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## **Frequently Asked Questions**

### **Q1: What does GSE's LIQUEX® technology do?**

A1: GSE's patented LIQUEX® technology offers a low-tech, economically viable and environmentally sustainable process for hydrocarbon extraction and recovery using a proprietary reagent, GSX®. GSX® has been demonstrated to be highly effective in liquefying, solubilizing and/or extracting bituminous matter in hydrocarbons, including coal, oil sands, and crude oil without the aid of any catalyst, promoter and/or surfactant.

### **Q2: How does the LIQUEX® technology work?**

A2: GSE's LIQUEX® technology is based on an extraction taking place when the reagent for the technology and organic matter, mainly comprising hydrocarbons, come into direct contact with each other, at which time the organic matter dissolves into the reagent. The ex-situ process is conducted by blending a hydrocarbon-containing substance (e.g., coal, oil sands), with GSX® in a mixing vessel to perform extraction. The GSX® extract mixture subsequently undergoes solid-liquid separation to produce a liquid stream and a solid residue. The resulting liquid stream is subjected to liquid-liquid separation (e.g., distillation) to recover the target hydrocarbons as well as the GSX® for future use in the process.

### **Q3: How does the LIQUEX® technology compare to alternative technologies?**

A3: GSE's technology is based on an extraction whereas many alternative technologies are based on a physical dissolution. As a result, GSE's process is highly efficient and effective. The technology is also "low-tech" and "low-severity," making it relatively easy to implement under or near ambient conditions, and requiring less utility resources than many alternatives. GSE's technology is also versatile, capable of being implemented both in situ and ex situ across a wide spectrum of hydrocarbon containing materials.

### **Q4: Why does GSE's LIQUEX® technology work better than alternative technologies?**

A4: The proprietary reagents are recyclable, low in toxicity and volatility, and less costly compared to other known liquefaction, solubilization and/or extraction reagents for hydrocarbons. The proprietary reagent penetrates or diffuses into particles, pieces, blocks or chunks of hydrocarbon-containing substances through their pores at appreciable rates, subsequently releasing the liquefiable, solubilizable or extractable fraction in them often almost completely even under or near ambient temperature and atmospheric pressure.

### **Q5: Is there a limited supply of GSX®?**

A5: Ample quantities of feedstock for GSX® is produced worldwide every year.

### **Q6: What are the benefits of GSE's technology for coal producers?**

A6: For coal production, the benefits of GSE's technology include:

- Expanding the marketability of coal, including lower grade coal, by yielding two higher value-added products;
- Liquefying coal directly without the aid of a catalyst, promoter and/or surfactant;
- Removing the risk of operating coal-liquefaction plants under extremely high temperature and pressure;

- Enhancing the environmental sustainability of the liquefaction process;
- Lowering capital and operating costs compared to alternative coal liquefaction technologies;
- Enabling producers to establish an economically compelling process in light of the recyclability of the reagent as well as the relative simplicity of the technology; and
- Minimizing the required utilities and carbon footprint from the process.

**Q7: What are the benefits of GSE's technology for oil sands producers?**

A7: For oil sands production, the benefits of this technology include:

- Maximizing bitumen extraction, including from lower grade oil sands;
- Minimizing water requirements;
- Reducing energy requirements;
- Significantly reducing extraction time;
- Enhancing the environmental sustainability of the extraction process by substantially decreasing the emission of pollutants and the generation of greenhouse gases, thus resulting in a low carbon footprint;
- Operating a process capable of remedying the existing tailing ponds with concomitant recovery of additional bitumen;
- Enabling producers to establish an economically compelling process in light of the recyclability of the reagent as well as the relative simplicity of the technology; and
- Eliminating the need for diluent to facilitate the transport of extracted bitumen due to the viscosity-reducing property of the reagent.

**Q8: How does GSE's LIQUEX® technology work for coal liquefaction?**

A8: Ground coal is blended with GSE's proprietary solvent, GSX®, in a simple mixing vessel at ambient pressure and temperature to dissolve bituminous material as well as other organic matter from the coal. The resultant mixture undergoes solid-liquid separation to produce a liquid stream and particulate solids. The liquid stream generally consists of GSX®, coal derived liquid (CDL) and moisture from the coal. Depending on the specific coal feedstock, a fraction of heavy metals and/or minerals (i.e., pollutants) may transfer to the liquid extract mixture. If necessary, any pollutants present can be treated with relative ease. GSX® is separated from CDL via distillation for future use in the process. The particulate solids comprises material originally present in the mined coal less the CDL, the majority of moisture and any pollutants not removed during extraction. The process results in two potentially higher value added products: (1) a coal derived liquid comprised mainly of hydrocarbons, and (2) a low moisture solid coal.

**Q9: How does GSE's LIQUEX® technology work for oil sands?**

A9: Oil sands is blended with GSE's proprietary solvent, GSX®, in a simple mixing vessel at ambient pressure and temperature to dissolve bituminous organic matter from the oil sands. The resultant mixture undergoes solid-liquid separation to produce a liquid stream and particulate solids. The liquid stream generally consists of GSX®, bituminous organic matter and water that is inherently present in oil sands. Depending on the specific oil sands feedstock, a fraction of heavy metals and/or minerals (i.e., pollutants) may transfer to the liquid extract mixture. If necessary, any pollutants present can be treated with relative ease. GSX® is separated from the recovered bitumen via distillation for future use in the process. The particulate solids are comprised of sand, clay, trace amounts of bitumen and any pollutants not removed during extraction. GSE's technology is feasible to extract bitumen from both low-grade and high-grade oil sands whereas other technologies cannot process lower grade oil sands economically, i.e., value of bitumen recovered using conventional technologies cannot offset production costs.

**Q10: Are there any environmental issues associated with GSE's technology?**

A10: Under the federal laws and regulations of the United States, GSE does not anticipate that storage, use or disposal of the proprietary reagent, GSX<sup>®</sup>, would trigger onerous or significant environmental compliance issues, provided customary protocols for chemical handling are followed. For purposes of manufacture, import and export, all of the key component chemicals of the GSE proprietary reagent, GSX<sup>®</sup>, were found to be on the USEPA's Toxic Substance Control Act (TSCA) Inventory by name, by an alternative name or by family. Additionally, a third party study of scientific literature of the effects of exposure to the chemical components of GSX<sup>®</sup> for humans, animals and the environment was conducted. The study found the chemicals to be of low toxicity and the use of GSX<sup>®</sup> is not expected to produce untoward effects when proper diligence and care is taken in the handling, transportation, use, and disposal of this product.

**Q11: Is GSE's technology patented?**

A11: GSE has multiple patents granted and pending in the United States and numerous countries around the world for its technologies.

**Q12: What does Green Source Energy<sup>®</sup> provide through its GSX<sup>®</sup> and LIQUEX<sup>®</sup> licensing and consulting services programs?**

A12: The GSX<sup>®</sup> and LIQUEX<sup>®</sup> licensing and consulting services programs provide licenses and related consulting and technology information necessary for implementing GSE's respective proprietary and patented technologies. For example, for coal liquefaction, the LIQUEX<sup>®</sup> services would include engineering, design and operating details and related consulting services for using GSE's proprietary hydrocarbon extraction process and related GSX<sup>®</sup> services necessary to use GSE's proprietary formulation(s) for the application.