Methane Observation Networks with Innovative Technology to Obtain Reductions – MONITOR

PROJECT DESCRIPTIONS

Bridger Photonics, Inc. – Bozeman, MT

Mobile LiDAR Sensors for Methane Leak Detection - $1,496,564

Bridger Photonics will develop a light-detection and ranging (LiDAR) system capable of rapid and precise methane measurements resulting in 3D topographic information about potential leak locations. A novel near-infrared fiber laser will enable long range detection with high sensitivity and can be deployed on a range of mobile platforms to survey multiple sites per day. This mobile LiDAR system will dramatically reduce the cost to identify, quantify, and locate methane leaks compared to currently available technologies.

IBM – Yorktown Heights, NY

On-Chip Optical Sensors and Network for Methane Leak Detection - $4,500,000

IBM will develop new low-cost optical sensors and integrate them in a distributed sensor network to enable enhanced methane leak detection from natural gas systems. The optical sensors will use on-chip tunable diode laser absorption spectroscopy (TDLAS) enabled by shortwave infrared silicon photonics technology. The team will leverage IBM's capabilities in advanced communication, networking, and analytics to create an ultra-low-power sensor network with custom models for source localization; the network approach can also incorporate diverse sensor technologies such as catalytic chemical sensors and long path optical sensors. This proposed self-organized network will enable a significant cost reduction to identify, quantify, and locate methane leaks compared to currently available technologies.

Rebellion Photonics – Houston, TX

Portable Imaging Spectrometer for Methane Leak Detection - $4,250,000

Rebellion Photonics will miniaturize a long wavelength infrared imaging spectrometer that is lightweight and highly portable. The image will contain multiple bands of spectral data for detection and characterization of methane leaks. The data will be processed using a cloud-based computing architecture that will stream results to mobile devices. The imager's low cost and high portability will allow for widespread deployment while mobile integration will provide increased awareness of leaks for faster leak repair.

Physical Sciences, Inc. – Andover, MA

UAV-based Laser Spectroscopy for Methane Leak Detection - $2,948,420

Physical Sciences will develop a complete system for methane detection based on a novel infrared backscatter technique. The system will exploit lightweight mid-infrared lasers, operate in multiple modes, and be mounted on a small unmanned aerial vehicle (UAV) to provide continuous perimeter monitoring and aerial surveillance for precise leak localization. This system will dramatically reduce the cost to identify, quantify, and locate methane leaks compared to currently available technologies.

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Palo Alto Research Center – Palo Alto, CA

Printed Carbon Nanotube Sensors for Methane Leak Detection - $3,395,164

Palo Alto Research Center (PARC) will create novel printed sensor arrays and integrate them into a system that can quantify and locate methane leaks. The team will use a variety of modified carbon nanotube (CNT) sensors to build a sensor array that provides a unique methane "fingerprint" resulting from the responses of each sensor in the array. The novel CNT sensor arrays offer a low-cost solution to identify, quantify, and locate methane leaks compared to currently available technologies.

Aeris Technologies – Redwood City, CA

Miniaturized Tunable Laser Spectrometer for Methane Leak Detection - $2,400,000

Aeris Technologies will build a miniaturized spectrometer with low power requirements to provide a robust solution for continuous leak monitoring for methane at natural gas production sites. The team will combine their mid-infrared sensor with a leak quantification algorithm based on advanced dispersion modeling and artificial neural networks. This system will be able to identify, quantify and locate methane leaks at a much lower cost compared to currently available technologies.

LI-COR – Lincoln, NE

Fixed Cavity Mode Spectrometer for Methane Leak Detection - $2,700,000

LI-COR will develop a low-cost optical sensor for methane based on a unique cavity mode spectrometer. The sensor will have minimal calibration requirements enabled by advanced software controls and a simplified hardware design. In addition, cost will be dramatically reduced by eliminating the need for expensive optical components. This project will produce a robust, highly sensitive, low-cost sensor to identify, quantify, and locate methane leaks from natural gas systems.

Maxion Technologies, Inc. – Jessup, MD

Tunable Mid-infrared Laser for Methane Sensing - $1,900,122

Maxion Technologies will develop a low cost, widely tunable, mid-infrared laser source to be used in systems to detect and quantify methane emissions. The design targets a strong methane absorption region currently accessible only by expensive lasers, and will improve the sensitivity and selectivity of optical methane sensors. The design allows for a 40x reduction in laser source cost, and the wide tunability will allow the same laser design to be shared across many applications, further increasing economies of scale and reducing costs. When incorporated into a methane detection system, this technology will enable significant reductions in the cost associated with identifying, quantifying, and locating methane leaks compared to currently available technologies.

General Electric Company – Niskayuna, NY

Microstructured Optical Fiber for Methane Sensing - $1,438,866

GE Global Research will use a novel microstructured optical fiber as part of an infrared spectroscopic system to detect and quantify methane emissions. The hollow optical fiber will utilize a microstructured design that allows permeability to methane but maintains low-loss propagation of light over long distances. The design allows identification of the location of methane leaks along the length of the fiber, which provides significant flexibility in deployment. When fielded as a full methane detection system, this technology will enable significant reductions in the cost associated with identifying, quantifying, and locating methane leaks compared to currently available technologies.

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The University of Colorado – Boulder, CO

Frequency Comb-based Methane Sensing - $2,125,470

The University of Colorado at Boulder will develop a reduced-cost frequency comb system for detection of methane over kilometer distances. Frequency combs are extremely sensitive, precise, and stable tools for spectroscopic identification of natural gas constituents. The planned dual frequency comb spectrometer will be able to distinguish methane, ethane, and propane, as well as methane with different carbon isotopes for differentiating biogenic and geologic methane sources. When employed as a full methane detection system, this technology will enable significant reductions in the cost associated with identifying, quantifying, and locating methane leaks compared to currently available technologies.

Duke University – Durham, NC

Miniaturized Coded Aperture Mass Spectrometer for Methane Sensing - $ 2,943,669

Duke University will build a miniaturized, coded aperture mass spectrometer for methane sensing. The coded aperture enables high resolution and high throughput in a compact device. The mass spectrometer design will be optimized for methane, and will provide the ability to distinguish between methane with different isotopic signatures for differentiating biogenic and geologic methane sources. Additionally, the sensor will identify other molecules that are common constituents of natural gas, as well as hazardous aromatic compounds such as benzene. The miniature mass spectrometer can be readily deployed and will dramatically reduce the cost to identify, quantify, and locate methane leaks compared to currently available technologies.

Delivering Efficient Local Thermal Amenities – DELTA

PROJECT DESCRIPTIONS

Syracuse University – Syracuse, NY

Micro-Environmental Control System - $3,199,963

Syracuse University will develop a near-range micro-environmental control system transforming the way office buildings are thermally conditioned to improve occupant comfort. The system leverages a high-efficiency micro-scroll compressor, in a micro vapor compression system, whose evaporator is embedded in a phase-change material. This material will store the cooling produced by the micro vapor compression system at night, releasing it as a cool breeze to make occupants more comfortable during the day. This micro-environmental control system could save more than 15% of the energy provided for heating and cooling.

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State University of New York at Stony Brook – Stony Brook, NY

Electroactive Smart Air-Conditioner VEnt Registers (eSAVER) for Improved Personal Comfort and Reduced Electricity Consumption - $2,049,260

The State University of New York (SUNY) at Stony Brook will develop an active air conditioning vent capable of modulating airflow distribution, velocity, and temperature to create localized thermal envelopes around building occupants. SUNY Stony Brook's smart vent will modulate the airflow using an array of electro-active polymer tubes that are individually controlled to create a localized curtain of air to suit the occupant's heating or cooling needs. The team estimates this will result in upwards of 30% energy savings through directed localization of existing building heating/cooling output.

Cornell University – Ithaca, NY

Thermoregulatory Clothing System for Building Energy Saving - $2,996,807

Cornell University will develop thermoregulatory materials that enable the expansion of the neutral temperature band for buildings in both heating and cooling seasons. The team's approach integrates advanced textile technologies and state-of-the-art electronics into a functional design without compromising comfort, wearability, washability, appearance, or safety. The thermoregulatory clothing system will sense the wearer's skin temperature and activate a heated or cooled airflow around the individual, reducing the energy required to heat or cool the building itself.

Stanford University – Stanford, CA

Photonic Structure Textiles for Localized Thermal Management - $2,381,500

Stanford University will develop transformative methods for integrating photonic structures into textiles. Controlling the thermal photonic properties of textiles can significantly influence the heat dissipation rate of the human body, which removes a significant amount of heat through thermal radiation. The team will leverage advances in photonic structures to build textiles with varying amounts of infrared transparency and reflectivity to enable a wearer to achieve comfort in a wider temperature range.

University of California at Berkeley – Berkeley, CA

Heating and Cooling the Human Body with Wirelessly Powered Devices - $2,618,462

The University of California at Berkeley will develop and integrate highly resonant wireless power transfer technology for office workstations to deliver efficient local cooling or heating to the feet, hands, face, and trunk of occupants. The team will leverage innovations in the development of low-power, wireless charging systems for consumer electronics and integrate these devices with local comfort devices such as heated shoe insoles and cooled and heated office chairs. This combination will lower building heating and cooling requirements by providing personal comfort without special clothing, large batteries, or tethered equipment.

University of Maryland – College Park, MD

Meta-Cooling Textile with Synergetic Infrared Radiation and Air Convection for Bidirectional Thermoregulation - $3,082,002

The University of Maryland will develop a thermally responsive fabric that extends the skin's thermoregulation ability to maintain comfort in hotter or cooler office settings. To provide cooling in hotter surroundings, the meta-fiber in the fabric will increase its infrared emissivity and shrink to open pores in the fabric to increase ventilation. In cooler conditions, these effects are reversed to increase the garment's ability to insulate the wearer. The added bidirectional regulation capacity will expand the thermal comfort range, thereby lowering the heating and cooling requirements for buildings.

Otherlab – San Francisco, CA

Passive Thermo-Adaptive Textiles with Laminated Polymer Bimorphs - $1,840,000

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Otherlab will develop a synthetic, thermally adaptive textile that incorporates a unique micro-patterning of fibers comprised of multiple materials in unique geometries. The construction of the textile optimizes the collective behavior of its fibers to amplify the thermally induced changes in an individual fiber, thus providing a greater range of insulation in response to temperature changes. Textile wearers will require fewer layers of clothing in a broader range of temperatures, effectively lowering the heating and cooling requirements for buildings. Beyond apparel, this textile technology will enable energy reductions in other applications, such as upholstery and bedding.

University of California at San Diego – San Diego, CA

Adaptive Textiles Technology with Active Cooling & Heating (ATTACH) - $2,600,000

University of California at San Diego will develop a smart responsive fabric that enables building occupants to adjust their personal temperature settings and promote thermal comfort to reduce or eliminate the need for building-level air conditioning. The project exploits a unique fabric architecture that can modulate its porosity or thickness to adjust thermal transport between the wearer and the surrounding environment. This fabric will increase or decrease its insulation value when ambient temperature decreases or increases, respectively, and along with other built-in printable and flexible components, allowing personal thermal comfort over a wide range of temperatures and reducing energy use for heating and cooling buildings.

SRI International – Menlo Park, CA

Wearable Electroactive Textile for Physiology-based Thermoregulation - $3,853,907

SRI International will develop a highly efficient, thermal regulation system that works alongside the human body's natural thermal regulation. This innovative technology uses a combination of low-cost polymer materials and micro-scale heating or cooling devices to efficiently manage heat transfer. The palms of the hands, soles of the feet, and the upper facial area have extensive blood vessel networks that serve as heat exchangers for the body. To leverage these areas for effective thermoregulation, the proposed textile system will be used to create versatile garments and accessories. SRI's design overcomes the limitations of existing approaches to locally heating and cooling individuals by leveraging the human body's thermal regulatory system.

The University of California at Irvine – Irvine, CA

Thermocomfort Cloth Inspired by Squid Skin - $2,400,000

The University of California at Irvine will develop a dynamically tunable thermoregulatory fabric. This fabric will leverage established heat-managing capabilities of materials like metalized mylar and color-changing polymers inspired by squid skin. The technology will provide wearers with the unique ability to adaptively harness their own individual radiant heat production to significantly reduce the energy required to heat and cool buildings.

University of Maryland – College Park, MD

Robotic Personal Conditioning Device - $2,590,788

The University of Maryland will develop a mobile platform to provide personalized cooling to individuals. This platform will contain a small, battery-powered, high-efficiency vapor compression heat pump to provide localized air conditioning as needed during the day while dumping stored heat and recharging batteries at night. The highly portable nature of the platform and accompanying sensor and control system will allow it to be optimally placed to improve personal comfort and reduce the energy required to cool buildings.

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