

# ENERGY TECHNOLOGY SOLUTIONS

Public-Private Partnerships Transforming Industry

December 2010



“We need a sustained commitment to research and development. Only R&D can yield game-changing technologies to lower costs, accelerate innovation, and drive new American industries and jobs.”

*Dr. Steven Chu*

*Secretary of Energy*

# Welcome

## Dear Stakeholder,

The economic challenges facing American industry today highlight the critical need for innovative technology solutions that will increase productivity, sustainability, and competitiveness. At the Industrial Technologies Program (ITP), we work to identify promising innovations and accelerate their progress through the research and development pipeline. All of us at ITP are pleased to present this overview of technologies from our research partnerships.

Partnership is key to our success. Our industrial partners help us identify and undertake technology research opportunities that are too risky for industry to undertake alone—yet promise broad benefits across the manufacturing sector. This partnership approach has succeeded year after year in providing industry with the technologies, tools, and practices needed to save energy and stimulate growth. Our products are actively making a difference, helping U.S. companies succeed in tough global markets. Since ITP's inception, the program and its partners have successfully launched 220 new, energy-efficient technologies and received 51 *R&D 100* Awards. Collectively, these technologies and other program activities have cut carbon emissions by 206 million tons and saved 9.3 quadrillion British thermal units (Btu).

We are proud to be serving American industry under the guidance of the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy. We invite you to learn more about our program at [www.industry.energy.gov](http://www.industry.energy.gov).

Industrial Technologies Program Staff  
Energy Efficiency and Renewable Energy  
U.S. Department of Energy

Innovation is vital  
to economic and  
environmental  
sustainability in  
U.S. industry.



# Technology Solutions

## Developing Technology Solutions at ITP

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## Technologies for Today

### Commercially Available Technologies

#### Industry Focus:

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|---|----|
| Aluminum                                    | 4  |
| Chemicals                                   | 6  |
| Forest Products                             | 11 |
| Glass                                       | 17 |
| Information and Communication<br>Technology | 19 |
| Metal Casting                               | 20 |
| Mining                                      | 23 |
| Petroleum Refining                          | 24 |
| Steel                                       | 25 |

#### Crosscutting Focus:

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| Air Systems                 | 29 |
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| Combustion                  | 33 |
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| Forging and Heat Treating   | 40 |
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### Knowledge-Based Results

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| Chemicals                 | 54 |
| Forging and Heat Treating | 55 |
| Glass                     | 55 |
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## Technologies for Tomorrow

### Emerging Technologies

#### Industry Focus:

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| Forest Products                             | 64 |
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| Information and Communication<br>Technology | 68 |
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#### Crosscutting Focus:

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## Resources for Today

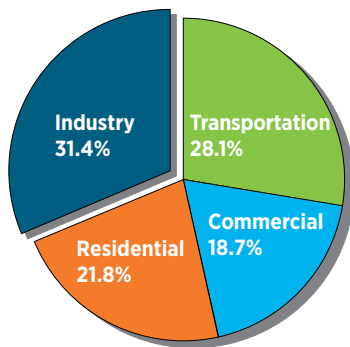
### Energy Management

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# Developing Technology Solutions at ITP

*The INDUSTRIAL TECHNOLOGIES PROGRAM is responsible for improving the energy efficiency of U.S. industry.*

U.S. industry consumed more than 31 quadrillion Btu in 2008—nearly a third of all energy used in the United States



The Industrial Technologies Program (ITP) leads the national effort to reduce energy use and carbon emissions by industry. Together with our partners, we develop real-world energy solutions for the top energy challenges facing the industrial sector.

ITP drives energy efficiency and carbon reduction throughout the manufacturing value chain, from the extraction of raw materials through the assembly of commercial products. Our research teams develop *next-generation processes* that eliminate entire manufacturing process steps or completely reinvent production pathways to radically reduce energy use, carbon emissions, and material requirements. Using advanced materials science and engineering, our teams also develop *next-generation materials* that deliver novel properties to increase productivity and flexibility, extend component life, and lower cost. These efforts are delivering the technological advances that will reinvigorate the manufacturing base and position U.S. industry as a global leader in clean energy technologies and products.

## Strategic Partnerships

ITP works closely with industrial partners to identify R&D opportunities that offer large potential energy savings across diverse industries. We tap the expertise of industry, academia, and the national laboratories to solve critical manufacturing issues and accelerate the commercialization of innovative technology solutions. We collaborate with industry, states, utilities, the financial community, and other stakeholders to help plants access the latest technologies and energy management practices, promoting energy efficiency throughout the supply chain.

## Research and Development

ITP provides cost-shared funding so collaborative partnerships can research and develop transformational, energy-efficient technologies for industry. These partnerships target technologies that are needed to save energy in specific energy-intensive industries, as well as those that can boost efficiency across many industries. These advanced technologies are then commercialized by the private sector, including many small businesses.

## Energy Management

ITP also focuses on near-term opportunities to improve industrial systems and practices today. We deliver a robust suite of tools and services to help industry identify the proven technologies and practices that offer the most cost-effective options for saving energy and reducing emissions.

## ITP's proven track record includes the following:

- More than 220 technologies in commercial markets
- Technical assistance delivered to more than 33,000 industrial plants
- Nearly 9.3 quadrillion ( $10^{15}$ ) Btu of energy saved through technology deployment and industrial technical assistance since program inception
- Carbon emissions reduced by 206 million tons
- 51 prestigious *R&D 100* Awards and at least 215 patents between 1991 and 2009

## Role of Industry

Industry is essential to America's energy security and economic health. The manufacturing sector ranks first in the world based on economic output, producing a vast array of products used in all sectors of the economy. U.S. industry alone uses more energy than any other G8 nation.

## U.S. Manufacturing\*

- Made one of the highest contributions to the U.S. economy (12% of GDP)
- Produced nearly a quarter of the world's manufacturing output
- Supplied over 55% of U.S. exports, worth over \$80 billion per month
- Employed over 11.8 million people directly and another 6.8 million in related industries
- Spurs job creation and investment in other sectors across the economy

\* 2008 data

# Technologies for Today

## Commercialized Technologies

The following commercially available technologies, developed with DOE support, are helping to improve U.S. competitiveness in diverse industries today.

### Oxygen-Enhanced Combustion for Recycled Aluminum

*Metal melting system reduces energy use and increases productivity*



A low-NOx combustion burner is integrated with an onsite vacuum-swing absorption (VSA) oxygen generation system to reduce NOx emissions and energy usage while increasing melting productivity. This burner controls the mixing of fuel, air, and high-purity oxygen streams to improve flame quality. The integrated VSA system provides an efficient method to produce oxygen using a patented high-efficiency molecular sieve to remove nitrogen from the air. This technology can be used in metal melters for zinc, lead, copper, and ferrous materials.

#### Contact:

- Russell Hewertson, Air Products & Chemicals, Inc., (610) 481-5966, hewertrj@airproducts.com, www.airproducts.com

#### Benefits:

- Reduces fuel consumption around 30% compared to typical air combustion
- Increases melter production rate by 26% compared to typical air combustion
- Allows compliance with stringent emission regulations for NOx and CO



### Dross Boss™ Aluminum Reclaimer for Foundry Applications

*Affordable metallic recovery system reduces landfill waste streams*



The Dross Boss™ reclaims metallics from hot dross and skim at their point of generation. The process reduces melting losses for foundries and other aluminum melters by recovering the contained metallics on-site. In some cases, the recovered metal may be reintroduced to the generating process in molten form to produce additional energy savings. The reclaiming process may be run manually or with an automatic mixing cycle, and it can accommodate hot dross in quantities ranging from 10–500 pounds.

#### Contact:

- Daniel Grotke, Q.C. Designs, Inc., (269) 983-6859, dgrotke@cs.com, www.qcdesignsinc.com

#### Benefits:

- Up to 80% metallic recovery from skim and dross
- Reduces energy used to transport and recover drosses at outside processors
- Avoids sending process salts to landfills



**Innovation of the Year Award in 2000 from Michigan's Small Business Association**



## Direct Chill Casting Model

*Modeling and optimization of direct chill casting reduces ingot cracking*



A new direct chill casting model based on the proCAST software characterizes heat and stress conditions and solidification criteria and assists in predicting crack formation during aluminum casting. Using this model, Secat helps aluminum producers optimize process parameters to improve ingot geometry and reduce stress cracking and butt deformation, which account for a 5% production loss during direct chill casting. By controlling the scrap level, this model reduces production costs and enables energy savings.

**Contact:**

- Todd Boggess, Secat, Inc., (859) 514-4956 ext. 103, [tboggess@secat.net](mailto:tboggess@secat.net), [www.secat.net](http://www.secat.net)

**Benefits:**

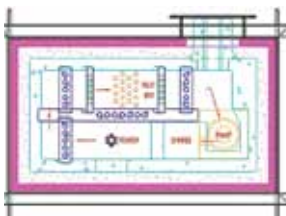
- Improves ingot consistency and quality
- Reduces production losses
- Eliminates butt sawing



**Secat service used to optimize production for two aluminum plants**

## Isothermal Melting

*Conductive heating improves energy efficiency and reduces metal oxidation*



Isothermal melting is a process utilizing newly developed immersion heaters to supply melting energy through conduction with greater than 97% efficiency. These heaters are part of a multi-component, continuous flow system that further enhances the efficiency of melting, alloying, and purifying aluminum. The system's unique ability to control the flow system temperature allows molten metal to be recycled back into the molten pool at the same temperature at which it was withdrawn. The isothermal melting system eliminates the excess energy and higher temperatures of traditional combustion systems that transfer energy by radiant heating.

**Contact:**

- C. Edward Eckert, Apogee Technology, Incorporated, (412) 795-8782, [EDT58@aol.com](mailto:EDT58@aol.com)

**Benefits:**

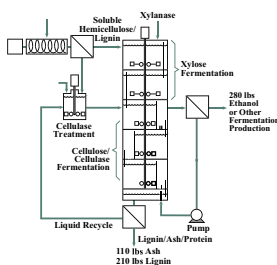
- Reduces metal lost to oxidation from 2-4% to less than 1% by keeping it in a molten state
- Can be retrofit to existing furnaces
- Applicable to multiple molten metal heating operations
- Uses 70% less energy than conventional gas-fired melters
- Zero in-plant emissions



**2006 R&D 100 Award Winner**

## Continuous Cascade Fermentation System for Chemical Precursors

*Low-energy system converts food processing waste to useful chemicals*



This fermentation technology enables the continuous processing of waste carbohydrates or other biomass feedstocks. The technology dramatically increases throughput by incorporating a proprietary cascade reactor design, maintaining a high cell density in the reactors, and using highly flocculent yeast to speed reactions. Industrial firms can utilize this technology to produce ethanol or other chemical precursors.

**Contact:**

- Clark Dale, Bio-Process Innovation, (765) 746-2100, [clark@bio-process.com](mailto:clark@bio-process.com), [www.bio-process.com](http://www.bio-process.com)

**Benefits:**

- Increases fermentation efficiencies
- Higher product concentration yields
- Applicable on a variety of substrates
- Increases production at lower cost

**One installation in place**

## CoFlo™: Innovative Concurrent Distillation Process

*New distillation trays improve performance and energy efficiency of separations*



The CoFlo™ distillation tray significantly increases vapor and liquid handling without sacrificing separation efficiency. In concurrent distillation, the upward flowing vapor atomizes liquid in a tray and carries it up to collectors in the tray above. There the liquid is separated and sent back down via a side downcomer. This design distributes vapor and liquid more evenly and can increase column capacity by up to 100% over the conventional sieve tray arrangement. The CoFlo system can be used in either vertical or horizontal distillation columns.

**Contact:**

- Bill Trutna, Raschig-Jaeger Technologies, (512) 261-8317, [wtrutna@austin.rr.com](mailto:wtrutna@austin.rr.com), [www.jaeger.com/coflo.htm](http://www.jaeger.com/coflo.htm)

**Benefits:**

- Allows column capacity increases of up to 100%
- Energy savings of 10%
- Reduces distillation column cost by 33%

**CoFlo, LLC**  
*Innovative Products*

## Improved Production of Ingeo™ Starch-Based Polylactide (PLA)

*Renewable plastic resins can replace petroleum-derived thermoplastics and fibers*



PLA is a polymer derived from renewable biomass feedstocks that can be used as a plastic (packaging, food service-ware, bottles, foamed trays, films, laminates, and durables) or a fiber (apparel, home-textiles, carpeting, and nonwovens). Ingeo PLA matches or exceeds the performance of other petroleum-based plastics and requires less energy to produce. ITP-funded research on the fundamental structure-property relationships of PLA resulted in two new processing technologies, which improved the polymer properties, lowered production costs, and furthered PLA's commercial adoption.

**Contact:**

- Jeff Kolstad, NatureWorks LLC, (952) 742-0522, [Jeff\\_Kolstad@natureworkslc.com](mailto:Jeff_Kolstad@natureworkslc.com), [www.natureworkslc.com](http://www.natureworkslc.com)

**Benefits:**

- Requires 50% less fossil resources than PET plastic
- Reduces CO<sub>2</sub> emissions by 60% v. PET
- Uses an annually renewable feedstock



**A 300 million pound/year capacity plant in operation**

## Solution Crystallization Modeling Tools

Software aids the design and optimization of crystallization processes



This software shortens the development time for new products manufactured via crystallization, the most widely used separation and purification process in the chemical and pharmaceutical industry for products that are solids at room temperature and pressure. This set of crystallization software includes a mixed-solvent electrolyte model for predicting solubility, a tool for simulating crystal size distribution, and software integrating electrolyte and crystallization tools with Fluent's computational fluid dynamics code.

### Benefits:

- Improves product quality in terms of crystal size purity
- Reduces losses, rework, and downtime

### Contact:

- Andre Anderko, OLI Systems, Inc., (973) 539-4996 ext. 25, [aanderko@olisystems.com](mailto:aanderko@olisystems.com), [www.olisystems.com](http://www.olisystems.com)
- Lewis Collins, Fluent, (603) 643-2600, [rlc@fluent.com](mailto:rlc@fluent.com), [www.fluent.com](http://www.fluent.com)



**55 commercial licenses of OLI Systems crystallization software**

## New Silicone Surfactants for Polyurethane Foam Production

More environmentally benign surfactants replace toxic methylene chloride during production



New silicone surfactants have been developed to improve the production of polyurethane foam without the use of methylene chloride, a toxic chemical that was recently eliminated from the U.S. polyurethane industry. This process change limited the production of some foam grades, but these new silicon surfactants enable the efficient production of the full range of foam grades using a more environmentally benign CO<sub>2</sub> blowing agent. The surfactants overcome challenges of using liquid CO<sub>2</sub> as a blowing agent by emulsifying it, thereby maintaining fine cells during foaming and achieving superior product quality.

### Benefits:

- Enables wide use of liquid CO<sub>2</sub> as a blowing agent, leading to reduced energy use and emissions
- Increases yield through finer foam cell structure, higher bun heights, and improved top-to-bottom physical property gradients

### Contact:

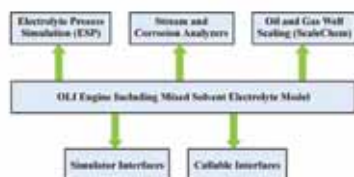
- Mark Listemann, Air Products and Chemicals, Inc., (610) 481-8590, [listemml@airproducts.com](mailto:listemml@airproducts.com), [www.airproducts.com](http://www.airproducts.com)



**Currently in use at seven plants in the United States**

## Mixed-Solvent Electrolyte Model

Model aids in optimizing crystallization and other separation processes



The mixed solvent electrolyte model accurately predicts the solubility of solids in complex multicomponent systems, providing a tool for designing crystallization processes. The model incorporates chemical equilibria to account for chemical speciation in multiphase, multicomponent systems. The model can accurately reproduce various types of experimental data for systems of aqueous electrolyte solutions.

### Benefits:

- Substitutes crystallization for more energy-intensive process units
- Improves process control and product quality
- Minimizes lab and plant testing costs and risks

### Contact:

- Andre Anderko, OLI Systems, Inc., (973) 539-4996 ext. 25, [aanderko@olisystems.com](mailto:aanderko@olisystems.com), [www.olisystems.com](http://www.olisystems.com)



**64 U.S. licenses and 96 non-U.S. licenses sold**

## Evergreen Nylon Carpet Recycling

*Cradle-to-cradle recovery of nylon from waste carpeting*



A novel recycling and recovery process reduces the amount of carpet-based material destined for the landfill and also produces virgin-quality caprolactam, the monomer building block of Nylon-6 resin used to make carpet fiber. This closed-loop depolymerization and purification process allows Nylon-6 recyclers to recover and reuse a significant portion of carpet-making materials while consuming less total energy than conventional caprolactam production methods. This process also produces calcium carbonate for carpet backing and reclaims other carpet polymers for future use.

**Benefits:**

- Reduces land-filling of nylon waste carpets and other Nylon-6 based materials
- Reduces raw material demand for Nylon-6 production

**Contact:**

- Jeff West, Shaw Industries, (770) 607-2514, Jeff.West@shawinc.com, www.shawinc.com



**Cradle-to-cradle process has recycled more than 250 million pounds of post-consumer carpeting since 2007**

## Ceramic Membranes for Gas Separation

*Low-cost, robust membrane allows economical recovery of industrial gases*



Ceramic membranes are very robust and can perform a variety of separations, but high costs have limited their industrial applications. Media and Process Technology, Inc., has overcome the cost barrier by developing a new, inexpensive ceramic membrane base layer that supports a gas-specific inorganic thin film layer. The ceramic membrane eliminates the cooling step that is typically required prior to industrial gas separations, resulting in significant energy savings. The targeted applications include hydrogen production, landfill gas recovery, and CO<sub>2</sub> removal in natural gas processing.

**Benefits:**

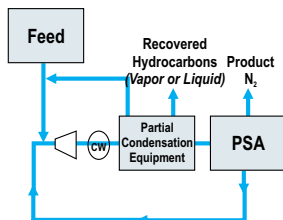
- Reduces energy consumed in gas separation
- Simplifies gas production processes

**Contact:**

- Paul Liu, Media and Process Technology, Inc., (412) 826-3711, pliu@mediaandprocess.com, www.mediaandprocess.com

## Pressure Swing Adsorption (PSA) for Product Recovery

*Highly selective PSA technology recovers valuable components from waste streams*



Many polyolefin plants use nitrogen to strip unreacted monomer and other additives from the product polymer. This gaseous waste stream is typically flared, but pressure swing adsorption enables the recovery of the nitrogen, monomer, and additives for reuse. In a single unit operation, this technology delivers low emissions for polymer degassing operations, while providing nitrogen with a hydrocarbon content as low as 500 ppm.

**Benefits:**

- 100% recovery of N<sub>2</sub> and hydrocarbons

**Contact:**

- Keith Ludwig, Air Products & Chemicals, Inc., (610) 481-5700, ludwigka@apci.com, www.airproducts.com



**Three units in operation**

## TruePeak Process Laser Analyzer

*In-situ measurement for chemical process control*



Current chemical process control uses few in situ sensors, relying instead on analytic techniques that require sample conditioning and transport, and significant turnaround time. In situ sensors can provide real-time measurements, enabling better understanding and control of the process and improving process optimization, product quality, and plant economics. The TruePeak sensor is a tunable diode laser analyzer that directly measures the concentration of O<sub>2</sub>, H<sub>2</sub>O, and potentially several other gasses. The rugged unit is capable of providing real-time, accurate measurements in harsh environments and can be used in a variety of chemical process applications.

### Contact:

- Don Wyatt, Yokogawa Corporation of America, (281) 488-0409, donald.wyatt@us.yokogawa.com, www.yokogawa.com/us

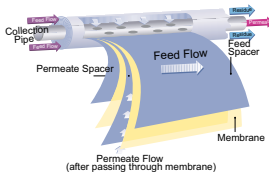
**More than 500 systems in operation worldwide**  
**More than 300 systems in operation in the U.S.**

### Benefits:

- Fast response time
- Suitable for processes up to 1,500°C and 20 bar
- Interference-free

## VaporSep®: Solvent Recovery from Effluent Streams

*Membrane separation used for economical recovery of industrial solvents*



The VaporSep® system uses selectively permeable membranes to separate volatile organic compounds (VOCs) from gaseous waste streams. The simple, reliable, energy-efficient membrane technology diverts and recovers feedstock from the waste stream. This system is being used for waste gas treatment in the petrochemical and pharmaceutical industries, and it has many more applications in recovering CFCs, olefins, refrigerants, and other solvents.

### Contact:

- Hans Wijmans, Membrane Technology and Research, Inc., (650) 543-3379, wijmans@mtrinc.com, www.mtrinc.com

**More than 100 systems in operation**  
**Chemical Engineering Magazine's Kirkpatrick Achievement Award**

### Benefits:

- Recovery efficiency of 99% for VOCs
- Saves material costs through the recovery of solvents and process chemicals
- Reduces chemical releases to the environment



## ResonantAcoustics® Mixing (RAM) Technology

*Acoustic waves reduce mixing time through microscale turbulence*



RAM is a non-contact mixing technology that creates a low-frequency acoustic field that facilitates mixing of gas, liquid, and solid materials. Vertical oscillations at over 100g acceleration create an acoustic streaming motion, which in turn causes a multitude of micro-mixing cells throughout the vessel. By operating at mechanical resonance, the RAM technology transfers the system's mechanical energy into the mixed materials with virtually no energy loss. RAM has application in the chemicals, pharmaceuticals, ceramic, cosmetics, electronics, and energetic materials industries. RAM has application in chemical, pharmaceutical, ceramic, cosmetics, electronics, pulp and paper, food additives, nanomaterial coatings and suspensions, mining materials beneficiation, and energetic materials processing.



### Contact:

- Scott Leap, Resodyn Acoustic Mixers, Inc., (406)-497-5255, scott.leap@resodyn.com, www.resodynmixers.com

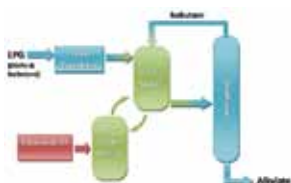
**More than 70 laboratory-scale and 3 production-scale mixers sold globally**  
**Processing Magazine Breakthrough Product of the Year Award**

### Benefits:

- Achieves mixing times 10 to 100 times faster than conventional techniques
- Eliminates time, cost, wasted materials, and disposal issues from impeller cleanup
- Enables same mixing performance at 40 HP as a non-resonant vibration-mixer at 770 HP
- Can be retrofit into existing batch processes

## ExSact: High-Octane Fuel Using a Solid-Acid Catalyst

*Reducing costs and improving safety in alkylate production*



ExSact addresses the rising demand for cleaner-burning transportation fuels by converting light hydrocarbons ( $C_3$ - $C_5$ ) to a high-octane gasoline blend-stock (alkylate) using a unique solid-acid catalyst. The catalyst and novel fixed-bed reactor allow the alkylation reaction to occur with higher energy efficiency than conventional liquid-acid processes. The ExSact process reduces both capital and operating expenses over conventional technologies and can be retrofit into existing refineries.

### Contact:

- Mitrajit Mukherjee, Exelus Inc., (973) 740-2350, mmukherjee@exelusinc.com, www.exelusinc.com



**Multiple refineries are in the process of implementing the ExSact technology**

### Benefits:

- Produces higher-octane alkylate with higher yields and fewer byproducts
- Increases tolerance to feedstock impurities; requires minimal pretreatment
- Lower capital costs and power consumption
- Safer and more environmentally benign than liquid acids

## Methane de-NOx<sup>®</sup> Reburn Process

*Enhancing combustion and reducing NOx formation in stoker boilers*



Methane de-NOx<sup>®</sup> is a retrofit reburning process that improves solid waste fuel combustion while controlling NOx and CO emissions. The process injects natural gas above the stoker boiler grate and uses flue gas recirculation to enhance mixing and create an oxygen-deficient atmosphere that retards NOx formation. Overfire air is injected higher in the furnace to burn out the combustibles. This technology has been demonstrated on municipal solid waste-, coal-, and wood-waste/biomass-fired stoker boilers.

### Contact:

- Roger Glickert, Energy Systems Associates, (412) 429-3576, rglickert@energysystemsassoc.com, www.energysystemsassoc.com



### R&D 100 Award

**Japan Environmental Agency's Environmental Prize**

**AF&PA Environmental and Energy Achievement Award**

### Benefits:

- Reduces NOx emissions 50–70%
- Decreases natural gas use
- Increases waste fuel fire capacity

## Pressurized Ozone/Ultra-filtration Membrane System for TDS Removal

*Novel filtration system enables closed-loop operation to cut energy and water use*



A combination of pressurized ozone injection, dissolved air filtration (DAF) clarification, ultrafiltration, and, optionally, reverse osmosis (RO) membrane filtration cost-effectively removes dissolved solids and/or conductivity from paper mill process water and enables efficient closed-loop operation. Ozone injection increases the oxidation of total dissolved solids (TDS), converting them to total suspended solids (TSS), which agglomerate and precipitate, while the remaining processes provide the necessary degree of filtration depending on water use. Dirty mill process water can be economically cleaned and reused, eliminating the need to discharge and treat effluent or input and heat fresh water.

### Contact:

- Peter James Rudy, Cellulose Products and Services, pjrud@wyman.org

**Improves production, saves effluent discharge costs and mill water heating costs**

### Benefits:

- Improves DAF clarifier efficiency and removes 97.5%+ of TSS
- Removes up to 50% TDS in one pass with clarification/ultrafiltration
- Provides cost effective fresh water substitute using RO membrane option

## PyrOptix Detection and Control of Deposition on Pendant Tubes

*Infrared camera for inspection of kraft recovery boilers during operation*



The PyrOptix infrared camera system enables on-line detection of deposits, blockages, hot spots, and fixture damage in kraft recovery boilers. Without shutting down the boiler, the camera produces clear, thermal images and videos of boiler depths up to 100 feet. PyrOptix enables immediate response and trend analysis for system optimization in high-temperature, particle-laden environments. A sootblower control system integrated with the camera is in development.

### Contact:

- Dave Suplicki, Enertech, Inc., (330) 573-8998, dave.s@enertech.com

**Enertech**<sup>®</sup>  
Innovative Process Solutions

**More than 40 systems sold to the pulp and paper industry and other industries**

### Benefits:

- Reduces sootblowing steam by 20%
- Reduces shutdowns
- Improves boiler safety

## Chemical for Increasing Wood Pulping Yield: ChemStone OAE®-11

*Easy-to-handle additive improves quality and yield in all chemical pulping processes*



ChemStone OAE®-11 thoroughly penetrates dense wood chips and protects fine fibers from overprocessing. This novel pulping additive's unique chemistry increases alkali penetration by 30% within 15 minutes, but halts acid hydrolysis upon alkali availability to prevent overcooking. Unwanted compounds are prevented from re-precipitating, and byproducts are effectively eliminated from the fiber mixture. This cooking aid is effective for hardwood and softwood pulps and applicable to all pulping processes.

**Benefits:**

- Increases pulp yield 4-5%
- Decreases bleaching chemical use

**Contact:**

- Mike Blackstone, ChemStone, Inc., (864) 458-8077, mblackstone@chemstone.com, www.chemstone.com

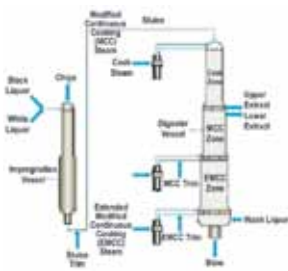


CHEMSTONE, INC.

**Up to 8 million tons of pulp processed with ChemStone OAE®-11 annually**

## Dynamic Simulation Model for Continuous Digesters

*Process model improves continuous digester performance for hardwood and softwood*



This PC-based model predicts the dynamic behavior of the continuous digester, including internal operating characteristics throughout the column. The model runs about 300 times faster than real-time and includes a graphical user interface. The simulation software is suitable for designing control systems, improving operating policies (including grade transitions and production rate changes), and training operators. Customized implementation service is provided for each digester.

**Benefits:**

- Increases yield 4-5%
- Reduces emissions and effluents

**Contact:**

- Ferhan Kayihan, IETEK, Integrated Engineering Technologies, (253) 925-2179, fkayihan@ietek.net, www.ietek.net



## Thermodyne™ Evaporator: A Molded Pulp Products Dryer

*Innovative technology enables faster, cleaner, safer drying of molded pulp products*



This energy-efficient dryer uses superheated steam and oxygen suppression to improve molded pulp product drying. As water evaporates from the product, the vapor is superheated by indirect integral heaters, raising the temperature within the dryer. This allows faster drying at lower temperatures than conventional air dryers. In addition, volatile organic compounds (VOCs) are recovered by the condensate. The dryer is suitable for manufacturing molded fiber particles and drying pulp and wood veneer products.

**Benefits:**

- Reduces energy use by 50%
- Lowers production costs
- Reduces scorching, burning, and discoloration of molded pulp products

**Contact:**

- Donald P. Curry, Merrill Air Engineers, (207) 767-1223, dcurry10@gmail.com



**Third dryer under construction in 2010**



## Partial Borate Autocausticizing

*Reduces CO<sub>2</sub> emissions and lime mud disposal costs in pulp mills*



The partial borate autocausticizing technology has been proven at mills globally to help improve recovery cycle operations, increase white liquor production, and generate cost savings by off-loading lime kilns and reducing fresh lime and lime stone purchases. Causticizing capacity is increased by adding sodium metaborate to the liquor cycle, which forms sodium hydroxide in the smelt-dissolving tank without the use of lime or additional causticizing processes. Furthermore, it reduces the CO<sub>2</sub> emissions that originate from fuel burning during the calcining process in the lime kiln and reduces the lime mud that must be disposed. This technology can be implemented with little capital investment.

### Benefits:

- Reduces lime kiln throughput, fuel requirements, and CO<sub>2</sub> emissions
- Allows for increased pulp capacity
- Reduces lime needed for causticizing



### Contact:

- Eric Schweighofer, Rio Tinto Minerals, (303) 713-5208, [eric.schweighofer@riotinto.com](mailto:eric.schweighofer@riotinto.com), [www.riotinto.com](http://www.riotinto.com)

## MultiWave™ Automated Sorting System for Efficient Recycling

*High-speed scanning system features improved lignin sensor*



The MultiWave™ sensor is a paper and plastic sorting system that incorporates an innovative lignin sensor originally developed through North Carolina State University-led R&D. The lignin sensor effectively detects the presence of paper in a waste stream conveyed at high speeds by measuring the lignin's fluorescence under green light. Based on the sensor data, the master computer then fires compressed air jets to eliminate rejected materials. The lignin sensor enables the MultiWave™ system to scan more than 160 ft<sup>2</sup> per second in machine widths up to 96 inches, significantly increasing throughput rates.

### Benefits:

- Increases throughput rates
- Enhances sorting and ejection accuracy
- Conveys up to 15 tons per hour



### Contact:

- Felix Hottenstein, MSS Inc., (615) 781-2669, [hotrock@magsep.com](mailto:hotrock@magsep.com), [www.magsep.com](http://www.magsep.com)

**19 units in operation**

## ChemStone RBS400

*Yield-enhancing additive reduces scaling in pulping equipment*



ChemStone RBS400 increases circulation flow in pulping equipment by reducing scale build-up and plugging. Based on a new, patent-pending polymeric phosphonate, this digester additive controls the metals that interfere with bleaching and with the sulfur chemistry of a kraft cook. The chemical also reduces dichloromethane (DCM) extractives by controlling calcium before it can react with fatty and resin acids. Even fouled digesters and evaporators can be cleaned with just a 1 lb/ton dose.

### Benefits:

- Increases Southern hardwood yield by 3% alone, and by more than 5% when used with ChemStone OAE®-11
- Minimizes downtime needed for cleaning calcium scales
- Controls calcium levels and reduces DCM extractives

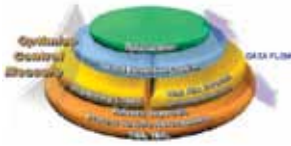
### Contact:

- Mike Blackstone, ChemStone, Inc., (864) 458-8077, [mblackstone@chemstone.com](mailto:mblackstone@chemstone.com), [www.chemstone.com](http://www.chemstone.com)



## Advanced Quality Control (AQC) Solution for Thermo-Mechanical Pulping

*Implementation of proper segments, sensors, and advanced equipment offers advanced pulping control*



Using a combination of proprietary software and control sensors, the Advanced Quality Control (AQC) Solution for thermo-mechanical pulping allows paper mills to model process variables and predict product quality. Sensors measure several pulping process qualities, including consistency, fiber length, refiner temperature and pressure, and other key factors. The technology's controller, configured to meet process quality requirements and to run at optimal conditions, determines the predictive model. Pulp mills using these predictive models can make real-time process changes to optimize product quality and minimize over-refining and wasted energy.

**Contact:**

- Adam Melton, Metso Automation, (251) 625-3434, adam.melton@metso.com, www.metso.com

**Benefits:**

- Reduces peak energy demand by matching real-time pricing from local electrical utilities
- Reduces raw material costs
- Improves final pulp quality by reducing variability by 30-80%



**Installed in 26 mills worldwide**

## Biological Air Emissions Control

*Technology controls VOC and HAP emissions with use of microorganisms*



An innovative biological treatment system integrates two types of bio-oxidation in a three-stage process to help forest product facilities remove emissions of volatile organic compounds (VOC) and hazardous air pollutants (HAP) from process exhaust streams. As an energy-saving alternative to regenerative thermal and catalytic oxidation, this technology uses microorganisms to degrade air emissions, eliminating natural gas combustion and the associated secondary pollutants. This system also has applications in the automotive coating, chemical, and pharmaceutical industries.

**Contact:**

- James T. Boswell, Met-Pro Environmental Air Solutions, (936) 597-7711, jboswell@bioreaction.com, www.mpeas.com
- Mike Foggia, Met-Pro Environmental Air Solutions, (888) 508-2808, mfoggia@bioreaction.com, www.mpeas.com

**Benefits:**

- Provides a 90% reduction in operating cost from thermal oxidation
- Eliminates the use of natural gas as a fuel in thermal oxidation



**12 units currently installed in the wood products industry**  
**1 unit installed in an automotive coating process**

## Gas-Fired Paper Dryer

*Efficient, drop-in replacement for steam dryers*



An innovative, gas-fired drum dryer incorporates a ribbon burner and dimpled heat transfer surface to increase the rate and energy efficiency of industrial drying, particularly for paper and food processing applications. The total package is integrated with all required controls and has been designed for long-term operation with minimal maintenance.

### Contact:

- Fred Elbert, Gas Technology Institute, (518) 747-1331, fred.elbert@glv.com, [www.glv.com/PulpPaperHome.aspx](http://www.glv.com/PulpPaperHome.aspx)



**1 unit operating in the United States**

### Benefits:

- Improves dryer efficiency, especially when heat is recuperated from the combustion gases
- Simple and safe drop-in solution will sometimes replace 2-3 steam-heated dryers

## XTREME™ Cleaner: Removal of Light Sticky Contaminants

*High-capacity, efficient cleaning of post-consumer paper prior to recycling*



The XTREME™ Cleaner is a centrifugal cleaning technology that effectively removes “stickies,” wax, polyethylene, binding glue, and other contaminants from post-consumer fiber sources. This long-residence-time, small-diameter cleaner’s improved kneading and vortex separation technology effectively separates tiny contaminants that are close to the specific gravity of the fiber itself. Paper mills using this technology can use lower-cost furnish without lowering paper quality.

### Contact:

- Kathy Murphy, Kadant Black Clawson, Inc., (513) 229-8100, [info@kadantbc.com](mailto:info@kadantbc.com), [www.kadantbc.com](http://www.kadantbc.com)



**More than 50 systems in operation**

### Benefits:

- Reduces energy use by 50%
- Reduces paper breaks by 40-60%

## Screenable Water-Based Pressure-Sensitive Adhesives

*Increasing recyclability of paper with easily-removed tape and labels*



Recycling Compatible Adhesives

New water-based pressure-sensitive adhesives (PSAs) can be easily removed by screens early in the paper recycling process, saving a substantial amount of energy across the paper industry. Currently, when PSAs are part of the recovered paper stream, they create lost production and diminished product quality in a recycling pulp mill. Also, a large number of recycling mills do not accept these products due to the problems they create. Substituting current PSAs with screenable versions will increase the amount of paper that can be recovered for recycling.

### Contact:

- Mike Witte, Franklin International, (614) 445-1466, [mikewitte@franklininternational.com](mailto:mikewitte@franklininternational.com), [www.franklininternational.com](http://www.franklininternational.com)



### Benefits:

- Saves energy by allowing previously wasted paper to be captured in process recycle streams and reused
- Reduces process problems and improves final product quality
- Increases the amount of paper recovered for recycling and reduces landfill waste

## RootViz FS

*X-Ray technology uses non-destructive root imaging to accelerate plant research*



This high-throughput, high-resolution, non-destructive system images and characterizes plant roots using low-voltage digital X-ray radiography, combined with special growth substrate material, plant containers, and image processing algorithms. The ability to analyze plant root structure and function in a timely, cost-efficient manner is critical for genetic improvement programs, such as biomass feedstock research on poplar, switchgrass, corn, and soybeans. This technology performs with high throughput and, because the X-rays do not destroy the plant, enables the analysis of the same plant multiple times.

**Contact:**

- Daniel McDonald, Phenotype Screening Corporation, (865) 694-9459, [mcdonaldw@phenotypescreening.com](mailto:mcdonaldw@phenotypescreening.com), [www.phenotypescreening.com](http://www.phenotypescreening.com)

**Benefits:**

- Accelerates research by about 30% and lowers research costs
- Reduces the number of plants needed to be grown because multiple measurements can be made on the same plant
- Offers high-resolution (100 microns) X-ray images of entire root volume



**2007 R&D 100 Award Winner**

## Screenable, Pressure-Sensitive Adhesives for EnviroSensitive™ Labels

*Novel adhesive facilitates recycling of paper labels*



EnviroSensitive™ labels utilize a unique pressure-sensitive adhesive (PSA) that is easily removed from recovered paper during the recycling process. This adhesive forms larger adhesive particles during repulping, enhancing its removal during screening while reducing or eliminating the adhesive's impact on the recycling process. This new, environmentally benign PSA allows recyclers to repulp a wider variety of waste paper and reduce processing backups. The adhesive has "quick-stick" permanence and is available only on EnviroSensitive™ Labels.

**Contact:**

- Nicole Orcutt, Avery Dennison, (800) 777-2879 ext. 321, [nicole.orcutt@averydennison.com](mailto:nicole.orcutt@averydennison.com), [www.averydennison.com](http://www.averydennison.com)

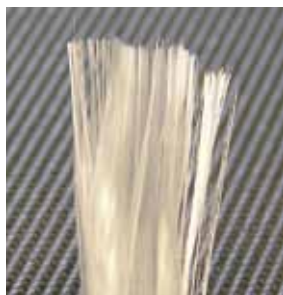
**Benefits:**

- Maintains excellent strength and adhesive properties
- Improves energy efficiency of recycled papermaking
- Reduces equipment downtime
- Lowers fiber loss and chemical costs



## Converting Waste Glass Fiber into High Quality VCAS™ Pozzolan

*Glass plant waste converted for use in cement and concrete*



In a new process, waste glass fiber is converted into VCAS™ (vitrified calcium aluminosilicate) pozzolan that can be used in cement and concrete applications. Waste glass fiber ground to a fine powder functions as a reactive pozzolanic cement extender for use in Portland-cement-based materials. The pozzolan provides increased long-term strength and improved long-term durability to concrete. Because glass manufacturing waste is typically vitreous, clean, and low in iron and alkalis, the resulting pozzolan is highly consistent in chemical composition and ideal for white concrete applications. The VCAS(TM) pozzolan also has applications in high-performance concrete and as a coating and polymer filler.

### Contact:

- Raymond T. Hemmings, Albacem LLC, (770) 590-1560, [hemmings@earthlink.net](mailto:hemmings@earthlink.net), [www.vitrominerals.com](http://www.vitrominerals.com)

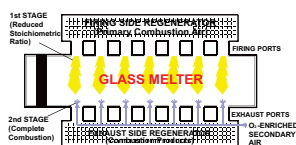
**Continuous process operating in 2 U.S. plants.**

### Benefits:

- Decreases the amount of cement and water used in concrete
- Reduces the carbon and energy footprint of cement processing
- Reduces the waste stream from glass fiber manufacturing
- Certified 100% post-industrial recycled product contributes to LEED certification for sustainable building

## Oxygen-Enriched Air Staging

*NOx emissions reduced for glass furnaces*



This technique controls NOx formation and improves heat transfer in air-gas glass furnaces without interrupting furnace operation or adversely affecting product quality. The system stages combustion by holding back a portion of the combustion air normally provided during the earliest stages of combustion and flame development. The resulting flame is hotter and more luminous. Glass manufacturers can employ this technique in existing endport and sideport regenerative glass furnaces.

### Benefits:

- NOx levels reduced 40–70%
- Cost-effective method to meet emission reductions



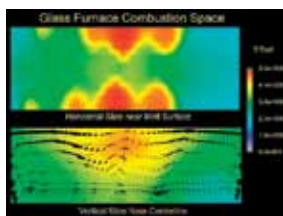
### Contact:

- Kevin Cook, Eclipse, Inc., (407) 628-3338 ext. 171, [kcook@eclipsenet.com](mailto:kcook@eclipsenet.com), [www.eclipsenet.com](http://www.eclipsenet.com)

**Five units operating in the United States  
R&D 100 Award Winner**

## Glass Furnace Model: Glass Melting Simulation Software

*3D modeling software improves glass melting efficiency*



Glass Furnace Model (GFM) is a three-dimensional combustion space/melt tank/batch melting model that uses real-world furnace data and conditions to improve the regulation of heat flux distribution on the batch and glass melt surfaces both in existing and new glass furnaces. The GFM consists of three major computational models: a combustion space model, a radiation heat transfer model, and a multiphase glass melt model. The GFM was extensively validated against a comprehensive database acquired from in-situ measurements in three different types of operating furnaces.

### Benefits:

- Improves glass melting efficiency through enhanced understanding of heat flux distribution
- Optimizes existing furnaces or enables operators to investigate new furnace designs
- Leads to improved glass quality



### Contact:

- Cynthia Wesolowski, Argonne National Laboratory, (630) 252-7694, [weso@anl.gov](mailto:weso@anl.gov), [www.anl.gov/techtransfer/Software\\_Shop/GFMSoftware/GFM\\_Software.html](http://www.anl.gov/techtransfer/Software_Shop/GFMSoftware/GFM_Software.html)

**2004 R&D 100 Award Winner**

## Oxy-Fuel Firing

*Oxy-fuel combustion saves energy and reduces emissions*



Oxy-fuel firing uses oxygen instead of air in the high-temperature combustion process employed in glass melting furnaces. Burners specifically designed for oxy-fuel firing are employed to provide maximum efficiencies. Oxygen is provided to glass manufacturers by one of three primary technologies, depending on the economics for each glass facility. Glass manufacturers are using this process in all major glass sectors.

### Benefits:

- Reduces fuel use by 15–45%
- Reduces NOx emissions up to 90%
- Increases production rates

**AIR PRODUCTS**

**AIR LIQUIDE**

THE LINDE GROUP

**PRAXAIR**

### Contact:

- Kevin Lievre, Air Products and Chemicals, Inc., (610) 481-7007, [lievrek@airproducts.com](mailto:lievrek@airproducts.com), [www.airproducts.com](http://www.airproducts.com)
- Bob Oesterreich, Air Liquide Industrial, (713) 896-2332, [bob.oesterreich@airliquide.com](mailto:bob.oesterreich@airliquide.com)
- Tony Palermo, Linde LLC, (908) 771-1215, [tony.palermo@linde.com](mailto:tony.palermo@linde.com), [www.lindeus.com](http://www.lindeus.com)
- Wladimir Sarmiento-Darkin, Praxair Inc., (716) 879-7362, [wladimir\\_sarmiento-darkin@praxair.com](mailto:wladimir_sarmiento-darkin@praxair.com), [www.praxair.com](http://www.praxair.com)

**Approximately 100 units operating in the United States**

## PrimeFire 400: High-Luminosity, Low-NOx Burner

*High-efficiency burner lowers cost and emissions in oxy-fuel glass melters*



Designed for oxy-fuel glass furnaces, the PrimeFire 400 is an advanced flat flame burner that can be fitted into existing control schemes. This burner improves performance by modifying the fuel prior to combustion and then forming and burning soot in the flame. The PrimeFire 400 comes in four sizes with maximum capacities of 2, 4, 10, and 20 million Btu/hour. All models can be fired using natural gas or fuel oil.

### Benefits:

- Thermal efficiency increases up to 20%
- Reduces NOx by up to 50%
- Extends furnace life

### Contact:

- Kevin Cook, Eclipse, Inc., (407) 628-3338 ext. 171, [kcook@eclipsenet.com](mailto:kcook@eclipsenet.com), [www.eclipsenet.com](http://www.eclipsenet.com)

**ECLIPSE**  
Innovative Thermal Solutions

**Operating in 2 U.S. plants**

## High Throughput Vacuum Processing for Innovative Uses of Glass

*Reducing costs with automated thin-film module manufacturing*



A new process coats ordinary window glass with a thin film of cadmium telluride (CdTe), a waste product of copper processing, to create photovoltaic (PV) solar cells while lowering direct manufacturing and equipment costs. This new process uses up to 100 times less semiconductor material than required by the crystalline silicon process. All phases of the process occur in a single vacuum chamber, resulting in an efficient, high-quality, uniform process. It takes less than two hours to build one photovoltaic module from start to finish.

### Benefits:

- Low capital costs and highly scalable
- Low waste and high yield
- High throughput

### Contact:

- Kurt Barth, Abound Solar, (970) 619-5340, [kbarth@abound.com](mailto:kbarth@abound.com), [www.abound.com](http://www.abound.com)

**abound**  
solar

**Used in Abound Solar's thin-film photovoltaic manufacturing process**

## Dynamic Control of Cooling

*Advanced artificial intelligence and wireless technology for efficient HVAC*



A Federspiel Controls energy management system, the Real-Time Energy Optimizer™, utilizes sophisticated artificial intelligence technology to deliver real-time control of temperature in data centers. A wireless mesh network of sensors monitors server inlet air temperature and controls the variable frequency drives (VFDs) on air conditioner fans. Wireless sensors provide an installation that is fast, easy, and non-intrusive.

### Contact:

- Federspiel Controls, (510) 524-8480, [sales@federspielcontrols.com](mailto:sales@federspielcontrols.com), [www.federspielcontrols.com](http://www.federspielcontrols.com)

### Benefits:

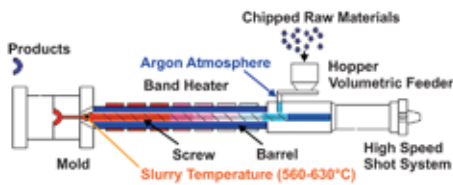
- Energy savings of up to 50% for cooling
- Increases data center uptime and extends equipment life
- Reduces carbon footprint



**2010 Green Enterprise IT Award Finalist**  
**2009 Best of California Award for Green IT**

## Thixomolding®: Improved Magnesium Molding Process

*Injection molding process substantially reduces energy, waste, and operating costs*



The Thixomolding® process offers a viable alternative to die casting and occurs in a closed machine that can be monitored and operated by one person. In one step, room-temperature magnesium chips are heated to semi-solid slurry and molded into components in a process similar to plastic injection molding. After cooling in air, these components are ready for trimming and assembly or secondary operations. Few, if any, finishing processes are required.

**Contact:**

- Raymond Decker, Thixomat, Inc., (734) 995-5550, rdecker@thixomat.com, www.thixomat.com

**Benefits:**

- Reduces operating costs and increases die life
- Improves product yields to 90%
- Significantly reduces pollutant emissions and eliminates the use of sulfur hexafluoride

**More than 50 licenses and 400 machines worldwide**

## Ceramic Composite for Metal Casting

*New material produces superior, affordable dies*



A new ceramic composite in the nitride/nitride-carbide family provides stability to molten metals and is resistant to corrosion, oxidation, thermal fatigue, and cracking. As an alternative to conventional coated steel forming dies, lower-cost hybrid composites have the potential to last up to 10 times longer with significantly lower weight. The ceramic dies also produce fewer casting rejections, thereby reducing the energy required to recycle rejected castings.

**Contact:**

- J. C. Withers, Materials and Electrochemical Research Corporation, (520) 574-1980, jcwithers@mercorp.com, www.mercorp.com

**Benefits:**

- 5-10 times longer die life
- 2-5 times harder than tool steels

**Installed in several U.S. locations**

## SeeFOAM®: CPFDP® Software for Lost Foam Pattern Blowing

*Software package allows engineers to detect potential filling problems before cutting tooling*



A foundry engineering software package correctly models fill patterns, visualizes the effects of vent locations and fill gun parameters, and provides final local pattern density. Using Computational Particle Fluid Dynamics (CPFDP), the software models white expanded polystyrene (EPS) patterns while monitoring any significant interaction between the individual EPS bead motion and air flow. This user-friendly software package gives engineers the ability to detect pattern defects before a tooling is produced or filled, saving costs with improved tooling designs. The model has been validated by automobile manufacturers in the U.S. and Japan.

**Contact:**

- Peter Blaser, Arena-flow, LLC, (505) 275-3849, info@arena-flow.com, www.arena-flow.com

**Benefits:**

- Accurately predicts location and causes of foam pattern defects
- Optimizes fill gun parameters and vent locations
- Creates foam patterns with consistent density and permeability
- Saves tooling production costs, reduces scrap



**American Foundry Society's 2010 Applied Research Award Winner**



## Rapid Solidification Process (RSP) Tooling: Quality Mold Production

*Simple, more efficient tooling for multiple industries*



The Rapid Solidification Process (RSP) was developed to improve the efficiency of manufacturing molds and dies. RSP Tooling uses a system that is able to spray molten steel onto a ceramic negative, while spinning and changing the spray angle for even distribution. RSP allows production-quality tooling for steel, glass, metal casting, forging, and heat-treating applications to be made in a fraction of the time and at a significantly reduced cost compared to conventional tool-making practices.

### Benefits:

- Saves 50% of additional insert cost
- Increases tool hardness
- Extends tool lifetime



### Contact:

- James R. Knirsch, RSP Tooling, LLC, (440) 349-5262, knirsch@rsptooling.com, www.rsptooling.com

**2001 FLC Award, 2000 DOE Energy@23 Award, and 1998 R&D 100 Award**

## Integrating Rapid Solidification Process Tooling and Rapid Prototyping in Die Casting

*Cutting lead time, costs, and energy for production of tooling*



A new Rapid Solidification Process (RSP) technology for the die casting industry reduces lead time for prototyping and producing die casting tooling while substantially reducing energy use and scrap compared to conventional machining practices. The approach combines rapid solidification processing and net-shape materials processing in a single step. A mold design is converted to a tooling master using a rapid prototyping technology such as stereolithography. Then, a thick deposit of tool steel is applied via spray forming to capture the desired shape, surface texture, and detail. Tools have been produced for the die casting, plastic injection, investment casting, glass forming, and metal forming industries.

### Benefits:

- Reduces costs and delivery times
- Cuts cycle time by 25% for plastic injection or die casting operations
- Reduces part cost by 80%



### Contact:

- James Knirsch, RSP Tooling, LLC, (440) 349-5262, knirsch@rsptooling.com, www.rsptooling.com

**More than 100 dies in production**

**Nortech Innovator of the Year award in manufacturing technologies**

## Multiple-Station Air Gauge: Non-Contact Part Inspection and Gauging

*Air gauge system accurately gauges parts without damaging casting patterns*



The multiple-station air gauge system allows precise, non-contact measurement of low-modulus materials during the casting process without damaging casting patterns. The system works by blowing air on surfaces and monitoring the pressure ratios created by airflows between a central primary air chamber and 30 separate secondary chambers. The system reduces processing time, product reject rate, and scrap generation, thereby increasing the energy efficiency of the casting process.

### Benefits:

- Takes 30 measurements in less than one minute
- Accurate within five ten-thousandths of an inch

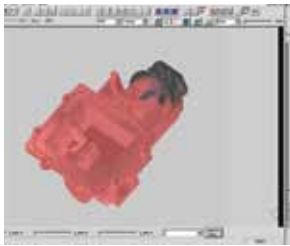
### Contact:

- Brian Backus, Delaware Machinery and Tool, (765) 284-3335, bbackus@delawaremachinery.com, www.delawaremachinery.com

**System was used to determine standards for EPS foam shrink rates**

## CastView™ Modeling Program: Die Casting Design Visualization

*Quick evaluation of die casting design during the design phase*



CastView™ is a PC-based modeling program that simulates molten metal and heat flow in the die casting process, allowing designers to detect potential die casting problems during the design phase. This easy-to-use program utilizes imported stereolithography CAD files to create detailed simulations in minutes of die cavity filling and thermal distribution. CastView™ can reduce scrap by 20% or more, resulting in increased yield and saving the energy formerly wasted by producing defective parts.

### Contact:

- North American Die Casting Association, (847) 279-0001, [www.diecasting.org](http://www.diecasting.org)

### Benefits:

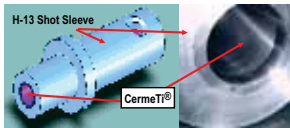
- Fewer die iterations
- Better casting designs and better running dies



**135 units sold**

## CermeTi®: Titanium Matrix Composite-Lined Shot Sleeves for Aluminum Die Casting

*Innovative material saves energy and extends shot sleeve lifetime*



CermeTi® is a rugged titanium metal matrix composite material with the toughness of titanium and the soldering and abrasion resistance of ceramic. This alloy contains microscopic particles of hard ceramic that enable excellent heat retention and resistance to aluminum soldering—ideal properties for H-13 tool steel shot sleeve liner material. Shot sleeves using this material demonstrate reduced heat loss during injection, permitting lower pouring temperatures or slower plunger tip speeds. This material is produced by powder metal technology and can be made to custom-sized near net shapes.

### Contact:

- Susan M. Abkowitz, Dynamet Technology, Inc., (781) 272-5967, [smabkowitz@dynamettechnology.com](mailto:smabkowitz@dynamettechnology.com), [www.dynamettechnology.com](http://www.dynamettechnology.com)
- Harvey Fisher, Dynamet Technology, Inc., (781) 272-5967, [hfisher@dynamettechnology.com](mailto:hfisher@dynamettechnology.com), [www.dynamettechnology.com](http://www.dynamettechnology.com)

### Benefits:

- Longer shot sleeve and tip life
- Less down time and fewer rejects
- Lower costs, less energy use, and fewer emissions



**Used in 5 U.S. aluminum plants**

## Copper Die Casting Technology for Motor Rotors

*High-temperature die materials enable cost-effective die casting of efficient copper rotors*



A novel process for die casting copper rotors uses pre-heated molds from high-temperature tungsten and nickel-based alloys. Despite its lower electrical conductivity, aluminum—rather than copper—is traditionally used for the squirrel cage of induction motor rotors because of its lower casting cost. By pre-heating and maintaining die temperature, the new process reduces the temperature differential between the mold surface and the cooler interior, preventing destructive thermal shock and fatigue. Die life of conventional die steels is also improved with the process.

### Contact:

- Ned Brush, Copper Development Association, Inc., (781) 891-6909, [ebrush@comcast.net](mailto:ebrush@comcast.net), [www.copper-motor-rotor.org](http://www.copper-motor-rotor.org)
- Dale T. Peters, Copper Development Association, Inc., (843) 681-4121, [dtpeters@roadunner.com](mailto:dtpeters@roadunner.com), [www.copper-motor-rotor.org](http://www.copper-motor-rotor.org)

### Benefits:

- Reduces electric motor total energy loss by 15–20%
- Lower operating cost than for aluminum rotors
- Increases motor efficiency without increasing size



**More than 100,000 motor rotors operating in the United States in 2007**

## RIM™ Radio-Imaging Method: Imaging Ahead of Mining

*Precise identification of cleaner, more complex coal beds*



The RIM™ Radio-Imaging Method uses wireless synchronization between a transmitter and remote imaging receiver to produce images of coal seams. RIM™ sends an electromagnetic wave through the subject area, detects differences in conductivity between the coal and the surrounding materials, and produces images of the geological strata. This information is used to produce an image that maps the mine's geological features for targeted mining. RIM™ applications include metaliferous mining, environmental research, and civil engineering.

### Contact:

- Joseph Duncan, Stolar Horizon, Inc., (575) 445-3607, [jtd@stolarhorizon.com](mailto:jtd@stolarhorizon.com), [www.stolarhorizon.com](http://www.stolarhorizon.com)



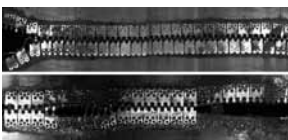
**Used in more than 100 mines from 2003 to 2009**

### Benefits:

- Longwall mapping—finds geological hazards
- Predicts coal and ore thickness and trends
- Detects and maps old mine voids

## Belt Vision Inspection System for Improving Mining Productivity

*Low-cost, comprehensive inspection system identifies defects and reduces downtime*



The Belt Vision system uses a camera and computer system to monitor mechanical splice deterioration in conveyer belts while in operation in underground and surface mines. The computer system, located on the belt or on a remote desktop, digitizes and records continuous imaging of the belt and splices. Mine personnel using this system can review live or historical images several times a day with minimal effort and take action before belt splices fail.

### Contact:

- Titus Beitzel or Chris Yoder, Pillar Innovations, (301) 245-4007, [info@pillarinnovations.com](mailto:info@pillarinnovations.com), [www.pillarinnovations.com](http://www.pillarinnovations.com)

### Benefits:

- Reduces belt downtime and energy consumption
- Promotes better maintenance scheduling
- Improves belt availability and mine productivity



**12 units in operation**

## Ultra Efficient Vibrating Machine Model VM09v001

*A new smart screening technology will increase energy efficiency and throughput*



The VM09v001 machine uses miniaturized lead zirconate titanate (PZT) and/or electromagnetic motors with a closed-loop power management system to cause only the "live" screening deck to vibrate at system and/or panel resonance frequencies. This approach is replacing conventional screens that use the brute force of a large electric motor and eccentric-shaft to mechanically shake the entire machine. The Ultra Efficient Vibrating Machine provides fine mineral separations for the mining industry and has applications for construction, pharmaceutical, agriculture, and petroleum industries.

### Contact:

- Daryoush Allaei, QRDC, Inc., (952) 556-5205, [dallaei@qrdc.com](mailto:dallaei@qrdc.com), [www.qrdc.com](http://www.qrdc.com)

### Benefits:

- Increases capacity and efficiency
- Reduces energy consumption by 50-70%
- Lowers maintenance and eliminates lubrication—no shafts, bearings, bushings, or other moving parts
- Decreases excess noise and vibration to improve worker safety

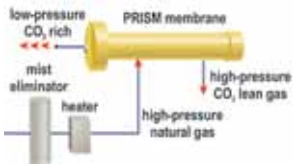


**2004 R&D 100 Award**

**2002 Smart Structures Product Implementation (SPIE) Award**

## PRISM® Membrane Technology for Natural Gas Cleaning

*Effective, low-cost removal of CO<sub>2</sub> and H<sub>2</sub>S from natural gas*



The PRISM® membrane separation technology converts sub-quality natural gas into pipeline-grade gas by removing impurities, such as CO<sub>2</sub> and H<sub>2</sub>S. The highly selective membrane system separates gases based on relative permeation rates, enabling stand-alone or synergistic separations processes. This system can be used as a bulk-removal device, or it can replace or minimize the size of traditional amine systems. The membrane's compact size and tolerance to particular contaminants and water make it suitable for offshore and remote applications.

### Benefits:

- Reduces system size and weight by 40%
- Low initial capital costs
- Reduces downtime and maintenance costs



### Contact:

- Charles Page, Air Products & Chemicals, (800) 635-8842, [pagec@airproducts.com](mailto:pagec@airproducts.com), [www.airproducts.com](http://www.airproducts.com)

## Membrane-Based Vapor Separation for Underground Gasoline Storage Tanks

*Reverse separation membranes prevent volatile organic compound (VOC) release during fuel storage tank venting*



A novel reverse separation membrane system discharges air from underground gasoline storage tanks while preventing the release of VOCs. Traditional venting methods typically permeate VOCs more rapidly than air, but this new system discharges clean air at low to slightly negative pressure while controlling and recycling the larger VOC molecules. As a result, storage tanks and vessels can be kept under slight vacuum, virtually eliminating fugitive and vent emissions from the system. In addition, this system enables continuous monitoring of storage tank internal conditions, structural integrity, and leak-checking.

### Benefits:

- Decreases VOC emissions
- Greater than 95% venting reduction with little or no penalty
- Extends service life and lowers maintenance costs



### Contact:

- Stuart Nemser, Compact Membrane Systems, Inc., (302) 999-7996, [snemser@compactmembrane.com](mailto:snemser@compactmembrane.com), [www.compactmembrane.com](http://www.compactmembrane.com)

**350 systems sold in 2008**

## Ammonia Absorption Refrigeration Unit for Refinery Operations

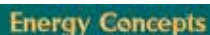
*Waste-heat-powered technology recovers fuel, increases refinery capacity*



An advanced ammonia refrigeration unit recovers gasoline and liquefied petroleum gas (LPG) from refinery fuel gas header streams. This waste-heat-powered technology cools the waste stream, causing the condensation of valuable liquid products that would otherwise remain in the stream. In addition, this technology raises the column capacity of fluid catalytic crackers by reducing the burden of overloaded wet-gas compressors. This technology is also applicable to mainstream industrial refrigeration operations and has spawned several other developments based on this platform.

### Benefits:

- Delivers temperatures as low as -50°F
- 2-year payback time
- Decreases CO<sub>2</sub> emissions
- Increases refinery throughput



### Contact:

- Donald Erickson, Energy Concepts Co., (410) 266-6521, [enerconcep@aol.com](mailto:enerconcep@aol.com), [www.energy-concepts.com](http://www.energy-concepts.com)

**2 units installed in refineries**

**Denver installation designated “Environmental Project of the Year” by the Association of Energy Engineers**

## Mesabi Nugget Cokeless Ironmaking

*High-quality, low-cost iron nugget production*



The Mesabi Nugget cokeless ironmaking technology optimizes the ITmk3® process, which turns iron ores into high-quality iron nuggets in a rotary hearth furnace. The technology is able to complete reduction, melting, and slag removal in only about 10 minutes. The pilot plant produced 9,500 metric tons of iron nuggets superior in quality to direct reduced iron (DRI) and similar to blast furnace pig iron. The product can be used as a supplemental iron source in electric arc furnaces, basic oxygen furnaces (BOF), and metal castings.

### Contact:

- Larry W. Shields, Midrex Technologies Inc., (704) 423-3345, lshields@midrex.com, www.midrex.com



### Benefits:

- Produces nuggets of 96–98% nugget purity
- Reduces energy use by 30%
- Reduces emissions by over 40%

### Used in a Minnesota ironmaking plant

## AmeriBronze® Alloy Improves Steel Furnace Component Life

*Aluminum bronze alloy slashes maintenance downtime and costs while increasing productivity and revenues*



A high-performance aluminum bronze alloy, AmeriBronze®, offers unprecedented improvements in the operating life of basic oxygen furnace (BOF) and electric arc furnace (EAF) components, such as hoods, roofs, side vents, and flux chutes. The alloy resists corrosive steelmaking environments, extreme temperatures, and physical erosion caused by slag particulates splashing in the furnace. As of mid-2007, an aluminum bronze skirt installation has withstood approximately 6,000 steel production cycles over nearly 3 years without requiring process-related maintenance.

### Contact:

- AmeriFab, Inc., (317) 231-0100, sales@amerifabinc.com, www.amerifabinc.com



### Benefits:

- Cuts maintenance costs by more than 95% and increases component lifetime up to five times
- Minimizes equipment shutdowns and subsequent furnace reheating

### Winner of 2006 Ohio Governor's Award for Excellence in Energy Efficiency

## Dilute Oxygen Combustion (DOC) System

*Improving reheat furnace productivity while reducing NOx emissions*



The Praxair® DOC system injects fuel gas and oxygen through separate high-velocity jets, allowing the gases to heat up before mixing together. This prevents high peak flame temperatures that generate NOx. The diffuse flame heats the steel more uniformly and uses less fuel than air injection. Though installation is simple and inexpensive, the technology vastly improves rolling mill yields and efficiency.

### Contact:

- Pravin Mathur, Praxair, Inc., (203) 837-2262, Pravin\_Mathur@praxair.com, www.praxair.com



### Benefits:

- Reduces fuel use by 50%
- Increases furnace productivity 10–30%
- Lower capital and operating costs

### Suitable for steel reheating, non-ferrous smelting applications

## Zinc Removal from Galvanized Steel Scrap: Increasing Scrap Value

*Recovering zinc pollutant for reuse*



Zinc removal from galvanized steel scrap is a multi-stage process that produces a zinc-free black scrap and a zinc byproduct. Scrap is shredded and the zinc removed with hot sodium hydroxide in a rotating drum. The scrap is a uniform and clean feedstock for steel and iron making. Subsequent process stages recover the zinc as valuable powder, eliminating the need to landfill it as waste or re-refine it to recover zinc value.

**Contact:**

- Art Greenberg, CMA Recycling Corporation, (219) 391-7075, arthur.greenberg@cmacorp.net, www.cmacorp.net



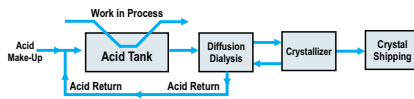
**Benefits:**

- Produces high-value black scrap for iron foundries
- Recycles 98% pure, salable metallic zinc
- Eliminates bag house zinc disposal or recovery cost

### Two production de-zincing plants in operation Seeking licensees worldwide

## Pickliq® Process for Recovering Acids and Metal Salts from Pickling Liquors

*Low-energy technique enables cost-efficient recovery*



The Pickliq® process efficiently recovers pickling acids and saleable metal salts using a unique combination of membrane diffusion dialysis, heat interchange, and low-temperature crystallization technologies. This low-energy approach enables continuous operation and maintains optimum tank acid and iron concentrations. This process has improved process control and product quality for the steel fabrication industry, but could also benefit the metal finishing and circuit board industries.

**Benefits:**

- Improves productivity and quality control
- Reduces product rejections and rework
- Minimizes demand for virgin acids and neutralizing chemicals



**Contact:**

- Douglas Olsen, Green Technology Group, Inc., d.olsen7@yahoo.com, www.douglasolsen.com/gtg.html

### Enables cost-efficient recovery for smaller facilities

## Nickel Aluminide Transfer Rolls

*High-strength rolls resist sagging and oxidation at high temperatures*



High-strength and wear-resistant nickel aluminide rolls reduce shutdowns and maintenance operations in industrial annealing systems. The nickel aluminide alloys provide greater high-temperature strength and wear resistance compared to the conventional H-series alloys currently used. These aluminide rolls enable straight-through plate processing and could enable additional processing of other surface-critical materials.

**Contact:**

- Roman Pankiw, Duraloy Technologies, Inc., (724) 887-5100, techmgr@duraloy.com, www.duraloy.com



**Benefits:**

- Roll lifetime exceeds 3-7 years of nearly continuous use in plate mill annealing
- 30% energy savings per annealed plate
- Reduces shutdowns and maintenance operations

### More than 150 plate furnace rolls in operation 2007 R&D 100 Award Winner

## Automated Steel Cleanliness Analysis Tool (ASCAT)

*New microscopy system improves steel mill performance and quality*



ASCAT, based on a scanning electron microscope combined with specially developed hardware and software, provides a means of understanding the effects of inclusions in the steelmaking process and on the resulting properties of steel. Controlling the properties of inclusions allows for higher quality steel production. A silicon drift detector is used to acquire X-ray composition information an order of magnitude faster than previous equipment. ASCAT can be used to evaluate slag treatment practices, causes of clogging and erosion, castability, degasser circulation optimization, and slab disposition.

### Contact:

- Gary Casuccio, RJ Lee Group, (724) 387-1818 or (724) 387-1776, gcasuccio@rjlg.com, www.rjlg.com



### Benefits:

- Improves energy efficiency by minimizing steel rejection and remelting of rejected steel
- Increases production of high-grade steels and alloys and reduces downgrades

### Two units in operation

## INTEG Hot Strip Mill Model

*Computer-based model predicts properties of hot mill products*



The Hot Strip Mill Model (HSMM) is a PC-based, off-line model that simulates the steel rolling process and predicts final product properties. Users can easily configure mill settings, which the model then inputs to physical models to calculate thermal, flow stress, microstructure evolution, and final mechanical properties. These capabilities allow mill operators to avoid costly industrial trials. The model can handle both strip and plate products for a variety of steel grades.

### Contact:

- Rick Shulkosky, INTEG Process Group, Inc., (724) 933-9350, hsmmsales@integpg.com, www.integpg.com



### Benefits:

- Saves time and money
- Decreases product variability
- Accelerates product development

### More than 25 companies worldwide use the HSMM Free 30-day demo

## Laser Contouring System (LCS): Increasing the Lifetime and Productivity of Steel Furnaces

*Accurate 3-D measurements of refractory thickness in furnaces and ladles*



The LCS is a high-speed, laser-based tool that measures the thickness of refractory bricks lining basic oxygen furnaces (BOFs) and ladles. The LCS provides highly accurate 3-D measurements of the entire vessel's lining thickness in minutes. Quick, on-line feedback eliminates downtime and costs due to off-line inspection and unnecessary relining. Steelmakers using this system can extend equipment lifetime while ensuring operational safety.

### Contact:

- Michel Bonin, Process Metrix, LLC, (925) 460-0385 ext. 112, mbonin@processmetrix.com, www.processmetrix.com

### Benefits:

- Provides rapid, accurate measurements of refractory lining thickness
- Optimizes the relining frequency
- Reduces furnace downtime and associated loss of production



### 10 installations in the United States

## Low-Temperature Colossal Supersaturation of Stainless Steels (LTCSS)

*Introduction of carbon atoms increases hardness without forming chromium carbides*



LTCSS allows austenitic stainless steels to be heat treated without losing hardness or corrosion resistance. The process introduces carbon atoms into the austenitic crystal structure without the formation of chromium carbides, which compromise the corrosion-resistant properties of the alloy. This method, used by the U.S. Naval Research Laboratory for treating steel components, increases carbon absorption while also improving corrosion resistance, wear resistance, and fatigue strength.

**Contact:**

- Sunniva Collins, Swagelok Company, (440) 456-3511, sunniva.collins@swagelok.com, www.swagelok.com

**Benefits:**

- Increases corrosion/erosion resistance of stainless steel components
- Imparts higher hardness to stainless steel components
- Avoids carbide formation
- Allows sheet metal to be treated and still retain its ductility



Value beyond the expected®

**2006 ASM Engineered Materials Achievement Award  
2008 R&D 100 Award**

## Shorter Spheroidizing Annealing Time for Tube and Pipe Manufacturing

*Changing carbide particles to a spherical shape makes steel easier to machine and form*



An enhanced spheroidized annealing process makes through-hardened steel tubes and pipes easier to machine and form. The steel is heated to temperatures at which the carbide temperatures have the tendency to form spherical shapes. Changing hard, elongated carbide particles to a spherical shape makes the steels easier to form. This process maintains key steel parameters while reducing the annealing times, temperatures, and associated energy requirements.

**Contact:**

- Robert Kolarik, The Timken Company, (330) 471-2378, bob.kolarik@timken.com, www.timken.com

**Benefits:**

- Reduces fuel requirements by reducing annealing cycle time by 20%
- Increases productivity approximately 10% due to reduced cycle time



**In operation at one U.S. steel plant in 2010**

## Life Improvement of Pot Hardware in Continuous Hot Dipping

*Bath hardware components have longer life through minimized crystal growth and corrosion*



A new generation of bath hardware components are made with novel materials and, compared with conventional materials, provide 10 times improved corrosion and wear resistance in a Zn/Al bath. The advanced materials, such as an iron-aluminum-cobalt alloy, achieve longer life in the corrosive galvanizing bath by minimizing crystal growth, corrosion attack, and bearing surface degradation. While providing extended component life, the new hardware remains cost effective.

**Contact:**

- Mark Bright, Pyrotek, Inc., (440) 349-8810, marbri@pyrotek-inc.com, www.pyrotek-inc.com

**Benefits:**

- Reduces waste and process scrap volume by limiting downtime in the galvanizing process
- Reduces emissions from sheet steel manufacturing plants
- Limits the formation of surface imperfections on the finished sheet steel



**48 pieces of stabilizer roll bearings and 26 pieces of sink roll bearings sold in 2007**



## Hollow-Fiber Membrane Compressed Air Drying System

*Higher flow capacity during drying increases productivity and reduces energy consumption*



A hollow-fiber membrane for gas dehydration uses membrane dryers to remove water vapor from compressed air streams. Compressed air normally needs to be dried to avoid condensation or freezing in lines and to meet the air quality needs of industrial processes. The membrane module features a bundle of hollow-fiber membranes in a plastic shell with aluminum end caps. It produces higher flow capacity and lower purge loss, which enables high productivity and lower energy consumption. Compact and lighter in weight than heatless desiccants, this system provides flexibility and is easily packaged into a compressed air system.

### Contact:

- Dilip Kalthod, Air Products and Chemicals Inc., (314) 995-3371, kalthodg@airproducts.com, www.airproducts.com

### Benefits:

- 25 times improved selectivity versus first-generation membrane systems
- Provides purge control for additional power and cost savings
- Reduces solid waste production
- Excellent turndown capability, down to zero feed



**5,730 units operating in the United States in January 2010**

## Trane CDQ™ Desiccant Dehumidification System

*Hybrid air conditioning system incorporates Cromer cycle to provide very dry air at a low operating cost*



The Trane CDQ™ (Cool, Dry, Quiet) dehumidification system uses a slowly rotating desiccant wheel to transfer moisture from supply air to return air. As the CDQ wheel turns, a desiccant absorbs moisture from the supply air and releases it into the mixed air or return air stream, increasing moisture removal at the cooling coil. Significantly drier air leaves the unit, resulting in better control of the building humidity level and improved indoor air quality.

### Contact:

- Dan Pollock, Trane, (859) 288-2763, dpollock@trane.com, www.trane.com

### Benefits:

- Energy savings of 20–77% over standard equipment
- Produces air as dry as 30 grains per pound
- Increases dehumidification capacity of standard HVAC systems



**More than 700 units installed since 2005**

## Adaptive Climate Controller (ACC) for Single-Phase AC Motors in HVAC Systems

*New motor controller reduces noise, improves air quality, and increases efficiency*



The ACC employs an Optically Programmable (OP) controller combination to continually monitor, control, power, and regulate the speed of fractional horsepower AC motors in new or field-installed HVAC units and systems. Using feedback from sensors placed in the system, the controller “adaptively” regulates the amount of airflow based on the actual demand and the amount of cooling or heating available from the HVAC system output coils. This technique conserves energy by always using the optimum amount of electrical and thermal energy needed to satisfy demand. The ACC is applicable to most single-phase AC induction motors up to 240 VAC and 10 amps, and is an easy field upgrade in unit ventilators, fan coils, PTACs, and exhaust fans.

### Contact:

- Ethan Durham, Opto Generic Devices, Inc., (315) 858-1002, ethan.durham@ogd3.com, www.ogd3.com

### Benefits:

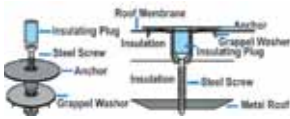
- Over 30% electrical energy savings
- Improves indoor temperature, humidity, and air quality control
- Accepts one or two analog inputs, including temperature and low DC voltage from a sensor or building management system



**Retrofitted into thousands of HVAC systems nationwide**

## RR-1 Insulating Screw Cap

*New fastening system increases building energy efficiency*



The corrosion-resistant RR-1 insulating screw cap is a simple but effective heat loss solution for commercial and industrial buildings. This improved fastener consists of an injection-molded, polycarbonate alloy anchor, a soft insulating plug, and an optional grappel washer. The metal screw portion of the fastener is embedded at least 1 inch into the insulation board, reducing heat transfer through the fastener. This new design makes the fastener less likely to corrode or lose holding strength over time, ensuring long-lasting building protection.

**Contact:**

**THE ROMINE COMPANY**

- Robert Romine, The Romine Company, (740) 345-9144, info@rominecompany.com, www.rominecompany.com

**Approximately 300,000 units sold**

**Benefits:**

- Improves corrosion resistance, largely preventing wind-induced roof failures
- Reduces building energy costs
- Low installation costs; no pre-drilling required
- Rapid payback in both cold and humid climates

## GFX Waste Fluid Heat Recovery System

*Coil tube design increases heat transfer coefficients for fluid waste heat exchangers*



The GFX system's design incorporates equal flow rates on both sides of the heat exchanger for optimum efficiency. Gray water or waste fluid supply flows through an inner drain section, while makeup or incoming fluid supply flows through the outer coil jacket. GFX's lack of internal welds eliminates cross-contamination problems caused by weld failures and tube leaks common to shell and tube heat exchangers. Eliminating the potential for cross contamination ensures low maintenance costs and guarantees consistent energy savings. A variety of coatings are available for various process demands.

**Contact:**



- Carmine F. Vasile, WaterFilm Energy Inc., (631)758-6271, gfx-ch@msn.com, www.gfxtechnology.com

**Benefits:**

- Recovers up to 70% of the heat carried to settling ponds or sewers
- Has demonstrated simple payback period of 1.7 years
- Lower first and operating costs than multiple-process heating units

**Several thousand units installed in the United States**

## Flameless Catalytic Infrared Energy (FCIR)

*Efficient moisture removal avoids heating surrounding air*



FCIR is generated by catalyzing natural gas or propane with a proprietary enhanced platinum catalyst. The system delivers highly efficient and tightly controlled infrared radiant energy to the moist wood or other particulates as they travel along a conveyor engineered to uniformly expose the particulates to radiant energy. As a result, this system transfers long-wavelength infrared energy directly to the water and converts it to a vapor, avoiding scorching and air emissions issues inherent with conventional drying systems.

**Contact:**

- Virgil Macaluso, Catalytic Drying Technologies, Inc., (620) 331-0750, virgil@cat-group.com, www.catalyticdrying.com

**Benefits:**

- Reduces operating and life-cycle costs
- Reduces the amount of scorched product
- Decreases residence time in the dryer



Division of Catalytic Industrial Group, Inc.

**Two units operating in the United States since 2007**

## Autotherm® Energy Recovery System

*Stored engine heat provides vehicle heating after engine shutdown*



Autotherm's system uses heat stored in an engine to continually provide heat to a vehicle's cab when the engine is not running, providing several hours of comfort after the vehicle is turned off. The system operates the vehicle's existing heater using a dash-mounted system control unit and a small electric recirculating pump. This strategy eliminates the fuel consumption and emissions normally associated with operating a stationary vehicle's heater.

### Contact:

- Don Boyer, Autotherm Division, Enthel Systems, Inc., (847) 726-1717, [dboyer@autothermusa.com](mailto:dboyer@autothermusa.com), [www.autothermusa.com](http://www.autothermusa.com)

**AUTOTHERM**

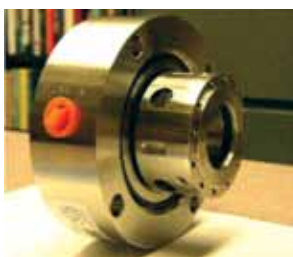
### Benefits:

- Reduces 100% of fuel use and associated emissions for an idling vehicle
- Reduces operating costs and has a payback of one heating season

## Thousands of units installed

## Zero-Emission Mechanical Seal

*Reducing process emissions and downtime with new seal technologies*



A zero-emissions mechanical seal for use in petroleum and chemical processing pumps achieves superior heat transfer capability through the insertion of 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. The technology has been granted two patents, with a third pending, and is available for licensing by a manufacturer or end-user.

### Contact:

- Michael Khonsari, Louisiana State University, (225) 578-9192, [khonsari@me.lsu.edu](mailto:khonsari@me.lsu.edu), [me.lsu.edu](http://me.lsu.edu)



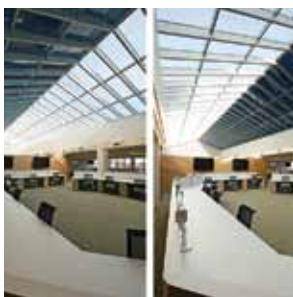
### Benefits:

- Saves energy by reducing friction between seal surfaces
- Reduces process downtime during replacement of worn-out seals
- Decreases harmful environmental effects of seal leakage

## Two patents granted and one patent pending

## SageGlass® Electronically Tintable Glass

*Modulating sunlight transmission reduces heating and cooling loads in buildings*



SageGlass® electronically tintable windows switch from clear to dark within 5-10 minutes to modulate light transmission and solar heat gain. Windows have traditionally been one of the most inefficient components of the building envelope, but SageGlass® dynamic windows reduce solar heat gain in warm months and provide passive solar heat in cold months. They also provide controllable daylighting and preserve the building occupant's view and connection to the outdoors. The SageGlass® coating is composed of five layers of ceramic materials, and 1,500 sq. ft. of SageGlass® windows requires less energy to operate than a 60-watt lightbulb.

### Contact:

- Jim Wilson, SAGE Electrochromics, Inc., (507) 331-4880, [jwilson@sage-ec.com](mailto:jwilson@sage-ec.com), [www.sage-ec.com](http://www.sage-ec.com)



### Benefits:

- Can reduce annual cooling loads in commercial buildings by 20%
- Can reduce peak electricity demand by 19-26% in most U.S. regions
- Reduces solar energy transmission by up to 81%
- Maintains the view and connection to the outdoors

## Installed in hundreds of buildings around the world

## Uniformly Heating and Drying Materials with Patented Microwave Technology

*Rapid, volumetric heating for continuous industrial processes*



This microwave heating and drying technology excels at providing rapid, uniform heating in a precisely controllable manner. While conventional drying methods heat products from the surface inward, microwaves rapidly heat moisture throughout the product and minimize over-heating of the material surface. The modular systems utilize a smaller footprint than traditional drying equipment and can serve multiple drying functions. The technology can act as a stand-alone drying solution, a pre-heater to improve productivity of an existing dryer, or a post-dryer to remove the final residual moisture in the product.

### Benefits:

- Eliminates drying bottlenecks to increase productivity
- Improves moisture uniformity and enhances drying process control
- Minimizes wasted energy and reduces greenhouse gas emissions

### Contact:

- Darian Spell, Industrial Microwave Systems, LLC, (919) 371-1403, [darian.spell@industrialmicrowave.com](mailto:darian.spell@industrialmicrowave.com), [www.industrialmicrowave.com](http://www.industrialmicrowave.com)



### Installations or ongoing research in the following applications:

**textile and nonwovens, foam products, pet food and treats, baked goods, wood/lumber, and chemicals**

## Freight Wing™ Aerodynamic Fairings

*Improves fuel efficiency and profitability of trucking fleets*



Freight Wing™ fairings streamline trucks or box-shaped semi-trailers to reduce the effects of aerodynamic drag and significantly reduce a truck's fuel consumption. Prior to the development of the Freight Wing™, design challenges had prevented past concepts from meeting industry needs. Following the success of its belly fairings and gap fairings, Freight Wing developed a second-generation belly fairing product that produces even greater fuel savings.

### Benefits:

- Reduces fuel consumption by up to 6% with belly and gap fairings
- Reduces emissions of combustion products, including particulates, SOx, NOx, and CO<sub>2</sub>

### Contact:

- Sean Graham, Freight Wing, Inc., (206) 769-7880, [sean@freightwing.com](mailto:sean@freightwing.com), [www.freightwing.com](http://www.freightwing.com)



**Used by more than 100 trucking fleets in the United States and Canada**

## Mobile Zone: Paint Booth for Reduced Energy Consumption and Air Pollution

*Advanced ventilation system reduces ventilating air requirements*



The Mobile Zone that substantially reduces costly ventilating air requirements for spray paint booths. Paint booths are usually ventilated with 100% outside air that is often subsequently heated or cooled to maintain usable work temperatures. The amount of ventilating air entering the spray booth determines the energy usage and scale of pollution. The Mobile Zone system separates the painter from the contaminated air of the spray booth by providing the painter with a separate, mobile work platform during spray coating operations. The cab is flushed with fresh air, while the rest of the spray booth uses filtered, recirculated air.

### Benefits:

- Reduces the size of heating, cooling, and pollution control equipment between 60-98%
- Significant capital and energy cost savings
- Meets existing OSHA, EPA, and NFPA standards for worker conditions

### Contact:

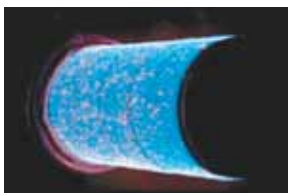
- Clyde Smith, Mobile Zone Associates, (615) 356-2789, [clydefot@bellsouth.net](mailto:clydefot@bellsouth.net), [www.mobilezonepaintbooth.com](http://www.mobilezonepaintbooth.com)

Mobile Zone Paint Booth

**One installation in the United States in 2010**

## CSB™: Radiation-Stabilized Burner

*Ultra-low NOx and CO emissions with conventional or biogas fuels*



ALZETA's CSB™ uses Radiation-Stabilized combustion to achieve performance benefits over conventional burner technologies. With uniform premix and a heat-radiating surface, flame temperatures are reduced such that single-digit NOx levels are achieved without costly FGR and/or SCR post-combustion treatments. The uniform, short flame is ideally suited for the high-efficiency compact heat exchangers found in today's most advanced boilers and heaters. Since the surface defines the shape of the flame, fuel-related combustion effects are minimized, which is driving increasing CSB™ use in biogas and digester gas applications.

### Contact:

- Jim Gotterba, ALZETA Corporation, (408) 727-8282, [jgotterba@alzeta.com](mailto:jgotterba@alzeta.com), [www.alzeta.com](http://www.alzeta.com)



**More than 400 units sold**

### Benefits:

- Sub-7 ppm NOx
- Sub-50 ppm CO
- Fuel flexibility delivers similar performance on almost any gaseous fuel
- Uniform, predictable heat distribution

## M-PAKT™ Ultra-Low NOx Burners: Very Low NOx and Less than 5 ppm CO

*Ultra-low NOx emissions, high efficiency, and high heat transfer rates*



These burners achieve ultra-low NOx emissions by combining a unique type of clean-burning combustion technology called ultraclean, low-swirl combustion (UCLSC), with premixed flames. High energy efficiency is achieved in this type of combustion because the appropriate ratios of air and fuel are mixed to burn completely. Also, the characteristically lifted flame of the burner provides for highly efficient energy conversion because no heat is lost in heat transfer from the flame to the burner.

### Contact:

- Time Lee, Maxon, A Honeywell Company, (765) 284-3304, [tlee@maxoncorp.com](mailto:tlee@maxoncorp.com), [www.maxoncorp.com](http://www.maxoncorp.com)



### Benefits:

- Generates 10-100 times less nitrogen oxide than conventional burners (less than 5 ppm)
- Costs comparable or lower than many conventional burners

## MultiGas™ 2030 Gas Analyzer for Power Plant and SCR Monitoring

*Real-time combustion tuning and emissions monitoring*



The system allows for real-time measurement of criteria emissions and pollutants, including pollutants that are not commonly monitored, such as formaldehyde and ammonia. The MultiGas™ 2030 is a rugged, reliable, low-cost gas analyzer with unsurpassed capabilities that can be used portably or rack-mounted to provide a continuous emissions monitoring (CEM) system. It can also be utilized to provide online feedback for operational tuning of combustion-based industrial processes, including process heating and steam systems. The unique design of the MultiGas™ 2030 eliminates expensive and time-consuming calibrations.

### Contact:

- MKS Instruments, Inc., (800) 227-8766, [www.mksinst.com](http://www.mksinst.com)



### Benefits:

- 10-100 ppb sensitivity for many toxic gases
- Simultaneous analysis and display of more than 30 gases
- No calibration required
- Rugged, reliable design

**Monitors engines and catalysts, stack emissions, processes, ambient air, or selective catalytic reduction performance**

## SlurryCarb®: Clean Energy from Biosolids

*Achieving 100% beneficial reuse of biosolids and other high-moisture feedstocks*



The SlurryCarb® process is an efficient and environmentally sound method for producing renewable energy from municipal sewage sludge (MSS) and other high-moisture, organically-based byproducts and wastes. The process employs heat and pressure to carbonize organic matter and achieve cell lysis and decarboxylation. The resulting slurry can then be mechanically dewatered to 50% solids before being dried further to produce a clean solid fuel. This renewable fuel, called eFuel, can be used efficiently in conventional coal combustion equipment as a substitute for fossil fuels.

**Contact:**

- Brian Dooley, EnerTech Environmental, Inc., (404) 856-5825, bdooley@enertech.com, www.enertech.com/technology/slurrycarb.html

**Benefits:**

- Requires approximately 60% less energy than traditional drying methods
- Has a negative carbon footprint when eFuel is used to supplement fossil fuels
- eFuel has a heating value of around 6,500 Btu/lb



**2008 Global Frost & Sullivan Green Excellence of the Year Award**  
**The first large-scale SlurryCarb® facility is ramping up operations in Rialto, CA**

## SpyroCor™ Radiant Heat Transfer System (HTS)

*Twisted ceramic design saves energy for steel and aluminum annealing and metal heat-treating furnaces*



SpyroCor™ - HTS has a patented high surface area, multifin twist design that enables nonturbulent, high convection heat flow in radiant tube heaters. The burner leg of the heater transfers heat to the insert via convection, and this energy is radiated by the insert to conserve heat in the furnace. As a result of even heat transfer, the SpyroCor reduces heat loss in the exhaust leg of the heater, delivering more energy to the metal load and increasing throughput.

**Contact:**

- Tom Briselden, Spin-Works, LLC, (814) 440-2604, tbriselden@spin-works.com, www.spin-works.com

**Benefits:**

- Reduces heat loss in the exhaust leg by 15-20%
- Balances heat transfer between burner leg and exhaust leg
- Increases throughput at lower energy usage levels
- Reduces NOx levels by 10%
- Reduces carbon footprint by 5-20%



**More than 16,400 units sold through 2009**

## Advanced Diagnostics and Control for Furnaces, Fired Heaters, and Boilers

*Measuring oxygen and carbon monoxide levels to improve combustion controls*



This technology optimizes ethylene furnace operation with advanced combustion diagnostics and rapid Btu measurements of fuel. Tunable diode laser (TDL) analyzers obtain measurements of combustion gases in or near the combustion zone. Rapid fuel Btu measurement allows feed-forward control of fuel and reduces coil outlet temperature variability. Enhanced, spatially resolved hot zone measurements helps optimize and tune burners, achieve more uniform heat transfer, and minimize undesirable combustion by-products.

**Contact:**

- Don Wyatt, Yokogawa Corporation of America, (281) 488-0409, donald.wyatt@us.yokogawa.com, www.yokogawa.com/iab/vigilantplant/tld/iab-vp-tld-en.htm

**Benefits:**

- Improves combustion efficiency and reduces energy use
- Tolerates process pressure up to 10 bar and temperature up to 1,500+°C
- Provides in-situ analysis without sample conditioning



**More than 350 units shipped**

## Stoichiometric Combustion Control

*Fast CO analyzer detects O<sub>2</sub> demand and controls dampers, fans, and registers*



Fully automating the available air to the three types of common heaters saves fuel when heating liquids and inducing chemical reactions in refineries and chemical production facilities. This process features a CO analyzer that provides CO data to the existing heater control system. The control strategy is then modified to reduce the air to the heater via the stack dampers, fans, and burner registers. When a small amount of CO is generated, the control system automatically maintains that operating point, increasing or decreasing air flow as needed.

### Contact:

- Craig Rahn, Bambeck Systems, Inc., (949) 250-3100 ext. 114, [crahn@bambecksystems.com](mailto:crahn@bambecksystems.com), [www.bambecksystems.com](http://www.bambecksystems.com)



**More than 700 of original technology installed**  
**7 enhanced ultra-low NOx and CO versions installed**

### Benefits:

- Reduces NOx emissions from 30–45% and CO in proportion to the size of the heater
- Eliminates the possibility of any dangerous combustible conditions developing in the heater

## Silica-Titania Composites (STC) System for Emission Control

*Regenerative filtering system removes mercury while eliminating adsorbent disposal*



STC technology is composed of the synergistic combination of adsorption and photocatalytic oxidation with ultraviolet light to achieve pollutant removal during industrial processes. STC technology can be regenerated in place, avoiding the cost and risk associated with continuous replacement and disposal of typical adsorbent materials such as activated carbon. Applications include mercury removal from caustic exhaust streams in the chlor-alkali industry, mercury removal from the flue gas of coal-fired power plants, and indoor air purification.

### Contact:

- David Mazyck, Mazyck Technology Solutions, (352) 494-6350, [dwmazyck@maztechsolutions.com](mailto:dwmazyck@maztechsolutions.com), [www.MazTechSolutions.com](http://www.MazTechSolutions.com)



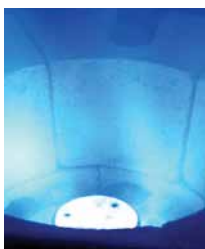
**2 units in operation for mercury removal at chlor-alkali plants**

### Benefits:

- Reduces the cost per pound of mercury removed compared to activated carbon method
- Maintains the salability of fly ash when used for mercury removal from flue gas
- Significant energy savings compared to conventional technologies

## Callidus Ultra Blue (CUB) Burner: Next Generation Burner Technology

*Ultra-low emission, high-efficiency burners help end users meet stringent environmental regulations*



CUB burners combine three advanced technologies to achieve extremely low emission levels and maximize fired heater efficiencies, namely: ultra-low emission burner technology, an enhanced fired heater system, and an online temperature sensing and burner control system. Callidus CUB burners eliminate or reduce the need for expensive post-combustion emissions control equipment.

### Contact:

- William De Los Santos, Callidus Technologies by Honeywell, (918) 523-2123, [william.delossantos@honeywell.com](mailto:william.delossantos@honeywell.com), [www.callidus.com](http://www.callidus.com)



**More than 5,000 units sold to the refining and petrochemical industries**

### Benefits:

- Reduces thermal NOx in the combustion zone by 80–90%
- Burner turndown ratio up to 10:1
- Enhanced stability and improved flame shape
- No external flue gas recirculation or steam injection necessary

## Deep Discharge Zinc-Bromine Battery Module

*New battery increases load-leveling efficiency and reduces peak-power purchases and demand charges*



A new zinc-bromine battery (ZBB) increases load-leveling efficiency and offers longer cycle life with less weight. The system architecture can scale from 25 kW to 2 MW of grid-connected or grid-independent inverter capacity coupled with solar, wind, fuel cells, or diesel gensets along with 50 kWh to 8 MWh of energy storage on a single platform. The system features the unique capability of discharging down to zero voltage without degrading battery life. These features provide continuous and uninterrupted energy delivery for energy utilities and industrial users during peak-power cycles and energy shortages.

**Contact:**

- Eric Apfelbach, ZBB Energy Corporation, (262) 253-9800, sales@zbbenergy.com, www.zbbenergy.com

**Benefits:**

- Offers modular, configurable, scalable platform and energy storage specific to each application
- Reduces capital expenditure for equipment, installation design, and materials
- Lower total cost of ownership than Li-ion and lead-acid due to replacement of cell stacks versus whole battery system



**10 systems sold since 2009**

## Ice Bear Energy Storage

*Smart grid-enabled distributed energy storage for utility-scale deployment*



Ice Energy, Inc.'s Ice Bear system provides a smart grid-ready energy storage solution to the electric utility industry for optimizing energy system efficiency and grid reliability. The system delivers sustainable energy equivalent to thousands of megawatts of clean peaking power for utilities by leveraging the higher efficiencies of generating and transmitting power off-peak, storing the energy as ice at thousands of distributed locations, and dispatching it during times of peak air conditioning demand. Ice Energy's Ice Bear system is the first energy storage solution specifically developed for use on small- to mid-sized commercial buildings.

**Contact:**

- Ice Energy, Inc., (970) 545-3630, iceinfo@ice-energy.com, www.ice-energy.com

**Benefits:**

- Shifts 95% of AC load from peak to off-peak periods
- Reduces energy requirements by 5-25%, depending on climate zone and application
- Reduces greenhouse gas emissions by as much as 40%



**53 MW storage project underway with Southern California Public Power Authority**

## Dual-Pressure Euler Turbine for Industrial and Building Applications

*Drastically improves the efficiency of single-stage steam turbines*



Doubling the efficiency of a single-stage steam turbine reduces the steam flow needed to produce the required power output. The dual-pressure Euler turbine improves generation efficiency by increasing the reaction and power by lowering the rotor exit pressure. Harnessing this reaction energy allows the single-pressure machine to be converted to a two-stage turbine, that is, it becomes a combined impulse and reaction turbine with internal compression. This technology also features a vertical shaft that saves space in crowded equipment rooms and enables installation through standard doorways.

**Contact:**

- Lance Hays, Energent Corporation, (949) 261-7533 ext. 227, biphasel@aol.com, www.energent.net

**Benefits:**

- Reduces CO<sub>2</sub> and NO<sub>x</sub> emissions by 50%
- Uses energy that is normally dissipated by a pressure-reducing valve, converting the wasted energy into electric power
- Can achieve overall efficiencies up to 80%
- Designed to operate with poor-quality steam



**15 units operating in the United States**



## Cummins QSK60G Advanced Reciprocation Engine

*Natural gas-fueled engine efficiently uses fuel for continuous duty at low emissions levels*



The QSK60G engine increases efficiency at ultra-low NOx levels by combining a Miller cycle camshaft, an electronic engine management system, high-compression-ratio pistons, low-loss exhaust valves, a high-efficiency turbo, reduced engine speed, a compressor bypass valve, and long-life spark plugs. The engine is offered in both 50 Hz and 60 Hz model versions. The 50 Hz model is generating more than 70 MW of power in Northern Europe. Gas generator sets using this technology have demonstrated optimum performance and efficient use of fuel for continuous duty. The technology has also enabled combined heat and power (CHP) and peaking applications.

### Contact:

- Peter Schroeck, Cummins Energy Solutions, (973) 316-6037, peter.schroeck@cummins.com, www.cummins.com

**Integrated in more than 50 Cummins Power Generation gas generator sets since 2007**

### Benefits:

- Improves brake thermal efficiency (BTE) 40% over that of conventional stationary gas engines
- Operates at ultra-low NOx emission levels (0.5 g/bhp-hr)

## Dresser Waukesha Advanced Power Generation (APG) 1000 Advanced Reciprocating Engine

*Engine technology features patented ignition system and combustion chamber design for efficient power generation*



The APG 1000 is a 16-cylinder, turbocharged, lean-burn engine that combines a Miller Cycle design with advanced combustion and control technologies. The result is high-efficiency power generation in the 1 MW to 3 MW range at ultra-low emissions levels. With its patented ignition system and combustion chamber concepts, the APG 1000 delivers 40% higher power output than the previous generation of engines built on a similar platform. Offered in 50 Hz and 60 Hz configurations, this is one of the world's most efficient 1 MW units at 1,800 RPM and among the lowest in lean-burn emissions.

### Contact:

- Ryan Krafcheck, Dresser Waukesha Inc., (262) 896-4917, ryan.krafcheck@dresser.com, www.waukeshaengine.com

**Operating on natural gas, landfill gas, and digester gas in hospitals, greenhouses, landfills, and farms around the world**

### Benefits:

- Improves brake thermal efficiency (BTE) 40% over that of conventional stationary gas engines
- Operates at ultra-low NOx emission levels (0.5 g/bhp-hr)
- Reduces electricity costs by up to 10%
- Increases durability and reliability

## Pure Comfort™: Cogeneration Systems

*Ultra-efficient, natural-gas-driven system provides combined cooling, heating, and power solutions for buildings*



PureComfort™ systems use microturbines for power generation and a double-effect absorption chiller for waste-heat reuse. The exhaust heat from the natural-gas-powered microturbines is captured in a manifold and used to generate additional useable energy in the form of cold and hot water. This system can provide simultaneous cooling and heating for buildings, thus conserving space and simplifying design. PureComfort™ solutions are offered in 193 kW to 285 kW configurations.

### Contact:

- Edward Bludnicki, Carrier, (860) 674-3086, edward.bludnicki@carrier.utc.com, www.commercial.carrier.com

### Benefits:

- Achieves up to 90% system efficiency
- Operates with ultra-low emissions of less than 9 ppm NOx
- Avoids the use of any ozone-depleting fluorocarbons for cooling



**57 sites in operation**

## Cat® G3520C and G3520E Advanced Reciprocating Engines

*Engines feature advanced combustion chamber design and controls for high-efficiency distributed power generation*



The Cat® G3520C and G3520E natural gas-fueled engines feature the integration of advanced combustion, improved air systems, and dedicated controls for increased efficiency. Their open chamber design accepts very-low-pressure gas, resulting in high fuel efficiency. A larger, improved air system effectively cools the larger flow of combustion air mixture and allows for higher power density. The control system consists of a simple and flexible design that tightly maintains the level of NOx emissions. The G3520C 20-cylinder engine is suitable for 1MW-2MW extended-duty distributed generation and combined heat and power (CHP) applications.

**Contact:**

- Michael Devine, Caterpillar Inc., Devine\_Michael\_A@cat.com, www.cat.com

**Benefits:**

- 44% brake thermal efficiency, exceeding Phase I ARES goals
- Operates at ultra-low NOx emission levels (0.5 g/bhp-hr)
- Lower owning and operating costs compared to pre-chamber designs



**More than 5 GW of ARES-class engines installed worldwide**

## SEMCO Revolution®: Active Desiccant/Vapor Compression Hybrid Rooftop Unit

*System provides humidity control and unlimited comfort controllability in an energy-efficient package*



The Revolution® is a rooftop air conditioner that can be applied as a dedicated outdoor air system (DOAS) handling 100% outdoor air or as a total conditioning system (TCS). This system combines the strengths of an advanced direct-expansion cooling cycle, utilizing variable speed compressors and optimal control strategies, with the unique dehumidification capability offered by an active desiccant wheel. When an exhaust air stream is available for recovery, a total energy recovery module can be easily integrated into the Revolution®, further increasing the system's operating efficiency. The Revolution® replaces conventional packaged systems and handles both outdoor air and space cooling/heating loads.

**Contact:**

- John Fischer, SEMCO Inc., (770) 850-1030, john.fischer@flaktwoods.com, www.semcoinc.com

**Benefits:**

- More compact, cost effective, and energy efficient than conventional air-conditioning hardware packages
- Improves equipment and control reliability by reducing the probability of frozen coil



**2005 R&D 100 Award Winner**

## Capstone Microturbines

*High-efficiency turbines generate reliable power and heat with low environmental impact*



Capstone microturbines, with outputs ranging from 30–600 kW and packaged solutions up to 1MW, are ideal for stationary power production at commercial, institutional, and light industrial sites, particularly those with space limitations. Microturbines, or small gas turbines, are composed of a compressor, combustor, turbine, recuperator, and generator. The recuperator recovers waste heat from exhaust by preheating incoming combustion air. These low-emission, fuel-flexible machines can run on natural gas, waste biogas, flare gas, diesel, biodiesel, propane, or kerosene.

**Contact:**

- Justin Rathke, Capstone Turbine Corporation, (818) 734-5467, jrathke@capstoneturbine.com, www.capstoneturbine.com

**Benefits:**

- 80% fuel efficient for CHP applications, compared to typical ~33% efficiency of utility power generation
- Runs on a variety of fuels, including those with high H<sub>2</sub>S levels
- Low maintenance requirements due to small number of moving parts and use of air bearings
- Ultra-low emissions with no active aftertreatment



**Over 5,000 microturbine systems installed worldwide**

## Mercury™ 50 Recuperated Gas Turbine

*A breakthrough in recuperative gas turbine technology addresses distributed generation barriers*



The Mercury™ 50 gas turbine incorporates several state-of-the-art combustion and materials technologies to achieve single-digit NO<sub>x</sub> emissions, improve thermal efficiency, and reduce the cost of electricity. Recuperation recovers turbine exhaust heat and uses the energy to preheat combustion air, yielding high turbine efficiencies at modest temperatures and pressure ratios. The unique flowpath and shortened gas-turbine rotor provide high-dynamic stability, further increasing the system's reliability. An ultra-lean premix combustion system, with 8 fuel injectors and an augmented diverter valve, delivers ultra-low emission levels at full- and part-load operation. The Mercury 50 is operating commercially in a wide variety of facilities, including hospitals, universities, electric power plants, and manufacturing facilities around the world.

### Benefits:

- 38.5% efficiency at ISO conditions—the highest electrical efficiency in its size range
- Lowest biogas emissions of all industrial gas turbines
- No catalysts or ammonia required to achieve low emission

### Solar Turbines

*A Caterpillar Company*

### Contact:

- Applications Engineering, Solar Turbines Incorporated, (619) 544-5352, [powergen@solarturbines.com](mailto:powergen@solarturbines.com), [www.solarturbines.com](http://www.solarturbines.com)

### Multiple installations with LEED Platinum Certification and Energy

### Star Awards

### More than half a million field operating hours

## Rapid Heat Treatment of Cast Aluminum Parts

*Automated, in-line fluidized beds reduce processing time with individual heating*



In a new continuous process, cast aluminum components are heated individually in a fluidized bed and remain in the bed only as long as necessary. This method reduces processing times and energy required for heat treatment compared to conventional processes in a convection and vacuum furnace. The technology offers additional benefits by using microprocessor-controlled pulse-fired burners, which allow for precise temperature control that reduces rejection rates and increases product consistency. In addition, the fluidized bed also allows casters to capture and reuse the casting sand that is typically discarded. This process is also applicable to aluminum forgings, magnesium, nitinol, and even PVC.

### Benefits:

- Reduces heat treating energy use by up to 90%
- Improves product performance and reduces rejection rates
- Reduces the number of personnel required for loading, unloading, and transferring cast components



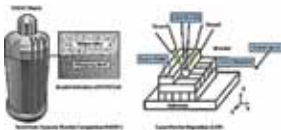
### Contact:

- Mike Bernstein, Arizotah Global Enterprises, LLC, (763) 383-4720 ext. 19, mbernstein@arizotah.com, www.rapidheattreat.com

**9 units operating in the United States in 2008**

## Dynaforge Functionally Graded Materials (FGM) for Manufacturing Tools and Dies

*Tools and dies production process increases wear resistance*



Laser powder deposition and solid-state dynamic powder consolidation result in FGMs that produce more robust tools and dies. Conventional tool manufacturing processes result in low material yields, significant machining times, and high overall costs. The FGM-produced tools and dies manufacture higher quality parts, leading to shorter process cycle times and a reduction in waste scraps. Additionally, FGM pieces have a longer lifetime than traditional tools and dies, reducing the associated replacement costs.

### Benefits:

- Reduces die surface degradation
- Increases wear resistance and dimensional stability
- Improves elevated-temperature properties
- Reduces scrap and waste



### Contact:

- Louis Lherbier, Carpenter Powder Products, Inc., (412) 257-5126, llherbier@cartech.com, www.cartech.com

**Sold more than 280 tools from 2008 through 2009**

## Enhancement of Aluminum Alloy Forgings

*Advanced furnace uses radiant heating for high-performance forgings*



The Advanced Heating System (AHS) uses an optimized combination of radiation and convection to heat aluminum billets faster than conventional gas-fired heating. This reduced heating time increases production rates, but also inhibits grain growth, and thereby doubles the fatigue life of the component. This process uses less energy than conventional batch-type gas-fired heating. The system was developed at Oak Ridge National Lab in collaboration with Queen City Forging and other partners, and the equipment is manufactured by Infrared Heating Technologies.

### Benefits:

Compared to batch gas-fired heaters:

- Reduces energy consumption
- Increases production rate



### Contact:

- Charles Blue, Infrared Heating Technologies, LLC, (865) 574-9784, ctblue@infraredheating.com, www.infraredheating.com

**2004 R&D 100 Award**

**2005 Emerging Technology Award from Ohio's Thomas Edison Program**

## Intensive Quenching

*A clean, efficient quenching technology for heat treating and forging*



Intensive quenching (IQ) involves very rapid quenching of steel parts in violently agitated water. The high velocity of the water quenchant causes uniform development of surface stresses and a hard martensite layer, which together prevent cracking or distortion of the part. The process is energy efficient and uses an environmentally friendly substitute, plain water, for conventional oil or water/polymer quenchants.

### Contact:

- Michael Aronov, IQ Technologies, Inc., (440) 542-0821, info@intensivequench.com, www.intensivequench.com

### Benefits:

- Reduces energy consumption
- Reduces production cost by up to 40%
- Improves strength of quenched part

**IntensiQuench®**

By: IQ Technologies Inc.

## Two units installed in the United States

## Meta-Lax® Thermal Stress Reliever

*Quick, energy-efficient vibration technology prevents distortion and cracking*



The Meta-Lax® process relieves thermal stress within metal components by using nondestructive, highly efficient sub-harmonic vibrations to prevent distortion and cracking. Meta-Lax, short for “metal relaxation,” is a proven substitute for 80–90% of heat-treatment stress relief in metal-working applications. It improves the inconsistencies of the previous resonant-vibration technology by using more efficient, more consistent sub-harmonic vibrational energy, which is the optimum vibration stress-relief frequency. The system has no size or weight limitations, and the technology can be applied to most metals.

### Contact:

- Thomas Hebel, Bonal Technologies, Inc., (800) 638-2529, info@bonal.com, www.bonal.com

**BONAL**  
TECHNOLOGIES

### Benefits:

- Reduces energy consumption and carbon emissions by 98%
- Prevents 50–95% of weld distortion and cracking
- Reduces process time and costs 65–98% compared to heat treatment.
- Reduces scrap up to 100%

## 1,850 systems in operation

## PulseForge 3100: Pulsed Thermal Processing of Printed Electronics

*High-speed sintering of metal inks at room temperature*



The PulseForge 3100 uses rapid pulses of light for high-speed drying, curing, sintering, or annealing high-temperature materials on plastics and paper, enabling inexpensive and flexible electronics products. The system’s high-intensity flashlamps briefly heat inks and films to elevated, controlled temperatures, cutting processing times to fractions of a second. The PulseForge 3100 is designed to integrate seamlessly with roll-to-roll web handling systems for continuous production processes, or with conveyor systems for handling discrete product units. Applications include photovoltaics, electronic displays, batteries, and radio frequency identification (RFID) chips.

### Contact:

- Stan Farnsworth, NovaCentrix, (512) 491-9500 x210, Stan.Farnsworth@novacentrix.com, www.novacentrix.com

### Benefits:

- Capable of processing at line speeds above 150 feet per minute
- Treated substrates include PET, paper, PVC, polyethylene, and metal foils
- Enables the use of new and novel ink materials, including copper inks

**NOVACENTRIX**

**2009 R&D 100 Award Winner**

**2008 Best New Manufacturing Technology from IDTechEx**

## MicroCure™ Variable Frequency Microwave Furnace

*Consistent heating enhances materials development and processing*



MicroCure™, a line of Variable Frequency Microwave furnaces, provides uniform energy distribution and consistent heating with every run. By sweeping over a broad range of microwave frequencies, power distribution becomes uniform due to superposition of thousands of individual microwave modes. Rapid sweeping also eliminates arcing with metals and electronic circuitry. MicroCure™ furnaces are used in production for several different electronic manufacturing applications; for the development of new materials and processes; and for biomedical, semiconductor, and automotive processing.

**Contact:**

- Bob Schauer, Lambda Technologies, Inc., (888) 290-2873 ext. 258, bschauer@microcure.com, www.microcure.com

**More than 150 systems in operation worldwide**

**Benefits:**

- Improves energy efficiency
- Reduces curing time by 95%
- Increases productivity
- Lowers processing temperatures

## Force Modulation System for Vehicle Manufacturing

*Stamping and forming of high-strength steels for lightweight parts*



A new technology for forming higher strength steel parts employs force modulation cushions to enable the blank holding tonnage necessary to control metal flow during stamping and forming processes. Higher strength steels are valuable in the production of safe, light, fuel-efficient vehicles. The technology is in commercial use in metal stamping operations in North and South America, including at Ford and Chrysler and at major suppliers. These systems are typically used in draw operations that employ high-strength steel. In addition, systems have been sold to the white goods and renewable energy industries.

**Contact:**

- Redmond Clark, Metalforming Controls Corp., (847) 639-1165, rclark@mfcontrols.com, www.mfcontrols.com

**Multiple successful international installations and a growing number of systems in domestic operation**

**Benefits:**

- Reduces impact shocks and return shocks by up to 90%
- Generates up to 25 tons of resistance with 1/3 the cylinder footprint
- Extends cylinder life beyond 30 million hits, more than 10 times longer

## Vanadium Carbide (VC) Coating Process to Enhance Metal Wear-Resistance

*Improved tool productivity saves energy and cuts costs*



The VC coating process cost effectively provides a superior protective coating for a wide range of tool and dies that require hardened, wear-resistant surfaces. Based on thermal diffusion technology, the process uses simple direct-heated furnaces for preheating and coating, and a simple hot water wash tank for the finished parts. Well-controlled VC surface layers with a low coefficient of friction can be made up to 15 microns thick. This process eliminates the need for multiple heat-treating steps. Primary applications are in the steel, metal casting, aluminum, glass, plastics, and rubber industries.

**Contact:**

- Mark Podob, Metlab Potero, (215) 233-2600 ext. 232, mpodob@metlabheattreat.com, www.metlabheattreat.com

**Benefits:**

- Reduces energy use by up to 35-50%
- Improves productivity by 10-30% and reduces process costs by 20%
- Increases tool life 5-30 times
- Reduces water usage by 20-50% and eliminates harmful gas emissions

## Pyrogel XT™: Aerogel-Based Insulation for Industrial Steam Distribution Systems

*Breakthrough insulation technology reduces thermal energy loss*



Pyrogel XT™ is a flexible insulation material for use on piping, tanks, vessels, and equipment at temperatures up to 1,200°F (650°C). Based on silica aerogel nanotechnology, Pyrogel XT™ offers a step-change in thermal performance, installation productivity, and in-service durability against water, heat, and mechanical abuse. Aerogels have the lowest thermal conductivity of any known solid, and recent processing developments now allow it to be cost competitive with existing industrial insulation materials.

### Contact:

- Sara Rosenberg, Aspen Aerogels, Inc., (508) 691-1134, [srosenberg@aerogel.com](mailto:srosenberg@aerogel.com), [www.aerogel.com](http://www.aerogel.com)

**aspen** aerogels™

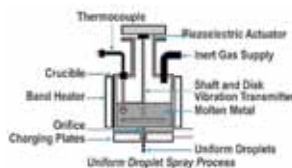
**Millions of square feet installed at hundreds of industrial facilities**

### Benefits:

- 2-5 times thinner for the same level of thermal performance
- Reduces installation labor
- Offers long-term water resistance and protection against corrosion

## Uniform Droplet Spray Process: Achieving Targeted Alloy Droplet Microstructures

*Controlled droplet deposition for improved materials processing*



The uniform droplet spray (UDS) process is a nongas atomization technique that produces uniform alloy droplets with identical thermal properties. UDS controls the breakup of a laminar jet, a method similar to ink-jet printing, and deposits droplets according to the targeted microstructure. This process is ideal for producing novel particulate materials at high production rates with low capital and operating costs.

### Contact:

- Jack Turner, Massachusetts Institute of Technology, (617) 253-6966, [jht@mit.edu](mailto:jht@mit.edu)



Massachusetts  
Institute of  
Technology

**Licensed to six firms in the United States and Japan**

### Benefits:

- Generates high-quality alloy droplets
- Saves time and energy over traditional methods

## H-Series Cast Austenitic Stainless Steels

*Stronger, more reliable steels based on scientific design methodology*



New H-Series cast austenitic stainless steels exhibit greater durability across a wide variety of operating conditions due to improved, high-strength compositions. The steels were designed using a combination of precise microstructure characterization and computational tools, providing them with more strength at higher temperatures. These benefits apply to many applications, unlike other H-Series customizations that are effective only for specific conditions. Many applications are benefiting from these new stainless steels, including the steel, heat treating, and petrochemical industries.

### Contact:

- Tiffany Marcej, Duraloy Technologies, Inc., (724) 887-5100, [sales@duraloy.com](mailto:sales@duraloy.com), [www.duraloy.com](http://www.duraloy.com)



### Benefits:

- Reduces equipment downtime
- Enables higher operating temperatures with fewer replacements
- Improves energy efficiency and productivity

## Ceramic and Refractory Low-Permeability Components for Aluminum Metal and Casting

*New cost-effective materials result in higher efficiency low-pressure die casting*



XL coatings for Dense Fused Silica (DFS) riser tubes exhibit excellent thermal shock properties and resistance to molten aluminum attack while remaining impermeable during low pressure aluminum die casting. The tubes' superior durability enables manufacturers to reduce equipment downtime, saving defect/rework costs. Computer modeling of particle-size distribution to minimize permeability has also led to the development of monolithic fused silica castables that are now in industrial tests.

**Contact:**

- Scott Denning, Pyrotek, Inc., (866) PYROTEK/(866) 797-6835, scoden@pyrotek-inc.com, www.pyrotek-inc.com

**Benefits:**

- XL glaze coating extends tube life 3-5 times
- Silica castables extend tube life by 8 times



**More than 15,900 XL-coated DFS riser tubes sold**

## Metal Infused Surface Treatment (MIST) for Improving Industrial Process Efficiency

*Coating technology extends working life of tools, components, and process systems*



MIST technology is a durable, versatile surface treatment process that imparts thin adherent ceramic films to a variety of metals, carbides, and other inorganic surfaces. It can reduce acute pain points such as wear, corrosion, and fouling of items treated. MIST increases the efficiency of both new and old machines and processes and is currently used in the die casting, petroleum, and canning industries. In the petroleum industry, it is applied on-site.

**Contact:**

- Morgan Spears, C3 International, LLC, (678) 624-0230, info@c3international.com, www.c3international.com

**Benefits:**

- Extends equipment life by 3-10 times
- Reduces associated downtime costs
- Improves efficiency



## Aluminum Conductor Composite Core (ACCC)<sup>®</sup>

*New overhead conductor technology doubles the peak capacity of existing distribution lines*



The new ACCC<sup>®</sup> conductor type allows for up to 28% more conductive aluminum to be wrapped within the same outside diameter of conventional cable. The new core uses a lighter weight, high-strength carbon and glass fiber core embedded in a high-performance thermoset resin matrix. The hybrid structural core is helically wound with fully annealed, trapezoidal-shaped, conductive aluminum wires. The conductor performs efficiently at higher temperatures than conventional steel-cored conductors, and its higher capacity improves grid reliability. If one parallel line fails, the other lines can handle the extra current flow.

**Contact:**

- Chip White, Composite Technology Corp., (949) 428-8500, cwhite@compositetechcorp.com, www.compositetechcorp.com

**Benefits:**

- Line losses reduced by 30% or more with increased conductivity
- Thermal stability of the composite core reduces line sag, thereby improving grid reliability, decreasing EMF exposure, and enabling up to twice the electrical current of conventional steel-core conductors



**More than 6,000 miles of ACCC<sup>®</sup> conductor installed world-wide in 152 projects**



## Corrosion Analyzer™ for Advanced Materials and Fabricated Components

*Helping equipment designers effectively select appropriate alloys*



The Corrosion Analyzer™ is an innovative tool and commercial software package that predicts the occurrence of localized corrosion and pitting damage accumulation for many alloys used in corrosive environments. This technology gives users better understanding of localized corrosion behavior and enables them to select better alloys for components. The software predicts the rates at which a number of oxidation/reduction reactions will proceed, including the metal dissolution reaction. This tool generates polarization curves to support rate calculations and understand the effects of chemistry, passivation, and surface films on corrosion rates.

### Contact:

- Andre Anderko, OLI Systems, Inc., (973) 539-4996 ext 25, [aanderko@olisystems.com](mailto:aanderko@olisystems.com), [www.olisystems.com](http://www.olisystems.com)

### 2007 R&D 100 Award

### Benefits:

- Reduces equipment failure and unscheduled downtime
- Decreases productivity losses
- Saves material and time during equipment design

## Nickel Aluminide (Ni<sub>3</sub>Al) Intermetallic: Heat and Corrosion-Resistant Alloys

*Coating technology extends working life of tools, components, and process systems*



The Ni<sub>3</sub>Al intermetallic has a highly ordered crystal structure that provides high-temperature strength and oxidation resistance. The alloy's resistance to creep and carburization makes it ideal for use in steelmaking and heat treating furnaces and is currently available as transfer rolls, forging dies, heat treating fixtures, and burner tubes. Ni<sub>3</sub>Al intermetallic allows higher operating temperatures, thereby reducing residence time, extending service-life, and improving energy efficiency.

### Contact:

- Roman Pankiw, Duraloy Technologies, Inc. (724) 887-5100, [techmgr@duraloy.com](mailto:techmgr@duraloy.com), [www.duraloy.com](http://www.duraloy.com)

### More than 100 rolls in service for 8 years

### Benefits:

- Improves productivity and product quality
- Increases creep and yield strength by 30–40%
- Improves energy efficiency by up to 33%

## Improved Composite Tubes for Kraft Recovery Boilers

*Study identifies materials and practices to enhance boiler efficiency and safety*



The results of a multidisciplinary study identified both operational improvements and alloy materials to minimize recovery boiler composite tube cracking. The study found that a boiler tube cladding of modified alloy 825 was more resistant to floor tube cracking than alloy 625 or 304L stainless steel. The study's results are now being used worldwide for kraft recovery boiler installations and to design and fabricate new and rebuilt kraft recovery boilers. Sandvik's Sanicro-38 co-extruded tubes, utilizing a modified alloy 825, have been in service for more than 10 years with no reported recovery boiler floor cracking.

### Contact:

- Dan Ellis, Sandvik Materials Technology, (616) 607-9616, [dan.ellis@sandvik.com](mailto:dan.ellis@sandvik.com), [www.sandvik.com](http://www.sandvik.com)

### Benefits:

- Increases thermal efficiency
- Decreases boiler shutdowns
- Improves boiler safety

## SVS-III: Self-Validating Temperature Measurement System

*New materials lead to development of improved monitoring equipment*



The SVS-III system is the only thermocouple probe that provides in-situ, dynamic, self-validating/self-calibrating performance. The newly designed diagnostic transmitter is contained in an explosion-proof instrument housing for easy field mounting in place of conventional transmitters. The patented SVS technology employs multiple independent measurements at the sensor tip to detect and correct sensor drift while providing continual real-time feedback on sensor health. These features provide high value by enabling improved process control, which increases yields while reducing operating costs.

### Contact:

- Peter Erickson, AccuTru International Corporation, (281) 358-5600, peter.erickson@accutru.com, www.accutru.com



### Benefits:

- Improves temperature reliability and accuracy
- Reduces energy and emissions
- Enables predictive maintenance
- Increases process yields and reduces scrap
- Lowers the cost of operation

**36 units operating in the United States**

## Solid-State Sensors for Monitoring Hydrogen

*Lower cost process control and leak detection*



These sensors provide real-time, point-of-use monitoring of hydrogen concentration for process control applications and leak detection. The solid-state technology does not require expensive support equipment, but produces accurate measurements at a lower total cost of ownership than traditional analyzers and sensors. The products available are handheld leak detectors, area monitors, and in-line process monitors. H2scan Corporation's sensors are used in many industrial applications, along with nuclear, alternative, and renewable energy. In addition, the sensors are applicable for incipient fault detection in power transformers as a part of smart grid infrastructure.

### Contact:

- Prabhu Soundarrajan, H2scan Corporation, (661) 775 9575 ext 613, psoundarrajan@h2scan.com or sales@h2scan.com, www.h2scan.com



### Benefits:

- Hydrogen-specific sensing
- Measurement range of 15 ppm to 100% vol H<sub>2</sub>
- Compact and low power
- Unaffected by CO, sulfur gases, and moisture

**More than 1,000 sensor systems sold**

## Parallel Beam X-Ray Diffraction (XRD) System

*Advanced X-ray optics enable on-line steel phase measurement*



Evolution from original solid model to (nearly) final product

This XRD system is the first system that is suitable for on-line measurement of steel composition. Measurements typically performed in the lab are now possible during production, because of the system's insensitivity to sample position, temperature changes, and vibration. XRD technology can be used for measuring structural phases, stress, grain size, and crystal orientation. Compared to current XRD technology, X-Ray Optical Systems, Inc.'s product has increased X-ray intensity (up to 100 times), improved measurement efficiency, and decreased power consumption.

### Contact:

- Tom Bievenue, X-Ray Optical Systems, Inc., (518) 880-1500 ext. 702, tbievenue@xos.com, www.xos.com



### Benefits:

- Allows real-time, on-line monitoring
- Compact and portable
- Low power requirements

## Fiber Sizing Sensor and Controller: FibrSizr™

*Revolutionary optical technology provides measurement of fiber sizes*



The FibrSizr™ enables on-line measurements and process control for fiber size. The technology uses ensemble laser diffraction to provide accurate real-time measurements of fiber size distribution, reducing the time and labor needed for off-line fiber size measurements. Fiber manufacturers for a broad range of polymers and glasses can utilize this technology to improve their operational performance.

### Contact:

- Amir Naqwi, Powerscope, Inc., (612) 331-4247, [anaqwi@powerscopetech.com](mailto:anaqwi@powerscopetech.com), [www.powerscopetech.com](http://www.powerscopetech.com)

**Power**scope

### Benefits:

- Reduces energy and material waste
- Increases productivity and product quality

## Self-Powered Vibration Power Harvesting Kit

*Wireless sensor kit operates on captured vibration energy*



A vibration power harvesting device eliminates the need for battery changes in wireless sensors and transmitters. Typical maintenance costs for batteries can exceed the sensor's cost at \$80–500 per replacement. KCF Technologies, Inc.'s device converts vibration energy to DC electricity, powering a wireless sensor for up to 15 years without any maintenance time or expenses. The technology can be used wherever wireless sensor networks are deployed, including refrigeration and HVAC systems, pulp processing and paper printing, condition-based maintenance, and power generation facilities.

### Contact:

- Michael Grissom, KCF Technologies, Inc., (814) 867-4097, [mgrissom@kcftech.com](mailto:mgrissom@kcftech.com), [www.kcftech.com](http://www.kcftech.com)

### Benefits:

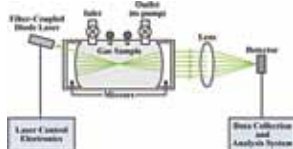
- Eliminates downtime and costs associated with battery maintenance
- Expands sensing capabilities to increase safety and security
- Increases data transmission capabilities

**KCF**  
technologies

**Silver “Best of Sensors Expo” Award in 2008 for Wireless Sensors**

## Off-Axis ICOS: Cavity-Enhanced Gas Analyzer for Process Control

*Providing fast, accurate measurement of acetylene contamination*



A new gas process control monitor uses Off-Axis ICOS to quickly enable ethylene manufacturers to monitor trace acetylene levels, a critical task during production. Off-Axis ICOS features a unique diode laser absorption spectrometry in which the laser path-length is extended to several kilometers using a high-finesse optical cavity. The compact technology is 50 times faster and considerably less expensive than traditional gas chromatography. The monitor has successfully been integrated into gas-handling and computing subsystems.

### Contact:

- Manish Gupta, Los Gatos Research, (650) 965-7874, [m.gupta@lgrinc.com](mailto:m.gupta@lgrinc.com), [www.lgrinc.com](http://www.lgrinc.com)

### Benefits:

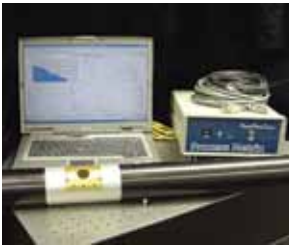
- Minimizes reprocessing and potential system contamination from excess acetylene
- Measures contamination 50 times faster than traditional processes
- Improves raw material conversion to finished product
- Less expensive than traditional gas chromatography

**L G R**

**5–10 units in operation**

## Process Metrix PPC: In-Situ Process Particle Counter (PPC)

*Optical technology provides real-time particulate monitoring*



The Process Metrix PPC is a real-time, laser-optical PPC and sizer that can be used for dust monitoring of turboexpanders, gas turbines, and process stacks. Without continuous monitoring for particulate contamination and feedback control, systems must be set for unknown conditions, which results in lower efficiency. Using optical technology, the PPC allows expanders and gas turbines to operate closer to optimum conditions, improving efficiency, protecting turbines, and allowing use of lower quality fuels.

**Contact:**

- Don Holve, Process Metrix, LLC, (925) 460-0385 ext. 116, [dholve@processmetrix.com](mailto:dholve@processmetrix.com), [www.processmetrix.com](http://www.processmetrix.com)

**Benefits:**

- Reduces production downtime from failures caused by particulate contamination
- Protects turbines from high particulate concentrations that lead to blade wear
- Facilitates additional installations of high-efficiency turbines in more applications



**17 units operating around the world since 2005**

## On-Line Laser-Based Ultrasonic Thickness (LUT) Gauge

*Effective, real-time measurements of steel tube wall thickness*



The LUT gauge is a noncontact, on-line system that measures steel tube wall thickness and eccentricity in real time. The system's real-time response allows managers to adjust the tubemaking process as variations are detected, rather than after an entire production run is completed. As a result, tube manufacturers can produce more tubes meeting specifications and reduce the number reprocessed.

**Contact:**

- Marc Choquet, Tecnar Automation, (450) 461-1221 ext. 227, [mchoquet@tecnar.com](mailto:mchoquet@tecnar.com), [www.tecnar.com](http://www.tecnar.com)

**Benefits:**

- \$500,000 annual cost savings
- 5% energy savings
- Accuracy of +/- 0.5% in tube wall measurement



**More than 2 million tubes inspected since 2002  
14 systems sold as of December 2009**

## Fiber Optic Sensor for Combustion Measurement and Control

*Robust system allows real-time monitoring of temperature and chemical composition*



MetroLaser's system uses laser-based fiber optics to monitor the temperature and chemical composition of combustion gases. In contrast to conventional techniques such as extractive sampling, this system is non-intrusive and suitable for real-time process control. The fiber optic system is also insensitive to vibration, temperature, pressure, flame luminosity, and particle interference, all of which can cause failure or calibration drift for conventional sensors.

**Contact:**

- John Bergmans, Bergmans Mechatronics, (714) 474-8956, [jbergmans@bergmans.com](mailto:jbergmans@bergmans.com), [www.bergmans.com/Project Portfolio/Thermometry/thermometry.html](http://www.bergmans.com/Project Portfolio/Thermometry/thermometry.html)

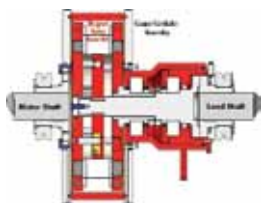
**Benefits:**

- Non-intrusive measurements of gas temperature and H<sub>2</sub>O concentration
- Improves measurement precision, resulting in energy savings

**Derivative systems are operating in pharmaceutical applications**

## Adjustable-Speed Drives (ASD) for 500 to 4,000 Horsepower Industrial Applications

*New drive system saves energy and extends variable speed control to larger motors*



The Adjustable Speed Drive (ASD) works by transmitting torque from the motor to the load across an air gap. Without a mechanical connection between the driving and driven sides of the equipment, the drive tolerates misalignment and eliminates vibration. Torque is created by induced magnetic fields between the rare-earth magnet rotor on the load shaft and the copper conductor rotor on the motor shaft. By varying the air gap between the rotors, the amount of transmitted torque is adjusted, thus permitting adjustable, controllable, and repeatable speed control.

### Contact:

- Donald J. Jacques, MagnaDrive Corporation, (425) 463-4703, [djacques@magnadrive.com](mailto:djacques@magnadrive.com), [www.magnadrive.com](http://www.magnadrive.com)

### Benefits:

- Improves product quality and optimizes process rates
- Extends motor and equipment life and provides overload protection

**MagnaDrive**  
The Next Industrial Revolution

**36 units over 500 hp operating in the United States**

## Variable-Speed, Low-Cost Motor for Industrial Applications

*Matching load and speed requirements saves energy*



DynaMotors, Inc. developed a low-cost, single phase, brushless, variable-speed motor technology for use in industrial and commercial control systems. A version has also been developed to replace inefficient, single-speed motors in residential HVAC systems. Unlike conventional motors, the DynaMotor uses optically controlled solid-state switches embedded in its rotor windings to control speed and torque. With its variable speed capability, motor speed can be matched to load requirements, and the motor can perform more efficiently than the single-speed motor it replaces.

### Contact:

- Doug Toman or Bill Jones, Dynamotors, Inc., (216) 292-7278, [dtoman@dynamotors.com](mailto:dtoman@dynamotors.com), [www.dynamotors.com](http://www.dynamotors.com)

**DynaMotors**

### Benefits:

- Features completely integrated controls for a compact, low cost installation
- Emits no harmful radio frequency/ electromagnetic interference (RFI/EMI), unlike conventional variable-speed technologies

**Innovative technology protected by seven patents**

## HotEye™ Rolled Steel Bar (RSB) System

*Accurate flaw detection regardless of water spray, dust, and vibrations*



The RSB System accurately detects steel bar surface defects in-line and in real time to mark them for downstream removal. Capable of operating at temperatures of up to 2,600°F, this system inspects the surface of rods, bars, billets, and rails moving at speeds of more than 200 mph. The system inspects the entire surface of the steel product to detect and generate images of all types of surface defects. Defect information is instantly relayed to mill operators, facilitating immediate identification and location of the surface defect.

### Contact:

- OG Technologies, Inc., (734) 973-7500, [sales@ogtechnologies.com](mailto:sales@ogtechnologies.com), [www.ogtechnologies.com](http://www.ogtechnologies.com)

**OG Technologies**

### Benefits:

- Decreases surface-related rejection rates by 50%
- Reduces scrap generation, minimizing reheating and reprocessing
- Reduces energy consumption and environmental waste
- Reduces rate of false positives in defect detection to 2%

**2006 R&D 100 Award**

## ALPIS®: Pulsed Laser Imager for Detecting Hydrocarbon and VOC Emissions

*Leak and emission detection without air sampling*



The Airborne Lidar Pipeline Inspection System (ALPIS®) is a helicopter-based, mid-infrared, Differential Absorption Lidar (DIAL) system that detects leaks in natural gas and hazardous liquids pipelines from 500 feet above ground level. Once a volatile organic compound (VOC) is detected, the GPS coordinates, an estimate of the leak size, and a high-resolution video image of the location are recorded and delivered to the customer the next day. This remote capability provides better information, enabling response teams to effectively maintain their pipeline.

**Contact:**

- Rusty Jennett, LaSen, Inc., (575) 522-5110, rustyjennett@gmail.com, www.laseninc.com



**Benefits:**

- Delivers complete survey results online within 1 to 12 hours of inspection
- Provides real-time detection of benzene, propane, and other volatiles

**Currently used by 17 major U.S. oil and gas companies**

## Essential Insight.mesh™: Wireless Distributed Vibration and Temperature Condition Monitoring System

*Flexible, cost-effective monitoring for motor-driven industrial equipment*



The Essential Insight.mesh™ system is a wireless condition monitoring solution for rotating machinery categorized as “essential”—requiring more frequent monitoring than manual data collection, but not requiring a permanently wired continuous machinery shutdown protection system. The system uses industrial mesh networking technology for extremely reliable communications and very low power consumption. It currently supports both vibration and temperature sensors and is fully integrated with GE’s System 1® condition monitoring software platform.

**Contact:**

- Steve Sabin, GE Energy, (775) 215-2291, steve.sabin@ge.com, www.ge-energy.com/bentlywireless



**Benefits:**

- Enables better maintenance planning and fewer mechanical failures
- Increases performance and improves efficiency
- Allows assets in inaccessible areas to be monitored without the cost of permanent wiring
- Dramatically reduces deployment cost and time

**Installation time from deployment to data collection of two days or fewer at most plants**

## Wireless Sensors for Process Stream Sampling and Analysis

*New wireless sensor meets demanding requirements of industrial production lines*



Honeywell International successfully commercialized a wireless system that addresses the current problems with effective sampling and real-time control in manufacturing sensors and controls. The Frequency Hopping Spread Spectrum board is a critical component of the production line, contributing to production line measurement and control. Its low cost will enable wireless sensors to be used to determine energy and environmental process parameters that are traditionally not monitored. Additionally, industrial power and cogeneration plants can use the sensors to balance generation demands, operations efficiencies, and regulatory constraints.

### Contact:

- Soroush Amidi, Honeywell Process Solutions, (514) 217-2173, [soroush.amidi@honeywell.com](mailto:soroush.amidi@honeywell.com), [hpsweb.honeywell.com](http://hpsweb.honeywell.com)

**Honeywell**

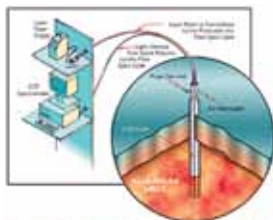
### Benefits:

- Low cost and easy to deploy, increasing the number of measurements available to improve process efficiency
- Minimizes the energy needed to heat up or cool down a process
- Allows remote installation without additional wires

**More than 4,000 units sold in 2009 and more than 10,000 units sold since introduction**

## Laser-Induced Breakdown Spectroscopy (LIBS)

*Improving product quality with in-situ, real-time measurement of melt constituents*



The LIBS technology uses a laser and a spectrometer to measure the constituents of the melt in a process furnace. A laser is fired repetitively through a fiber optic cable and into the melt through a probe. The laser vaporizes a small amount of melt at the probe tip to produce a plasma, which emits a signal that is detected and sent to a spectrometer. The LIBS system is in use for aluminum production, but has other applications in the steel and glass industries, such as monitoring trace alkali metal content in electronic glasses.

### Contact:

- Robert De Saro, Energy Research Company, (718) 608-8788, [rdesaro@er-co.com](mailto:rdesaro@er-co.com), [www.er-co.com](http://www.er-co.com)



**Three units sold**

**ERCo**

### Benefits:

- Real-time operation
- No calibration needed
- Eliminates furnace idle time for off-line measurements

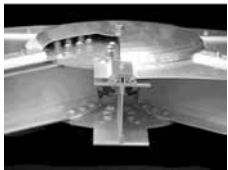
## Knowledge-Based Results

The following results from technical research projects funded by DOE have contributed to the scientific understanding and improvement of industrial processes.

### Aluminum

#### Calculation Methods for Extruded Aluminum Design

*Methods improve design of aluminum shapes, save materials and energy*



Integrated numerical methods were developed for accurately predicting the strength of extrudable aluminum structures. Researchers demonstrated a design methodology using finite strip analysis and studied the kinds of structures used in the building, bridge, automotive, and other transportation industries. These methods improve the design of irregular shapes and coldrolled members.

**Benefits:**

- Optimized aluminum structures require less material, which reduces the use and cost of energy in manufacturing

**Contact:**

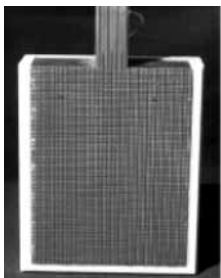
- Teoman Pekoz, Cornell University, (607) 255-6366, TP26@cornell.edu, www.cornell.edu



**Methods are integrated into specifications issued by The Aluminum Association**

#### Design of Mold Surface Topography

*Combined experimental and computational models improve ingot quality at reduced costs*



Cornell University and Alcoa, Inc. developed computational and experimental models that improve mold surface topography designs and control shell surface and subsurface morphologies. This work integrates heat transfer and deformation analysis, melting, contact modeling, and metallurgical engineering. Engineers using these models can design mold surface topographies that lead to desired morphologies, reducing the amount of metal lost to furnace skimming operations and improving the quality of cast ingots.

**Benefits:**

- Reduces scalping operation and costs
- Improves micro-structures and ingot quality
- Optimizes shell surface morphology designs

**Contact:**

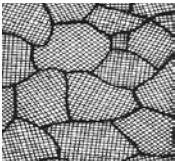
- Nicholas Zabaras, Cornell University, (607) 588-9104, zabaras@cornell.edu, www.cornell.edu





## Methods to Measure Aluminum Alloy Textures

*Improving strip-cast aluminum sheets for energy and material savings*



New techniques were developed to improve strip-cast production of aluminum sheets by on-line monitoring to control the aluminum's recrystallization behavior and its related mechanical anisotropy and formability. This innovative technology may be applied across all sheet production operations. Strip cast aluminum offers energy and materials savings as compared to conventional ingot casting and rolling.

**Benefits:**

- Improves product recovery rate
- Increases productivity
- Reduces fuel consumption

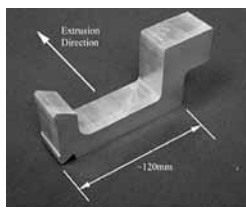
**Contact:**

- Zhong Li, Aleris International, (740) 922-8390, zhong.li@aleric.com, www.aleric.com



## Energy-Efficient Manufacturing of Superior Aluminum Extrusions

*Methods improve design of aluminum shapes, saving materials and energy*



An extrusion process and property prediction models for aluminum alloy extrusions were developed to increase metal yield and save energy. This 5% increase will save energy and materials and reduce CO<sub>2</sub> emissions. The methods developed in this study will improve the consistency and efficiency of extrusion operations, benefitting producers and their consumers in the aerospace, transportation, and building industries.

**Benefits:**

- Increases metal yield 5%
- Reduces CO<sub>2</sub> emissions

**Contact:**

- Mike Rinker, Pacific Northwest National Laboratory, (509) 375-6623, mike.rinker@pnl.gov, www.pnl.gov



## Auxiliary Equipment

### TCAce, A Total Cost Assessment (TCA) Tool

*Software allows users to integrate environmental and safety costs into business decisions*



TCAce manages the TCA process by enabling companies to use sliding ranges and probabilities to reflect the true nature of contingencies. TCA methodology enables industry to include all environmental, health, and safety costs in decision-making. TCAce integrates scenario case studies and sensitivity/uncertainty/risk analysis into a company's existing economic evaluation framework to enable sound decisions. It also identifies both internal and external conventional, hidden human health and environmental impact costs.

**Benefits:**

- Reduces manufacturing costs
- Selects waste management investment decisions that reduce environmental impact and long-term liabilities
- Integrates internal costs and externalities into a single assessment process

**Contact:**

- Lise Laurin, EarthShift LLC, (802) 434-3326, llaurin@earthshift.com, www.earthshift.com

**Improves expected decision profitability by millions of dollars**

## Chemicals

### Barracuda® Computational Particle Fluid Dynamics (CPFD) Software

*Software accurately models particle movement through process equipment*



The Barracuda® CPFD software and its unique numerical simulation technology solve the long-standing problem of incorporating the correct physics of solid particle movement with fluids. The software assists in the design of energy-efficient and environmentally friendly processes for any industrial application that requires accurate modeling of complex mixing and chemical reaction processes with liquid-solids or gas-solids. Examples include the production of white pigment (TiO<sub>2</sub>), gasoline, plastics, nylon, and polysilicon. In addition, the software has found use in coal or biomass power plants and gasifiers.

**Contact:**

- Ken Williams, CPFD Software, Inc., (505) 275-3849 x102, ken@cpfd-software.com, www.cpdf-software.com

**Benefits:**

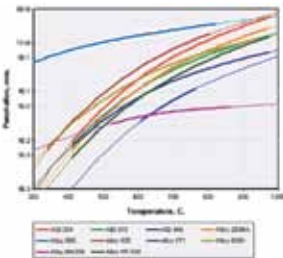
- Reduces energy consumption for the production of metal oxides
- Reduces emissions from the production of gasoline
- Prevents damaging outputs and inefficient energy use



**Used domestically and internationally across the automotive, chemical, petrochemical, ore refining, and power generation industries**

### ASSET: Alloy Selection System for Elevated Temperatures

*Predicts corrosion mechanisms and rates for process equipment in harsh environments*



ASSET software helps equipment designers and operators identify the most economic alloys for process equipment used in the chemical industry or in other environments with high temperatures and corrosive gases. The software predicts the dominant corrosion mechanisms using thermochemical calculations and predicts corrosion losses using analyses of extensive databases containing 15.4 million hours of corrosion data at 200-1,200°C for 100 commercial alloys. These highly accurate predictions help engineers choose the right alloys to increase process safety while avoiding expensive and overly conservative choices.

**Contact:**

- Randy John, Shell Global Solutions (US) Inc., (281) 544-7229, randy.john@shell.com, www.shell.com/home/content/globalsolutions

**Benefits:**

- Identifies cost-effective alloys
- Facilitates better equipment maintenance planning
- Reduces unplanned outages



**About 60 commercial licenses sold  
Currently being extended to include more corrosion mechanisms and gases**

## Forging and Heat Treating

### Materials and Process Design for High-Temperature Carburizing

*A computational materials design approach for optimizing the carburizing process*



An integrated approach to materials and process design enables high-performance alloy producers to optimize the high-temperature carburizing process and develop more durable case hardened tool and die steels. High-temperature carburizing allows order-of-magnitude increases in case depth and Vickers hardness (VHN) of 1,000 without the formation of detrimental primary carbides. The Center for Heat Treating Excellence has developed the methods for optimizing both vacuum and plasma high-temperature carburizing processes for new high-temperature alloys.

**Benefits:**

- Reduces carburizing energy consumption by a factor of 4
- Increases part durability to reduce scrap generation
- Eliminates need for chrome plating in many applications

**Contact:**

- Diran Apelian, Worcester Polytechnic Institute, (508) 831-5992, [dapelian@wpi.edu](mailto:dapelian@wpi.edu), [wpi.edu](http://wpi.edu)

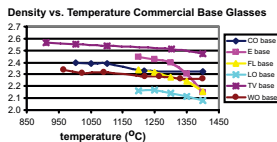


**More than 20,000 pounds of QuesTek Ferrium C61 and C69 tool steel produced per year**

## Glass

### High-Temperature Glass Melt Property Database

*Published database enables improved product and process modeling*



The database, published in a 290-page book available for sale through the American Ceramic Society, contains information on many key glass melt properties for several glass compositional families. This data can be used by the entire glass industry to improve modeling capabilities, which will ultimately improve glass melting and forming processes. Accurate, improved modeling can also eliminate the need for costly experimental melts to test for proposed process changes.

**Benefits:**

- Improves efficiency
- Increases yields
- Reduces environmental impacts

**Contact:**

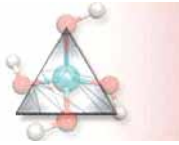
- Harrie J. Stevens, Center for Glass Research, Alfred University, (607) 871-2662, [stevenshj@alfred.edu](mailto:stevenshj@alfred.edu), [www.alfred.edu](http://www.alfred.edu)



## Materials

### Thermochemical Database for High-Temperature Materials

*Improving the availability and accuracy of thermochemical property data*



A new database containing thermomechanical data for gas-phase and condensed-phase species improves simulations and modeling of materials and refractories in high-temperature industrial environments. The data include thermodynamic figures, models for non-ideal behavior, and calculated molecular properties, so that optimal selection of compatible materials and interpretation of failure mechanisms can occur.

**Benefits:**

- Improves modeling capabilities
- Enables accurate thermodynamic predictions

**Contact:**

- Mark Allendorf, Sandia National Laboratories, (925) 294-2895, mdallen@sandia.gov, www.sandia.gov/HiTempThermo/
- Theodore M. Besmann, Oak Ridge National Laboratory, (865) 574-6852, besmanntm@ornl.gov, www.ornl.gov



**More than 70 subscribers**

## Metal Casting

### Macro-Inclusions Atlas: Reducing Casting Rejections

*Internet atlas compiles macro-inclusion causes and descriptions*



The Macro-Inclusions Atlas provides foundry operators with access to information which they can apply on a real-time basis to reduce the frequency of macro-inclusions. Analysis and photos are available on a wide range of samples applicable to foundry operators. Through the analysis of the chemistry and size of problematic inclusions, foundry operators can determine potential sources of macro-inclusions and identify countermeasures to reduce their occurrence.

**Benefits:**

- Publically available, easily accessible Internet tool
- Reduces casting rejections, wasted energy, and quality control costs

**Contact:**

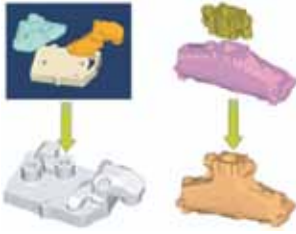
- Available at [neon.memscmu.edu/afs/afs2/atlas1.html](http://neon.memscmu.edu/afs/afs2/atlas1.html)



**Provides defect descriptions, mapping, and chemical composition for foundries**

## Lost Foam Casting Technology

*Efficient production of high-quality metal parts with improved quality*



The Lost Foam Casting Process produces high-value parts by eliminating cores and consolidating several cast components into one single casting. In addition, the technology improves casting dimensional accuracy to reduce materials consumption and machining costs. All of these unique process features reduce energy consumption and have enabled lost foam casting production to grow in value. The University of Alabama at Birmingham and partners continue to build on the success of this commercial technology with further R&D improvements.

**Contact:**

- Charles Bates, Casting Engineering Laboratory, University of Alabama at Birmingham, (205) 975-8120, [info@uabcastingengineeringlab.com](mailto:info@uabcastingengineeringlab.com), [www.uabcastingengineeringlab.com](http://www.uabcastingengineeringlab.com)



**Benefits:**

- Improves process control and quality of cast parts
- Increases energy efficiency
- Reduces scrap production from 25% to 3%

**Production value more than \$800 million annually**

## Steel

### Deformation Behavior Model of Lightweight Steel Structures under Impact Loading

*Tool could accelerate the implementation of safer lightweight steels in vehicles*



The crash behavior of lightweight steel vehicles is simulated by an advanced computational model for assessing vehicle design and performance. This model builds on the accomplishments of the Ultra Light Steel Auto Body-Advanced Vehicle Concept to provide insight into innovative, lightweight designs. Understanding lightweight steel performance will allow manufacturers to reduce vehicular weight while ensuring safety standards.

**Contact:**

- Joe Vehec, American Iron and Steel Institute, (412) 922-2772 ext. 216, [aisiap@aol.com](mailto:aisiap@aol.com), [www.steeltrp.com](http://www.steeltrp.com)

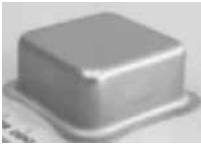
**Benefits:**

- Enables significant improvements in design of lightweight steel vehicles
- Minimizes the number of physical structures needed to be built for testing
- Saves manufacturing time and money



## Formability Characterization of Advanced High-Strength Steels

*Increased knowledge will result in lighter, safer, higher efficiency structures*



Comprehensive research data characterize the formability of new high-strength, lightweight steels, including dual phase and transformation-induced plasticity steels. Metallurgical strengthening mechanisms were quantified at elevated strain rates, producing data on sheet steel capabilities under stress. This study also provides insight on the effects of strain on microstructures and property inter-relationships. Understanding new steels and strengthening processes will enable the automotive industry to design safer lightweight systems, improving vehicle energy efficiency.

**Benefits:**

- Increases safety of high-strength steel designs
- Improves use of input materials and resources



**Contact:**

- Joe Vehec, American Iron and Steel Institute, (412) 922-2772 ext. 216, aisiap@aol.com, www.steeltrp.com

## Cold Work Embrittlement (CWE) of Interstitial-Free (IF) Steels

*Understanding CWE can reduce steel fractures during secondary formation*



A standard, reliable methodology helps steel and parts manufacturers determine the effect of CWE on IF steel performance. The methodology evaluates the influence of steel chemistry and processing conditions, microstructure, and test conditions on CWE. The study also provides CWE's effect on fatigue properties specifically in rolled and high strain, deep drawn conditions. This knowledge can help manufacturers take advantage of IF steel's advantages, such as low content of solute interstitial elements, while improving the reliability of steel parts.

**Benefits:**

- Enables steel producers to increase supply of medium-strength IF steel
- Reduces fractures during secondary deformation
- Produces more reliable, lighter weight cars

CANMET



**Contact:**

- John Bowker, CANMET/MTL, (613) 992-0710, jbowker@nrcan.gc.ca
- Joe Vehec, American Iron and Steel Institute, (412) 922-2772 ext. 216, aisiap@aol.com

# Technologies for Tomorrow

## Promising Technologies

The following emerging technologies co-funded by DOE are expected to have commercial applications within the next three years. Fact sheets describing these innovations and other promising technologies are available at [www.eere.energy.gov/industry](http://www.eere.energy.gov/industry).

### Vertical Flotation Melter (VFM)



The VFM is an innovative melting process that decoats, preheats, and melts scrap aluminum in one operation. The VFM provides a heat transfer coefficient 10 times higher than that of a conventional furnace while reducing emissions and improving metal recovery. Energy Research Company has operated a 1,000 pph pilot-scale VFM for experimental development in its Fayetteville, NY, facility.

**Contact:**

- Robert De Saro from Energy Research Company at [rdesaro@er-co.com](mailto:rdesaro@er-co.com)

### Heat Treatment Model for Aluminum Castings



An integrated heat treatment model would allow manufacturers to optimize their thermal cycle and achieve specified microstructures and mechanical properties in critical sections of aluminum alloy castings. It would also allow the development of improved alloys and more efficient thermal cycles. This project involves developing and verifying such a model and integrating it with commercial casting process simulation and design software. The University of Connecticut, the University of Massachusetts-Amherst, and the Worcester Polytechnic Institute are developing the heat treatment model together with several industrial partners.

**Contact:**

- Yiming Rong from Worcester Polytechnic Institute at [rong@wpi.edu](mailto:rong@wpi.edu)

## Affinity Ceramic Membranes for Carbon Dioxide Separation

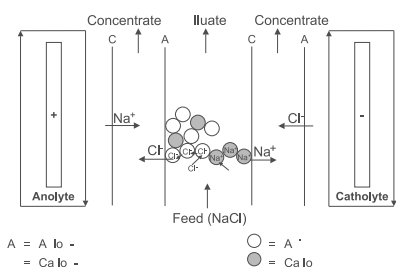


This ceramic membrane has an affinity for carbon dioxide and can be used to remove CO<sub>2</sub> from a variety of gas streams. Like other membranes, this system is more energy efficient and compact than conventional separation processes. It is also thermally, hydrothermally, and chemically stable, and so can be used in applications involving high temperatures and harsh environments, such as hydrogen production. Media and Process Technology, Inc., developed the membrane and is currently pursuing commercialization.

### Contact:

- Rich Ciora from Media and Process Technology, Inc., at [rciora@mediaandprocess.com](mailto:rciora@mediaandprocess.com)

## Electrodeionization for Product Purification



Resin-wafer electrodeionization (RW-EDI) combines features of ion exchange and electro dialysis into an energy-efficient process for removing dissolved salts or recovering charged products. RW-EDI has many potential uses including direct production and separation of products, product purification, desalination, salt waste recovery, and water recycling. Argonne National Laboratory received R&D 100 Awards in 2002 and 2006 for developing the technology and has completed successful pilot tests. RW-EDI is expected to reduce operating and capital costs by approximately 40%. Argonne expects to license the technology to a Fortune 500 commercial technology vendor in 2010.

### Contact:

- Seth Snyder from Argonne National Laboratory at [seth@anl.gov](mailto:seth@anl.gov)

## Membrane for Reducing Diesel Engine Emissions



Diesel engine exhaust is a major source of NO<sub>x</sub> pollution. Compact Membrane Systems, Inc., is developing a membrane that reduces NO<sub>x</sub> emissions by enriching the nitrogen content of the engine intake air. The new membrane extracts oxygen from the intake air stream, altering its composition from 78% N<sub>2</sub> to 82% N<sub>2</sub>. Compact Membrane Systems, Inc., is conducting laboratory and field tests with marine and locomotive companies and has demonstrated reductions in NO<sub>x</sub> emissions of up to 50%.

### Contact:

- Stuart Nemser from Compact Membrane Systems, Inc., at [snemser@compactmembrane.com](mailto:snemser@compactmembrane.com)

## Process Intensification through Multifunctional Reactor Engineering



The multiphase, pulse-flow catalytic reactor for acid-catalyzed C<sub>4</sub> paraffin/olefin alkylation will optimize existing trickle-bed reactors and enhance mass and heat transfer. Large-scale pulse-flow reactor technology enables high-efficiency contacting and thus increased mass transfer between fluid phases. In addition to its initial application, the novel reactor design could benefit many other processes across the chemical industry, in particular those that employ liquid catalysts. The technology has been successfully demonstrated at a Catalytic Distillation Technologies (CDTECH) pilot plant.

### Contact:

- Will Cross from Chemical Research and Licensing Co. at [will.cross@cdtech.com](mailto:will.cross@cdtech.com)



## Dimpled Tube Heat Exchangers for the Chemical Industry

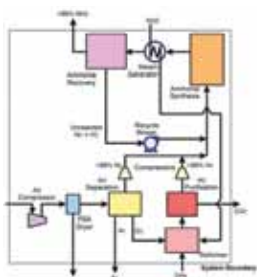


Cost-effective dimpled tube technology improves the thermal efficiency of convective sections of industrial heat transfer equipment by up to 15–20% while having a strong potential for mitigating fouling rates. Each dimple on the tube surface generates a vortex in the gas flowing over it, thereby intensifying convective heat transfer. Unlike other approaches to increase heat transfer rates in the convective section of process heaters, dimpled tube technology does not increase the pressure drop across the tube bank. The Gas Technology Institute has completed field trials at a participating refinery and is ready for a full-scale technology demonstration.

**Contact:**

- Yaroslav Chudnovsky from the Gas Technology Institute at [yaroslav.chudnovsky@gastechnology.org](mailto:yaroslav.chudnovsky@gastechnology.org)

## Ammonia Production Using Pressure Swing Adsorption (PSA)



A new PSA process for ammonia production eliminates the energy-intensive refrigeration and condensation needed to recover ammonia in current processes. The new production method increases ammonia yield, reduces natural gas feedstock use, lowers energy consumption, and offers capital cost savings compared to traditional methods. The new PSA process is scalable and enables on-demand ammonia production, eliminating the need to transport and store ammonia at power plants.

**Contact:**

- Felix Jegede from SmartKoncept Technology at [fjegede@smartkoncept-tech.com](mailto:fjegede@smartkoncept-tech.com)

## Sorbents for Efficient Gas Separation

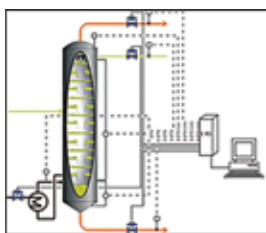


Praxair has developed a process that combines a new oxygen-selective adsorbent material with pressure swing adsorption (PSA) to cost-effectively produce industrial gases, such as oxygen and nitrogen. This technology could also be used for purifying argon, helium, or other gases by removing trace quantities of oxygen while consuming less energy than conventional techniques. Praxair has tested the process and is evaluating options for further development and commercialization.

**Contact:**

- Neil Stephenson from Praxair, Inc., at [neil\\_stephenson@praxair.com](mailto:neil_stephenson@praxair.com)

## Distillation Column Flooding Predictor



The flooding predictor uses a patented pattern recognition system to identify the onset of flood and pre-flood conditions in distillation and separation columns. Distillation is a low-efficiency operation that consumes several quadrillion Btu each year. The ability to predict and avoid flood conditions allows refiners to operate columns nearer their true hydraulic limit, increasing throughput and energy efficiency. 2ndpoint, LLC is testing the system on a commercial scale and preparing for commercialization.

**Contact:**

- George Dzyacky from 2ndpoint, LLC at [ged@2ndpoint.com](mailto:ged@2ndpoint.com)

## Advanced Distillation using Microchannel Process Technology (MPT)



Application of MPT to distillation offers impressive process intensification, reducing the height of an equivalent transfer plate (HETP) from several feet to less than an inch. This technology greatly reduces the size of distillation equipment and eliminates the need for external heat exchangers (reboilers/condensers). Furthermore, its modularity enables innovative process configurations. All of this leads to more efficient, less capital-intensive separations. Velocys, Inc. plans to develop and commercialize advanced distillation using MPT for a range of energy-intensive separations.

### Contact:

- Laura Silva from Velocys, Inc., at [silva@velocys.com](mailto:silva@velocys.com)

## Purification Process for Purified Terephthalic Acid (PTA) Production



A new PTA process uses a two-step crystallization technique that operates at a lower pressure and temperature and allows for 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. Such operation would eliminate the environmental problems caused by methyl bromide and the high cost of corrosion-resistant specialty alloys used as construction materials. GTC Corporation developed the technology in 2006 and is awaiting a commercial-scale demonstration test site.

### Contact:

- Randi Wytcherley from GTC Technology US LLC at [rwytcherley@gtctech.com](mailto:rwytcherley@gtctech.com)

## Plastics, Fibers, and Solvents from Biosynthetically Derived Organic Acids



Bacteria is being used to ferment sugars derived from wood wastes and plant crop residues to produce succinic acid. Succinic acid is a chemical building block that can be used to produce a wide range of products—from PBS, an innovative biodegradable plastic, to more traditional polymers such as polyesters, polyurethanes, and nylons that are used to make textiles, automotive parts, and electronics. Unlike petrochemicals, bio-based succinic acid is renewable and its production is carbon negative. DNP Green Technology commissioned the world's first bio-based succinic acid plant with a 2,000-metric-ton annual capacity in January 2010.

### Contact:

- Dilum Dunuwila from DNP Green Technology at [dilum.dunuwila@dnpgreen.com](mailto:dilum.dunuwila@dnpgreen.com)

## Microchannel Reactor System for Hydrogen Peroxide Production by Direct Combination of H<sub>2</sub> and O<sub>2</sub>



A microchannel reactor and heat exchanger system allows for energy-efficient and cost-effective on-site generation of hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>). The microchannel reactors possess extremely high surface-to-volume ratios and exhibit enhanced heat and mass transfer rates, allowing for H<sub>2</sub> concentrations of about 5% without the risk of combustion. H<sub>2</sub>O<sub>2</sub> has diverse applications in pulp and paper bleaching, health care, water purification, and the synthesis of various oxychemicals. On-site H<sub>2</sub>O<sub>2</sub> generation will reduce transportation, storage, and concentration/dilution costs. Stevens Institute of Technology and FMC Corporation are testing a pilot unit at an FMC Corporation facility.

### Contact:

- Adeniyi Lawal from Stevens Institute of Technology at [alawal@stevens.edu](mailto:alawal@stevens.edu)

## Low-Cost Chemical Feedstocks Using a Natural Gas Liquid (NGL) Removal Process



A new, low-cost, more energy-efficient NGL recovery process carries out the separation of trace water vapor and the recovery of NGL at a warmer temperature than conventional methods. Pressure drops in the new technology are almost negligible, compared to the typical 500–600 psi pressure drops during gas expansion in the cryogenic recovery process. These features will generate substantial energy and cost savings by maximizing heat recovery; minimizing pressure losses; and eliminating the need for a compressor, turbo-expander, or separate dehydration system. Gas Technology Institute is leading the development of this new NGL recovery process, which will also benefit gas/liquid separations and distillation in the chemicals industry.

**Contact:**

- Howard Meyer from Gas Technology Institute at [howard.meyer@gastechnology.org](mailto:howard.meyer@gastechnology.org)

## Hydrogen Generation from Biomass



The new BioForming process enables the economic production of hydrogen from a range of biomass-derived feedstocks, including glycerol and sugars. The process reforms water-soluble oxygenated hydrocarbons in a single step. It produces a hydrogen-rich gas that is easily purified and can be used in hydrogen-fueled systems such as fuel cells and transportation. 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. Virent patented the BioForming process, which also has applications in the manufacturing of glass, vitamins, and food products.

**Contact:**

- Bob Rozmiarek from Virent Energy Systems, LLC at [Bob\\_Rozmiarek@virent.com](mailto:Bob_Rozmiarek@virent.com)

## Distillation Column Modeling Tools

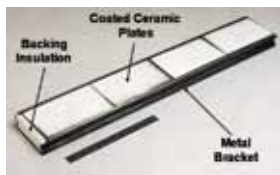


The Graphical Structured Packing Interface (GraSPI) is a software package for creating high-fidelity geometries for fluid flow simulation through packing elements used in distillation columns. The software was built as a derivative of FLUENT software, and the combined GraSPI and FLUENT software will allow plants to improve column design and operating parameters to increase product purity and reduce energy use. Oak Ridge National Laboratory (ORNL) developed this software in collaboration with University of Texas at Austin and Fluent, Inc.

**Contact:**

- Valmor de Almeida from Oak Ridge National Laboratory at [dealmeidav@ornl.gov](mailto:dealmeidav@ornl.gov)
- Bruce Eldridge from University of Texas at Austin at [rbelldr@che.utexas.edu](mailto:rbelldr@che.utexas.edu)

## Back-Surface Reflector for High-Efficiency Infrared Paper Drying

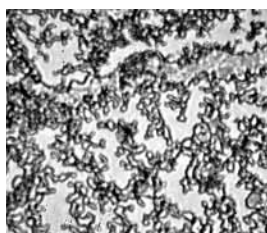


An innovative back surface reflector (BSR) technology can decrease the amount of electricity needed for paper drying. The BSR absorbs energy that is transmitted through the paper sheet and re-radiates it toward the paper with more efficiency than current technologies. The new BSR design dramatically increases the percentage of input power that is absorbed by the paper sheet, decreasing energy costs and increasing product quality and throughput. Creare, Inc. has demonstrated a 90% efficiency improvement over existing drying techniques and is currently negotiating to sell a license to a firm that will manufacture this technology.

**Contact:**

- Jay Rozzi from Creare, Inc. at [jcr@creare.com](mailto:jcr@creare.com)

## Microwave Pretreatment Technology for Chemical Pulping



A method for precipitating and flocculating hemicellulose from pulping liquors could reduce the energy required to pulp wood and increase the throughput of wood pulping plants. Hemicellulose removal allows for higher solids concentration in the evaporator, which reduces emissions. Recovered hemicellulose can be added to pulp, thereby increasing yield, or can be used as chemical feedstock. Oak Ridge National Laboratory is seeking to commercialize this patented process.

**Contact:**

- Jennifer T. Caldwell from Oak Ridge National Laboratory at [caldwelljt@ornl.gov](mailto:caldwelljt@ornl.gov)

## Electrohydraulic Contaminant Removal



An innovative technology uses an underwater spark to “detackify” stickies and pitch in the processing streams at secondary fiber mills. The spark technology reduces electricity and chemical use while improving fiber quality. The Institute of Paper Science and Technology (IPST) has conducted several mill trials to evaluate and validate this technology. The technology has been licensed to BIM Kemi in Sweden.

**Contact:**

- Sujit Banerjee from Institute of Paper Science and Technology at Georgia Tech at [sb@gatech.edu](mailto:sb@gatech.edu)

## Biofine Technology



A novel, high-temperature, dilute-acid hydrolysis system converts low-grade, cellulose-containing wastes from paper mills, forestry, and other operations into levulinic acid, a versatile platform chemical that is an intermediate to several high-value chemical and advanced fuel products. More than half of the nation’s 200 million tons of municipal solid waste are plant-based materials that are difficult to recycle and naturally resistant to chemical breakdown. This system converts these wastes into levulinic acid and its derivatives while also generating formic acid, a valuable byproduct. BioMetrics, Inc. developed this technology and conducted a successful validation test.

**Contact:**

- Steve Fitzpatrick from Biometrics, LLC at [steve@biometricsma.com](mailto:steve@biometricsma.com)

## Directed Green Liquor Utilization (D-GLU) Pulping



The innovative D-GLU pulping process is designed to redirect up to 40% of the green liquor (pre-cooking liquor) from the causticizing plant to the front end (the impregnation vessel or IV) of a Kamyr digester. This method reduces the lime kiln load, lowers the energy intensity of the digester, and improves pulp yield. North Carolina State University and the Georgia Institute of Technology are currently working with MeadWestvaco to perform a full-scale mill trial during 2010 at the Evadale pulp mill in Texas.

### Contact:

- Lucian A. Lucia from North Carolina State University at [lucian.lucia@ncsu.edu](mailto:lucian.lucia@ncsu.edu)
- Sujit Banerjee from Georgia Institute of Technology at [sujit.banerjee@ipst.gatech.edu](mailto:sujit.banerjee@ipst.gatech.edu)
- Gary Colson from MeadWestvaco at [gary.colson@mwv.com](mailto:gary.colson@mwv.com)

## Oxalic Acid Pretreatment



Pretreatment of wood chips with dilute oxalic acid solution for about 10 minutes reduces electrical energy requirements for mechanical pulping by 25%, improves paper strength properties, reduces pitch content, improves dewatering, and produces value-added chemicals enabling a biorefinery dimension. Biopulping International, Inc. developed the technology together with several industrial and university partners, and has completed a successful pilot-scale demonstration at Andritz's pilot plant. Deployment of this technology is expected to have a payback of two years or less.

### Contact:

- Masood Akhtar from Biopulping International, Inc at [makhtar@biopulping.com](mailto:makhtar@biopulping.com)

## Biomass Fractionation

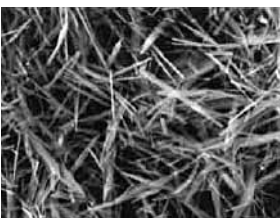


A new process for wood pulping will efficiently convert cellulosic biomass into fiber, fermentation sugars, protein, and energy, while producing much less pollutant emissions than the current kraft process. These pollutant emissions result in significant costs for pollution abatement. Once the feedstock exits the process, the purified fiber can be used as a pulp for creating many different pulp and paper products. PureVision Technology, Inc. has scaled up the process to a ½-ton-per-day continuous fractionation reactor and plans to develop a 20-ton-per-day pilot plant to evaluate different feedstocks for the process.

### Contact:

- Chim Yong Chin from PureVision Technology, Inc. at [chim@purevisiontechnology.com](mailto:chim@purevisiontechnology.com)

## Fibrous Paper Fillers

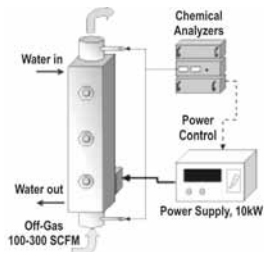


Novel calcium and silica-based fillers can displace more than 40% of the pulp in papermaking while maintaining critical paper properties and reducing energy use. G.R. International (GRI) has been working with the University of Washington and Washington State University to optimize and evaluate fibrous fillers and with various industrial partners, including Grays Harbor Paper Company, Georgia-Pacific Camas, and E3 Energy Partners, to evaluate the performance of the technology in papermaking. GRI has received commitment letters from the state of Washington and banks to expand the current prototype plant to a full commercial plant, and the technology is available for licensing.

### Contact:

- Vijay K. Mathur from G.R. International at [griinc@hotmail.com](mailto:griinc@hotmail.com)

## Low-Temperature Plasma Technology for Controlling Volatile Organic Compound (VOC) Emissions



A new technology uses non-thermal plasmas that can selectively destroy VOCs by producing excited ions or free radicals that oxidize, reduce, or decompose pollutant molecules. This easy-to-install technology can cost effectively reduce VOC emissions in pulp mills and wood products plants. Drexel University and the Pacific Northwest National Laboratory developed this system, which has been demonstrated at a Georgia-Pacific Corporation mill. Drexel is currently working with Matpro on further tests and commercialization efforts.

**Contact:**

- Alexander Fridman of Drexel University at [fridman@drexel.edu](mailto:fridman@drexel.edu)

## Direct Causticizing for Black Liquor Gasification (BLG) in a Circulating Fluidized Bed



Pressurized BLG could increase the efficiency of the chemical recovery process in kraft pulping while producing fuel. The causticizing step is performed in situ during gasification by adding sodium trititanate to the liquor. Complete direct causticizing eliminates the traditional lime cycle, reducing fossil fuel use and costs. The titanate is recovered by hydrolysis and remixed with incoming liquor. The synthesis gas product can be used in combined cycle power generation or converted to liquid fuel. The Institute of Paper Science and Technology at Georgia Tech is seeking a pulp mill to host a pilot-scale demonstration.

**Contact:**

- Scott Sinquefield from Institute of Paper Science and Technology at Georgia Tech at [scott.sinquefield@ipst.gatech.edu](mailto:scott.sinquefield@ipst.gatech.edu)

## Dilute Acid Cellulose Hydrolysis (DACH) Process



A DACH Process and Reactor System uses a double tubular reactor system in two stages, continuously converting cellulose feedstock into fermentable sugar solution products. The second stage of the process reactor system recovers excess process heat and acid chemicals for reuse in the first stage. The process hydrolyzes cellulose into pentose, hexose, or glucose sugars at the point of use. The resulting sugars may then be yeast-fermented to ethanol or other commercial organic chemicals. The technology was developed by Brelsford Engineering, Inc. (BEI) and is being commercialized through licensing.

**Contact:**

- Donald Brelsford from Brelsford Engineering, Inc., at [brelsfordenginc@aol.com](mailto:brelsfordenginc@aol.com)

## High-Intensity Plasma Melting



An innovative, modular glass melter utilizes electric-based plasma melting and increases torch life and process stability. Plasmelt Glass Technologies, LLC is developing this technology with support from AGY and Johns Manville. Plasmelt is conducting exploratory glass melting trials on a wide variety of glass compositions and is continuing to improve process parameters in its pilot-scale melter.

**Contact:**

- Ron Gonterman from Plasmelt at [Ron@plasmelt.com](mailto:Ron@plasmelt.com)

## FastFuse™: Rapid Energy Saving Glass Lamination via Radio Frequency (RF) Heating



FastFuse™ selective RF heating technology replaces energy-intensive, multi-step autoclave processes for laminated glass and other composites. Traditional glass lamination wastes large amounts of energy to heat the vinyl interlayers through the glass. The single-step RF process heats the vinyl interlayers directly, eliminating 90–95% of the lamination time and energy usage, while increasing throughput. Ceralink, Inc. developed and demonstrated FastFuse™ with autoglass, mirrors, solar cells, armor glass and ceramics, and LEDs in panels up to 2' x 3'.

**Contact:**

- Shawn Allan from Ceralink, Inc., at [shawn@ceralink.com](mailto:shawn@ceralink.com)

## Manufacturing Ceramic Products from Waste Glass



A new, energy-saving ceramic production method uses recycled waste glass in place of ceramic raw materials that require high firing temperatures and energy-intensive processing steps, thereby reducing energy costs while increasing the glass recycling rate. The keys to the new method are the elimination of processing problems and reduced sensitivity to contaminants, which have greatly limited the use of recycled glass in the past. An automated manufacturing plant has been designed and each step of the process has been evaluated at pilot scale. The high-quality prototype ceramic tiles produced are suitable for ceramic wall and floor tile applications. Haun Labs is seeking industrial partners to commercialize this technology.

**Contact:**

- Michael Haun from Haun Labs at [mjhaun@haunlabs.com](mailto:mjhaun@haunlabs.com)

## Submerged Combustion Melting (SCM)

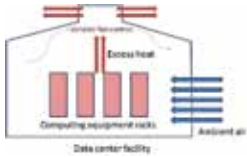


In SCM, flames are fired directly into a bath of molten glass, leading to intense melting and mixing that can significantly reduce melter size and capital costs. This process provides excellent homogenization, while combustion within the melt enables high thermal efficiency and lower gas-phase emissions. The Gas Technology Institute (GTI) led an industrial consortium of five glass companies that melted a wide range of industrial glass compositions at up to 1,500 pounds per hour in a pilot melter. They are now developing rapid glass refining methods and scaling the technology for industrial use.

**Contact:**

- David Rue from Gas Technology Institute at [david.rue@gastechnology.org](mailto:david.rue@gastechnology.org)

## Next Generation Passive Cooling Design for Data Centers



The Yahoo! Compute Coop (YCC) project is designing a new data center that allows for use of outside, ambient air cooling for 99% of the year via the unique building shape and orientation and the server alignment within the building. The YCC design is estimated to save over 95% of cooling energy used in conventional data centers. A backup evaporative cooling system is ready in the event of high temperatures. The relatively low initial cost to build, compatibility with current server and network models, and efficient use of power and water are all key features that make the YCC a highly adoptable innovation for the data center industry. Yahoo! opened the first YCC-design data center in the fall of 2010 in Lockport, New York and is seeking a patent for the design.

### Contact:

- Christina Page from Yahoo! Inc. at [cpage@yahoo-inc.com](mailto:cpage@yahoo-inc.com)

## Dynamic Power Optimization: An Energy-Proportional Data Center



Power Assure's Dynamic Power Optimization software manages IT equipment within data centers to reduce electrical power consumption. Normally, IT equipment remains "always on," even during periods of low server utilization. Idle servers are responsible for wasted electrical energy consumption, which also creates the need for unnecessary cooling. Power Assure and Palo Alto Research Center (PARC) will combine their prototype technology to enable a data center to become "always available," operating on demand and reducing power consumption of managed servers by 50% without sacrificing performance.

### Contact:

- Victor Neeley from Power Assure at [vneley@powerassure.com](mailto:vneley@powerassure.com)



## In-Situ Real-Time Monitoring and Control of Mold-Making and Filling Processes

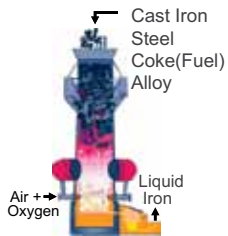


New improvements in lost foam casting and green sand casting include advancement of online measurement and control capabilities of typical foundries and improvement in monitoring pattern/mold characteristics prior to and during filling. This project developed analytic methods and procedures to quantify a series of molds and patterns in terms of their primary properties, resulting in better control over the casting process, reduced scrap rate, and increased consistency in casting quality. Tennessee Technological University will complete technical development in 2010 and start the commercialization phase.

**Contact:**

- Mohamed Abdelrahman from Tennessee Technological University at [mabdelrahman@tntech.edu](mailto:mabdelrahman@tntech.edu)

## Cupola Furnace Process Model



A new computer model improves process control by integrating many operational variables of cupola furnaces. This comprehensive model develops heat and material balances to further optimize furnace operations and reduce energy consumption and greenhouse-gas emissions. S. Katz & Associates, in collaboration with the American Foundry Society, GM-Research, and more than 20 industry sponsors, developed this technology and is looking to form a strategic partnership for commercialization.

**Contact:**

- Seymour Katz from S. Katz & Associates at [skatzassociates@gmail.com](mailto:skatzassociates@gmail.com)

## Through-the-Earth Communications for the Mining Industry

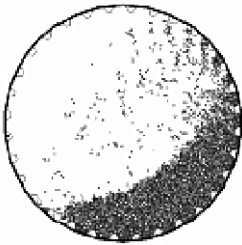


A wireless radio system, with a range of more than 100 meters through the earth, increases underground mining safety and productivity by enhancing communications and position information. Los Alamos National Laboratory and several partners originally developed this technology. Vital Alert Communication Inc. is commercializing this technology and anticipates that the product will be commercially available in November 2010.

**Contact:**

- Ann Hueter from Vital Alert Communication Inc. at [ann.hueter@vitalalert.com](mailto:ann.hueter@vitalalert.com)

## Grinding Mill Optimization Software



New 3-D simulation software visualizes charge motion and provides quantitative information (power, forces on mill lifters, wear, etc.) for semi-autogenous grinding (SAG) mills and ball mills. The software models individual collisions of ball and rock particles, producing improved lifter design and operating conditions. The University of Utah developed this technology in partnership with Idaho National Engineering Laboratory, Process Engineering Resources Inc., and Kennecott Utah Copper Corporation. The software has been successfully demonstrated for plant-scale SAG mills and is being updated for computational speed and visualization speed.

**Contact:**

- Raj Rajamani from University of Utah at [raj.rajamani@utah.edu](mailto:raj.rajamani@utah.edu)

## GranuFlow™ Process for Coal Preparation



The GranuFlow™ treatment process agglomerates fine coal particles that are normally lost to slurry impoundments. The process involves adding an emulsion of asphalt, or similar binder, to fine-sized coal slurries before mechanical dewatering begins in equipment like vacuum filters or centrifuges. The binder selectively agglomerates the coal, but not the clays or other mineral matter. This technology reduces moisture content and mitigates problems with downstream handling, dusting, and freezing.

**Contact:**

- David Akers from CQ Inc. at [dakers@cq-inc.com](mailto:dakers@cq-inc.com)

## Novel Dry Coal Deshaling Mobile Unit



A new dry deshaling technology removes materials with high-ash content prior to loading and further coal cleaning. This coal cleaning unit provides high-density separation near the extraction point or working face of a mining operation. The system requires little to no water, facilitating easier product transportation and waste material hauling. These features enable mine personnel to remove waste rock while minimizing coal losses to the rejection stream.

**Contact:**

- Dan Norrgran from Eriez Manufacturing Company at [dnorrgran@eriez.com](mailto:dnorrgran@eriez.com)

## Drill-String Radar (DSR) Navigation for Horizontal Directional Drilling



An innovative DSR technology identifies coal-rock boundaries to guide horizontal drilling in coal seams. In contrast to conventional gamma sensors, this radio-wave-based sensor withstands drilling vibrations and can be used for real-time control. DSR thereby reduces the energy, risk, cost, and time required for horizontal drilling. Stolar Research Corporation worked with industrial partners to develop the DSR technology, a 2005 R&D 100 Award winner, and is planning near-term commercialization efforts.

**Contact:**

- John Howard from Stolar Research Corporation at [jgh@stolarresearch.com](mailto:jgh@stolarresearch.com)

## Dense-Medium Cyclone Optimization Tools



New engineering tools provide real-time feedback to improve the energy efficiency of dense-medium cyclone operations. These user-friendly tools allow operators to assess, troubleshoot, and predict cyclone performance. Virginia Polytechnic Institute, together with Massey Coal Services, Precision Testing Laboratory, and Partition Enterprises, developed and conducted field tests of these software tools. The project team is working on a marketing agreement to distribute the software via the web.

**Contact:**

- Gerald Luttrell from Virginia Tech at [luttrell@vt.edu](mailto:luttrell@vt.edu)

## Three-Phase Rotary Separator Turbine (RST3)



The RST3 generates substantial power from previously wasted process energy. The system effectively separates solid waste, oil, gas, and water, while harnessing energy from the high-pressure mixture brought to the surface from offshore wells. This clean power source accelerates the rotating portion of the RST3 unit to separate the mixture more efficiently than traditional methods. The new process often creates net energy for other offshore oil platform operations, reducing the need for electricity produced from natural gas turbine generators. Dresser-Rand is commercializing the technology.

**Contact:**

- Jay Kumar from Dresser-Rand at [JKumar@Dresser-Rand.com](mailto:JKumar@Dresser-Rand.com)

## Bio-Synthetic Motor Oils and Lubricants



Eco Oil is an enhanced, biosynthetic motor oil that will help reduce refined petroleum consumption. Eco Oil is derived from high-oleic canola oil refined into an estolide base oil and then blended with additives to formulate a finished 4-stroke motor oil usable in gasoline and diesel engines. While being sustainable and readily bio-degradable, the oil exhibits lubricating characteristics as good or better than those found in fossil-based oils. LubriGreen is currently partnering with several of the world's largest oil companies to commercialize the product.

**Contact:**

- Allen Barbieri from LubriGreen Bio-Synthetics at [ab@lubrigreen.com](mailto:ab@lubrigreen.com)

## Implo Treat: Fluid Implosion System to Stimulate Existing Oil and Gas Well Flows



A fluid implosion system for oil and gas wells uses a surge of hydraulic pressure to remove plugging material from the perforation tunnels of well-bore casings. Formation fluid implodes into the casing and carries debris and compaction from the plugged tunnels within the formation. This causes the perforations to start flowing for the first time and increases the well production rate. The patented technology is entirely mechanical and hydraulic; it does not use dangerous explosives or chemicals.

**Contact:**

- Emmet Brieger at (575) 354-2522

## Hot Oxygen Injection into the Blast Furnace



Injecting hot oxygen directly in blast furnace tuyeres, rather than enriching the hot blast, increases the local oxygen enrichment in the vicinity of the injected powdered coal plume. Praxair, Inc. has developed a thermal nozzle that generates a high-temperature, high-momentum oxygen jet that provides superior mixing, rapid devolatilization, and more complete carbon burnout for blast furnace coal injection. This process improves operating cost, energy consumption, and emissions performance. This technology is undergoing a full-scale commercial demonstration.

**Contact:**

- Pravin Mathur from Praxair, Inc., at [Pravin\\_Mathur@praxair.com](mailto:Pravin_Mathur@praxair.com)

## Metallic Iron Nodule Technology in Electric Furnace Steelmaking



Furnace atmospheric control methods have been developed to improve the production of value-added iron nodules that will be used as feedstock in electric arc furnace steelmaking. Metal iron nodule technology offers a high-quality scrap substitute, reduces production costs, increases steel product quality, and enables more effective use of sub-bituminous coal. The Natural Resources Research Institute at University of Minnesota Duluth developed these methods and is testing them at a Nucor Steel facility.

**Contact:**

- Donald Fosnacht from University of Minnesota Duluth at [dfosnach@nrri.umn.edu](mailto:dfosnach@nrri.umn.edu)

## Processing Steel Waste into Commercial Products

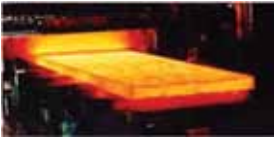


This unique hydrometallurgical process recycles dust from electric arc furnaces and other waste streams into valuable iron and zinc oxides. The waste is oxidized and digested in acid and then treated to isolate and retrieve individual components of the dust. Complete recycling is possible, with no greenhouse gas emissions, eliminating the landfill and CO<sub>2</sub> streams associated with existing treatments. Energy consumption is dramatically lower, as well. The process has been vetted through extensive pilot plant work, and the engineering design is complete. Investment opportunities are available for green technology investors.

**Contact:**

- Kathleen McGrath from Metalox, LLC at [kathleenmcgrath@earthlink.net](mailto:kathleenmcgrath@earthlink.net)

## Next Generation Heating System for Scale-Free Steel Reheating



A new system reduces scale formation during steel reheating by employing fuel-rich combustion of natural gas with preheated or oxygen-enriched air to control flue gas composition in selected furnace zones. Reducing scale formation increases product yield and revenue by reducing the furnace downtime and manpower required to collect and remove scale from reheating furnaces. This process offers substantial reductions in energy use and costs associated with handling, disposal, and reprocessing of scale. E3M, Inc. developed this technology and is preparing to implement an industrial installation.

### Contact:

- Arvind Thekdi from E3M, Inc., at [athekdi@e3minc.com](mailto:athekdi@e3minc.com)

## Pickliq®: Regeneration of Hydrochloric Acid Pickling Liquors

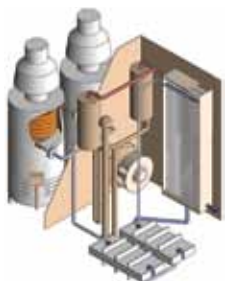


The Pickliq® Hydrochloric Acid Regeneration (PHAR) system uses sulfuric acid to produce ferrous sulfate crystals that can be sold for industrial purposes, thus eliminating the disposal problems associated with conventional pickling technology. Conventional pickling technology generates 1.5 billion gallons of spent pickle liquor nationwide each year, resulting in costly and energy-intensive handling, treatment, and disposal. This new technology significantly reduces operating, environmental, and capital costs. Green Technology Group is demonstrating and developing the PHAR system for commercial use.

### Contact:

- Douglas Olsen from Green Technology Group at [d.olsen7@yahoo.com](mailto:d.olsen7@yahoo.com)

## High-Efficiency Liquid-Desiccant Regenerator

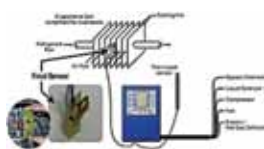


A new generation of liquid-desiccant technology lowers the overall cost and size of existing dehumidification technologies while improving performance. The two-stage regenerator consists of a first-stage boiler and a second-stage scavenging-air regenerator that has the potential to nearly double the efficiency of liquid-desiccant systems. The steam produced in the boiler from driving the liquid desiccant above its boiling point provides thermal energy to run the scavenging-air regenerator. AIL Research, Inc. developed this technology and has reached an agreement with PAX Streamline to manufacture the liquid-desiccant regenerator.

**Contact:**

- Andrew Lowenstein from AIL Research, Inc., at [ail@ailr.com](mailto:ail@ailr.com)

## Intelligent Controls for Refrigeration Systems



A new, low-cost frost sensor for defrost control systems has been developed and patented to start the defrost cycle in refrigeration systems only when necessary and to stop the cycle as soon as the ice has been removed from the heat exchanger. In typical installations, the defrost cycle in a refrigeration unit often begins too soon and runs too long. The frost sensor, designed to measure the heat transfer from a heat exchanger fin as a function of ice formation, can also be used to monitor the level of dirt formation on the fins and be used in a preventative maintenance program for scheduling cleanings. ADA Technologies is in the process of licensing this technology.

**Contact:**

- Nick Knowlton from ADA Technologies, Inc., at [nickk@adatech.com](mailto:nickk@adatech.com)

## New Regenerative Cycle for Vapor Compression Refrigeration



A new thermodynamic cycle for refrigeration equipment is characterized by the regenerative use of the potential energy of the working fluid. A compressor compresses the working fluid to only 60–70% of the final pressure, while a jet device provides additional compression using the internal potential energy of the working fluid flow. The new system increases efficiency and saves energy relative to currently available technology, which typically employs a one-step vapor compression cycle. Magnetic Development, Inc. developed the system and is performing prototype testing in conjunction with Heatcraft, Inc.

**Contact:**

- Mark Bergander from Magnetic Development, Inc., at [mark@mdienergy.com](mailto:mark@mdienergy.com)

## Energy-Saving Controls for High Intensity Discharge (HID) Lamps



PowerSaver II technology and products are programmable, automatic, and autonomous when installed in HID lamps, controlling illumination to meet customer needs and lighting standards. These energy saving controls can be programmed to shut off specific HID lamps at specific times, and illumination can be reduced to a level from 25–90% of full brightness to reduce overall energy consumption. Not only is HID lighting the most cost- and energy-efficient technology available today for high-power lighting applications, it also reduces maintenance costs. This technology was developed by Electronic Energy Solutions and is undergoing pilot demonstrations.

**Contact:**

- Peter Blake from Electronic Energy Solutions, LLC, at [peter@eesolutions.org](mailto:peter@eesolutions.org)

## Sunlight Responsive Thermo-chromic Window System



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 Thermo-chromic windows reversibly change light transmission via thermo-chromic materials that are activated solely by the sun's heating effect. The window design allows for good daylighting, a low solar heat gain coefficient, a low U-value, and a high insulation value. Compared to traditional window systems, this technology is expected to achieve 30% energy savings. The windows are expected to be commercialized in 2010.

**Contact:**

- Fred Millett from Pleotint LLC at [fredm@pleotint.com](mailto:fredm@pleotint.com)

## Formira™: Powering Cell Phones with Fuel Cells Running on Renewable Fuels

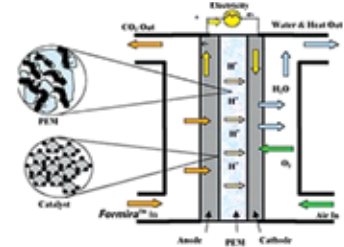


Figure 1: Formira™ Fuel Cell

The Formira™ fuel cell, fueled by air and formic acid, will reduce electricity consumption of battery charging. 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. The power density of the Formira™ fuel cell is higher than that of a direct methanol fuel cell. In addition, it performs at a lower operating temperature and uses lower cost catalysts.

**Contact:**

- Tekion, Inc. at [info@tekion.com](mailto:info@tekion.com)



## Super Boiler



The Super Boiler design allows for ultra-low emissions, reduced footprint, and reduced weight. This is achieved through an integrated package design that combines the advantages of a staged, intercooled combustion system with forced internal recirculation, high-intensity heat transfer surfaces, an advanced transport membrane condenser, and a smart control system. The performance goals for the technology include 94% fuel efficiency, 5 ppmv NO<sub>x</sub> and CO emissions, and 50% size and weight reduction compared with conventional boilers. The first-generation Super Boiler has been developed and field-tested.

### Contact:

- Daniel Willems from Gas Technology Institute at [daniel.willems@gastechnology.org](mailto:daniel.willems@gastechnology.org)

## Advanced Process Heater (APH)

Combined with HTS  
30% to 50% energy savings

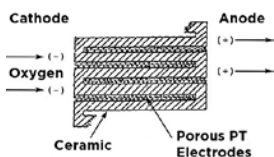


The APH combines heat transfer and waste heat recovery components into a high-performance package for industries that use fuel-based process heating systems. It consists of a high-temperature heat exchanger and burner with a radiant tube heat transfer system (RHTS). The performance goals for the technology include fuel efficiencies more than 70%, improvements in temperature uniformity by 50–100°F, and reduced emissions. The RHTS is commercially available, and the complete APH system is currently being prepared for commercialization.

### Contact:

- Tom Briselden from STORM Development at [tbriz@att.net](mailto:tbriz@att.net)

## Miniature, Inexpensive, Amperometric Oxygen Sensor



CeramPhysics's miniature amperometric oxygen sensor measures oxygen partial pressure from parts-per-million levels to 100% oxygen. The new sensor, with a multilayer ceramic capacitor, is ideal for inexpensive mass production. The large reduction in the 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. The packaged sensor and its controller are expected to be less expensive than any others on the market.

### Contact:

- Fred Clark from CeramPhysics, Inc., at [ceramphysics@gmail.com](mailto:ceramphysics@gmail.com)

## Process Heater System



The advanced process heater system combines three technologies to achieve ultra-high efficiency and extremely low emissions: an ultra-low emission (ULE) burner, an enhanced fired heater with high heat recovery capability, and online temperature sensors with a burner control system. Designed for new and retrofit applications, the process heater system will be applicable for petroleum refining and chemical processes. The burner system is commercially available, and the advanced heater design is currently undergoing commercialization.

### Contact:

- Bernard Lupien from TIAX LLC at [lupien.bernard@tiaxllc.com](mailto:lupien.bernard@tiaxllc.com)

## Utility Interactive Inverter System for Distributed Generation

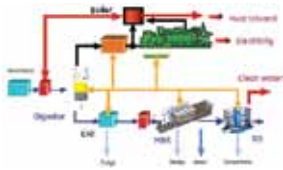


Advanced Energy Conversion, LLC is developing inverter technology that incorporates a zero-voltage transition (ZVT) converter, which will yield a system that is smaller, less expensive to manufacture, and more efficient than existing commercial technologies. The ZVT inverter's high operating efficiency makes it possible to eliminate the cooling fan while reducing the amount of bulk energy storage. It also results in a reduction of electrolytic capacitors in the power stage, which improves inverter reliability and reduces cost. The technology has passed all tests necessary for certification and is available for licensing to be commercialized.

### Contact:

- David Torrey from Advanced Energy Conversion, LLC, at [DavidTorrey@advancedenergyconversion.com](mailto:DavidTorrey@advancedenergyconversion.com)

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



An automated wastewater processing solution recovers energy and water from industrial wastewater effluent streams. The integrated waste-to-value system consists of multiple components, including pretreatment and anaerobic digestion to generate biogas fuel and an aerobic membrane reactor to further clean the water. The control solution aims to improve the performance and reliability of the integrated waste-to-value system, reducing the occurrence of severe upsets and improving the overall operational efficiency. GE Global Research is currently developing this technology, which will be subsequently demonstrated through a pilot plant implementation.

### Contact:

- Aditya Kumar from GE Global Research at [kumara@research.ge.com](mailto:kumara@research.ge.com)

## Advanced Reciprocating Engines



The Advanced Reciprocating Engine Systems program (ARES) is an ongoing effort that coordinates separate, yet parallel, engine development projects among major U.S. stationary gaseous fuel engine manufacturers. Cummins, Caterpillar, and Dresser Waukesha have commercialized ARES Phase I systems that meet or exceed brake thermal efficiencies (BTE) of 42% with NO<sub>x</sub> emissions below 0.5 g/bhp-hr. These companies are now developing systems that meet ARES Phase II goals—47% BTE with NO<sub>x</sub> emissions below 0.1 g/bhp-hr—and will ultimately meet ARES Phase III goals—50% BTE with NO<sub>x</sub> emissions below 0.1 g/bhp-hr. Additional ARES goals target cost competitiveness, low maintenance costs (less than \$0.01/ekW-hr), and opportunity fuel capability (e.g. landfill gas).

### Contact:

- David T. Montgomery from Caterpillar, Inc., at [montgomery\\_dave@cat.com](mailto:montgomery_dave@cat.com)
- Edward J. Lyford-Pike from Cummins Energy Solutions at [edward.j.lyford-pike@cummins.com](mailto:edward.j.lyford-pike@cummins.com)
- James R. Zurlo from Dresser Waukesha at [jim.zurlo@dresser.com](mailto:jim.zurlo@dresser.com)

## Novel Refractory Materials for High-Temperature, High-Alkaline Environments



A new family of refractory materials is being developed for use in high-temperature, high-alkaline industrial environments such as those found in aluminum, lime, and gasification processes. These magnesia- and alumina-based compositions utilize 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 novel materials reduce downtime and energy loss associated with the repair and replacement of degraded refractory linings.

**Contact:**

- James Hemrick from Oak Ridge National Laboratory at [hemrickjg@ornl.gov](mailto:hemrickjg@ornl.gov)

## Erosion-Resistant (ER) Nanocoatings for Improved Energy Efficiency in Gas Turbine Engines



A new family of ER nanocoatings for gas turbine engine applications protects compressor airfoils from erosion. This technology, developed by MDS-Prad Technologies and the National Energy Technology Laboratory, will enable engines to extend high operational efficiency through a larger portion of their life cycle. The near-term commercialization strategy is to focus on applications in both industrial and aviation turbines. Current research is working toward FAA certification for commercial aviation and field-testing in a commercial industrial gas turbine generating power under inlet fogging conditions.

**Contact:**

- David E. Alman from National Energy Technology Laboratory at [david.alman@netl.doe.gov](mailto:david.alman@netl.doe.gov)

## Production Scale-Up of Activated Carbons for Ultracapacitors

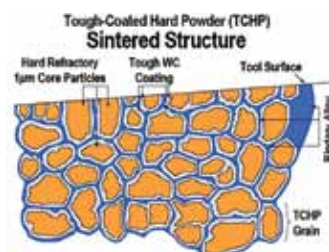


Methods that use low-cost feedstock (carbohydrates) were developed to prepare porous carbons with tunable pore size distribution for use in ultracapacitors at a greatly reduced production cost. Ultracapacitors are a promising energy storage technology for the electric and hybrid vehicles that will decrease the nation's dependence on petroleum. However, the pore size distribution, and hence the surface area, of current carbons is not optimized for liquid electrolytes, and the best carbons are very expensive. TDA is building a pilot plant for increased carbon production.

**Contact:**

- Steven Dietz from TDA Research, Inc., at [sdietz@tda.com](mailto:sdietz@tda.com)

## Tough-Coated Hard Powders



Tough-Coated Hard Powders enable new, combined levels of fracture toughness and hardness that will increase wear life in a wide range of finished products. These tools also show resistance to abrasion, friction, and corrosion. The tool material can be reground and reused many times before disposal. The combination of extreme strength, significantly extended component and tool life, and reduced friction and thermal losses will enable significant cost, energy, and environmental impact improvements. The technology is being tested with major wire producers producing dies and wire-drawing components.

**Contact:**

- John Keane from Allomet Corporation at [John.Keane@Allomet.Net](mailto:John.Keane@Allomet.Net)

## Advanced Nanocomposites for Increased Energy Efficiency

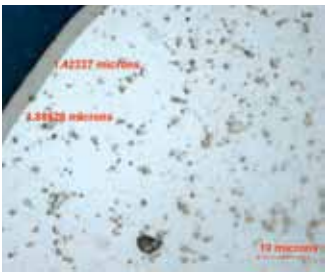


A new family of ceramic-based monolithic composites increases the energy efficiency and operating life-time of wear-intensive industrial components and systems. Initial studies of aluminum magnesium boride (AlMgB14)-based composites demonstrate potential for achieving a highly wear-resistant and lightweight material through powder processing and hot pressing. Combinations of hardness and toughness were tested to achieve optimum levels of each. Ames Laboratory at Iowa State University developed these materials and is working with a start-up company to acquire the equipment to produce the material for large-volume sales.

**Contact:**

- Bruce Cook from Ames Laboratory at [cook@ameslab.gov](mailto:cook@ameslab.gov)

## Nanocoatings for High-Efficiency Industrial Hydraulic and Tooling Systems

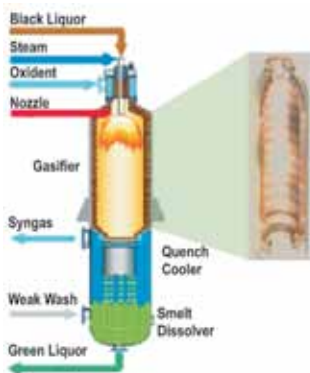


A new family of “superhard” nanocomposites, which derives its hardness from microstructural engineering of the constituent phases, minimizes material wear and degradation in hydraulics and tooling applications. These coatings combine high hardness with a low friction coefficient, which increases mechanical and volumetric efficiencies and decreases fuel consumption in hydraulics systems. In addition, these coatings have enabled greater use of water-based, fossil-fuel-free lubricants. When these coatings are applied to industrial tooling systems, machining operations benefit from higher cutting/milling speeds and reduced energy consumption and emissions.

**Contact:**

- Clifton Higdon from Eaton Corp. at [cliftonhigdon@eaton.com](mailto:cliftonhigdon@eaton.com)

## Materials for High-Temperature Black Liquor Gasification



Degradation-resistant materials for black liquor gasifiers help prevent costly material loss due to high alkali concentrations and temperatures. Oak Ridge National Laboratory, University of Missouri-Rolla, Weyerhaeuser, and several other partners developed these materials for gasifier refractory linings and nozzles. Compared to the typical 6-month lifetime, these new materials continue to show excellent resistance to corrosion and spallation after more than 1 year of operation at a Weyerhaeuser mill.

**Contact:**

- James Keiser from Oak Ridge National Laboratory at [keiserjr@ornl.gov](mailto:keiserjr@ornl.gov)

## Ultra-Efficient and Power-Dense Electric Motors



A low-loss, high-power-density industrial motor can replace existing induction motors for a wide range of line-start and variable-speed applications. This motor is more efficient than conventional motors due to its smaller size and lower weight. The technology has great potential for use in pumps, fans, and compressors, which use more than 60% of industrial electric motor energy. Baldor's Advanced Technology Group is developing this technology.

**Contact:**

- John Malinowski from Baldor Electric Co. at [jmalinowski@baldor.com](mailto:jmalinowski@baldor.com)

## PhotoVolt Concentrated PV: Dual Thermal and Electric Concentrated Photovoltaic System



Utilizing its high-intensity, proprietary PhotoVolt solar cell, GreenField Solar's Concentrated PV (CPV) system incorporates a novel dense array design that generates electricity and thermal energy, resulting in solar energy efficiency levels of 70%. The dense array CPV system operates at up to 900 suns concentration and can achieve low solar electricity costs. The technology can also harvest thermal energy that can be utilized for process heating, reducing fossil fuels use and energy costs. GreenField is completing demonstration and is transitioning to commercial release and production scale-up.

**Contact:**

- Mico Perales from GreenField Solar at [mico.perales@greenfieldsolar.com](mailto:mico.perales@greenfieldsolar.com)

## Wind Fins: Novel Lower-Cost Wind Power System



The Wind Fin uses a unique, patent-pending design that features a single, vertical, aerodynamic blade that oscillates back and forth downwind of the tower, rather than rotating around it. This design imparts several competitive advantages over existing small horizontal- and vertical-axis wind turbines. Wind tunnel and outdoor tests show that the Wind Fin operates efficiently at lower wind speeds of 5–20 mph, enabling it to have an annual energy output that is approximately one-third greater than conventional commercial products of comparable size. Wind Innovations, LLC plans to launch its first commercial product in 2012.

**Contact:**

- Will Swearingen from Wind Innovations, LLC, at [will@windinnovations.com](mailto:will@windinnovations.com)

## Northwest PowerPipe™ Spherical Cross-Flow Turbine



The Northwest PowerPipe™ generates renewable electricity from large-diameter water transmission pipelines via a novel spherical cross-flow turbine (the Schlabach/Smith Spherical Turbine). Pipeline operators can ameliorate the costs incurred from pumping water up steep grades by capturing and utilizing the energy in the flowing water on the downhill grade. This technology can be retrofitted into existing pipelines or incorporated into new pipeline construction. Lucid Energy Technologies, LLP, is building off of test site results and preparing for full commercialization of the system in 2011.

**Contact:**

- Gina Leichty from Lucid Energy Technologies, LLP, at [gina.leichty@lucidenergy.com](mailto:gina.leichty@lucidenergy.com)

## Vortex-Induced Vibrations for Aquatic Clean Energy (VIVACE) Converter



A revolutionary, environmentally friendly technology is being developed to extract horizontal hydrokinetic energy from water currents as slow as 1–2 knots. The VIVACE technology harnesses energy from flow-induced motions (FIM) of cylinders such as vortex-induced vibrations (VIV) and galloping, which will normally damage offshore structures. By utilizing FIM rather than suppressing it, kinetic energy can be transformed into electricity with an energy density 14,600 times higher than energy farms and 15–100 times higher than traditional hydrokinetic energy devices. A contract with the U.S. Navy has been established to deploy a working prototype in a river.

**Contact:**

- Michael Bernitsas from Vortex Hydro Energy LLC at [bernitsasmm@vortexhydroenergy.com](mailto:bernitsasmm@vortexhydroenergy.com)

## Sensing and Control of Cupola Furnaces

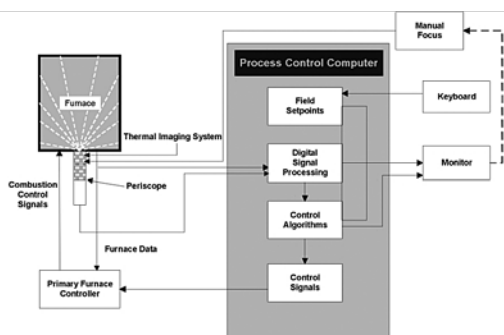


This project developed analytical methods and instrumentation to characterize a series of molds and to monitor the process of metal fill, resulting in better control over the casting process, reduced scrap rate, and increased consistency in casting quality. Improvements in lost foam casting and green sand casting include advancement of online measurement and control capabilities of typical foundries and improved monitoring of pattern/mold characteristics prior to and during filling. Tennessee Technological University will complete technical development in 2010 and then start the commercialization phase.

### Contact:

- Mohamed Abdelrahman from Tennessee Technological University at [mabdelrahman@tntech.edu](mailto:mabdelrahman@tntech.edu)

## Thermal Imaging of High-Temperature Furnaces



This near-infrared thermal imaging system integrates with existing furnace controllers to fine-tune the combustion process. A periscope probe is used to map the combustion space and eliminate hot spots and instabilities. Optimizing the combustion process has been shown to decrease total fuel usage by at least 5%, with a corresponding decrease in CO, CO<sub>2</sub>, and NO<sub>x</sub> emissions. The Gas Technology Institute and project partners have field-tested the system.

### Contact:

- David Rue from Gas Technology Institute at [david.rue@gastechnology.org](mailto:david.rue@gastechnology.org)

## Flame Image Analysis for Natural Gas-Fired Furnaces



The University of Missouri-Columbia developed new sensors that provide real-time detection of flame properties and 3-D temperature profiling for gas-fired furnaces. This system's novel monitoring capabilities increase efficiency, improve product quality, and lower NO<sub>x</sub> and CO emissions. The sensors can be integrated with the furnace control system, or they can be utilized as a diagnostic tool for manual control adjustments. Potential applications include melting or reheating furnaces that are used in the glass, aluminum, steel, and forging industries. The system has shown promising results in commercial testing.

### Contact:

- Shahla Keyvan from University of Missouri-Columbia at [Keyvan@missouri.edu](mailto:Keyvan@missouri.edu)

# Resources for Today

## Energy Management

*U.S. companies are using DOE resources to identify opportunities for quick-payback process improvements that save energy. Most items are available online and may be obtained at no cost.*

### ✓ Tools for Energy Analysis:

Download free software tools to find ways to reduce energy losses. Attend training sessions held throughout the country.

### ✓ Technical Resources for Plants:

Learn about energy-saving ideas from tip sheets, fact sheets, and sourcebooks on industrial equipment and processes.

### ✓ Learn from Other Companies:

Search case studies and project databases for energy-saving ideas and lessons learned.

### ✓ Plant Assessments:

To identify energy-saving opportunities, eligible plants may apply for an assessment by DOE's university-based Industrial Assessment Centers.

### ✓ Funding and Other Incentives Available:

ITP offers solicitations for R&D and other partnering opportunities. Search ITP's States Incentives and Resources Database to locate resources offered by the federal government, states, utilities, and others.

### ✓ Industry-Specific Resources:

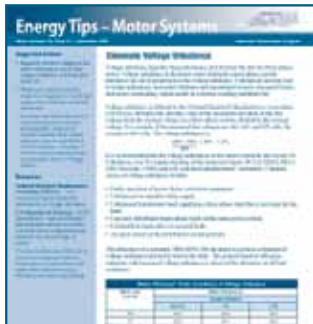
Find out more about energy use and R&D needs in environmental and energy profiles, energy bandwidth analyses, energy footprints, energy use and loss analyses, and technology roadmaps.

### ✓ Newsletters and Webcasts:

Get ITP's quarterly newsletter, *Energy Matters*, written by industry experts, or access live or archived webcasts.

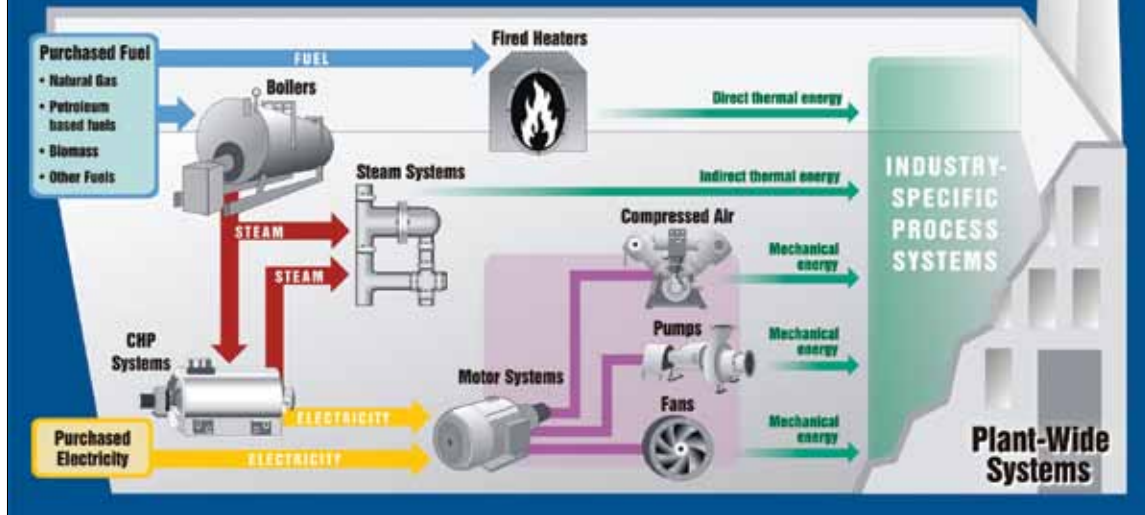
To learn more, contact the EERE Information Center (1-877-337-3463) or visit the ITP web site at

[www.industry.energy.gov](http://www.industry.energy.gov)





DOE offers free software tools and training to help plants identify their top energy-savings opportunities.



## Energy Management Toolkit

ITP maintains a robust Energy Management Toolkit to help plant operators continually identify and implement energy management best practices and technical solutions that will save energy and reduce costs. The Toolkit currently includes the following software tools and more:

### Plant-wide

Industrial Buildings and Grounds Scorecard  
Quick Plant Energy Profiler/Integrated Tool Suite

### Motor-Driven

MotorMaster+/MotorMaster+ International  
Pumping System Assessment Tool (PSAT)  
AirMaster+  
Fan System Assessment Tool (FSAT)

### Steam

Steam System Tool Suite

### Process Heating

Process Heating Assessment and Survey Tool (PHAST)

### Data Centers

DC Pro Software Tool Suite

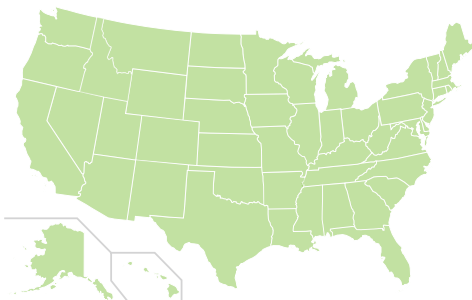
## Training

Training sessions are available to help plant engineers get the most out of these tools to maximize savings. Sessions focus on effective use of system-wide and component-specific tools and are available throughout the year and around the country. In addition, DOE and its industry partners host webcasts and one-day workshops to help plants identify and implement measures to save energy and reduce greenhouse gas emissions.

### Training Session Topics

- **Steam Systems**
- **Process Heating Systems**
- **Compressed Air Systems**
- **Motor Systems**
- **Pump Systems**
- **Fan Systems**
- **Data Centers**

## State and Regional Partnerships



ITP works with public and private partners in each state to help industry use energy more efficiently. End users are encouraged to use our online database to find out about ITP research projects as well as training, assessments, and other resources and opportunities by state. The database also provides contact information for Industrial Assessment Centers, state energy offices, and other energy experts.

For more information on ITP state activities, opportunities, and incentives, visit the ITP website: [www.eere.energy.gov/industry/states/state\\_activities/main\\_map.asp](http://www.eere.energy.gov/industry/states/state_activities/main_map.asp).

## Promoting Superior Energy Performance<sup>cm</sup>

ITP has supported the Superior Energy Performance<sup>cm</sup> certification program in partnership with the U.S. Council for Energy-Efficient Manufacturing to offer industrial facilities a pathway for continuously improving their energy efficiency while maintaining competitiveness. The U.S. program will launch in 2011 to provide a transparent, nationally accepted system for validating improvements in energy intensity and management.

Facilities of all sizes and levels of experience are encouraged to participate.

The program includes the following elements:

- **Energy Management Standard, ISO 50001:** Globally accepted framework for managing energy, including all aspects of procurement and use
- **System Assessment Standards:** ASME standards for conducting energy-efficiency assessments in specific energy systems—pumps, process heating, steam, and compressed air
- **SEP Measurement and Verification Protocol:** Methodology to verify energy performance improvement and conformance to ISO 50001
- **Certified Practitioners:** Professionals certified to assist plants in implementing ISO 50001, conducting system assessments, and verifying conformance to SEP requirements for certification

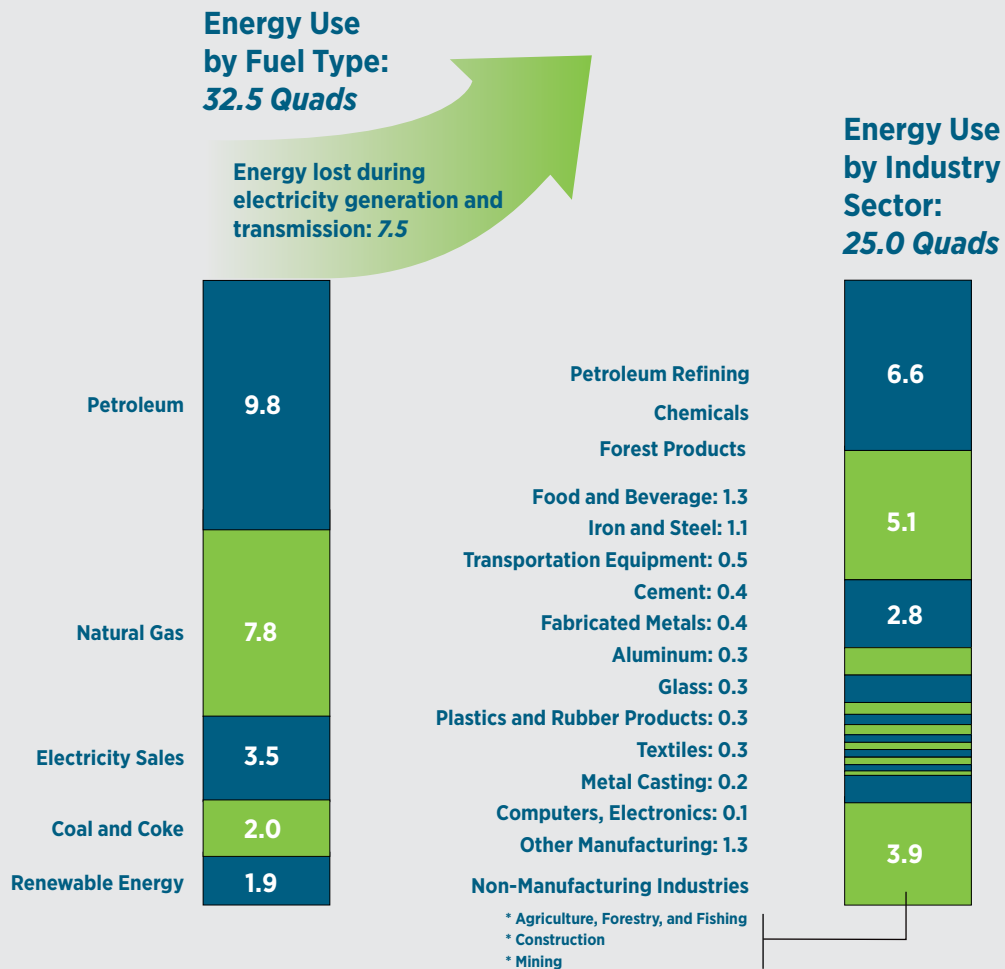
For more information, please visit [www.superiorenergyperformance.net](http://www.superiorenergyperformance.net).

A multi-country effort known as the Global Superior Energy Performance (GSEP) partnership is also under development to create and harmonize nationally accredited energy performance certification programs to serve a global market.



# U.S. Industrial Sector Energy Use—A Snapshot

Industrial Energy Use by Fuel Type and Industry Sector, 2006\*



Sources:

Energy Information Administration, *2006 Manufacturing Energy Consumption Survey*, Table 1.2

Energy Information Administration, *Annual Energy Review 2009*, Table 2.1d

\* 2006 is the latest year for which all data shown in this chart are available; 2008 data are available only at aggregate levels.

Technologies co-funded by DOE reduce the energy intensity of industrial processes.

## Industry partners help DOE to...

- Identify priorities for the R&D portfolio
- Cost-share innovative technology development
- Communicate research results to industry

## DOE builds and maintains robust R&D portfolios for industry by conducting...

- Technology and market analyses
- Expert peer reviews
- Stage-gate project management

## ITP responds to the unique challenges facing industry:

### Collaborative R&D and Outreach

- Collaborative R&D on next-generation manufacturing processes, materials, and technologies
- Field testing of promising technologies to reduce investment risk

- Tools and protocols for continuously improving energy management
- Transformational technologies that are too risky or costly to attract adequate private funding

### Targets

- Significant energy savings
- DOE and national goals





## **FOR MORE INFORMATION, CONTACT:**

EERE Information Center

1-877-EERE-INFO (1-877 337 3463)

[www.eere.energy.gov/informationcenter](http://www.eere.energy.gov/informationcenter)

The Industrial Technologies Program (ITP) is the lead government program working to increase the energy efficiency of U.S. industry—which accounts for about one-third of U.S. energy use. In partnership with industry, ITP helps research, develop, and deploy innovative technologies that companies can use to improve their energy productivity, reduce carbon emissions, and gain a competitive edge.

Please visit our website at

[www.industry.energy.gov](http://www.industry.energy.gov)



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