the ocean thermal market, the Kalina Cycle® is expected to serve as an enabling technology to bring forward the development of power generation projects from this renewable resource through OTEC. Whilst the additional Eco-Gen order builds on the close collaboration between Global Geothermal Limited and GERD, the preeminent geothermal institution in Japan, it also provides a strong platform for targeting much larger, low enthalpy geothermal projects, globally.

Additional details regarding these significant developments have been provided in the following sections:

- >> Ocean thermal contract - [page 2.](#)
- >> Eco-Gen unit order - [page 3.](#)
- >> Chairman's comment - [page 4.](#)

<sup>1</sup> - Global Geothermal Limited is a majority owned (~94.9%) subsidiary of Australian Securities Exchange listed, Wasabi Energy Limited (ASX: WAS).

<sup>2</sup> - Kalina Cycle® is a registered trademark of Global Geothermal Limited. The Kalina Cycle® is a patented power cycle technology owned by Global Geothermal Limited.

<sup>3</sup> - OCEES, Ocean Engineering & Energy Systems International, is a leading private U.S. company focused on the development of OTEC. Refer to page 2 for additional information.

<sup>4</sup> - GERD, Geothermal Energy Research & Development Co., Ltd, is a private Japanese company focused on the development of geothermal resources in Japan. Refer to page 3 for additional information.

# Secures Contract for the Design of a 6,000kW Ocean Thermal Kalina Cycle® Power Plant

## Overview

Global Geothermal Limited's wholly owned subsidiary, Recurrent Engineering LLC<sup>5</sup>, has secured a contract to immediately commence the detailed front end engineering design (FEED) for an optimised Kalina Cycle® power plant based on ocean thermal energy conversion technology.

The power plant proposed by OCEES (to be installed at an identified, but as yet undisclosed location) represents the world's first ocean thermal application of the Kalina Cycle® and once built would be one of the largest commercial ocean thermal power plants ever built anywhere in the world.

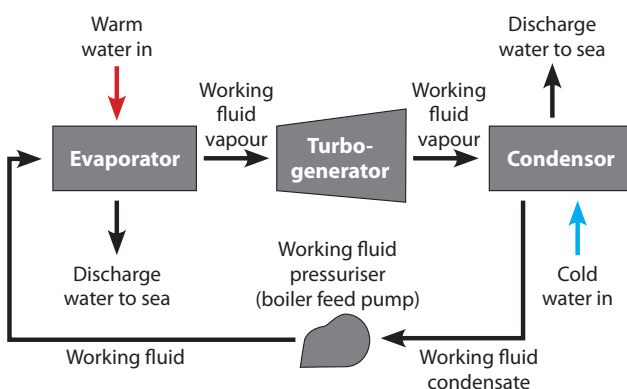
## Global Ocean Thermal Potential

Oceans cover more than 70% of the earth's surface and absorb abundant solar radiation throughout the day, and act as a heat-sink, with a potentially self-regenerating supply of energy. In order to be able to extract thermal energy from a resource, a temperature gradient is required. In the case of ocean thermal the temperature gradient is generally achieved by sourcing warm water from the equatorial ocean surface and colder water from the ocean depths.

A historical study performed by the U.S. Department of State, identified potentially exploitable ocean thermal resources across 98 different countries and territories, and estimated the power generation capacity of this resource to be up to 577,000MW<sup>6</sup>.

The Kalina Cycle® enables ammonia-water concentrations to be varied according to system temperatures and the addition of a recuperator minimises the heat losses generally experienced in other closed-cycle designs, thereby improving the overall efficiency of the power cycle.

## Ocean Thermal Kalina Cycle® Schematic



## Client - Strategic Partnership



OCEES, Ocean Engineering and Energy Systems International, is the world's leading provider of OTEC technologies with substantial experience across numerous OTEC power systems. OCEES works with governments and industry to advance the development and adoption of OTEC technology globally, and is engaged by companies interested in developing the ocean thermal power generation, including most recently, the global defence company, Lockheed Martin.

OCEES and Recurrent Engineering LLC have integrated the Kalina Cycle® technology into a patented closed-cycle OTEC system (*refer to schematic*) developed by OCEES, to enhance OTEC power generation efficiencies, resulting in enhanced economics for new projects.

OCEES considers the Kalina Cycle®; *"a break-through technology for OTEC power systems, providing a nearly 80% increase in efficiency over previous closed-cycle (OTEC) designs"*.

## Market Opportunity

The market potential for incorporating the Kalina Cycle® into OTEC systems is very significant, but it requires specialised expertise. The collaborative relationship between Global Geothermal Limited and OCEES, which predates the announcement of this landmark contract by a number of years, is expected to be pivotal in the effective delivery of the Kalina Cycle® technology to this emerging market segment.

## Commercial Implications

The adoption of OTEC technology has been developed and demonstrated over a three decade period, but the adoption of the technology has been challenged by the high capital costs. However, due to the thermodynamic efficiencies of the Kalina Cycle®, OCEES expects the technology to be a catalyst for the development of OTEC projects globally, providing Global Geothermal Limited with a significant commercial opportunity.

Global Geothermal Limited will derive substantial fees from OTEC developers for licensing and engineering services relating to the design and utilisation of the patented Kalina Cycle®.

<sup>5</sup> - Recurrent Engineering LLC is a U.S. based private company and a fully owned subsidiary of Global Geothermal Limited.

<sup>6</sup> - Ocean Thermal Energy Conversion Primer. L. A. Vega, PICHT. Marine Technology Society Journal V. 6, No. 4 Winter 2002/2003 pp. 25-35.

# Secures Order for a Second Eco-Gen Kalina Cycle® Power Plant for the Japanese Geothermal Market

## Overview

Global Geothermal Limited's wholly owned subsidiary Recurrent Engineering LLC has received an order for a second 50kW Eco-Gen geothermal power plant. The compact Eco-Gen unit (image below) is a specialised low temperature application of the Kalina Cycle® that has been developed in collaboration with GERD specifically targeting the Japanese hot-spring and broader low enthalpy geothermal market.

## Geothermal Potential of Japan

The 16 major geothermal power plants operating in Japan are responsible for producing 536MW of power, approximately 5% of installed geothermal capacity globally<sup>7</sup>. The estimated additional geothermal power generating potential in Japan is estimated to be 11,760MW<sup>8</sup>.

Despite this enormous potential, no large capacity geothermal power plants have been built in Japan in recent years due to the 2003 Renewable Portfolio Standards policy not incorporating geothermal energy as a recognised source of renewable energy. The Japanese government has recently set an aggressive target to reduce greenhouse gas emissions by 25% by 2020, providing increased support for geothermal energy. The Japanese government is increasingly supportive of geothermal development in Japan and is reportedly considering the introduction of a feed-in tariff to support the timely development of the country's geothermal resources.

## 50kW Eco-Gen Kalina Cycle® Unit Schematic



## Client - Strategic Partnership

**GERD**

Geothermal Energy Research & Development Co., Ltd.

GERD is a private Japanese company established in 1975 with the primary objective of supporting geothermal development in Japan. GERD is widely recognised as the leading geothermal institution in Japan and receives support from both industry and government, including financial support from NEDO<sup>10</sup>.

GERD is of immense strategic importance to Global Geothermal Limited as it is owned by 32 major Japanese organisations<sup>9</sup> including three of the largest geothermal turbine suppliers in the world, which have collectively supplied the key equipment for over 80% of all geothermal power plants developed globally<sup>11</sup>. Global Geothermal Limited intends to continue working collaboratively with GERD to develop and deliver highly innovative solutions based on the Kalina Cycle® technology to the Japanese geothermal market.



New Energy and Industrial Technology Development Organization

## Market Opportunity

In addition to the geothermal potential, the abundance of hot-springs in Japan, consisting of over 27,866 separate occurrences, provides Global Geothermal Limited with a near term market opportunity. The enhanced thermodynamics of the Kalina Cycle® combined with the cascaded utilisation of hot-spring water as proposed by GERD represents approximately 718MW of power generation potential from the existing hot-springs<sup>8</sup>.

## Commercial Implications

The two state-of-the-art plants which have been successfully operating in Japan, at the Kashima Steel Works (3,450kW) and the Fuji Oil Refinery (3,900kW), for 11 and 6 years, respectively, provide powerful in country references for the technology. Through the support of GERD, Global Geothermal Limited intends to establish the Kalina Cycle® into the Japanese hot-spring market and enjoy the benefits of being a first-mover into this market.

<sup>7</sup> - Geothermal Energy Association. Geothermal Energy: International Market Update. May 2010.

<sup>8</sup> - Muraoka, 2008. Hot-spring power generation: A breakthrough to Japanese geothermal developments. National Institute of Advanced Industrial Science & Technology (AIST). March 2009.

<sup>9</sup> - Geothermal Energy Research & Development Co., Ltd. - Company Profile, as accessed at: [gerd.co.jp/info01-e.html](http://gerd.co.jp/info01-e.html) on the 17 November 2010.

<sup>10</sup> - NEDO, New Energy and Industrial Technology Development Organisation, is responsible for the research and development of industrial, energy and environmental technologies in Japan.

<sup>11</sup> - Analysis by Activated Logic 2010, adapted from Emerging Energy Research, Global Geothermal Markets & Strategies, 2009.

## Comment from the Chairman

Executive Chairman of Wasabi Energy and Director of Global Geothermal Limited, Mr. John Byrne commented:

*"Earlier this year we demonstrated our Kalina Cycle® EPC capabilities by successfully commissioning the world's first solar thermal Kalina Cycle® power plant at EXPO2010 in Shanghai, in collaboration with our Chinese licensee, SSNE."*

*"These two new contracts, highlight our ongoing efforts to strategically build our position in existing market segments and to introduce our technology to new market segments in partnership with recognised market leaders."*

Yours Sincerely,



Mr. John Byrne  
Executive Chairman

*"To this end, we are currently in advanced negotiations with a number of multinational organisations which have expressed significant commercial interest in adopting and/or delivering the Kalina Cycle® technology to their respective industries."*

Mr. Byrne added:

*"As the licensing component of the Global Geothermal Limited business is gathering momentum, at the corporate Wasabi Energy level, we are working diligently towards establishing a build-own-operate project portfolio by leveraging our technology ownership and engineering capabilities."*

## For further information contact

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### EXPO2010 Kalina Cycle® Power Plant

The Kalina Cycle® power plant recently installed at EXPO2010 in Shanghai, demonstrates the thermodynamic efficiencies of the technology by generating approximately 50kW of power from very low temperature (~90°C) solar-heated fluid collected from the roof of an adjoining building.

The Eco-Gen units being delivered to GERD by Global Geothermal will generate a similar power output to the Kalina Cycle power plant installed at Expo2010, except will extract thermal energy from geothermal fluids at hot-spring sites across Japan (at approximately the same temperature) instead of utilising a solar heated fluid.

Image courtesy of Dr. Malcolm Jacques

## Overview of the Kalina Cycle® technology

Global Geothermal's Kalina Cycle®, the proven and most thermodynamically efficient power cycle technology in the world, is now on the verge of large-scale adoption in:

- **Enhanced Energy Efficiency** (EEE), and
- **Renewable Energy Generation** (REG);

applications, across the globe.

Building on the initial Kalina Cycle® Technology breakthroughs in the mid 1980's, the innovative technology has undergone intensive development, optimisation and large-scale demonstration with some of the most significant power generation and industrial companies in the world. A comprehensive suite of second generation Kalina Cycle® innovations including the patented RIP-Cycle and Multiple Heat-Source applications have recently been pioneered by Global Geothermal Limited; however the superior and unparalleled thermodynamic efficiencies remain firmly at the core of the Kalina Cycle®.

The superior efficiency of the Kalina Cycle® provides an environmentally sustainable alternative for power generation, whilst offering significant savings in the construction of new power generation capacity and ongoing operational costs.

The thermodynamic power cycles which collectively constitute the Kalina Cycle® have been reviewed and verified by the U.S. Department of Energy (DOE), numerous leading universities and a variety of independent researchers and consulting engineers over a 20 year period, including, most recently, Shaw Group's Stone & Webster.

*The Kalina Cycle® is the greatest innovation in power generation technology in over a century.*

The adoption of the Kalina Cycle® is underpinned by a series of operational and economic advantages over alternative power generation technologies.

### Operational Advantages

- Use of existing and proven power plant components
- Underlying principles are simple and understood
- Ammonia has no ozone depleting potential
- Less sensitivity to decreases in heat source temperature
- Safe power plant configuration
- Improved design performance on both hot & cold days

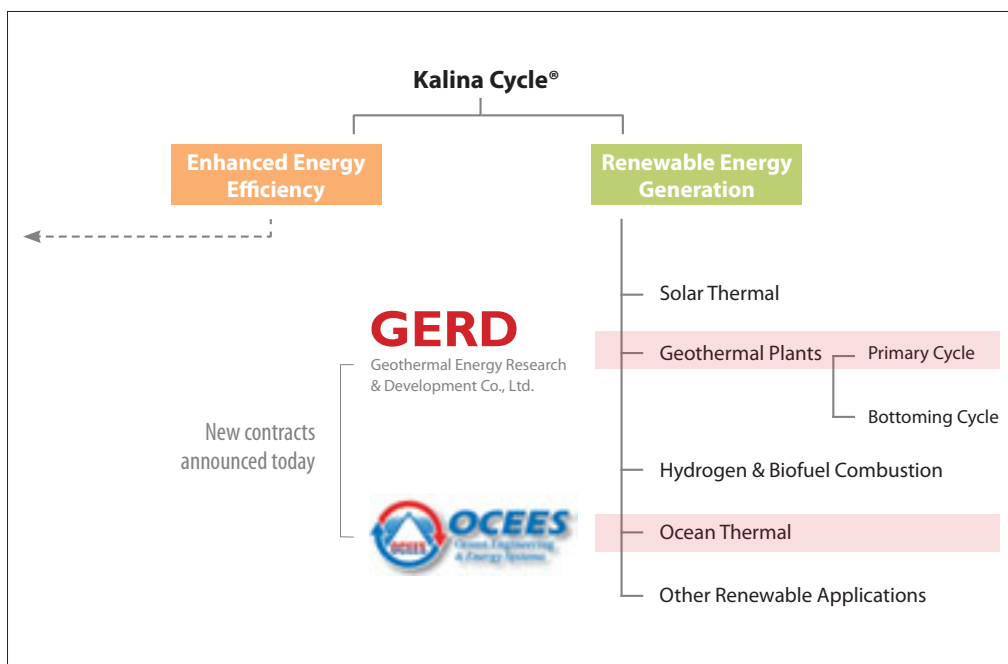
### Economic Advantages

- 10% to 50% more power with the same heat input
- Lower power plant auxiliary loads
- Ammonia is a relatively inexpensive working fluid
- Very high capacity factor with minimal downtime
- Reduced capital cost for fixed output rating
- Optimise plant efficiency with ammonia-water variation

### Global Geothermal's Kalina Cycle®.

*The next-generation, power cycle technology.*

## Segmented Applications for Kalina Cycle® Technology



## Recent Activity

- Commissioned first plant in China in April 2010
- Eco-Gen Box** - as well as pursuing other opportunities
- Actively evaluating geothermal integration projects
- Exploring potential opportunities
- OTEC** - major contract plus pursuing through OCEES
- Actively exploring innovative project opportunities

## Corporate Information

General corporate information regarding Wasabi Energy and the companies Wasabi Energy holds a strategic investment in can be found in this section. Announcements regarding Wasabi Energy corporate developments are made to the Australian Securities Exchange (ASX) and are also available on the Wasabi Energy website. Additional information regarding the investee companies can be found at their respective web sites, details below.



### About Global Geothermal Limited

Global Geothermal Limited (GGL) holds an extensive Kalina Cycle® intellectual property portfolio and is focused on licensing the innovative technology into two core business streams, Enhanced Energy Efficiency (EEE) and Renewable Energy Generation (REG).

In 2007, Global Geothermal Limited, a private company incorporated in the United Kingdom, was established to consolidate the global Kalina Cycle® intellectual property interests, which involved the acquisition of U.S. based engineering firm, Recurrent Engineering LLC, now a wholly owned subsidiary. The initiation of new Kalina Cycle® projects generally requires Global Geothermal Limited issuing a Kalina Cycle® technology license to the project developer, and for Recurrent Engineering LLC to provide the power cycle engineering necessary for the design of the Kalina Cycle® power plant.

Global Geothermal Limited's majority shareholder, Wasabi Energy Limited has been progressively increasing its ownership interest in the Kalina Cycle® technology for over 5 years, through the acquisition of a range of commercial interests and substantial intellectual property portfolios. Wasabi Energy currently holds ~94.9% of Global Geothermal Limited.



### About Wasabi Energy

Wasabi Energy Limited is an Australian Securities Exchange listed public company (ASX:WAS) that holds strategic investments in companies and projects it believes can provide solutions to the world's energy and environmental challenges. Wasabi Energy is actively involved in the management of the respective investee companies and assists in the achievement of critical business milestones, financing growth and ultimately the delivery of results that matter.

Wasabi Energy has recently focused its portfolio of investments into three core business streams, renewable power, sustainable water and renewable biofuels. Each of these core business streams is represented by a strategic corporate investment by Wasabi Energy (Global Geothermal Limited, Aqua Guardian Group and Australian Renewable Fuels, respectively) and has been strategically selected to provide solutions for the key sustainability challenges facing the world.

Additional information:  
[www.wasabienergy.com](http://www.wasabienergy.com)



Wasabi Energy Ownership: 94.9%

[globalgeothermal.com](http://globalgeothermal.com)



Wasabi Energy Ownership: 50%

[aquaguardiangroup.com](http://aquaguardiangroup.com)



Wasabi Energy Ownership: 23.3%

[arfuels.com.au](http://arfuels.com.au)

Renewable power

Sustainable water

Renewable biofuels