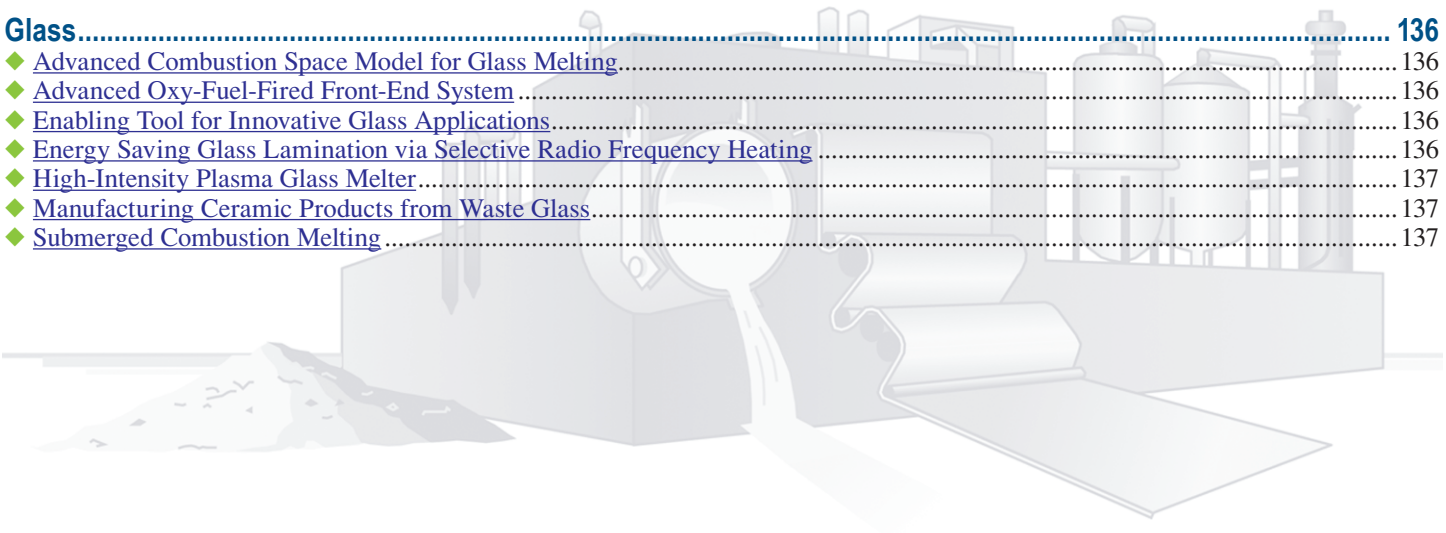
Appendix 2:
ITP Emerging Technologies



ITP Emerging Technologies

IMPACTS

IMPACTS

ITP Emerging Technologies

Aluminum

Direct Chill Casting Model

(www.secat.net)

The direct chill (DC) casting process is used for 68% of the aluminum ingots produced in the United States. Ingot scraps from stress cracks and butt deformation account for a 5% loss in production. The interaction of the DC process is too complex to analyze by intuition or practical experience. A new DC casting model is being developed to increase the general knowledge of the interaction effects and should lower production losses to 2%. The model will provide insights into the mechanisms of crack formation and butt deformation, and will help optimize DC process parameters and ingot geometry.

Chemicals

Acetic Acid Manufacture by the Selective Photocatalytic Oxidation of Ethane

(www.kse.net)

Acetic acid is used as a chemical reagent for producing numerous plastics, synthetic fibers, and fabrics, as well as polymers and esters in manufacturing adhesives, paints, inks, and varnishes. Currently, carbon monoxide (CO) and methanol are used to produce acetic acid, but CO production wastes raw materials and generates greenhouse gas emissions. This project will develop a UV photocatalytic technology that improves the oxidation of ethane to acetic acid at high selectivity. The technique is more energy efficient, does not require high temperature and pressure, and does not over-oxidize the hydrocarbon raw materials to carbon dioxide. The technology can potentially be used in a wide range of chemical oxidation reactions, reducing energy use and greenhouse gas emissions in the chemical industry.

Affinity Ceramic Membranes with CO_2 Transport Channels

(www.mediaandprocess.com)

Compared with more conventional separation processes, membrane separation processes offer several advantages, including increased energy efficiency, compact design, and operational flexibility. Numerous unexploited applications exist for advanced separations in aggressive environments that rely on a membrane's affinity to a specific chemical as opposed to traditional molecular sieving. Highly selective thermally/hydrothermally stable inorganic membranes offer a solution to these difficult industrial separation applications.

Ammonia Production Using Pressure Swing Adsorption

(www.smartkoncept-tech.com)

A new process is being developed that will enable the energy-efficient production of ammonia. Pressure swing adsorption (PSA) technology will increase ammonia yield, reduce natural gas feedstock use, significantly lower energy consumption, and offer capital cost savings compared with traditional cryogenic methods. The PSA process is scalable and can be applied to retrofit existing ammonia plants or to build new field plants. It enables on-demand ammonia production eliminating the need to transport and store at power plants large amounts of ammonia, which is classified as a hazardous chemical by OSHA. The technology has applications in NO_x and CO_2-reducing technologies in the chemical industry and at power plants.

IMPACTS

Chemicals
(continued)

Concurrent Distillation
(www.utexas.edu)
The Trutna Tray (Co-Flo Tray) improves the performance of distillation and absorption trays by using a co-current flow design. Compared with the conventional sieve tray, the co-current tray increased production capacity by more than 100% without sacrificing separation efficiency. Three tray variations have been pilot-tested using an industrial-scale distillation column. The de-entraining section of the Co-Flo Tray is routinely used by the UT Austin's Separation Research Program in all of its air/water and caustic scrubbing studies. The special collector design and the enhanced liquid/vapor separation capability offer great potential for future de-entraining applications.

Dimpled-Tube Heat Exchangers
(www.gastechnology.org)
A project to improve the thermal efficiency of convective sections of industrial fired-process heaters demonstrates that a dimpled-tube technology will significantly improve the energy efficiency of fired-process heaters and will reduce fouling rates. The heat-transfer enhancement approach uses a tube surface with a system of three-dimensional cavities (dimples). Cost-effective enhancement occurs because intensive vortex flow patterns are generated by cavities and provide intensive heat and mass transfer between the surface and the flowing media. A pilot-scale dimpled-tube test unit at a participating refinery increased heat flow by 50% to 60% compared with traditional tubes and reduced pressure drop by 30% to 40%.

Distillation Column Flooding Predictor

(www.2ndpoint.com)
A new control technology more accurately identifies incipient floods in petrochemical distillation and separation columns. The Flooding Predictor, a patented pattern recognition technology, allows a column to be operated at or near the incipient flood point. The technology identifies patterns of transient instabilities that occur just before flooding events. Identifying the incipient flood point allows the control objective to be shifted from delta-pressure to the actual flood point. Shifting the control objective virtually eliminates column flooding events, while increasing throughput

Chemicals
(continued)

Electrodeionization for Product Purification
(www.anl.gov)
This technology combines the advantages of ion exchange (an adsorption technology) and electrodialysis (a membrane separation) for a wide range of potential applications in the chemical industry, including direct production and separation of products, product purification and desalination, salt waste recovery, and water recycling. Targeted applications include organic acid production, dextrose desalination, ultrapure water production, product polishing, and waste salt recovery.

Heat Integrated Distillation Using Microchannel Technology
(www.velocys.com)
A new technology using compact equipment is being developed to reduce distillation capital cost and increase energy efficiency. Microchannel process technology enables highly efficient mass transfer, resulting in process intensification. The technology also integrates heat transfer with fractionation, eliminating the need for external heat exchange equipment. Microchannels can be used to target heat loads at precise locations in the equipment, which can be tailored to individual distillation stage requirements. Heat load tailoring reduces wasted energy to improve overall distillation efficiency. This technology will likely have initial applications in the separation of high-value materials.

High Octane Fuel-Stocks via Engineered Solid Acid Catalysts
(www.exelusinc.com)
High octane alkylate, an ideal clean fuel component for reformulated gasoline, is currently made using toxic liquid acid catalysts such as hydrofluoric acid. A commercially viable and environmentally superior alternative to conventional liquid-acid alkylation processes is being developed called the ExSact process. This pilot-tested process uses benign, engineered, solid-acid catalysts coupled with an innovative reactor design to produce high-octane gasoline. Low energy consumption and production of fewer by-products compared to existing technologies result in significant savings in operating costs.

Chemicals
(continued)

Low Cost Chemical Feedstocks Using a Natural Gas Liquid (NGL) Removal Process
(www.gastechnology.org)
Conventional NGL recovery technologies, such as cryogenic turbo-expanders, are highly energy intensive and expensive to operate, requiring low temperatures and substantial energy to recompress the processed gas back to the pipeline pressure. A new technology is being developed that is a low-cost and much more energy-efficient NGL recovery process that can be commercialized by the natural gas industry. Once commercialized, this technology has the potential to save up to 200 trillion Btu per year by 2020, reduce the cost of NGL separation from natural gas, and provide cheaper feedstocks to the chemical and petrochemical industries.

Low Emission Diesel Engines
(www.compactmembrane.com)
Diesel engine exhaust is a major source of NO_X pollution. The formation of NO_X in diesel engines is dependent on the combustion temperature, which can be affected by the engine cylinder charge. An innovative membrane is being developed to adjust the cylinder charge and reduce the NO_X emissions by delivering nitrogen-enriched air (NEA) to the diesel engine. The NEA system can reduce NO_X formation in diesel engines by 50%.

Microchannel Reactor System for Hydrogen Peroxide Production
(www.fmc.com)
Newly developed reactors allow for on-site, on-demand generation of hydrogen peroxide (H_2O_2) and reduce the costs of transportation, storage, and dilution associated with conventional H_2O_2 production methods. Microchannel reactors possess extremely high surface-to-volume ratios and exhibit enhanced heat and mass transfer rates. The unique design allows for the peroxide-generating reaction to occur at H_2 concentrations above 5% without the risk of combustion. In addition, the reactor's low-pressure operating conditions maximize energy efficiency and safety.

Chemicals
(continued)

Novel Membrane Reactor
(www.compactmembrane.com)
Various industrial processes, from pharmaceutical production to polymer formation, involve organic reversible reactions among acids, aldehydes, ketones, alcohols, and amines. Researchers are developing a cost-effective, robust membrane with universal applicability in almost any organic-water environment for potential separation of the reaction water. In contrast to existing membrane technologies that have significant temperature and chemical limitations, the extremely high ruggedness of the new membrane would improve stability under harsh operating conditions, be able to withstand high temperatures when used with reactive chemicals (130°C or higher), and have high water permeability.

Process Intensification through Multifunctional Reactor Engineering
(www.cdtech.com)
An innovative process is being developed to increase energy efficiency and profitability in the chemical industry. Large-scale pulse flow reactor technology enables high-efficiency contacting and therefore increased mass transfer between fluid phases. The initial target application for this technology is the alkylation of olefins with isobutane to produce a high-octane gasoline blendstock. The pulse flow reactor will significantly reduce operating costs compared with conventional high-shear mixing that uses large-scale impellers. The novel reactor design also could benefit many other processes across the chemical industry, particularly those using liquid catalysts.

Purification Process for Purified Terephthalic Acid (PTA) Production
(www.gtctech.com)
A novel purified terephthalic acid (PTA) production process using a two-step crystallization technique promises to make a significant economic impact on the PTA industry. The process operates at lower pressure and temperature, significantly reducing energy consumption, and enables the use of lower purity, lower-cost para-xylene feedstock. The process uses a highly selective, proprietary organic solvent blend that allows for bromine-free oxidation, which eliminates the environmental problems caused by methyl bromide and the high cost of corrosion-resistant specialty alloys used in construction materials.

IMPACTS

Chemicals
(continued)

Scalable Production of Fermentation-Derived Acetic Acid
(www.anl.gov)
Half of the 2.3 billion pounds of U.S. acetic acid production is used in manufacturing vinyl acetate monomer (VAM) and is economical only in very large production plants. Nearly 80% of the VAM is produced by methanol carbonylation, which requires high temperatures and exotic construction materials and is energy intensive. Fermentation-derived acetic acid production allows for small-scale production at low temperatures, significantly reducing the energy requirement of the process.

Solid Catalyzed Isobutane/Olefin Alkylation
(www.precision-combustion.com)
Alkylate is used in the petrochemical industry as an additive to improve gasoline combustion efficiency. Recent emphasis on reducing emissions and oil consumption has increased the number of applications using this additive, and demand for alkylate has risen. Alkylate production uses an acid-based alkylation process that requires significant energy intensive pre- and post-plant level processing of input reactants and spent output materials. The spent materials are flammable and acidic and, while a large portion is recycled back into the process, incur environmental/health risks and handling costs. This project will develop an environmentally friendly catalytic system that uses a durable zeolite-based solid catalyst that eliminates the use of liquid acids and their associated cost-intensive handling and processing. The new catalyst system also improves the service life of the solid catalyst by reducing polymerization on the catalyst's surface (a life-limiting factor in previous solid catalyst reactors), which improves yield and energy consumption and decreases capital and operating costs.

Solution Crystallization Modeling Tools
(www.olisystems.com)
Reliable simulation of crystallization requires accurate modeling of many factors. A new modeling tool synthesizes several essential elements, at least one of which has been only crudely approximated in previously available tools. This new modeling tool helps chemical engineers to better predict and control the crystal size distribution. It also improves the understanding of the effects of mixing and spatial variation of temperature and composition on the product quality, and ultimately will optimize crystallization efficiency. The resulting enhanced computational fluid dynamics capabilities are also applicable to a range of industrial applications beyond crystallization.

Forest Products

Biomass Fractionation
(www.purevisiontechnology.com)
Biomass fractionation effectively separates lignocellulosic biomass into useful intermediate components, including cellulose fiber, xylose-rich syrup, lignin, and biogrowth media. The high-purity, high-yield cellulose fiber is available for efficient hydrolysis to glucose or for pulp applications. The glucose and xylose syrups can be converted to ethanol, butanol, and many other chemicals. The sulfur-free, highly depolymerized lignin can be converted to biofuels or can be used directly as boiler fuel. The low-toxicity, extractives-rich liquor is a suitable biogrowth media to produce a yeast co-product for animal feed protein markets and for biocatalyst propagation. The flexibility of the process provides a hedge against the volatile fuel market and allows for future technological upgrades to higher-value fuels, chemicals and other co-products.

Decontamination of Process Streams through Electrohydraulic Discharge
(www.ipst.gatech.edu)
In recycling paper, "stickies" cause considerable downtime and require costly minerals and polymers to be added for handling and detackifying them during the recycling process. A new mechanical method - pulsed power technology - is being demonstrated at several recycling mills to replace these costly chemicals. This technology uses a shock wave, developed from a spark discharging under water, to diffuse the stickies and create hydroxyl radicals from water, which oxidizes the stickies. This oxidation causes the stickies to lose their tack and become benign, thus allowing recycling to continue unimpeded.

Forest Products
(continued)

Direct Causticizing for Black Liquor Gasification in a Circulating Fluidized Bed
(www.ipst.gatech.edu)
A new direct causticizing process is being developed that saves energy and increases the profitability of pressurized black liquor gasification (PBLG). The process performs the causticizing step in situ during BLG by applying titanates to the liquor in a pressurized circulating fluidized bed reactor. Complete direct causticizing eliminates the traditional lime cycle, saving both fossil energy and money compared with using energy-intensive lime kilns. The synthesis gas product from PBLG can be applied to either combined cycle power generation or liquid fuels such as mixed alcohols or Fischer Tropsch diesel, increasing the efficiency of the chemical recovery process while producing fuel feedstock or electricity.

Directed Green Liquor Utilization (D-Glu) Pulping
(www.ncsu.edu)
Increases in the rate and selectivity of kraft pulping without incurring major capital costs will increase the economic return of the pulp and paper industry. A high sulfidity pretreatment of wood chips is one of the most promising and low capital means to achieve these increases. Green liquor is easily accessible in a kraft mill and has a naturally high sulfidity (rich in hydrosulfide ions), which is critical for accelerating pulping and providing a high value product. Researchers have discovered ways to reduce pulping time and energy requirements through the intelligent application of green liquor in the digester.

Fibrous Fillers to Manufacture Ultra-High Ash/Performance Paper
Mineral fillers that increase paper brightness and opacity and improve paper print quality have reduced costs by replacing wood fiber. However, filler loading has been limited to 15% to 20% because higher loading levels cause a loss of sheet strength and bulk as well as "dusting" during printing. A new fibrous filler technology has been developed that may overcome these problems and replace high-cost wood fiber. The new fillers will ultimately produce a composite paper containing up to 50% ash, with equal or better performance characteristics than conventionally attainable paper. The new technology will also lead to better retention of fillers, additives, and pulp fines, significantly reducing biological and chemical oxygen demands in the mill process water.

Forest Products
(continued)

Gas-Fired Drum Dryer
(www.gastechnology.org)
A new paper dryer is being developed and pilot-scale tested to significantly increase the efficiency of papermaking. The Gas-Fired Paper Dryer (GFPD) is a natural-gas-fired system that uses a combination of a flame sheet and dimpled pattern on the drum's inner surface to improve combustion stability, reduce pollutant emissions, and cost-effectively enhance heat transfer from combustion products to the paper web. This patented approach could be implemented into new or existing equipment. The GFPD will ultimately help the paper industry (especially drying limited mills) reduce energy use and increase the production rate of paper machines by 10% to 20%.

Innovative Back Surface Reflector for High-Efficiency Infrared Paper Drying

(www.creare.com)
An innovative back surface reflector (BSR) that will dramatically improve the efficiency, quality, and throughput of the papermaking process is being developed. Electric infrared (IR) dryers with current BSR technology suffer from extremely low energy efficiency, using only 10% of the input power supplied to an IR dryer to dry the paper; the rest is lost as waste heat. The new BSR design dramatically increases the percentage of input power that is absorbed by the paper sheet, decreasing energy costs and increasing product quality and throughput.

Low Temperature Plasma Technology for Treating VOC Emissions
(www.drexel.edu)
Pulp mills and wood product plants are under increasing pressure to control the emissions of volatile organic compounds (VOCs) generated during their operations. The present-day control technology – regenerative thermal oxidizers – is energy-intensive and depends on combustion technologies that heat the entire waste stream. An emerging technology using nonthermal plasmas can selectively and cost effectively destroy VOCs by producing excited species (free radicals and ions) that oxidize, reduce, or decompose pollutant molecules.

IMPACTS

Forest Products
(continued)

Materials for High-Temperature Black Liquor Gasification
(www.ornl.gov)
New black liquor gasification technology with combined-cycle cogeneration of steam and electricity can increase energy output for the forest products industry. However, high inorganic salt concentrations and high temperatures significantly degrade refractory materials and metallic components. Improved refractories and wear-resistant nozzle materials are being developed to enable high-temperature black liquor gasification units to attain a longer service life. These improvements will reduce operating downtime and increase energy production and support the use of black liquor gasification.

Microwave Pretreatment Technology for Chemical Pulping
(www.ornl.gov)
A new technology is being developed that improves both economic and environmental performance in chemical pulping processes. Microwave pretreatment is an energy-efficient technology that enhances the ability of pulping chemicals to pass easily into wood chips. In addition to directly reducing the energy required to pulp wood, microwave pretreatment decreases the amount of natural gas required to operate the lime kiln and decreases process chemical usage. The technology allows larger and/or more diverse chip sizes to be pulped and increases pulp mill throughput.

Novel Isocyanate-Reactive Adhesives for Structural Wood-Based Composites
(www.vt.edu)
Laminated veneer lumber (LVL) is a wood composite that is produced by bonding thin wood veneers together and is used for various wood construction applications. The current LVL manufacturing process is energy intensive, using adhesives that require extensive wood drying (to moisture contents of 6% to 8%) and high-temperature hot-pressing (~200°C). An alternative isocyanate-reactive that cures at room temperature (cold-setting) and is optimized for higher veneer moisture content promises significant energy savings. This new technology will also sharply reduce volatile organic compound emissions and improve product appearance and durability.

Forest Products
(continued)

Oxalic Acid Technology
(www.biopulping.com)
As shown in pilot-scale tests, a short pretreatment of different types of wood chips with varying amounts of a dilute solution of oxalic acid saves electrical energy (20% to 30%), improves paper strength properties, and reduces resin content by 30% prior to mechanical pulping. The pretreatment also removes hemicellulose from wood chips, which could then be converted into value-added chemicals, including cellulosic ethanol. Based on pilot-scale results and the rising costs of electricity and the purchased price of softwood bleached kraft used in making paper, companies have expressed interest in evaluating this technology further.

Pulse Drying of Paper Pulp
(www.wavedry.com)
Paper manufacturing begins with wet pulp fibers that are progressively shaped, dewatered, and dried through evaporation into finished products. Virtually all paper manufacturing production is limited by the evaporative drying stage. The most common air drying process is impingement evaporation, where hot gas jets blow on the wet paper web. However, pulse impingement drying improves efficiency of this process by 59% and speeds overall paper production by 21%. Pulse drying of paper webs applies directly to "Yankee" and "MG" style paper drying equipment, and indirectly to newsprint, box board, and finer grades of paper.

Screenable Water-Based Pressure Sensitive Adhesives
(www.franklinadhesivesandpolymers.com)
A new family of water-based pressure sensitive adhesives (PSA) that greatly increase the amount of paper products recoverable for recycling was developed and is being marketed. Screens can easily remove the new PSAs early in the paper recycling process. These products have an environmentally friendly impact by reducing the amount of high-grade paper going to landfills. In addition, eliminating waxes and adhesive contaminants from recycled pulp will greatly reduce costly process problems and increase final product quality in the paper industry.

Forest Products
(continued)

Steam Cycle Washer for Unbleached Pulp
(www.ptpc.com)
A new commercial-scale steam cycle washer is being developed to increase profitability by substantially reducing energy consumption, improving fiber and product quality, and ensuring that environmental compliance exceeds current regulations. This steam-pressurized, high-consistency pulp washer will enhance pulp industry profitability by allowing most pulp mills to reduce electrical power consumption for unbleached pulp production by up to 21%, evaporator load by 50%, and plant effluent and fresh-water usage by 45%.

Glass

Advanced Combustion Space Model for Glass Melting
(www.anl.gov)
Improved understanding and modeling of the combustion process in glass melting will result in innovative furnace designs that will have higher combustion and furnace efficiencies, minimized pollutant formation (primarily NO_X reduction), and improved glass quality.

Advanced Oxy-Fuel-Fired Front-End System
(www.owenscorning.com)
A consortium of companies involved in the glass industry has developed the Advanced Oxy-Fuel-Fired Front-End System. A combination of burner modeling and bench trials was used to develop a burner and block that generate the appropriate size and shape of flame for optimal heat transfer distribution. This will result in reduced energy use and decreased CO_2 emissions. The new burner system can be integrated into a front-end system with capital costs that are competitive with a conventional air/gas system. Full-scale installation and testing are under way in a Tennessee glass plant.

Enabling Tool for Innovative Glass Applications

(www.imp.mtu.edu)
Flat architectural and automotive glasses have traditionally been fabricated using technologies that have inherent cutting limitations because they are generally incapable of fabricating glass products with small radii, concave edges, or pierced holes. A new technology uses waste glass as a low-cost media for abrasive water-jet cutting of glass and other materials. This technology can refine and automate the glass manufacturing process while reducing the number of stages and equipment required to produce intricate glass products. Other waste materials can also be used.

Energy Saving Glass Lamination via Selective Radio Frequency Heating

(www.ceralink.com)
A new technique for glass lamination is being developed that will save significant amounts of energy and increase throughput. Traditional glass lamination involves bonding two or more sheets of glass with vinyl interlayers, which wastes large amounts of energy to get heat through the glass to the vinyl, where the heat is desired. The new technology heats the vinyl directly using a single-step radio frequency process. The new process will dramatically decrease the lamination time and will result in significant energy savings across the U.S. laminated glass industry.

IMPACTS

Glass
(continued)

High-Intensity Plasma Glass Melter
A high-intensity plasma glass melter was developed with a square-foot-per-ton-per-day throughput index that is significantly smaller than commercial glass melters. This plasma technology package increases the systems' energy efficiency and reduces emissions. To achieve this high throughput and high quality, the system uses a dual-torch transferred arc-plasma technology, a rotating melt chamber to increase melt rate, skull melting to eliminate the need for a refractory lining and to reduce contamination of the glass from refractory and electrode components, and state-of-the-art control technology to provide stable conditions.

Manufacturing Ceramic Products from Waste Glass

(www.haunlabs.com)
Ceramic products have traditionally been processed from raw materials that require high firing temperatures and energy-intensive processing steps. A new technology lowers energy costs by substituting raw materials with recycled waste glass. Products manufactured by this new method are less sensitive to contaminants in the glass and can be made from difficult-to-recycle green or mixed-color container glass waste. Firing temperatures can be reduced by as much as 37%, lowering energy costs and CO_2 emissions. The technology has been used to design a low-cost highly-automated manufacturing process for producing ceramic tile from large volumes of waste glass. High-quality ceramic tile with competitive specifications has been processed from 92% to 100% recycled glass with a wide range of colors and surface textures. The technology has been applied to several types of glass, including post-consumer container, flat and lamp glass, and industrial fiber-glass waste streams.

Submerged Combustion Melting
(www.gastechnology.org)
A consortium of companies developed a high-intensity glass melter based on the submerged combustion melting technology. This melter serves as the melting and homogenization section of a segmented, lower-capital-cost, energy-efficient Next Generation Glass Melting System. This technology will potentially increase efficiency, lower capital costs, provide more flexible operation, and lower emissions.

Metal Casting

Cupola Furnace Process Model
A comprehensive mathematical model of the cupola furnace, a type of furnace used to melt iron that is subsequently cast into a variety of products, is being enhanced and updated. The model was incorporated into a user-friendly artificial-intelligence program that can help optimize the temperature, processing time, and other key variables of furnace operation. This improved operation results in energy savings, product quality enhancement, and waste reduction.

In-Situ Real Time Monitoring and Control of Mold Making and Filling Processes
(www.tntech.edu)
Two of the major R&D priorities of the metalcasting industry are reduction in scrap and variation in casting quality, with a target 40% reduction in scrap by 2020. In the past few decades, mold making technology has significantly improved, resulting in a reduction of scrap. Researchers are targeting improvements in lost foam casting and green sand casting. The results of this effort will provide an innovative approach to introduce technologies for real-time characterization of sand molds and lost foam patterns and the monitoring of the mold-filling process.

Integrating Rapid Solidification Process Tooling and Rapid Prototyping in Die Casting
In this project, a new and unique Rapid Solidification Process (RSP) technology will be introduced to the tooling industry to reduce lead time for prototyping and producing dies. In addition to increased productivity, the RSP tooling technology will substantially increase tool life while reducing energy use and scrap compared with conventional machining practices. Tools have been produced for the die casting, plastic injection, investment casting, glass forming, and forging industries.

ITP Emerging Technologies

Metal Casting

(continued)

Lost Foam Casting Technology

(www.uab.edu/engineering)

Lost foam casting is a highly flexible process suitable for casting metal components with complex geometries. Research supported by ITP has led to a greater understanding of the process and to new control measures. These will increase foundry energy efficiency and reduce scrap. Emerging technologies from the ITP-supported research include: in-plant quality assurance procedures to measure casting parameters; real-time x-ray apparatus which allows visualization of the metal/pattern replacement process; and an apparatus for measuring pattern permeability (fusion) which is a major factor in the replacement process.

Process to Recover and Reuse Sulfur Dioxide in Metal Casting Operations

(www.adsorption.com)

Sulfur dioxide (SO_2) is used as a catalyst in forming cold-box molds and cores in the metal casting industry. The SO_2 is typically used once, scrubbed with a caustic solution, and then discarded (flushed to sewer or sent to a waste treatment facility). This new process recovers the SO_2 for reuse by processing it through a pressure-swing adsorption system that is expected to recover at least 95% of the SO_2. Using this process will reduce energy consumption, eliminate the need for caustic effluent, and pay back costs in less than 1 year

Mining

Drill-String Radar Navigation for Horizontal Directional Drilling

(www.stolarhorizon.com)

Horizontal drilling in a coal seam can relieve methane gas trapped in a coal bed, increasing the safety of coal miners and supplying methane, a desirable resource. Gamma sensors, currently used for horizontal drilling, cannot withstand the vibration of the drill and require additional costly drilling steps. Instead of gamma sensors, drill-string radar transmits radio waves and measures their reflection to identify boundary rocks, reducing vibration sensitivity and allowing real-time measurement while drilling. This technology will reduce the risk, cost, and time required for extraction.

GranuFlow™ Process in Coal Preparation Plants

The GranuFlow technology involves adding a binding agent such as an asphalt emulsion to a slurry of coal and water prior to mechanical dewatering. The binding agent agglomerates the fine-sized coal, increasing its capture during mechanical dewatering, thereby reducing coal loss to impoundments. The GranuFlow treatment also reduces moisture content, alleviating downstream handling, dusting, and freezing problems.

Grinding-Mill Optimization Software

(www.mines.utah.edu)

Millsoft 3D is simulation software for visualizing the charge motion in semi-autogenous mills and ball mills used in the mining industry. The software also provides various quantitative information, such as power, forces on the mill lifters, and wear. The three-dimensional code uses the discrete element method to model the individual collisions of ball and rock particles. The software handles mills of all sizes and can be used for shell lifter design and energy optimization of SAG mills.

IMPACTS

Mining
(continued)

High-Temperature Superconductors in Underground Communications
(www.lanl.gov)
Underground communications are important for the mining industry, urban first-responders, and others who frequently work underground. The through-the-earth radio system can increase underground mining production by improving communication and eventually allowing orientation and position information, which can benefit both an individual miner and a mining machine. Most importantly, fast wireless communication improves underground mining safety through early response to problems. A new system has been built using conventional copper and semiconductor designs and higher-performance superconducting designs. Using superconducting materials in underground communications equipment increases the range and clarity of through-the-earth wireless networks.

Novel Dry Coal Deshaling Mobile Unit
(www.eriez.com)
A new dry deshaling technology removes materials with high-ash content prior to loading and further coal cleaning. The new coal-cleaning unit provides high-density separation near the extraction point or working face of a mining operation. The system requires no water, facilitating easier product transportation and waste material hauling. These features enable mine personnel to remove waste rock and minimize coal losses to the rejection stream. This new method reduces land impacts and waste emissions while lowering capital and operating costs.

Real-Time Coal/Ore-Grade Sensor
(www.resonon.com)
Various project partners helped in the development of a real-time coal content/ore-grade sensor for exploration, mining, and processing operations. The project used the unique spectral characteristics of coal and ore to quantify coal content and ore grade in real time. The sensor would be suitable for both surface and underground mining operations either at the working face or where mined material is being processed. This feature would allow for greater selectivity and would decrease environmental impacts and energy requirements in exploration, mining and processing activities.

Mining
(continued)

Soft (Unfired) Ceramic Particles via Dynamic Cyclone Classification
(www.novafilter.com)
Many industrial processes involve the separation of particles from an airstream. The mining industry, in particular, has indicated a need for improved separation methods and reduced waste. In this technology, the particles are separated and transported by boundary layers and induced airflow vorticity near a stack of rotating (slightly separated) disks, which minimizes particle impact and attrition, as well as component wear. The dynamic cyclone classifier offers substantial potential for indirect energy savings by reducing the amount of off-spec product processed to achieve the same amount of product output. Smaller scale devices, operating under the same separation principles, can generate sharp particle classification cuts below 10 microns and are targeted for the pharmaceutical/neutriceutical, food/additives, cosmetic and specialty chemical markets.

Steel

High Quality Iron Nuggets Using a Rotary Hearth Furnace

A new process, that was demonstrated in a pilot plant, is an iron making technology that uses a rotary hearth furnace to turn iron ore fines and pulverized coal into iron nuggets of similar quality as blast furnace pig iron. The new technology will be able to effect reduction, melting, and slag removal in only about 10 minutes. The process is a simple one-step furnace operation that requires less energy, capital, and operating costs than existing pig iron technology. Consequently, high-quality iron product can be produced at a substantially lower cost.

Hot Oxygen Injection into the Blast Furnace

(www.praxair.com)

A new injection system has been developed to directly inject hot oxygen in blast furnace tuyeres. Material and energy balances on the blowpipe/raceway zone of the blast furnace have shown that injecting ambient temperature oxygen offers little overall benefit, whereas injecting hot oxygen offers several mechanisms for improving burnout. This process increases coal injection rates and reduces coke consumption. Consequently, direct injection of hot oxygen into blast furnace tuyeres improves operating cost, energy consumption, and emissions.

Metallic Iron Nodule Technology in Electric Arc Furnace Steelmaking

(www.umn.edu)

Scrap steel substitutes are becoming increasingly valuable for material currently used in electric arc furnace smelting because of lower production costs. A novel approach is investigating ways to process available raw materials into a value-added, high quality iron feedstock product at a lower total cost. By overcoming furnace and feedstock limitations, high-quality steel scrap substitutes are being produced, increasing final steel quality produced in electric arc furnaces, and reducing overall production costs.

Steel
(continued)

Next Generation Heating System for Scale-Free Steel Reheating

(www.e3minc.com)

A new system is being developed that reduces scale (iron oxide) formation in the steel reheating process. The technology employs fuel-rich combustion using preheated or oxygen-enriched air to control flue gas composition. This process substantially reduces energy use and costs associated with the handling, disposal, and reprocessing of scale. Reducing scale formation increases product yield and revenue by saving high-value steel that is currently lost as scale. Scale-free reheating improves productivity by reducing downtime and manpower to collect and remove scale from reheating furnaces. In addition, reducing scale from final rolled products may improve product quality and reduce metallurgical defects that require reprocessing.

Non-Chromium Passivation Techniques for Electrolytic Tin Plate

(www.steel.org)

Two previously identified non-chromium passivation treatments for electrolytic tin plate are being compared in a plant trial to determine their commercial viability. These new techniques will replace the existing cathodic dichromate treatment method that is facing environmental use restrictions. In addition, continued use of chromate treating solutions will result in ever-increasing operating costs.

Optical Sensor for Post-Combustion Control in Electric Arc Furnace Steelmaking

(www.steel.org)

This project is developing an optical sensor for electric arc furnace steelmaking based on measuring off-gas temperature and carbon monoxide, carbon dioxide, and water vapor concentrations. The remote-sensing optical instrument is based on tunable infrared-laser technology and will provide input signals for control and optimization of oxygen use and post-combustion emissions. This new technology will also address needs for improving energy use and developing automated process controls.

IMPACTS

Steel
(continued)

Optimizing Blast Furnace Operation to Increase Efficiency and Lower Costs
(www.purduecal.edu)

A key component to the smelting process in iron making is the blast furnace (BF) where recent concerns have been raised about suitable coal supply, energy efficiency and emissions. Improvement can be achieved by burning pulverized coal versus metallurgical or coke coal. Understanding the parameters that affect BF efficiency and productivity will become crucial as pulverized coal use increases and energy conservation is mandated. The complexity of a BF's materials burden and output gas distribution effects on productivity and stability are known but not fully understood. This project has developed software which can simulate BF behavior utilizing computational fluid dynamics. The software predicts BF gas distribution by including fluid flow and chemical kinetics as well as other fundamental BF operation parameters. Optimized BF operation for a given fuel injection rate and efficiency can be calculated and the resulting gas distribution compared to process monitoring data thus enabling improved BF efficiency and productivity and lower emissions.

Processing Electric Arc Furnace (EAF) Dust into Salable Chemical Products
(www.drinkardresearch.com)

This unique technology will hydro-metallurgically process EAF dust into saleable products. EAF dust is oxidized and digested in acid and then treated by a series of individual steps to isolate and retrieve individual components of the dust.

Regeneration of Hydrochloric Acid Pickling Liquor
The PHAR® hydrochloric acid regeneration system is an innovative method of regenerating spent hydrochloric acid from steel pickling. Conventional pickling technology generates 1.5 billion gallons of spent pickle liquor nationwide each year, resulting in costly and energy-intensive handling, treatment, and disposal. This new technology eliminates the disposal problem, significantly reducing operating, environmental, and capital costs. The process uses sulfuric acid to restore hydrochloric acid for reuse. Salable ferrous sulfate heptahydrate is a by-product.

Steel
(continued)

Steel Foam Materials and Structures
Metal foams with high levels of controlled porosity are an emerging class of ultra-lightweight materials receiving increased attention for a broad range of applications. Steel foams produced via a powder metallurgy process are about 50% lighter than conventional steel materials and can be produced as monolithic foams, as foam-filled tubular structures, and in sandwich panel geometries. The efficient energy-absorption characteristics of steel foams can increase safety in commercial and military vehicles. The light weight can improve operational efficiency and competitiveness in shipbuilding and rail systems. These foams can also be recycled and reproduced, as well as produced from recycled metal scrap. Additional process scale-up development is required to position steel foams for production readiness and commercialization.

Crosscutting Technologies

Advanced CHP System Utilizing Off-Gas from Coke Calcination

(www.gastechnology.org)

Calcined coke is a key component used in the iron, steel, and aluminum industries. Over the past few years, because of increased use of heavy oil grades, the sulfur content of green petroleum coke has increased by up to 7%. To reach a required sulfur content level (<2.5%) in the final calcined product, the green petroleum coke with high sulfur content requires higher temperatures and longer processing times for desulfurization versus that needed for calcination of the low-sulfur coke (<4%). As a result more excess heat and emissions are released to the environment, operating costs are increased, and more expensive materials and components are needed. The new technology aims to cost effectively utilize waste heat (both sensible and chemical) from the green petroleum coke calcination process in a fluidized bed. The recovered waste heat is converted into electricity and process steam, thereby reducing energy consumption and pollutant emissions.

Advanced Diagnostics and Control for Furnaces, Fired Heaters and Boilers

(www.dow.com)

Fired heaters account for about 37% of U.S. manufacturing energy end use. One of the most important issues in efficiently operating fired heaters is to minimize the excess air from the combustion system because the excess air wastes heat from the combustion process by sending it out the stack to the atmosphere. To minimize excess air, current practice is to measure oxygen; however, the ideal control point is at an excess oxygen level just above CO breakthrough (indicative of fuel rich conditions). An accurate and representative CO measurement can determine the setpoint for excess oxygen control, which is typically referred to as "CO trim control." With only oxygen analysis, the setpoint for control is fixed (based on design information + safety margin) and typically higher than the optimum; adding CO measurement can essentially measure where the excess air setpoint should be, independent of system conditions. This project seeks to develop and ultimately commercialize the measurement of oxygen and CO in the firebox and to develop a control strategy for ethylene furnaces. The ultimate benefit could be a 1% to 2% reduction in U.S. fired heater energy consumption.

Crosscutting Technologies
(continued)

Advanced Membrane Separation Technologies for Energy Recovery

(www.ornl.gov)

Recovering energy from lower-temperature waste streams represents a significant savings' opportunity but is technically challenging and has only been done with very limited success. To operate efficiently at lower temperatures, heat exchangers need a large surface area and are often too complex and cost prohibitive to integrate into existing systems. New separation membrane materials are being developed for use in a transport-membrane-condenser technology for recovering heat and water. The porous ceramic membrane condenses water and recovers heat from the waste stream. The new materials will be cost effective, efficient, durable, and resistant to corrosion and membrane fouling. This system has proven successful at laboratory scale and has the potential to recover waste heat in various industries or any application involving exhaust streams containing at least 15% moisture.

Advanced Nano-Composites for Increased Energy Efficiency

(www.ameslab.gov)

This technology is a new cost-effective family of industrial-scale process materials, which increase energy efficiency and the operating lifetime of wear-intensive industrial components and systems. Degradation of materials not only reduces energy efficiency of industrial processes, but lowers the nation's overall industrial competitiveness. Because every material wears or degrades to some extent during normal use in industrial environments this technology will result in greatly improved usable tool life, faster and more efficient pumping speeds, higher reliability in severe service valves, and decreased replacement costs and downtime.

Advanced Process Heater

(www.spin-works.com)

An innovative design combines the most advanced radiant tube heat transfer components into one high-performance package for industries that require high-performance heating. The advanced process heater (APH) incorporates a heat exchanger, burner, and flame holder with a traditional metallic radiant tube. Using time-proven, inexpensive composite material technology, the APH will provide superior heat transfer rates and thermal efficiencies compared with current equipment. In addition, the APH improves temperature uniformity by 50°F to 100°F while reducing NO_x and CO_2 emissions.

IMPACTS

Crosscutting Technologies
(continued)

Carbon Films for Next Generation Rotating Equipment Applications
(www.uic.edu)

Two super-low-friction carbon surfaces, Near Frictionless Carbon (NFC) film, and a carbon surface converted from carbide, Carbide Derived Carbon (CDC), have been combined to achieve extended wear life and higher energy savings in rotating-equipment applications. Results indicate that CDC has impressive commercial potential for improving the wear life, increasing reliability and reducing dry-running breakdowns in mechanical seals, sliding bearings, and shafts. The technology is a net shape and size process that forms an adherent, low-friction, wear-resistant layer, as opposed to a coating, for all silicon carbide and other metal carbide components. Friction coefficients in the same range as the best diamond or diamond-like coatings were demonstrated, as well as dry-running capability.

Dewatering Membrane for Hazy Hydro-Desulfurization of Unit Effluents
(www.compactmembrane.com)

Oil refinery products such as gasoline, kerosene, diesel, and fuel oils often go through a hydrodesulfurization (HDS) process to remove sulfur to reduce sulfur dioxide emissions during combustion. HDS is prone to water emulsion contamination or "haze," which can be difficult to remove. Hazy products cannot be used unless the haze is allowed to settle in a storage tank, creating shipping delays or storage constraints. A faster, cost-effective process to rapidly remove fuel haze is being developed using a new membrane in-line process. The process is expected to operate on a once-through basis and will target the removal of dissolved and dispersed water contamination. The membranes remove haze in a variety of water-fuel conditions and are very cost effective, having a product lifetime over 4 years. Other applications include removing water from chemical processing, pipeline ethanol, and other hydrocarbons such as lubricant and hydraulic fluids. The technology has already proven feasible at lab scale, and construction of a commercial size unit is in progress. Further testing will be conducted with industry partners in the laboratory and the field.

Crosscutting Technologies
(continued)

Energy-Efficient Thermomagnetic and Induction Hardening
(www.eaton.com)

In most industrial markets, maintaining dimensional tolerance of conventionally produced steel components during heat treatment or tempering can be challenging. To meet tolerance specifications, additional machining and retreatment are necessary but can be expensive and energy intensive. This project will develop an energy-efficient process using thermomagnetic processing and inductive high-frequency heat treatment. These new processes use thermal and magnetic interactions of bulk and surface material properties. The new processes consume less energy and achieves material durability without secondary non-value-added operations.

Energy Saving Controls for HID Lamps

(www.eesolutions.org)

This new technology is a simple, cost effective approach designed to work with conventional (magnetically ballasted) HID lamps of 70 to 1000 Watts, conserving up to 40% of typical energy consumption by managing illumination to customer needs or applicable standards. These intelligent controls save up to 50% of the maintenance costs associated with HID lighting. Many solutions offer improved HID lighting efficiency, but require replacement of existing lamps. This technology can be retrofit onto existing lamps thus saving capital costs. The fact remains that HID lighting is the most cost- and energy-efficient technology available today for high power (>100 Watts) lighting applications and this technology significantly improves energy efficiency and reduces maintenance costs in this lighting category.

Crosscutting Technologies
(continued)

Energy-Savings' Model for the Heat Treatment of Aluminum Castings
(www.wpi.edu)

A research program is extending the understanding of the evolution of microstructures during the heat treatment of complex, multi-component alloys. Quantitative relations among process, microstructure, and properties have been developed and applied to aluminum castings. The methodology developed can serve as a framework to develop quantitative process models for other alloy systems, including ferrous alloys. Compared with the current technology that specifies heat treatment cycle and furnace loadings based on prior specifications and historical "rules of thumb," the models are expected to reduce solutioninzing heat treatment times by 50% to 80%, leading to 25% to 50% reductions in cycle time and energy consumption and 50% indirect reduction in non-energy environmental impacts and variable costs. The models are available for further commercialization and applications.

Erosion-Resistant Nanocoatings for Improved Energy Efficiency in Gas Turbine Engines
(www.netl.doe.gov)

Optimized erosion-resistant nanostructured composite coatings are being developed for gas turbine engine applications. This project will verify the nanomaterial technology as an enabler for inlet fogging in industrial gas turbines and as an effective erosion protection strategy in commercial aviation turbines. These nanocoatings will provide erosion protection to compressor airfoils, allowing engines to retain operational efficiency through a larger portion of their life cycle. Preventing airfoil degradation will decrease engine operating costs, reduce carbon emissions, and provide significant energy savings through reduced fuel consumption.

High Efficiency Liquid-Desiccant Regenerator
(www.ailr.com)

The use of desiccants, which have a high affinity for moisture, can greatly reduce the energy required for typical drying and dehumidification. A new generation of liquid desiccant technology was developed that lowers overall cost and size, while improving the performance characteristics of existing dehumidification technologies. This new regenerator has the potential to almost double the efficiency of liquid-desiccant systems.

Crosscutting Technologies
(continued)

High-Efficiency Thermoelectric Materials/Devices for Industrial Process Refrigeration and Waste Heat Recovery
(www.aegistech.net)

Applications for recovering process waste heat often require an intermediate step to convert thermal energy into other useable forms of energy, such as thermo-mechanical. Another energy conversion pathway is the thermoelectric effect, where thermal energy is directly converted into electricity. This project will develop nanocomposite materials that generate electricity when a temperature difference exists across the bulk of the material – called the Seebeck effect. These new nanomaterial composites are thermodynamically efficient and overcome the barriers of high cost and large-scale manufacturing.

High Temperature Resistant Superhydrophobic Nanocomposite Coatings
(www.neicorporation.com)

During recovery of waste heat streams, heat exchanger technology performance and efficiency rely heavily on heat transfer. Heat transfer is primarily affected by the thin film condensate that forms on the surface, which reduces the heat transfer rate considerably. Preventing film formation has proven to be challenging in commercial vapor-to-liquid heat exchanger applications. This project will develop a viable and cost-effective superhydrophobic surface treatment that promotes "drop-wise" condensate formation, which will improve heat transfer significantly. The surface treatment derives its properties from a novel microstructure and is durable and cost effective. This surface treatment also can increase the exchanger's heat transfer rate three to four times, improving efficiency and energy usage.

Intelligent Controls for Refrigeration Systems
(www.adatech.com)

As much as 15% of electricity consumed by commercial and industrial refrigeration units can be saved by using intelligent defrost cycle controls. In typical installations, the defrost cycle is initiated at regular intervals during the day by a timer clock that is set to accommodate the peak humidity conditions of summer. In many cases, this causes the defrost cycle to begin too soon, and to run for an extended period of time. A new, low-cost frost sensor for defrost control systems has been developed and patented to start the defrost cycle only when necessary and to stop the cycle as soon as the ice has been removed from the heat exchanger.

IMPACTS

Crosscutting Technologies
(continued)

Intensive Quenching Technology for Heat Treating and Forging Industries
(www.intensivequench.com)

Intensive quenching technology (IQT) for steel products was developed as an alternative way of quenching steel parts. While conventional quenching is usually performed in environmentally unfriendly oil, the IQT process uses environmentally friendly water or low-concentration water/mineral salt solutions. Complete development and commercialization of IQT in heat-treating, powder metal, and forging industries will significantly reduce energy consumption and environmental impacts, thus enhancing the economic competitiveness of the domestic steel, metal casting, and mining industries.

Large-Scale Manufacturing of Nanoparticulate-Based Lubrication Additives
(www.anl.gov)

Lubrication applications currently consume 250 million barrels per year worldwide, and that consumption continues to increase. The major challenges for improving lubrication applications include reducing friction and increasing durability, which, if overcome, would reduce not only oil and fuel consumption but carbon dioxide emission and waste as well. This project is developing nanoparticulate-based additives using new boron-based materials instead of conventional sulphur- and phosphor-based additives. Producing these new high-performance additives uses advances in nano-manufacturing and nano-colloidal formulation. The raw materials required to manufacture these boron-based nano-lubricants are naturally occurring, abundant, nontoxic, and inexpensive.

Low-Cost, High-Efficiency, Periodic-Flow Gas Turbine for Distributed Energy Generation

(www.ventions.com)

An innovative gas microturbine is being developed that can realize higher thermal-to-electrical efficiencies and lower manufacturing costs compared with existing microturbine designs. The expensive recuperator used in current microturbines is replaced with a lower-cost regenerator that increases cycle thermal efficiency by 10% or greater and simultaneously reduces capital cost by 40%. The new system also is estimated to reduce CO_2 and other pollutant emissions by 15% to 40%.

Crosscutting Technologies
(continued)

Low-Cost Microchannel Heat Exchangers
(www.altextech.com)

Conventional brazed-plate heat exchangers are used across a broad range of industrial applications, including the industrial and commercial chiller market. These heat exchangers significantly contribute to system efficiency, energy losses, volume, weight, and cost. However, attempting to improve efficiency or reduce losses increases the heat exchanger's volume, weight, and cost to unacceptable levels. This project will develop an alternative to a brazed-plate heat exchanger that is up to 84% and 75% lower in volume and weight, respectively, and has up to 88% lower energy losses. The technology, the innovative WASHEX high-performance design and continuous manufacturing process, will reduce cost by over 70%. The size, weight, performance and low cost of WASHEX will allow it to be used in a wide variety of industrial and commercial chiller applications and will offer large market potential and energy savings.

Maximus™ Sonic Stop-Fill Device for LP Gas and Anhydrous Ammonia Tanks

(www.adeptscience.net)

A new technology is being developed to prevent liquefied petroleum (LP) gas and anhydrous ammonia tanks from being overfilled. Outage gauges, the current technology used for this function, release LP gas or anhydrous ammonia for the entire duration of the tank refill. The resulting vapor release is wasteful, environmentally unfriendly, and potentially a health and fire risk. In contrast, the Maximus stop-fill technology relies on an advanced acoustic method to noninvasively detect the presence of liquid or gas at a specific point on a tank. As the liquid level rises, the acoustic signals received by the sensor change, indicating the presence of liquid on the other side of the tank wall. The Maximus thereby achieves the exact same result as an outage gauge without wasted energy, environmental pollution, or safety risks.

Crosscutting Technologies
(continued)

Microchannel Magnetic Coolers with Negative Magnetocaloric Effect
(www.mercorp.com)

Magnetic refrigeration near room temperature using the magnetocalorific effect was shown possible in the mid to late seventies. Cooling systems using magnetic cooling have potentially significant energy savings by eliminating the use of liquid refrigerants and associated mechanical components used in conventional refrigeration devices. Unfortunately the high cost of the magnets and mediocre performance has prevented commercialization. Research has focused on improved material performance but the brittle nature of these new materials cause fabrication problems. This project will develop a viable commercial magnetic refrigerator with the efficiency near that of a convention carnot cycle cooling system using inexpensive gadolinium magnetic materials. The performance gain is obtained by controlling the energy flow in the system using synchronized magnetic field motion. Potential energy savings from this technology are expected to be at least 20% over current convention refrigeration methods.

Micro Gas Analyzer Solutions for Advancing Industrial Efficiency
(www.honeywell.com)

An innovative technology for on-line sampling and analysis of gas process streams in an industrial environment is being developed to enhance industrial efficiency. This new device couples a sampling and measurement system with a revolutionary gas composition micro-analyzer to provide continuous, on-line monitoring of gas process streams. By identifying and communicating variations in gas stream composition, the technology will improve product quality, reduce process upsets, avoid product loss and reduce waste.

Crosscutting Technologies
(continued)

Microreactor-Assisted Nanomaterial Deposition for Photovoltaic Thin-Film Production
(www.pnl.gov)

Despite reducing fossil fuel consumption for energy generation, renewable energy sources have obstacles and technical challenges – e.g., cost, efficiency, and environmental impact. A cost-effective and environmentally friendly manufacturing process is being developed for photovoltaic (PV) related nanomaterials and thin films. Current PV manufacturing involves high costs, poor material utilization, high carbon emissions, and significant chemical waste. A microreactor-assisted nanomaterial-based process is being developed to enable just-in-time production of intermediates or particles for immediate deposition on the desired substrate. In addition, portions of the process are enabled by supercritical fluids, which drastically reduce the use harmful solvents in these processes. The nanomaterial deposition part of the process allows better material utilization and film formation via particle property (e.g., size and shape) control and molecular level deposition control for solid films. The process improves PV films and offers shorter manufacturing times and could be applicable to other nanoscale material production.

Miniature, Inexpensive, Amperometric Oxygen Sensor

A new sensor to measure oxygen partial pressure from parts-per-million levels to 100% oxygen has been developed. It has particularly good sensitivity in the combustion range of 0.1% to 5% oxygen partial pressure. The new amperometric sensor, which is a multi-layer ceramic capacitor, is ideal for inexpensive mass production. The large reduction in cost of the sensor will economically allow any combustion process, including industrial, commercial, or residential furnaces and boilers, to be more closely monitored and controlled, thus saving energy.

IMPACTS

Crosscutting Technologies
(continued)

Modifications and Optimization of the Organic Rankine Cycle
(www.inl.gov)

Waste heat from industrial applications and processes has been recognized as an extremely abundant source of recoverable energy. An optimized organic rankine cycle has been developed for the conversion of low-temperature waste heat from gas turbine or reciprocating engine exhaust to electricity. An evaporator placed directly in the hot exhaust gas stream reduces system cost and improves efficiency by eliminating the usual secondary heat exchanger loop. This safe, robust direct evaporator design can be integrated with the gas turbine or reciprocating engine as a single package that is easy for customers to install and operate.

Nanocatalysts for Diesel Engine Emissions Remediation
(www.ornl.gov)

The widespread use of highly fuel-efficient diesel engines instead of gasoline engines can occur only if NO_x emissions in diesel engine exhaust can be reduced to benign gases to enable them to meet EPA regulatory requirements. Conventional catalysts are unable to reduce NO_x in the presence of excess air found in diesel emissions. As such, several new approaches are being investigated, with urea- or ammonia-assisted selective catalytic reduction (urea- or NH_3-selective catalytic reduction [SCR]) of NO_x as the leading technology. This technology needs to overcome poor durability and a narrow operating temperature range. A project is developing zeolite-based nanocatalysts whose modified molecular structures overcome the constraints in urea- or NH_3-SCR technology for treating diesel engine emissions. The new technology will enable a wider market share for diesel engines, thereby increasing energy savings as well as reducing exhaust emissions per mile driven.

Crosscutting Technologies
(continued)

Nanostructured Superhydrophobic Coatings
(www.ornl.gov)

Water-based drag, corrosion, icing, biofouling, and wetting in most water-exposure applications and processes increase energy consumption as well as replacement and maintenance costs. Many applications could benefit from a coating that reduces these problems (e.g., marine transportation, industrial liquid handling, structural steel, communication and power cables, roofing, and roadway materials). Water-repelling, durable, nanostructured superhydrophobic materials will be developed that substantially reduce a variety of negative effects between water and a treated substrate. The key to this application is the nanomaterials' ability to trap a layer of air between the substrate coating and any liquid having a high surface tension, like water. These remarkable, water-repellant, powder-based coatings are cost effective and easy to apply and can be manufactured from readily available raw materials.

New Regenerative Cycle for Vapor Compression Refrigeration

(www.mdienergy.com)

A new refrigeration technology is being developed that increases efficiency and saves energy relative to existing refrigeration techniques. The technology uses a novel thermodynamic cycle characterized by the regenerative use of the potential energy of the working fluid. A compressor compresses the working fluid to only 50% to 60% of the final pressure, while a jet device provides additional compression by using the internal potential energy of the working fluid flow. The compressor requires less mechanical energy, resulting in significant energy savings.

Crosscutting Technologies
(continued)

Novel Refractory Materials for High-Temperature, High-Alkaline Environments
(www.ornl.gov)

New refractory materials are being developed for use in high-temperature, high-alkaline industrial environments such as those found in industrial aluminum, lime, and gasification environments. These magnesia- and alumina-based compositions use unique bond systems, protective coatings, and in-situ phase formation techniques. The improved performance and reduced degradation under harsh chemical and thermal conditions will result in reduced energy losses through refractory walls. In addition, through alternative application techniques such as shotcreting, the materials reduce downtime and energy loss associated with repairing and replacing degraded refractory linings. The project will also focus on developing new application techniques and systems to facilitate hot installation and repairs.

Particulate Ejection Coal Fired Turbine

(www.novafilter.com)

A sub-scale prototype of a medialess inertial rotary disk filter was successfully evaluated to operate at the high temperatures/pressures typically found in coal-fired gas turbine generators. This technology demonstrates 98% to 99% coal ash removal efficiency without fouling, thus reducing the need for conventional disposable porous ceramic candle filters for hot gas filtration. Constant filtration efficiency and non-varying pressure drop across the all-metal filter eliminates brittle ceramic failures and allows operation at higher gas temperatures, which eliminates gas reheating and improves energy efficiency. The continuously self-cleaning technology may also eliminate landfilling of spent/replaced ceramic candles.

Process Heater System
(www.exxonmobil.com)

A new generation of process heaters has been developed and demonstrated that is extremely low in emissions. This innovative system incorporates several advanced technologies: 1) ultra-low-emission (ULE) burners; 2) a specially designed fired heater with enhanced heat recovery, optimized for use with the ULE burner systems; and 3) on-line tube metal temperature sensors and burner control system to optimize heater operation, reduce maintenance costs, and increase run lengths. The technology will have applications for a broad range of refining and chemical processes. The advanced heater components are being developed for new or retrofit applications.

Crosscutting Technologies
(continued)

Production Scale-up of Activated Carbons for Ultracapacitors

(www.tda.com)

Electric and hybrid vehicles are promising technologies for decreasing the dependence on petroleum. Cost effective and efficient energy storage devices are needed for these vehicles to remain economically viable, and ultracapacitors are a leading energy storage technology for this purpose. The most important parameter in determining the power and energy density of a carbon-based ultracapacitor is the amount of surface area accessible to the electrolyte, which is primarily determined by pore size distribution. The major problems with current carbons are that their pore size distribution is not optimized for liquid electrolytes and the best carbons are very expensive. Methods that use low-cost feedstock (carbohydrates) were developed to prepare porous carbons with tunable pore size distribution at a greatly reduced production cost.

Radiation Barrier Heating Mantle for High-Temperature Furnaces

(www.procedyne.com)

Retort furnaces, which consist of a heating-mantle jacket surrounding a retort vessel, are widely used to generate high temperatures for the metal-processing, chemical-processing, and heat-treating industries. A new porous wall radiation barrier (PWRB) heating mantle represents a breakthrough in heating mantles that significantly increases heat-transfer rates over both the existing gas-fired heating mantle and the electrically heated mantle. This unique development results in a heat-transfer rate in the 1,800°F to 2,400°F range that is 2 to 4 times greater than electric and conventional gas-fired mantles.

Robotically Enhanced Manufacturing Line
(www.timken.com)

Conventional metal processing lines employ equipment that frequently use energy inefficiently, release greenhouse gases, and increase the exposure of laborers to process related safety risks. A new project is developing an advanced, low-volume manufacturing line that operates on-demand, thereby saving energy and manpower. The system is designed to replace over-sized, energy-intensive furnaces that require continuous and therefore unproductive heating. In development, the novel process has been demonstrated to be about 22% more energy efficient than conventional small lot processing methods. This manufacturing line is also more productive and produces fewer emissions.

IMPACTS

Crosscutting Technologies
(continued)

Self-Assembled, Nanostructured Carbon for Energy Storage and Water Treatment
(www.ornl.gov)
Materials research has far-reaching implications in many industrial applications. Energy storage and water treatment are of particular interest as their demand and usage increase. Carbon-nanomaterials can provide solutions to a wide gamut of applications where technical progress has become challenging. Implementing the products of nanostructured materials research is not without constraints, especially scale-up, reliability, and high manufacturing costs. This project will overcome those difficulties by producing materials for use in cost-effective ultracapacitor devices for energy storage and safe, effective, and affordable capacitive deionization water treatment systems.

Self-Healing Polymeric Coatings
(www.neicorporation.com)
Materials used for industrial and consumer applications are usually coated to improve their appearance and protect them from the damaging effects of weathering (e.g., ultraviolet light and acid rain), corrosion, and mechanical wear. Typical coatings used are paints, stains or sealers, waxes, and other chemical treatments. Inevitably, this protection weakens and microscopic damage occurs, leading to more extensive damage or eventual failure, which requires recoating or replacement. This project will develop self-healing nanocomposite polymeric-based coatings. When mild heat is applied to these coatings, they can self-repair or self-heal minor surface scratches and relatively deep cracks. These coatings allow multiple healings, increase service life, and reduce costs and environmental impact from emissions and waste.

Sunlight Responsive Thermochromic (SRT™) Window System

(www.pleotint.com)
A new high-performance window capable of variable tint is being developed that combines dynamic sunlight control, high insulation values, and low solar gain. The Sunlight Responsive Thermochromic windows can reversibly change light transmission based on thermochromic materials activated solely by the heating effect of the sun. The window design allows for good daylighting, a low solar heat gain coefficient, a low U-value, and a high insulation value. Energy savings up to 30% are estimated compared with traditional window systems.

Crosscutting Technologies
(continued)

Super Boiler
(www.gastechnology.org)
The Super Boiler concept using ultra-high-efficiency, ultra-low-emission steam generation technologies is targeted for broad industrial applications over the next 15 to 25 years. The concept combines a suite of enabling technologies such as a staged intercooled combustion system with forced internal recirculation, high-intensity heat transfer surfaces, an advanced transport membrane condenser, and a smart control system in an integrated package. The performance goals include 94% fuel efficiency, 5 vppm NO_X and CO, and 50% size and weight reduction compared with a conventional firetube boiler.

Thermal Imaging Control of High Temperature Furnaces
(www.gastechnology.org)
The near-infrared thermal imaging system fine-tunes the main furnace controller for improved combustion performance. The system uses multiple infrared wavelengths combined with a periscope probe to map the full field of combustion space during furnace operation. Control algorithms minimize differences between measured field temperatures and temperature set points and send output signals to the main furnace combustion control. Optimizing the combustion process has been shown to decrease the total fuel use by at least 5%, with a corresponding decrease in airborne emissions.

Thermoelectric Generator for Diesel Engines

(www.hi-z.com)
This new technology generates electric energy from waste heat and has many applications in the power industry, as well as in the chemical and petroleum industries. One possible application is as an array on the exhaust of the gas turbine to increase efficiency. Heavy earth moving equipment for mining presents another potential application. A prototype generator is being tested by a truck manufacturer and has been driven on their test track for 500,000 miles to demonstrate the ability to endure shock and vibration.

Crosscutting Technologies
(continued)

Third-Generation Flywheels for Electricity Storage
(www.launchpnt.com)

A new type of electricity storage flywheel is being developed that can be scaled up cost effectively to much larger power and capacity than existing flywheel designs. This new third-generation flywheel – the Power Ring – uses totally new architecture and is designed to eventually reach electricity storage capacities exceeding 5 megawatt-hours per unit. The design uses a new class of magnetic bearing and a thin-walled composite hoop rotated at high speed to store kinetic energy. Power Ring flywheels will have many applications to support the U.S. power grid and to provide a reliable source of emergency power during electrical outages.

Tough-Coated Hard Powders
(www.allomet.net)

Revolutionary tough-coated hard powder (TCHP) pseudoalloys combine the extremes of fracture toughness, hardness, wear resistance, light weight, low coefficient of friction, and thermal properties. Designed nanostructures are created by nano-encapsulating extremely hard micrometer-scale core particles (e.g., diamond) with very tough materials (e.g., tungsten carbide and cobalt), which in the consolidation process become the contiguous matrix. As many unique properties can coexist in a TCHP variety as there are different core particle materials present in the uniform tough substrate. Extreme strength, double-digit component and tool life, and reduced friction and thermal losses combine to enable the potential for billions of dollars in annual cost, energy, and environmental impact improvements.

Ultra-Efficient and Power-Dense Electric Motors
(www.baldor.com)

A new technology increases motor efficiency while reducing the size and weight of the motor. The low-loss, high power density motor is more efficient, lighter, and smaller than current alternatives, including NEMA Premium® motors. The product will be a general-purpose motor that can replace existing induction motors for a wide range of line-start and variable-speed applications. The motor will be able to be started and run across the line or operated from a standard (volts/hertz) drive without requiring a rotor position feedback device.

Crosscutting Technologies
(continued)

Ultra-Fast Boriding in High-Temperature Materials Processing Industries
(www.anl.gov)

To improve the performance and durability of metals, some form of surface treatment is used. Ultra-fast boriding is a faster process that is energy efficient and environmentally friendly. It is a thermo-electrolytic process that forms a very hard and durable compound at the surface of the treated material. Despite the shorter processing times, the ultra-fast process deposits thicker protective coatings compared with conventional techniques. The process consumes less energy and does not produce gaseous emissions or environmental waste. The process also provides the added benefits of increased productivity and product durability.

Ultratough, Thermally Stable Polycrystalline Diamond/Silicon Carbide Nanocomposites for Drill Bits
(www.lanl.gov)

The search for natural resources continues to deeper depths and presents new drilling challenges for the gas, petroleum, and geothermal energy industries. New super-hard, wear-resistant, and durable materials are needed to improve drilling performance. Conventional polycrystalline diamond (PCD) compact materials have two major weaknesses–poor thermal stability and low impact strength–which can lead to slower drilling or premature failure. To offset these weaknesses, this project is developing new nanocomposite materials that combine PCDs with silicon carbide nanocomposites and nanofibers. The improved drilling efficiency of these nanocomposite materials will reduce energy consumption and capital costs.

IMPACTS

Crosscutting Technologies
(continued)

Utility Interactive Inverter System for Distributed Generation

(www.advanced-energy-conv.com)

A 2.5-kW utility interactive inverter system has been developed and is being tested and refined for use in distributed generation. The system embodies zero-voltage switching technology that will yield a system that is smaller, less expensive to manufacture, and more efficient than existing commercial technologies. By strategically focusing on a 2.5-kW utility interactive inverter employed in solar photovoltaic applications the company has found a stable regulatory environment and a market that is quickly expanding in this power level which supports numerous technologies.

Variable Speed, Low Cost Motor for Residential HVAC Systems

(www.dynamotors.com)

Existing variable-speed motors cost at least four times as much as single-speed motors and thus are currently used in only 5% of residential HVAC systems. A revolutionary low-cost, brushless, variable-speed motor technology uses solid-state switches on the rotating armature to control motor torque and speed. A variable-speed motor running continuously at half speed compared with a single-speed motor running at full speed but half the time uses 25% of the power to move the same amount of air in an HVAC blower, thus saving energy.

Wireless Sensor Network for Motor Energy Management

(www.eaton.com)

Energy use of large motors (over 200 hp) has already been reduced with advanced monitoring and diagnostic systems served by conventional field-wired sensors. Deploying monitoring systems on smaller motors could further reduce motor energy use by 18% but is not cost-effective with conventional wiring and thereby does not promote the identification of energy savings and opportunities to improve uptime. Wireless sensors that monitor voltage and current and integrate with advanced energy and inferential condition management software are being developed to serve this need. The technology will use smart sensors with embedded intelligence as well as network system robustness to ensure system security, self-configuration capability, cost effectiveness, and the ability to accommodate plant complexity.

Crosscutting Technologies
(continued)

Zero-Emission Mechanical Seal

(www.cerom.lsu.edu/projects_seal.htm)

Several zero emissions mechanical seal designs have been developed for use in petroleum and chemical processing pumps. The seals offer superior heat transfer capability compared with conventional seals by introducing special cooling channels into the surface of the stationary (mating) ring. The surface temperature can be controlled with simultaneous reduction of surface wear, allowing seals to run dry and qualify for zero emissions. This technology should reduce downtime, increase seal life, and decrease harmful environmental effects that occur from seal leakage. By reducing the friction and wear between the seal surfaces, the new designs should decrease power loss and save energy.

ITP Emerging Technologies

Other Industries

Advanced Water Removal via Membrane Solvent Extraction

(www.3m.com)

As U.S. ethanol production increases, two major concerns need to be addressed – water consumption and input energy. For every gallon of ethanol produced, about four gallons of water are used and at least 30% of the input energy is consumed during the distillation process. A new technology is being developed, membrane solvent extraction (MSE), that will reduce water and energy usage. The MSE's pervaporation process increases the process yield almost 10 times and can reuse waste energy streams (heat) within the plant. MSE technology can be retrofitted, reduces energy and water consumption by about 40%, and can be applied to various bioethanol production paths.

BEI Cellulose Hydrolysis Process

The BEI Dilute-Acid Cellulose Hydrolysis (DACH) Process and Reactor System uses a double tubular reactor system in two stages, which is automatically controlled to continuously convert cellulose feedstock into fermentable sugars solution products. The second stage of the BEI-DACH process reactor system recovers excess and surplus process heat and acid-chemicals for reuse in the first stage, providing exceptional energy and acid efficiencies and related economic savings. The BEI-DACH reactor system process hydrolyzes cellulose into a pentose, hexose, and glucose sugars solution at the point of use. These DACH sugars may then be continuously yeast-fermented into ethanol and/or single-cell-protein and into other organic chemicals as commercial products.

Biofine Technology

(www.biometicsma.com)

The Biofine technology can convert low-grade cellulose-containing wastes from paper mills, municipal solid waste plants, logging and agricultural operations, and other sources into levulinic acid, a versatile platform chemical that is an intermediate to several high-value chemical and oxygenated fuel products. Cellulose is converted to levulinic acid using a novel, high-temperature, dilute acid hydrolysis reaction system.

Other Industries

(continued)

Distributed Optical Fiber Sensors for Continuous Liquid Level Tank Gauging

The Noverflo Multipoint Tank Gauging (NMTG) system is a family of fiber optic sensor arrays designed for the oil and gas, transportation, and food/beverage processing industries. Compared with similar products, the NMTG offers a simple design that allows both low and high accuracy measurements to be made at a very low cost. The system can make accurate measurements in liquids of shifting densities and performs continuous density measurements at any tank level. A new data acquisitions system allows the NMTG to monitor hundreds of sensors and numerous external-switching devices without any upgrades to existing systems.

Eco Oil: A Superior-Performance, Bio-Based Motor Oil

One way to reduce dependence on foreign oil is to reduce the consumption of refined petroleum products. Eco Oil is an enhanced, bio-based synthetic motor oil that will help reduce refined petroleum consumption, adding stability to our national supply. Increased availability of bio-based motor oil also provides product diversity, creating additional options for government and consumer purchases, and results in fuel savings because of reduced engine friction. Reduced fuel usage also could lead to lowered emissions from internal combustion engines, reducing pollution.

Flexible Distributed Energy and Water from Waste for the Food and Beverage Industry

(www.geglobalresearch.com)

A comprehensive wastewater processing solution is being developed that recovers energy and purified water from industrial wastewater effluent streams. The integrated waste-to-value system consists of multiple components, including pretreatment, anaerobic digestion, aerobic reaction, filtration and gas processing, and combustion in a boiler and/or gas engine. This project addresses the challenge of variations in operating conditions and wastewater composition by developing an automated monitoring and supervisory controls solution. The control solution aims to improve the performance and reliability of the integrated waste-to-value system and reduce the occurrence of severe upsets by up to 90% using automated corrective action.

IMPACTS

Other Industries
(continued)

Helical Reaction Hydraulic Turbine
(www.lucidenergy.com/gck)

The Gorlov Helical Turbine (GHT) is a newly developed technology that is relatively inexpensive and ecologically benign and provides a reliable source of electricity by extracting the kinetic energy from flowing water. It is designed for hydroelectric applications in free flowing watercourses, which eliminates the need for a dam or other obstruction to the natural current flow. The GHT uses airfoil-shaped blades, which provide a reaction thrust that can rotate the GHT at twice the speed of the water flow. The GHT is self-starting and can produce power from a water flow as low as five feet per second, with power increasing in proportion to the water velocity cubed. Testing has demonstrated the GHT's superior power efficiency (35%) in free flowing water currents compared with conventional turbines.

High Speed/Low Effluent Process for Ethanol
(www.bio-process.com)

The High Speed/Low Effluent (HS/LE) process increases ethanol fermentation 5 to 8 times faster compared with current industry rates by using a newly developed, self-aggregating yeast strain. Either a "consecutive batch" or "continuous cascade" technology can be used for this fermentation process, for either wet mill or dry mill corn ethanol production. Cane juice, molasses, sweet sorghum, and other sugar/starch feedstocks may also be used with this process. In addition, a low-energy distillation process can improve ethanol production economics.

Hi-Q Rotor
(www.hiqproducts.com)

The Hi-Q Rotor is an advanced low-wind speed, hight efficiency, tri-symmetric wind blade theat presents a new geometry for wind blade technology. This innovative technologyy has high value for collecting wind in low and very low wind speeds where conventional turbines are ineffective. The Hi-Q Rotor was developed to harvest wind in Class 2, 3, and 4 wind sites.

Other Industries
(continued)

Horizontal Ribbon Growth
(www.oakland.edu)

This innovative technology consists of a process to develop crystalline silicon sheet from a polycrystalline silicon source. Its primary goal is the efficient, low-cost production of high-quality crystal silicon sheet for the solar and electronics industry. Development of this process will provide several important benefits, such as high production rates, low cost in terms of material and energy input, good dimensional control, improved crystal quality, and remarkable purity the same as the source material.

Hydrogen Generation from Biomass
(www.virent.com)

A newly patented process is enabling the economic production of hydrogen from a range of biomass-derived feedstocks, including glycerol and sugars. The key breakthrough in the reforming process is a proprietary catalyst that operates in the aqueous phase and has high hydrogen selectivity at low temperature. The process reforms water soluble oxygenated hydrocarbons in a single step and produces a hydrogen rich gas that is easily purified and that can be used as fuel stock for energy systems requiring a clean source of hydrogen, including fuel cells and transportation.

Low Head, Vortex Induced Vibrations River Energy Converter
(www.vortexhydroenergy.com)

A revolutionary technology is being developed to extract useful energy from low-head or low-power falling water resources. The technology is based on the vortex-induced vibrations (VIV) of cylinders. For decades, engineers have been trying to prevent VIV from damaging offshore equipment and structures. By exploiting and maximizing VIV rather than preventing it, the vibrations can be transformed into a valuable electrical resource. In harnessing this potentially destructive force, the calculated energy density is five times greater than the best available competing technology, which is a free-flowing water turbine.

Other Industries
(continued)

Nanoparticle Technology for Biorefinery of Non-Food Source Feedstocks
(www.ameslab.gov)

Rising petroleum prices and renewable energy initiatives have increased research into alternative fuels, in particular, biodiesel, which is biodegradable and nontoxic and is produced from various feedstocks. The use of crop-based feedstock for biodiesel fuel is limited by available cultivation acreage, low yield, and potential negative impact of higher prices in the food source market. Alternatively, a non-foodstock approach using waste animal fat or biomass or microalgae would be costly and complex. To overcome these drawbacks, a new process is using nanoparticle-based catalysts to cultivate microalgae to produce biodiesel fuel that meets industry standards. The new nanoparticle technology will be scaled up from pilot to industrial scale.

Novel Membrane-Based Process for Producing Lactate Esters
(www.vertecbiosolvents.com)

This research aims to develop nontoxic replacements for halogenated and toxic solvents. The new method, called "Direct Process", uses proprietary advanced fermentation, membrane separation, and chemical conversion technologies to convert renewable carbohydrate feedstocks into lactate esters in an energy-efficient, waste-reducing, and cost-effective way.

Plastics, Fibers, and Solvents from Biosynthetically Derived Organic Acids
(www.bio-amber.com)

Biologically-derived succinic acid is produced by fermenting sugar derived from grains and other biomass. After separation and purification, the succinic acid is used as a chemical intermediate that is converted into a wide assortment of products such as plastics for automobiles and household items, fibers for clothing, food additives, solvents, deicers, agricultural products, ink, and water treatment chemicals.

Other Industries
(continued)

Powering Cell Phones with Fuel Cells Running on Renewable Fuels

(www.tekion.com)

Small passive fuel cells that operate on air and formic acid are being developed to reduce electricity consumption from charging batteries. This renewable-fuel micro fuel cell will be used to charge cell phones, which use about 1.5 billion kWh per year, two-way radios, laptops, PDAs, and other portable devices, including military and emergency applications.

Thermophotovoltaic Electric Power Generation Using Exhaust Heat

(www.jxcrystals.com)

This new technology produces electricity directly from furnace exhaust waste heat by using infrared-sensitive photovoltaic cells. The cells are mounted inside ceramic tubes that are heated in the high-temperature exhaust stream from furnaces. This technology allows on-site generation of electricity from waste heat in industrial or residential applications.

Tidal Energy Systems

(www.verdantpower.com)

The kinetic energy of flowing water is a source of renewable energy. Systems similar to underwater wind turbines have been developed and are being demonstrated in tidal currents. The systems convert the kinetic energy of the tidal current to mechanical power, which is applied through a gearbox to an internal generator or to a direct-drive generator for electrical power. These water-to-wire, dam-less hydro systems have demonstrated little to no environmental impacts. On-going studies are showing that fish are safely swimming either around or through the slow revolving rotors of these kinetic hydropower systems.

IMPACTS

Other Industries
(continued)

Variable Length Wind Turbine Blade

(www.frontierwind.com)
The use of variable length blades on wind turbines, as opposed to the current use of fixed length blades, improves the wind turbine's performance, efficiency, and cost-effectiveness. Low wind speed provides better electrical output with longer blades, while high wind speeds demand shorter blades to minimize mechanical loading. The outboard (tip portion) of the blade fits inside the inboard (inner portion) and can be telescoped in and out according to wind conditions. Energy capture is expected to increase by about 10% to 15%, by increasing wind capture at existing sites and by expanding the number of locations where wind energy is feasible. Can be used in new or retrofit applications. Reduces system loading thus increasing system life while increasing energy generation.

Wind Fins: Novel Lower-Cost Wind Power System

An innovative vertical axis wind turbine is being developed as an alternative to conventional small horizontal-axis wind turbines (HAWTs). The Wind Fin technology exploits the kinetic energy of a vertically aligned, aerodynamic oscillating blade to generate electricity. The unique design blends more readily into the natural landscape than HAWTs and virtually eliminates lethality to birds and bats. Wind tunnel tests have shown that this technology will be comparable to or superior in performance to similar-sited wind turbines (20 kW) but at approximately half of the system cost. In addition, the Wind Fin can generate power at wind speeds as low as 5 mph, whereas many alternative systems require wind speeds of 10 mph or greater to begin operation. Testing has indicated that the technology will be technically and economically feasible over a wide range of sizes, potentially resulting in Wind Fins with a power output of 50 kW to 100 kW.