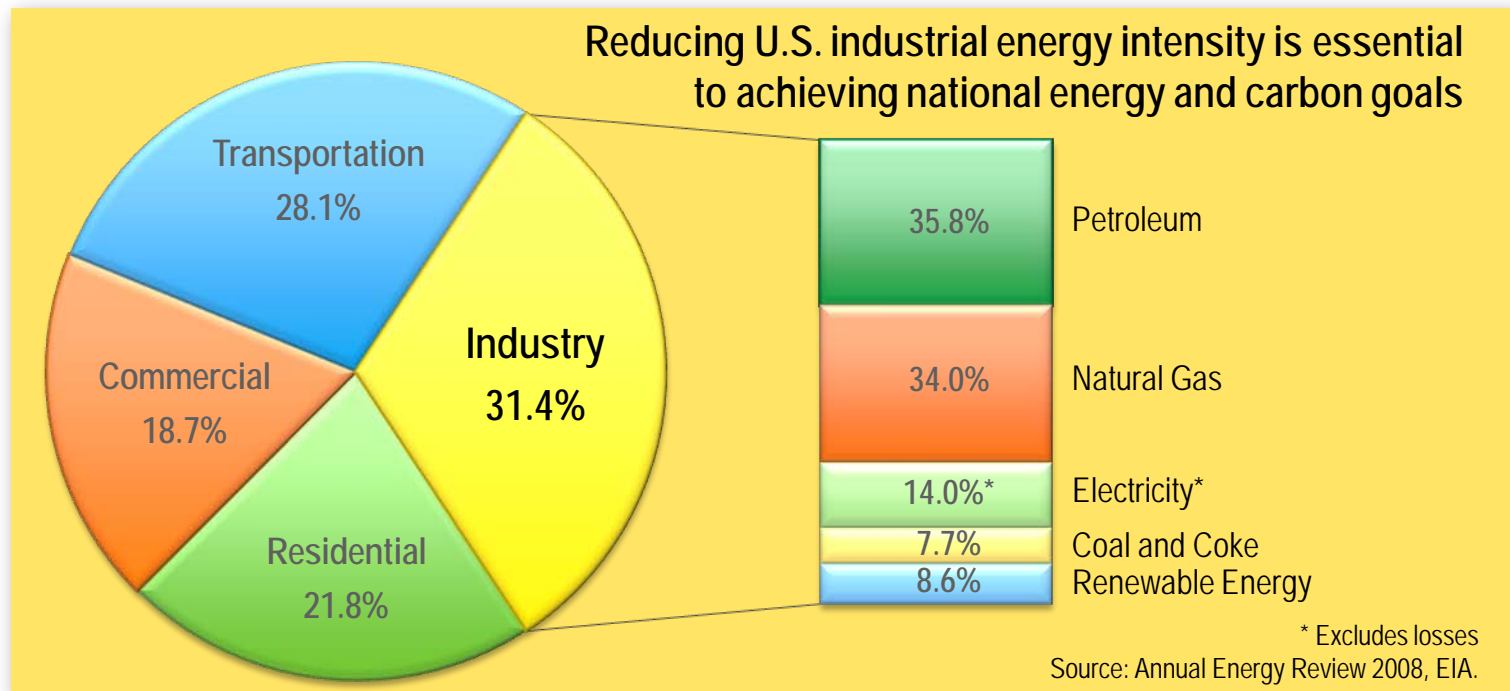


Industrial Technologies Program: *Energy Solutions for American Industry*

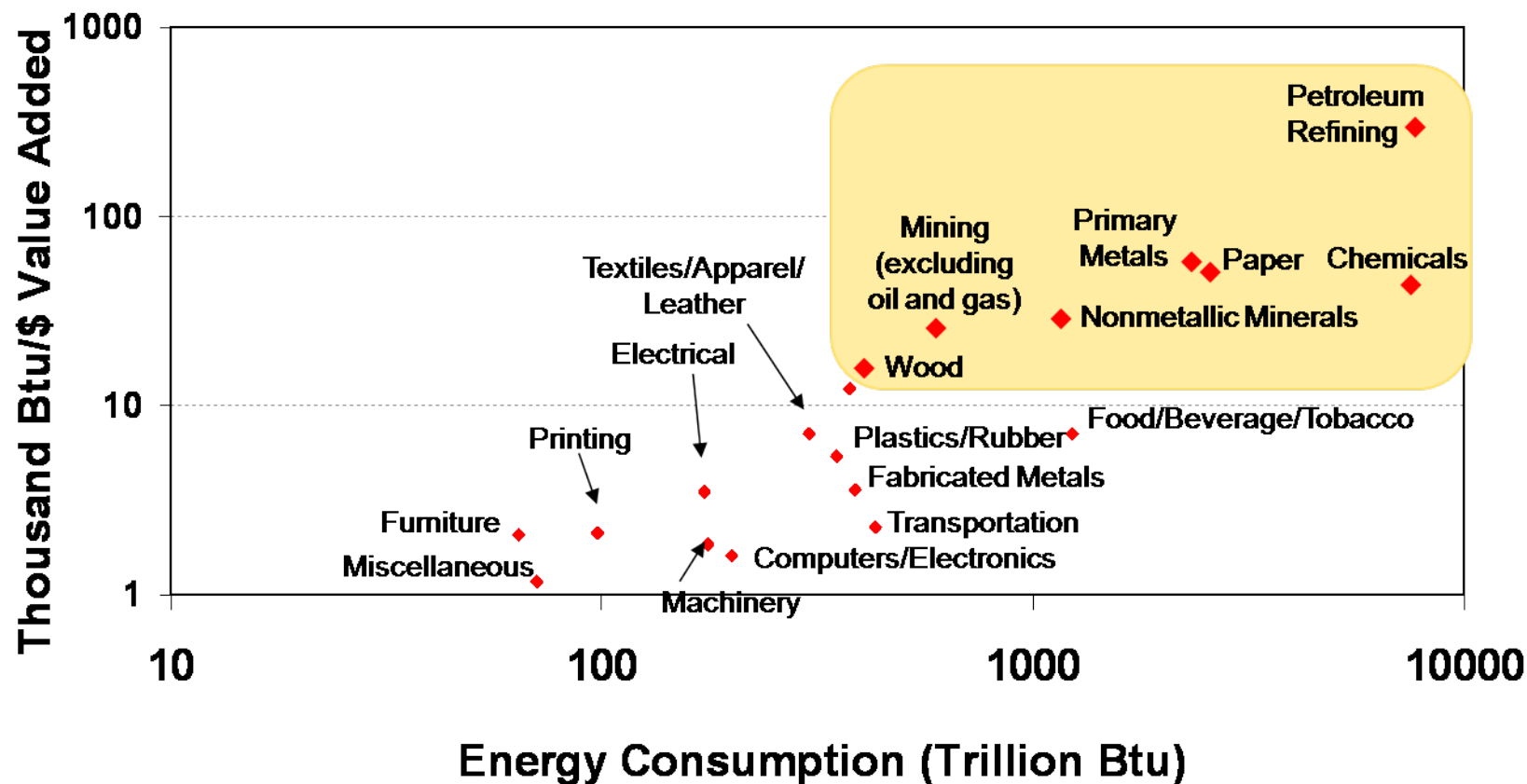
Isaac Chan
Acting Program Manager
July 2010



- Employs ~12 million people
- Makes the highest contribution to GDP (~12%)
- Supplies ~55% of U.S. exports, worth ~\$80 billion/month
- Spurs job creation and investment
- Every million dollars in energy cost savings has the potential to create approximately 16–17 new jobs.



The shift in ITP focus was prompted by tighter budgets and EERE concern regarding the perception of “corporate welfare” since 2001.



Improve national energy security, climate, environment, and economic competitiveness by transforming the way U.S. industry uses energy.



Research & Development

Develop advanced technologies addressing the top energy savings opportunities across industry



Technical Assistance

Help plants save energy today by assessing opportunities and facilitating adoption of best energy management practices

Related Authorizations

P.L. 102-486, “Energy Policy Act of 1992”
(industrial assessments, state grants)

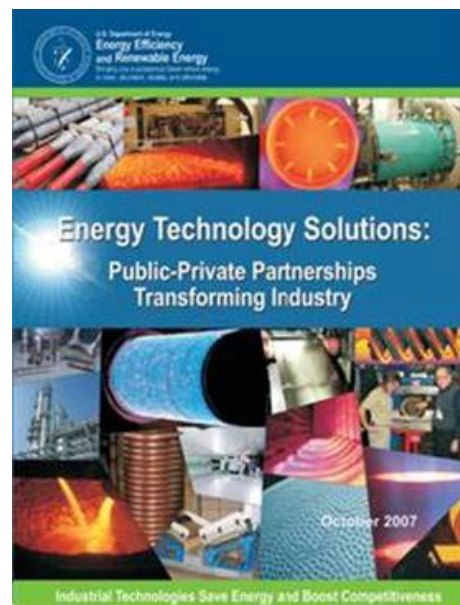
P.L. 109-58, “Energy Policy Act of 2005”
(voluntary agreements with industry)

P.L. 110-140, “Energy Independence and Security Act of 2007” (CHP and waste energy, energy-intensive industries program, data centers, motor standards, renewable energy manufacturing)

ITP: Delivering R&D Results For 30 Years

Working with industry, we have successfully developed and moved cutting-edge technologies and energy-saving measures into practice.

- Produced >220 commercialized technologies
- Resulted in 215 patents between 1994 and 2009
- Received 51 R&D 100 Awards since 1991
- Saved 8.5 quads of energy and reduced carbon emissions by 693 MMT*CO₂

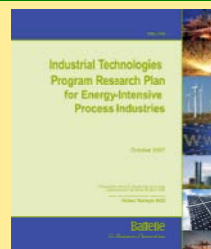


* Million Metric Tons

Energy Intensive Processes (EIP)

Addressing top opportunities to save energy and reduce carbon emissions across industry

- Reactions & Separations (catalysts, water management)
- Waste Heat Recovery (steam generation, heat utilization)
- High-Temperature Processing (lower-energy approaches)
- Sustainable Manufacturing (material efficiency, ICT, automation/wireless sensors to continuously optimize systems)



Industrial Materials of the Future

Accelerating development of advanced materials for higher efficiency industrial processing and products

- Strategic, High-Performance Materials
- Production Technologies and Structural Materials
- Advanced Processing To Minimize Materials Use



Nanomanufacturing

Enabling manufacture of products to transform energy production, use, and storage

- Manufacturing techniques for cost-competitive, large-scale production of nanomaterials
- Methods to integrate nanomaterials into intermediate and finished products that are less energy-intensive to produce and use

Fuel & Feedstock Flexibility

Energy security through diversification

- Fuel-flexible hardware
- Field testing shows effectiveness of fuel-flexible equipment in displacing fossil feedstocks

Combined Heat and Power (CHP)

Facilitating market uptake of energy efficiency technologies

- Systems recover waste heat to generate electricity and heat at >80% efficiency
- R&D on CHP and other technologies to expand markets

Selected Examples from ITP:

Commercial Successes

- Oxy-fuel firing for Glass Melters
- Ultra-Blue Low-NOx Burners
- Ni₃Al Alloys for High-T Applications
- Laser Ultrasonic Measurement System for Steel Tubing
- Ultracrystalline Diamond Mechanical Seals
- Wireless Sensor Technology for Condition-Based Monitoring
- Mercury 50 Recuperated Gas Turbine Generator Set

Present Activities

- Super Boiler (153 trillion Btu [TBtu])
- Organic Rankine Cycle for Waste Heat Recovery (22 TBtu)
- Membrane Solvent Extraction (42 TBtu)
- Ultra-fast Boring (56 TBtu)
- Near-Net-Shape Manufacturing of Low-Cost Titanium Powders (15 TBtu)
- Ultra-Efficient Power-Dense Motors (40 TBtu)
- Advanced Reciprocating Engines

Future Opportunities

- Low-temperature waste heat recovery
- Ultra-efficient, advanced reciprocating engines
- Advanced steam generation (250 TBtu)
- Hybrid distillation (240 TBtu)
- Advanced motor systems (258 TBtu)
- Low-cost carbon fiber composites
- Ultra-efficient desalination
- Low-water-use industrial processes
- Materials substitution

1. Aluminum
2. Chemicals
3. Forest & Paper Products
4. Glass
5. Metal Casting
6. Steel

- Identify transformational technology concepts in energy-intensive sectors.
- Conduct opportunity analysis with industry stakeholders in 2010.

Selected Examples from ITP:

Commercial Successes

- Lost Foam Metal Casting Process
- Rapid Solidification Process Tooling for Casting
- HotEye™ Steel Bar Inspection System
- Microstructure Engineering for Hot Strip Mills
- Distillation Column Flooding Predictor
- Ceramic Membranes for Gas Separation
- ChemStone OAE-11 Pulping Additive to Increase Alkali Penetration
- Multiport Paper Dryer
- Mesabi Nugget Cokeless Ironmaking

Present Activities

- Isothermal Melting of Aluminum (*15 TBtu*)
- Hot rolling Aluminum Scrap Reduction (*1 TBtu*)
- Energy Saving Melting and Revert Reduction Technology for Casting (*24 TBtu*)
- Next-Gen Scale-Free Reheating (*22 TBtu*)
- Microchannel Processing of Chemicals (*8 TBtu*)
- Highly Selective Oxidation Catalysts by Atomic Layer Deposition (*25 TBtu*)
- Novel Catalytic Membrane Reactors (*40 TBtu*)
- Directed Green Liquor Utilization Pulping (*28 TBtu*)

Future Opportunities

- Next-generation steelmaking (*180 TBtu*)
- Process intensification for chemicals production
- Alternative (non-conventional fossil fuel and bio-based) feedstocks for the production of chemicals, steel, etc.
- Efficient and low-carbon cement production
- High-efficiency ICT equipment and software; advanced cooling technologies; revolutionary power supply concepts



Resources to help manufacturers reduce energy use and carbon emissions *today* — and *continuously improve*.

Save
ENERGY
Now



Tools

- Energy and Carbon Baselineing / Plant Energy Profiler
- Data Center Pro
- Process Heating
- Steam Systems
- Motors, Pumps, Fans, and more

Technical Assistance

- Methods to track and manage energy intensity by product output
- Analysis of project feasibility and how to sell to management
- Referrals to existing state, utility, and other resources for project implementation

Assessments

- Large & med-size plants: three-day assessments of energy/utility systems
- Small & med-size plants: one-day, full-plant assessment conducted by university-based teams from Industrial Assessment Centers (IACs)
- States/Utility Led Assessments

Training

- Awareness
- Tool User
- System / Topic
- Qualified Specialists



Information

- Supply chain energy efficiency
- Tip sheets, case studies, source books
- Website and webcasts
- On-line databases (incentives & assessment results)
- EERE Information Center

Standards

- ISO 50001 energy management standard (scheduled in 2011)
- System assessment standards
- Protocols to measure and validate savings
- ANSI-accredited plant certification: Superior Energy Performance



Technology

- Produces high-quality iron directly from iron ore using 30% less energy and no (carbon-intensive) coke. This innovative technology completes the reduction, melting, and slag removal processes in 10 minutes vs. hours required in the traditional blast furnace.

DOE Role

- Invested \$6 million to evaluate viability at pilot scale.
- Development partners included Mesabi Nugget LLC, Steel Dynamics, and Kobe Steel.

Status

- February 2010: First shipment of Mesabi iron nuggets for testing at Steel Dynamics' flat-roll mill in Minnesota.



January 2010, the Mesabi Nugget plant one month before going fully operational

Impacts

- Market:** DOE funding paved way for private investment of \$265 million for commercial plant capable of producing 500,000 tons of nuggets annually in Hoyt Lakes, a small town in Minnesota. Total U.S. pig iron market >35 million tons/yr. Technology creates new markets for the taconite ore, providing economic stimulus and new jobs in an area hit hard by a weak economy.
- Energy:** Saves 4.7 million Btu/ton of iron produced (2.5 trillion Btu/year) with this first commercial plant. Reduces CO₂ emissions relative to the traditional coke/blast furnace route by >40%.
- Jobs:** Created 700 construction jobs to launch commercial plant in February 2010 and will require 65 permanent jobs for plant operation.

Super Boiler and Advanced Heat Recovery

Technology

- Next-generation boiler package technology uses a transport membrane condenser to extract sensible and latent heat from flue gas and achieve $\geq 94\%$ efficiency (vs. today's best of 85%) and ultra-low emissions (< 2 ppm NO_x and CO and < 1 ppm VOC).

DOE Role

- Funded R&D of transport membrane condenser and field evaluations of Advanced Heat Recovery System to validate performance.
- Leveraged federal and private sector resources to advance technology in market.

Status

- Field testing and validation ongoing at Baxter Healthcare, CA; Richardson Brand Candies, NY; and ORNL.



The Super Boiler has been tested at Specification Rubber Products Inc. (Alabaster AL) and Clement Pappas & Company (Ontario, CA)

Impacts

- Market:** Highly efficient steam generation technology to be available just as ~85,000 U.S. boilers (> 35 years old) come due for replacement. Boilers use > 6 quads per year.
- Energy:** 10% efficiency increase over state-of-the-art boilers; ~20-25% efficiency increase over average boiler efficiency; $\geq 94\%$ thermal efficiency.

Technology

- Uses high-intensity electrical resistance heaters to melt aluminum via conduction and convection, producing zero in-plant emissions.
- Modular design entails low capital and operating costs, reduces floor space 25%, and can increase efficiency by 70% vs. conventional gas-fired furnaces.

DOE Role

- Invested \$6 million to develop pilot-scale electric heaters for immersion in harsh, high-temperature molten metal.
- R&D for scale up for commercial test performance validation.

Status

- Technology field testing is planned for fall 2010.



First ITM test unit, installed at the Aleris rolled products facility in Newport, OH, in 2005. The ITM process was developed by Apogee Technologies in Verona, PA.

Impacts

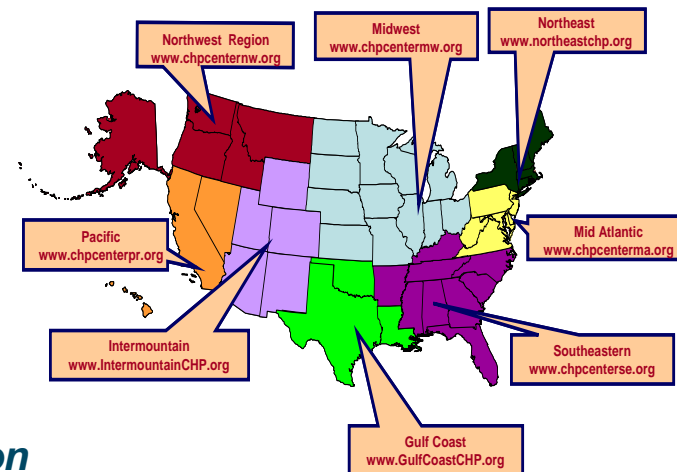
Market: \$438 million in estimated annual cost savings on energy and melt loss across the entire aluminum industry. Potential applications of ITM will extend energy and environmental benefits to other molten metal processes and to production of glass, chemicals, and forest products. Cost savings will translate into greater productivity and more jobs for the local community.

Energy: Potential to produce energy savings of 63 trillion Btu per year—a reduction in energy use that translates into a cost savings of \$340 million per year.
Reduces on-site generation of combustion gases, including CO₂, SO_x, NO_x, and particulates.

CHP offers a sizable near-term option for large energy efficiency improvements and CO2 reduction.

ITP activities include:

- Facilitating deployment and addressing barriers
- Serving as an independent, credible voice on applications and benefits
- Conducting R&D to improve efficiency, lower costs, and expand market applications



Fairless Hills Generation Station

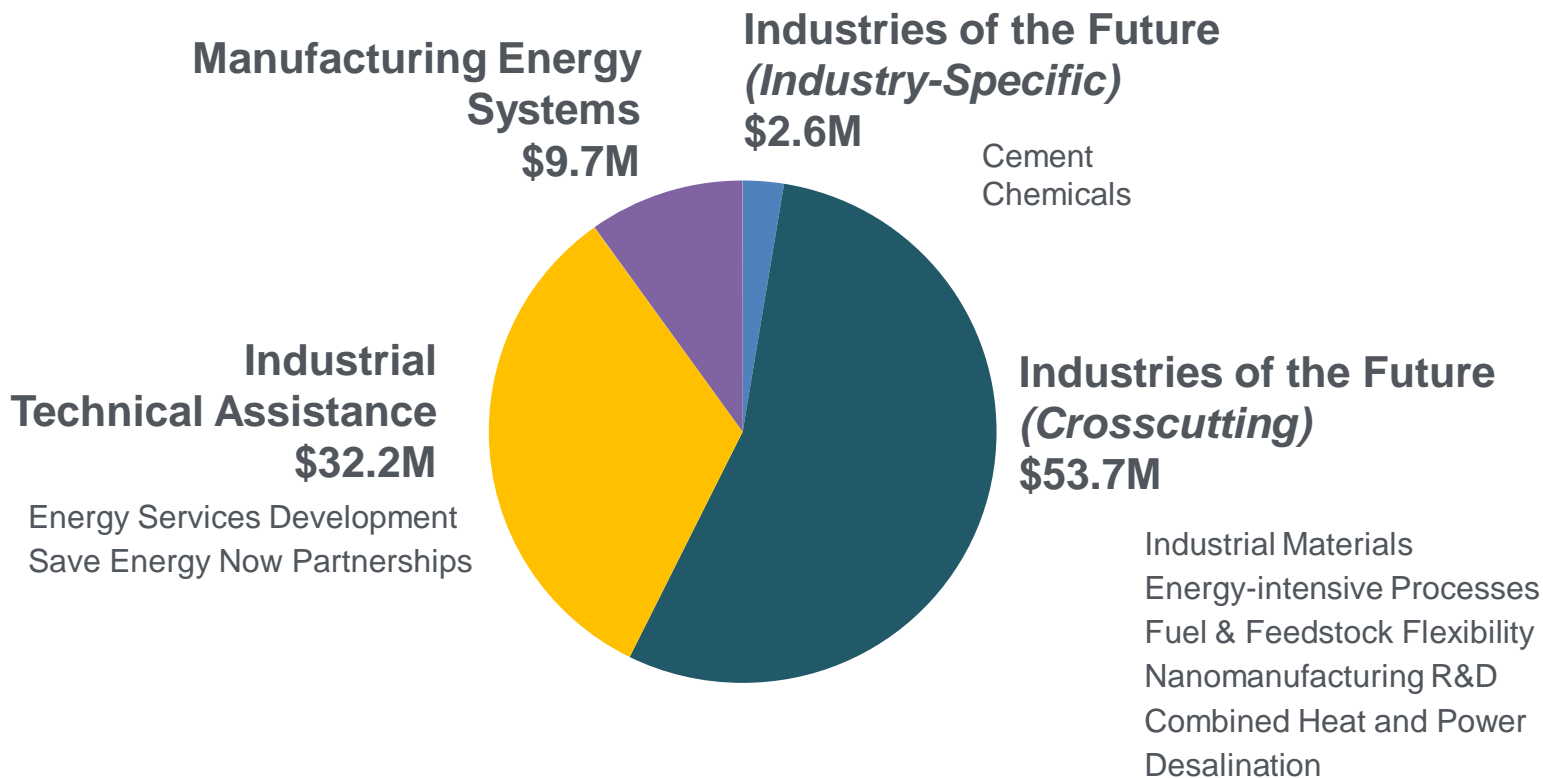
- Total capacity of 60 MW; utilizes landfill gas from two nearby Waste Management facilities
- CHP plant located in USSteel Fairless Works facility, operated by Exelon Power
- CHP plant provides steam for the US Steel Fairless Works operations; excess electricity is supplied to the grid

DOE supports eight regional Clean Energy Application Centers to provide local technical assistance, regulatory & compliance support, and site assessments for CHP applications.

Mid-Atlantic Clean Energy
Application Center
104 Engineering Unit A
University Park, PA 16802
(814) 863-0083

High Efficiency Manufacturing	<ul style="list-style-type: none">▪ Accelerated Deployment of Nanostructured Hydrotreating Catalysts▪ Application of Wear-Resistant, Nanocomposite Coatings Produced from Iron-Based Glassy Powders▪ Nanocatalysts for Diesel Engine Emission Remediation▪ Manufacturing of Superhydrophobic Surfaces with Nanoscale and Microscale Features
Energy Efficient Products	<ul style="list-style-type: none">▪ Erosion-Resistant Nanocoatings for Improved Energy Efficiency in Gas Turbines▪ Nanostructured Superhydrophobic Coatings for Breakthrough Energy Savings▪ Ultratough Thermally Stable Polycrystalline (TSP) Diamond/Silicon Carbide Nanocomposites for Drill Bits▪ Large-Scale Manufacturing of Nanoparticulate-Based Lubrication Additives for Improved Energy Efficiency▪ Development, Characterization, Production and Demonstration of Nanofluids for Industrial Cooling Applications
Energy Supply	<ul style="list-style-type: none">▪ Nanoparticle Technology for Biorefinery of Non-Food Source Feedstocks▪ Microchannel-Assisted Nanomaterial Deposition Technology for Photovoltaic Material Production
Energy Storage	<ul style="list-style-type: none">▪ Self-Assembled, Nanostructured Carbon for Energy Storage and Water Treatment

ITP's 2011 budget request emphasizes R&D on transformational technologies that apply broadly across industry to address critical national energy and climate challenges through energy efficiency.



* Excluding SBIR/STTR funding

Enabling the scientific innovation, process development, and manufacturing scale-up required to accelerate the commercialization of clean energy technologies.

Manufacturing Energy Systems Program (MESP)

- Solve critical manufacturing issues that help accelerate emergence of the most promising clean energy technologies into full-scale manufacturing.
- Harness the scientific ingenuity of American universities to help industry reduce the time and cost to translate innovation into commercial processes and products.



Save Energy Now: ITP's National Industrial Initiative

Pennsylvania-based LEADERS:



An industrial firm becomes a *Save Energy Now* LEADER by voluntarily pledging to reduce its energy intensity