



**Thermal Control**

**Energy Conversion**

# Creating Emerging Technologies

## THE HISTORY

*M*ainstream Engineering Corporation is a solutions-oriented research, development and manufacturing firm located in Rockledge, Florida. Founded in 1986, Mainstream was born of aerospace roots as a firm seeking to develop new thermal control and energy conversion technologies for NASA, the Department of Defense and the Department of Energy. The ability to provide fundamental, advanced, university-quality research coupled with leading development and production has created a tremendous demand for Mainstream's innovative products.

## THE FACILITIES

Our advanced engineering labs allow for detailed bench-testing of thermal mechanical components as well as complete systems. We recently added 20 new state-of-the-art laboratories where teams of cross-functional engineers collaborate in a productive environment. All of Mainstream's products are produced on site in a lean manufacturing facility with flexible assembly lines for manufacturing HVAC products, diesel engines, diesel generators and air-conditioning and refrigeration equipment.

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**Imagination is more important than knowledge. For knowledge is limited "to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand."**

**Albert Einstein**

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## THE FOCUS

Mainstream has the ability to provide a complete systems solution to essentially any energy conversion, combustion, biomass conversion, thermal control or heat flux cooling system including high-gravity and microgravity applications. This "subcontracted" R&D expertise provides a technical and cost advantage to the system developer by reducing the size, increasing the capacity and/or improving the reliability of the complete package.

Being solutions-oriented, we transition our applied R&D from fundamental research into useable hardware. Our vast knowledge of energy conversion and thermal control sub-systems allows us to team with large prime contractors or systems integrators who provide requirements for the total system. Cooperation between Mainstream and system integrators is critical to successfully utilize government small business seed funding (such as the SBIR program) for the development of technology or components to support the large primes or system integrators.

Mainstream has the technical expertise to fully transition an innovation from its initial laboratory proof-of-concept experimentation to production hardware and product commercialization.



# Engineering Research & Development

## THE TECHNOLOGY

**M**ainstream develops thermal control and energy conversion products that provide a technological advantage. We perform cutting-edge R&D and introduce it into products that provide real-world solutions. ***We perform basic research today for the needs of tomorrow.*** This approach allows us to explore and develop new innovations, inserting new technology as it matures.

### THERMAL CONTROL

Mainstream's thermal control solutions range from militarized HVAC/R equipment to specialized high-heat-flux cooling systems. Designed specifically to meet the needs of today's war fighters, our ruggedized military equipment withstands severe environments such as extreme temperature, sand/dust and salt-fog as well as other requirements including shock and vibration.

Our fundamental research in two-phase fluid dynamics, heat transfer, and thermodynamics is integrated into high-heat-flux solutions, which include jet impingement, spray cooling, microchannel cooling, and related emerging technologies. These advanced cooling techniques are necessary for solid-state lasers in directed-energy weapons and high-power electronics in radar jamming equipment.

### POWER ELECTRONICS

Mainstream's power electronics R&D group has developed dc-dc, ac-dc, and dc-ac converters ranging in power from 5 W to over 100 kW for fuel cells, turbomachinery, brushless motors, pulse power supplies, inverters, and battery chargers. We have a significant amount of experience working with WBG SiC and GaN devices, which we use to improve the power density and efficiency of power conversion systems.

### ENERGY CONVERSION

Mainstream's energy conversion R&D includes internal combustion engines, gas turbine engines, fuel cells and batteries. Mainstream is capable of developing purpose-built diesel engines for applications ranging from military portable power systems to commercial vehicles. Our component-level development provides system-level performance improvements in terms of fuel economy, emissions, reliability, and wear. We are performing basic research in combustion, emissions, and electro-chemistry.

### TURBOMACHINERY

Mainstream's first turbo-machines were high-efficiency refrigeration compressors. Today, we design, fabricate, test and produce high-efficiency compressors and turbines for refrigeration, air, steam and any other process fluid requiring a customized solution.

### CHEMICAL TECHNOLOGY

Mainstream's chemical technologies support the thermal control and energy conversion fields. We develop methods of creating liquid and gaseous fuels from biomass waste and systems for safely storing fuels for fuel cells. Mainstream also provides custom environmentally-friendly working fluids, fire suppressants and lubricants.

### MATERIALS SCIENCE

Mainstream ventured into the materials science technology arena through the development of innovative methods of producing carbon nanotubes and applying these methods to heat sinks with enhanced surfaces. While continuing to apply carbon nanotube technology (CNT) to other thermal systems as well as batteries, ultra capacitors, sensors and hydrogen storage systems, Mainstream has expanded into non-CNT materials programs focused around metallurgy, composites and hydrogen storage materials. We are also investigating metallic foams and other lightweight structural materials.

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**Mainstream's core philosophy of "stretching the limits of today's technology" is evidenced by our compelling track record of success in the market-place and our commitment to be more than "just good enough."**

***We will always strive for a better solution.***

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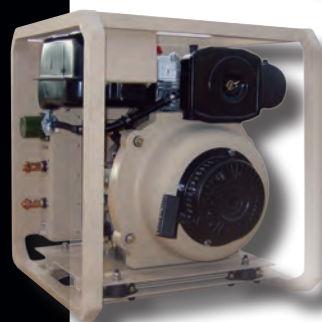
# Production & Manufacturing

## THE PRODUCTS

*B*uilding on Mainstream's success as an R&D company, our products are designed to provide a technological advantage over the competition because our engineers strive to create solutions where none previously existed. We don't produce "me-too" products or "build-to-print" solutions. Mainstream's products are proudly made in the United States, resulting in superior quality.



Modular Refrigeration/  
Freezer Unit [R-410A]



2-kW Electric Generator

Mainstream's product line includes:

**Modular Environmental Control Units (MECUs)**

*Air-conditioning and heating for military shelters*

**Modular Refrigeration/Freezer Units (MRUs)**

*Thermal Control for shipping containers*

**Lightweight Diesel-Engines and Generators**

*Portable power that is lighter and more reliable*

**Qwik Products**

*Heating, Ventilation, Air Conditioning & Refrigeration Products*



Modular Environmental  
Control Unit [R-410A, R290]



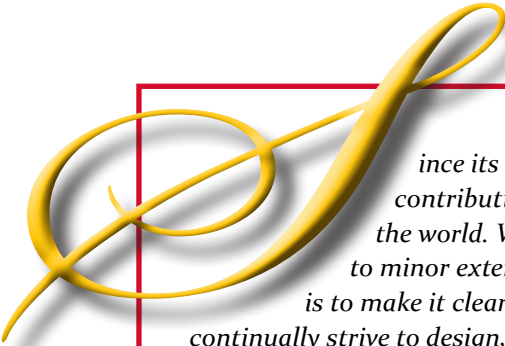
**Mainstream's products are proudly made in the United States, resulting in superior quality.**

## THE SOLUTIONS

- ▶ First vapor-compression refrigeration compressor to be flown on International Space Station
- ▶ First (24,000 RPM) magnetic-bearing, centrifugal compressor-based air-conditioning chiller
- ▶ Smallest, lightest diesel generators in the world
- ▶ Combined RAM-air-powered 60-kW generator and 56-kW cooling unit for the U.S. Navy's EA-18 Next Generation Jamming Pod
- ▶ Rugged modular environmental control units and modular refrigeration/ freezer units for Middle Eastern applications
- ▶ Heat-pump-augmented thermal control system demonstrator for NASA's future Lunar Outpost
- ▶ Compact cooling systems for high-power electronics and high-energy lasers
- ▶ Advanced nanotube-enhanced passive heat transfer surfaces and composites
- ▶ High heat flux cold plates capable of dissipating very high heat fluxes
- ▶ Innovative process to produce liquid fuels from waste products
- ▶ New high-yield method of creating heavy fuel from biomass with conversion efficiencies exceeding 60% (by weight) and organic landfill volume reductions greater than 47% (by volume)
- ▶ Economical and practical technology to convert anaerobic digester off-gas to electric power that also provides a 6x reduction in greenhouse gases
- ▶ New battery and fuel cell technologies



# Mainstream's Guiding Principles



*Since its beginning in 1986, Mainstream has existed to provide a meaningful contribution to our society by performing the best research and engineering in the world. We, as a company, set bold, difficult goals and do not limit these goals to minor extensions of today's technology. My objective, as founder and president, is to make it clear that Mainstream's core purpose is to pursue the impossible, to continually strive to design, develop and manufacture the finest energy conversion and thermal control products in the world, and to lead the world in research in these areas.*

*Mainstream will always be reaching past tomorrow— stretching the technical limits to push today's technology as far as possible— never content with “just good enough.” This achievement can only be accomplished by people who are passionate about their work and enjoy the challenges of achieving dramatic advances.*

*With these daring and ambitious goals will come occasional setbacks. Edison learned thousands of ways “how not to make a light bulb” before he discovered the one way to succeed in making a light bulb work. Setbacks, disappointments and failures are all part of the path to eventual success. Although we don't celebrate failure, we realize failure is inherent in achieving our boldest goals. We must try again and again, always confident that we will eventually succeed. This perseverance is what makes our company great. I will never be upset if we fail; only if we fail to try or simply give up!*

*Mainstream does not exist for the narrow purpose of making a profit, but rather to create and develop technology and product innovations that benefit humankind. Without reasonable profit, we cannot fund the strong initiatives necessary to achieve our goals. Thus, profit is not the end goal, but rather, the means of achieving our core purpose. If we focus on world-class research and continue developing superior products by pushing the technology envelope and treating our employees as our most important asset, then our profits will continue to flow naturally.*

*As Mainstream enters a period of enormous growth, we must maintain our core purpose: to research, develop and manufacture the best thermal control and energy conversion products and technologies in the world. Fulfilling this purpose is why Mainstream exists and will remain at the heart of everything we do.*

**Robert P. Scaringe, Ph.D., P.E.**

**Founder and President of Mainstream Engineering**



# Awards & Honors

- ▶ **SBA Small Business Prime Contractor of the Year Award**  
Regional Winner for Southeastern U.S.
- ▶ **Governor's New Product Award**  
State of Florida
- ▶ **SBA Blue Chip Enterprise Initiative Award** (multiple years)
- ▶ **NASA Technology Commercialization Award**
- ▶ **SBA Tibbetts Award for Commercialization**
- ▶ **U.S. House of Representatives**  
Mainstream's QwikBoost performance additive honorably mentioned on the floor of the House for its role in reducing energy consumption

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