The future is coming and we are here to help you create it. Evolution doesn’t just happen: it takes creative input, vision, and hard work. Energy Evolution LLC is committed to helping provide a better world through better understanding and use of our global energy resources.

- We take a holistic but practical approach by thinking big and working small.
- We provide research, consultation, and training in the areas of energy efficiency, thermal insulation, novel materials, and cryogenic systems.
- We develop and apply innovative approaches for the use of energy-saving technologies.

Debra H. Fesmire is CEO of Energy Evolution LLC. She holds a Bachelor of Science degree in education from Auburn University. She has over 15 years of experience as a Media & Technology Specialist and Teacher with Brevard Public Schools in Brevard County, Florida. Her administration experience includes the deployment of teams of technology training consultants in the area medical care. She has also worked as an educator and a certified coach for childbirth. She brings a wealth of talent and abilities for bringing together the right people, choosing the optimum path for the project, and balancing all the necessary steps to achieve a successful end result.

James E. Fesmire is founder and President of Energy Evolution LLC with a focus on thermal energy systems and materials. He is also Sr. Principal Investigator and founder of the Cryogenics Test Laboratory at NASA Kennedy Space Center for novel energy technology and materials research. He holds a Master of Science in Mechanical Engineering (Materials Science) from the University of Central Florida and Bachelor of Mechanical Engineering from Auburn University.

- Over 35 years of experience in the field of cryogenics and low-temperature problem solving.
- Cryogenic systems design work for the Space Shuttle, the International Space Station, future moon and Mars exploration, experimental rocket programs, commercial space launch vehicles and facilities, superconducting power, hydrogen storage and delivery, and a wide range of commercial and industrial applications.
- Extensive publications and patents in the area of thermal insulation systems, novel materials, and cryogenic testing.
Recipient of NASA medals for Distinguished Service, Exceptional Technology Achievement, Silver Achievement, and Exceptional Service; R&D 100 award and Space Technology Hall of Fame medal for aerogel insulation technology.

Our combined expertise of training, research, and engineering, with a professional network approach, will help define and solve your problem. *What are the barriers to implementation of new technology?* There are many, but we work to bring together the three essential ingredients for success: knowledge, value, and motivation.

**Services:**
- Consulting, teaching, and technical training
- Research and development (thermal systems, materials, and cryogenics)
- Litigation consulting and expert witness
- Marketing, product development, and patents
- Design, prototype construction, and physical testing
- Writing, technical reports, and proposals

**Target Areas:**
- Energy efficiency in construction and end product applications
- Engineering and technical consensus standards for thermal systems and materials
- Hydrogen for transportation and multi-use energy infrastructure
- Heat management for superconducting power cables, magnets, and devices
- Cold chain shipping and distribution of food and pharmaceuticals
- Thermal management in biological systems and medical equipment
- Commercial space launch systems, vehicles and facilities

**Contact Us:**
Phone: 1.321.385.7505
Email: debra@321energy.us
Email: james@321energy.us

**Technical Publications:**
[https://www.researchgate.net/profile/James_Fesmire/contributions](https://www.researchgate.net/profile/James_Fesmire/contributions)

*Energy Efficient Cryogenics – We're cold but we care!*
JAMES E. FESMIRE
President, Energy Evolution LLC
Telephone: 1.321.385.7505  Email: james@321energy.us

OBJECTIVE: Cryogenic Systems, Materials Research, Experimental Testing, and Problem-Solving

AREAS OF EXPERTISE:
- Cryogenic storage, transfer, and process control (LHe, LH₂, LN₂, LO₂, and LNG)
- Low temperature (from 4 K to 400 K) materials science and problem-solving
- Experimental research, approach, methodology, and apparatus
- Thermal insulation systems research, testing, and application
- Specialty in non-metallic materials including polymers, coatings, composites, and aerogels
- Energy efficient solutions for propellant/cryofuel systems, construction, and refrigerated transport
- Cryocoolers and cryogenic refrigeration for transportation, power, and scientific applications
- Prototype design, fabrication, testing, and analysis
- Pressure vessels and piping systems design, fabrication, testing, ASME Codes
- High vacuum, leak detection, and flow measurement technologies & methods
- Team leadership and technical management
- Research and writing of proposals, patents, and papers
- Education and training in cryogenics and vacuum systems design and operation
- Technology strategy, implementation, marketing, and business case development
- Communications, outreach, and policy in energy efficiency and technical standards

PROJECTS AND INITIATIVES:
- Leader of two international industry teams in technical standards development under ASTM International Committee C16 for cryogenic thermal insulation systems data, test methods, and equipment, and engineered applications resulting in comprehensive standard guides, ASTM C1774 & C740.
- Founder, team-builder, mentor, educator, academia collaborator, industry consultant, innovator, and technical leader of the Cryogenics Test Laboratory at NASA Kennedy Space Center.
- Co-Principal Investigator for Department of Energy three-year grant to advance hydrogen fuel cell technologies by a novel cryogenic composite tank approach and technologies to build an integrated insulation system prototype to meet heat leak targets of cryogenic hydrogen storage tanks for commercially produced fuel cell powered automobiles.
- Technical guidance and key contributor to the Simulated Propellant Loading System team for field testing new cryogenic components and operations technologies and utilization as a test bed for developing health monitoring and autonomous control software for launch pad control systems.
- Technical guidance and key contributor to the Ground Operations Demonstration Unit for Liquid Hydrogen team for advanced, energy-efficient cryogenic operations with large-scale integrated refrigeration for zero boiloff storage, liquefaction of gaseous hydrogen, and densification of LH₂.
- Multilayer insulation (MLI) systems testing and materials research for cryogenic spacecraft tanks and launch complex piping resulting in an extensive library of thermal data and technical know-how.
- Designing, developing, and testing different thermal insulation system prototypes and materials for Earth, Moon, and Mars surface cryogenic storage & transfer resulting in over 3,000 reported test data points dozens of publications for a wide range of Government, academic, and industry customers.
- Team leader (including US Navy and Department of Energy personnel) under a Department of Homeland Security grant to develop cryogenic insulation systems and advanced manufacturing for long flexible cryostats in high-temperature superconducting power applications.
• Principle Investigator of $3M multi-center research project for the NASA Space Operations Mission Directorate, *New materials and technologies for cost-efficient storage and transfer of cryogens,* to develop innovative thermal insulation systems for large-scale tanks and pipelines.

• Co-Principle Investigator of $2M multi-center research project for the NASA Space Operations Mission Directorate, *Technologies to increase reliability of thermal insulation systems,* to develop integrated high temperature to low temperature material systems. Leader of NASA-wide team *Thermal Insulation Systems Group* for integrated thermal systems development.

• Developed extensive, active laboratory capability based on a family of cryogenic boiloff calorimeters (cryostats) for thermo-physical properties of materials, fluid properties and control, two-phase transport, surface effects, evaporation processes, and heat transfer measurements.

• Founded the Cryogenics Test Laboratory at Kennedy Space Center for applied research & development and cryogenic technology innovation through national and global collaboration.

• Built a unique Government-Academia-Industry partnership approach, with a discipline area strategy, to collaboration for near-term problem-solving and long-term research goals.

• Leader of joint research programs with industry companies including 3M, Chart-MVE, Cabot, Lydall, Aspen Aerogels, Technip, Polyglass, and many others to develop thermal materials or systems for higher performance, reduced life-cycle costs, or to enable new capabilities.

• Team leader under a Department of Energy grant to develop cryogenic multilayer insulation systems for high-temperature superconducting power applications.

**ACCOMPLISHMENTS AND PROBLEM-SOLVING:**

• Designed and tested proof-of-concept for a new hybrid thermal insulation system for space launch vehicle upper stage, liquid hydrogen (LH$_2$) tanks, windward side, showing dramatic performance improvements for long-term on-orbit storage of cryogenic propellants (one week versus hours).

• Designed and built a cold helium heat exchanger inside a liquid hydrogen tank (125,000 liters) for integrated refrigeration system in future cryofuels applications.

• Co-inventor of hybrid aerogel composite materials for multifunctional thermal and structural applications in passive thermal management architectures (5 US Patents).

• Designed and constructed multiple cryostat instruments for insulation materials testing, pipelines, and tanks thermal performance testing (8 US Patents).

• Pioneer in aerogel technology development, *Flexible Aerogel Superinsulation,* through research partnership with Aspen Systems, resulting in R&D 100 Award and Space Technology Hall of Fame.

• Inventor of layered composite insulation systems for extreme environments which was successfully implemented on space launch facility cryogenic piping as well as the *Shuttle ET Liquid Hydrogen Vent* umbilical disconnect.

• Developed breakthrough aerogel-based insulation system to eliminate liquid nitrogen formation within *Shuttle ET Liquid Hydrogen Intertank* and help solve foam loss problems in flight.

• Developed novel aerogel-based insulation system for reducing ice formation on the *Shuttle ET Liquid Oxygen Feedline* bellows.

• Developed aerogel-based insulation system for reducing ice formation on the *Shuttle ET Liquid Hydrogen Vent* umbilical disconnect.

• Inventor of test method for determining moisture uptake in foam materials subjected to below-ambient temperature conditions and showed that closed cell foams can double their weight in water in a cryogenic tank space launch vehicle configuration.

• Designed cryogenic umbilical panel layouts (LO$_2$, LH$_2$, GN$_2$, and GHe) for the X33 vehicle along with new functional interface approach to cryogenic supply systems for efficient fluid servicing.

• Developed cryogenic system concepts for servicing new launch vehicles such as Shuttle-C, HLLV, SEI, NLS, Shuttle LRB, EELV, and RLV/X-33.

• Technical leader, fluids, of RLV/X-33 propellant densification (LO$_2$ and LH$_2$) technology development.

• Designed, developed, and tested a wide range of cryogenic valves, connectors, and devices for propellant loading systems (1 US Patent).

• Leader of Center-wide study of propellant system interface connections for safety improvements.
• Designed and tested liquid oxygen pumping and transfer system modifications for Space Shuttle Return-to-Flight (Challenger) with Space Shuttle Main Engine experts in vibration analysis.
• Designed, tested, and analyzed new vehicle interface flexhose assembly for Space Shuttle LH2 vent umbilical system including use of new Hastelloy material and manufacturing methodologies.
• Lead engineer for Space Station Freedom design project, Cryo Carrier Loading System.
• Co-inventor of novel cryogenic umbilical quick disconnect targeted for robotic resupply in space.

PROFESSIONAL AFFILIATIONS:
• Board of Directors member and Past-President, Cryogenic Society of America
• Member of Commission A1 (cryophysics/cryoengineering), International Institute of Refrigeration (IIR)
• Past Board of Directors member and past Program Chair, Cryogenic Engineering Conference (CEC)
• Member of ASTM International, Committee C16 on Thermal Insulation (chair of 3 Task Groups)
• Member of International Standards Organization ISO TC67/SC9 Liquefied natural gas equipment
• Member of Tau Beta Pi, Pi Tau Sigma, and Phi Kappa Phi, Auburn University

AWARDS & RECOGNITIONS:
• NASA Silver Achievement Medal, 2017
• ASTM International, Committee C16 on Thermal Insulation, Award of Appreciation, 2016
• NASA Space Flight Awareness Award, Densified Propellant Tiger Team, 2016
• NASA Group Achievement Award, Ground Operations Demonstration LH2 Team, 2015
• International Space Foundation, Space Technology Hall of Fame, Flexible Aerogel Technology, 2012
• NASA Distinguished Service Medal, 2011
• NASA Exceptional Technology Achievement Medal, 2009
• NASA Exceptional Service Medal, 1999
• NASA Engineering & Safety Center (NESC) Director’s Award for Engineering Excellence, 2005
• NASA Kennedy Space Center Director’s Gold Dollar Ace Award, 2005
• R&D 100 Award, Flexible Aerogel Superinsulation, with Aspen Aerogels, 2003
• NASA Silver Achievement Medal, Space Technology Mission Directorate, 2014
• NASA Engineering & Safety Center, LOX Feedline Bellows Ice Prevention Team, 2005
• NASA Kennedy Space Center, Certificate of Commendation, 2008
• United States delegate to the 20th International Congress of Refrigeration, Sydney AUSTRALIA, 1999
• NASA KSC Director’s Gold Dollar Award, Thermal Insulation Systems patent, 2006
• NASA KSC Director’s Gold Dollar Award, Thermal Insulation Testing Method and Apparatus patent, 2005
• NASA KSC Director’s Gold Dollar Award, Apparatus for Thermal Testing of Pipelines patent, August 2004
• NASA KSC Director’s Gold Dollar Award, Methods of Testing Thermal Insulation patent, 2004
• NASA KSC Director’s Gold Dollar Award, Multi-purpose Insulation Test Apparatus patent, 2003
• NASA Kennedy Space Center, Certificate of Commendation, 2003
• NASA KSC Director’s Gold Dollar Award, Continual Improvement, Cryogenics Testbed team, 1999
• NASA KSC Cryogenics Test Laboratory Team, STS-114 return-to-flight, 2006
• One NASA Peer Award, Maptis II Team, Marshall Space Flight Center, 2006

PUBLICATIONS AND PATENTS: (see listings A-G)
• Author or co-author of over 200 papers, publications, and patents
• Author or co-author of 16 US Patents and 7 Patents Pending (see listing A)
• Author or co-author of 73 refereed articles in the area of cryogenic engineering (see listing B)
• Author or co-author of 69 non-refereed articles in technical magazines or conference proceedings (see listings D & E)
• Author or co-author of 45 articles in NASA Research & Technology Report publications (see listing F)
• Presentations, university lectures, and seminars given worldwide including United Kingdom, The Netherlands, Japan, South Korea, Poland, Australia, France, Canada, and USA (see listing G)
• Best Paper Award, *Cryogenics* journal, Space Cryogenics Workshop 2007, for the paper entitled *Aerogel insulation systems for space launch applications*
• Author or co-author of dozens of NASA-accepted New Technology Reports (15 in the last 2 years)

**PROFESSIONAL EXPERIENCE:**

• 03/2015 to present, NASA Exploration Research & Technology Programs, Kennedy Space Center, Sr. Principal Investigator – Cryogenics, Head Researcher – Cryogenics Test Laboratory
• 11/2011 to present, Energy Evolution LLC, President and Founder
• 02/2008 to 03/2015, NASA Engineering & Technology Directorate, Kennedy Space Center, Sr. Principal Investigator, Cryogenics Test Laboratory
• 10/2005 to 01/2008, NASA Applied Technology Directorate, Kennedy Space Center, Principal Investigator, Cryogenics Test Laboratory
• 05/2000 to 10/2005, NASA Spaceport Engineering & Technology Directorate, Kennedy Space Center, Florida, Lead Engineer, Cryogenics Testbed
• 01/1988 to 05/2000, NASA Engineering Development, Kennedy Space Center, Florida, Senior Engineer in the Cryogenic Systems Group
• 03/1983 to 12/1987, NASA Design Engineering, Kennedy Space Center, Florida, Engineer-trainee in the Propellants and Gases Branch, Cryogenics Section

**EDUCATION:**

• Master of Science in Mechanical Engineering (Materials Science), University of Central Florida, 1992
• Bachelor of Mechanical Engineering, with *High Honor*, Auburn University, 1987
ATTACHMENTS

PATENTS, PUBLICATIONS, AND PRESENTATIONS

A. Patents
B. Refereed Publications
C. Refereed Publications Pending
D. Non-Refereed Journals / Technical Magazines
E. Papers / Conference Proceedings / Software
F. NASA/KSC Research & Technology Annual Reports
G. Selected Presentations and Seminars
A. Patents

B. Refereed Publications


C. Refereed Publications Pending

1. Fesmire, J. E., “Aerogel-Based Insulation Materials for Cryogenic Applications,” International Cryogenic Engineering Conference, Oxford University, United Kingdom, 2018

D. Non-Refereed Journals / Technical Magazines


E. Papers / Conference Proceedings / Software


F. NASA/KSC Research & Technology Annual Reports


G. Selected Presentations and Seminars


20. Georgia Institute of Technology, Atlanta, Georgia USA, “Insulation 101 Workshop” for the Academic Cold Chain Forum – Food and Pharmaceutical, seminar, April 2012.


