



## Marketing Study Identifies Significant Commercial Potential for SuperSand

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Strategic Energy Resources Limited (ASX: SER) is pleased to announce on behalf of our graphene technology subsidiary, Ionic Industries (Ionic), the completion of an independent marketing report on the potential of one of Ionic's innovative graphene-based products, dubbed SuperSand, to participate in the global Activated Carbon (AC) market.

The findings are very encouraging and validate Ionic's decision to make SuperSand the first of its products to be produced by its planned graphene oxide manufacturing pilot plant, for which an engineering study is almost complete, with commencement of construction of the pilot plant earmarked for later in 2015.

A key driver now for Ionic will be engagement with potential customers in the target areas identified in this marketing report and further detailed studies regarding specific markets.

The review was completed by The Freedonia Group, Inc, which has its main headquarters in Cleveland, Ohio, USA and a satellite office in Beijing, China. The Freedonia Group is a leading international business research company that provides critical market research through the publication of more than 400 research studies annually and customized research engagements for clients.

Below is the Executive Summary from the marketing report:

### **Global Activated Carbon Market Assessment**

**Prepared on Behalf of: Ionic Industries**

#### **Section I – Executive Summary**

SuperSand represents a potential substitute or replacement for activated carbon due to larger surface-to-volume ratio, customization for capturing different pollutants, customization of particle/pore sizes and product streams derived from a parent process. SuperSand is expected to provide equal performance at lower cost or better performance at comparable cost. As such, this report provides an overview of the global activated carbon market and potential substitution opportunities for Super Sand.

### Global Activated Carbon Market

- Global activated carbon demand (AC) was 1,550,000 metric tons (\$4.8 billion AUD) in 2014, with overall annual growth projected above 7% through 2019 and above 6% through 2024.
  - PAC (Powdered Activated Carbon) is the primary product of choice, with 2014 demand of 785,000 metric tons (\$2.4 billion AUD). Demand for PAC is projected to grow at a faster rate than overall activated carbon from 2014 to 2019 at 9.4% per year, driven by growth in mercury removal applications in air purification.
  - GAC (Granular Activated Carbon) demand was 725,000 metric tons (\$2.2 billion AUD) in 2014, and is expected to grow at a slower rate than overall activated carbon demand at 4.8% per annum, as it is not used in the fast-growing mercury removal market.
  - Other forms of activated carbon that are used in specialty applications, including chemically impregnated carbons and activated carbon cloth, compose a small portion of overall activated carbon demand (\$.075 million AUD). Demand for these products will increase at a moderate rate of 2.3% per year from 2014 to 2019, due to the high prices of most of these product types.

### SuperSand Market Potential – Addressable AC Segments

The following segments appear to be highly addressable for SuperSand:

- Industrial air purification is expected to overtake water treatment as the largest AC market segment by 2019. Increasing mercury emission regulations will drive this trend, which will be increasingly beneficial to PAC usage.
  - The market for mercury removal, flue gas treatment and other gas phase applications – particularly solvent recovery in coatings, adhesives and printing inks– appears viable for SuperSand as a replacement to AC. SuperSand’s technology to produce different sizes and performance factors could be optimized for each one of these applications. SuperSand’s properties suggest it would be addressable in the mercury removal and solvent recovery markets.
  - Flue gas treatment and mercury removal generally require adsorbents that are effective within the few seconds that it takes the gas to transit through the process, making Super Sand suited because of its surface structure.
  - Solvent recovery requires the ability to differentially absorb molecules of different sizes, and the tailorability of the pore sizes in SS would make it suitable for such applications.
- Population growth with a focus on improved drinking water in developing nations as well as increased regulations in developed areas will have a positive impact on the overall AC market for water treatment. Municipal water treatment is by far the majority, while residential uses make up a small portion of demand.
  - SuperSand appears to fit within GAC water treatment applications due to the large pollutant particle sizes that need to be removed. SuperSand usage may also benefit

applications with a higher loading rate of water in large water treatment systems for removal of synthetic organic compounds.

- Within the food and beverage segment, activated carbon is used in applications such as cane sugar refining, liquid sugar purification, alcoholic beverage purification, fruit juices to remove colorant, biochemical food products to adsorb molasses colorants as well as acids, lactose purification, flavoring decolorization, oils, natural glycerin and decaffeination of coffee or tea. Competing technologies – such as membrane and ion exchange systems – are expected to continue to improve efficiency of filtration, limiting the amount of activated carbon required for treatment in food applications.

- Sweetener decolorization is a potential market for SuperSand, replacing coal-based activated carbon, although the usage rate of activated carbon is slowing as producers are shifting toward alternate technologies that are more efficient. However, activated carbon usage in the food and beverage industry is a mature market, so alternative technology may be adopted slowly in industrialized countries.

These segments appear to be more limited in terms of addressability for Super Sand:

- Demand growth in pharmaceutical and medical applications will be the highest of all liquid phase activated carbon applications through 2019 as output of drugs and medicines increase and manufacturing processing standards improve globally.

- SuperSand appears to have potential to replace GAC in the pharmaceutical space in low-viscosity fluids based on particle sizes. However, the overall pharmaceutical and medical AC market is expanding from a small base compared to other markets, so this would have limited overall potential.

- In the mining industry activated carbon primarily has two main roles, wastewater treatment and precious metal recovery. Demand for activated carbon in the mining industry was 96,000 metric tons and is projected to grow 2.9% per annum from 2014 to 2019.

- SuperSand may be used in mining wastewater treatment – including water tailings – to control the quality of water leaving mine sites and to prevent the release of polluted water into the environment.
- SuperSand's application for the recovery of precious metals might be possible with further R&D. There is potential for a customized SuperSand product.

- Motor vehicles use activated carbon for evaporative emission control systems which are mandated in most countries.

- Evaporation canisters appear to be a potential market for SuperSand due to the requirement for larger pore size to capture hydrocarbons. The canisters are designed to last the lifetime of the vehicle. Further R&D is required for SuperSand in this area with the potential of a customized SuperSand product.

### Competitors (Activated Carbon Manufacturers) and Pricing

- The six largest activated carbon companies are Calgon Carbon, Osaka Gas, Cabot Norit, MeadWestvaco, ADA Carbon Solutions and Kuraray. These six companies represented \$1.731 billion AUD in activated carbon sales in 2014.
- These organizations target multiple end-use markets for activated carbon in both liquid and gas applications with GAC, PAC and other specialized activated carbon products.
- Large activated carbon companies heavily target North America, Asia/Pacific and Western Europe, which are the regions with the largest activated carbon demand.
- Activated carbon prices on average were \$2,550 AUD per metric ton in 2014 and are projected to grow 2.5% per year through 2019.
  - GAC is more expensive than PAC because it is a more capital-intensive product. However, PAC prices are expected to grow at a faster rate through 2019 at 3.4% per annum.
  - Other specialized activated carbon products were almost four times that of average overall activated carbon prices in 2014 on an Australian dollar per metric ton basis. The significant costs of these products will limit their market penetration moving forward.

### Geographic Demand

- Asia/Pacific was the largest region, with 31.7% of 2014 global AC demand. China accounted for 44% of the region's demand in 2014 and is projected to grow the fastest among large countries, at 11.3% per year from 2014 to 2019.
- North America is expected to pass Asia/Pacific by 2019 as the largest region for AC demand due to its above-average growth rate of 8.3% per annum from 2014 to 2019. North American demand will be driven by strong growth in mercury removal applications in the US.
- Western Europe is a relatively mature market for activated carbon because it has among the highest standards for air quality, water treatment and purity of the manufacturing process. Therefore, the region is expected to grow slower than the global average from 2014 to 2019.
- Central & South America, Eastern Europe and Africa & Middle East accounted for 20% of 2014 activated carbon demand. Demand for activated carbon will grow in these regions as their economies expand and standards for air quality and manufacturing processes become more in line with more industrialized countries.

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