



Advanced Materials and Technologies Enabled By Chemistry That Help Save Energy and Reduce GHG Emissions



General Stats

- An ACC study found that **chemistry in energy-saving products and technologies helps save up to 10.9 quadrillion BTUs of energy annually**, enough to power 56 million households or run up to 135 million vehicles each year. (McK)
- A study found that **for every unit of CO₂ emitted in the manufacturing of chemistry products, two units of CO₂ are saved through the energy savings enabled by those products.** (McK)
- By allowing manufacturers and consumers to do more with less, **using plastics can help reduce energy use and GHG emissions throughout the life of a product.** A study found that **replacing plastics with other materials would require the use of 57% more energy and result in a 61% increase in greenhouse gas emissions.** (PDACC)



Renewable Energy

- **Solar power** relies on silicon-based chemistry. (GBC)
- **Photovoltaic metallization pastes** help make solar panels more energy efficient and can increase their power output by around 30 percent. (SBS)
- **Wind power blades** are made using plastics and chemical additives, helping deliver renewable energy to our nation's electricity grid. (GBC)
- **Polymers and composite materials** are used in **glass and carbon-reinforced fiber for wind turbines.** Their use saves 123 units of GHGs for every unit emitted to make them. (McK)
- Advanced cell engineering is helping to **transform algae into clean, renewable, low-carbon energy.** (SBS)
- **Innovative new plastic solar panels** are poised to reach the mass residential market. (GBC)



Building & Construction

- Using **plastic building and construction materials** saves **467 trillion BTUs of energy per year** – enough to meet the average annual energy needs of 4.6 million U.S. households. Savings vary by material and product. (GBC, PDACC)
- **High-performance building insulation, sealants and wraps** are saving energy in our homes, offices and factories, which lowers GHG emissions.
- **Building insulation** saves up to 40 times the energy used to create it, which helps reduce GHG emissions. (GBC)
- **The advent of plastic house wrap technology** has reduced the infiltration of outside air into the average home by 10-50%, helping to drastically reduce the energy required to heat or cool the home. These plastic films have helped reduce GHG emissions in the U.S. by as much as 120 to 600 million tons of CO₂ since 1980 (assuming that all homes built since 1980 have some form of plastic barrier. (PDACC)

- **Plastic house wrap** that creates a weather resistant barrier saves **up to 360 times** the energy used to produce it (GBC)
- **Reflective light colored roofing membranes made of vinyl or thermoplastic olefin (TPO)** blends are key energy saving applications, especially for commercial buildings in southern climates. Studies have shown that the surface temperature of a light covered roof compared to a darker one saves significant energy. (PDACC)
- **Building insulation foam** saves 233 units of GHGs for every unit emitted to make it. (McK)
- **A chemical company is transforming carbon dioxide into a raw material to make flexible foam.** (SBS)
- **Composite vinyl windows improve thermal insulation** (significant improvement over fiberglass or wood), with lower weight and less maintenance (ESPC)
- Plastics rival traditional materials for **window glazing**. For example, **polycarbonate**—a material also used in eyeglasses—is used as panes. **These clear, lightweight, shatter-resistant plastic products have low thermal conductivity, which can help to reduce heating and cooling costs.** (PDACC)
- **Vinyl window frames are inherently energy efficient and save the U.S. nearly 2 trillion thermal units of energy per year**, helping reduce the greenhouse gas emissions associated with energy generation—all the while cutting maintenance time, materials and costs. (PDACC)
- **Polymeric concrete is lighter-weight**, easier to transport, and more durable than concrete (ESPC)
- **Vinyl based wall coverings** are commonly used for durable, easy-to-clean hospitality and health care facilities. **Vinyl requires only half as much energy to manufacture as the same amount of paper wall coverings.** (PDACC)
- **PVC water pipe reduces energy consumed in pumping water by as much as 200%.** Because it weighs less than traditional pipe, PVC pipe also saves energy in transportation to and from construction sites. It's durable and corrosion-free. (ESPC)



Lighting

- Chemistry enables **compact fluorescent lighting that uses 70% less energy than incandescent bulbs and saves 20 units of GHGs for every unit used to make it.** (GBC, McK)
- **LED lighting could cut global electricity demand for lighting by 30%.** [GBC]



Automotive

- In automotive design, plastics have contributed to a multitude of innovations in safety, performance and fuel efficiency. Today's plastics make up 50% of the volume of new cars but only 10% of the weight, which helps make cars lighter and more fuel efficient, resulting in fewer CO₂ emissions. Tough, modern plastics also help improve passenger safety and auto designers rely on the versatility of plastics when designing today's cars. (PDACC)
- **As the use of plastics in vehicle manufacturing increases, lightweighting design techniques** — the integration of plastics and polymer composites into vehicle design where some other materials have been traditionally used — **can benefit performance and energy savings.** Increasing numbers of automakers are using recycled plastics automotive applications to make things like seat cushions and radiator shrouds. (PDACC)

- The use of **polymers and composite materials in the automotive industry has been rising steadily over the past 30 years**. They enable significant weight reduction that helps to reduce fuel consumption and GHG emissions. (GBC)
- **Plastic and polymer composites typically make up 50% of the volume of a new light vehicle, but less than 9% of its weight**. (GBC)
- The use of polymers for automotive weight reduction **saves 3 units of GHGs for every unit emitted to make them**. (McK)
- An analysis by the U.S. Department of Energy shows a **6-8% improvement in fuel economy for every 10% reduction in weight**. The business of chemistry provides better performing and safer vehicles while providing solutions that enhance sustainability. (GBC)
- **Polymers have at least 30 different vehicle applications**, including chassis, under-the-hood, body and interior. (McK) Specific examples include **airbag door/chute systems, blow-molded running boards and seatbacks, bonded hybrid metal/plastic front end carriers, engine valve covers, injection-molded coolant tubes, plastic door modules, and rail-less window regulators**. (GBC, ESPC)
- **Chemistry is used for synthetic lubricants and diesel and gasoline fuel additives that improve engine efficiency**. Synthetic engine oil, compared to mineral lubricating oil, **reduces the fuel consumption of an engine by 5%**. [ACC]
- **When methacrylate polymers are formulated into automotive lubricants, they significantly improve fuel efficiency**.
- The use of chemistry for engine efficiency solutions **saves 21 units of GHGs for every unit emitted to make them**. (McK)



Appliances

- Replacing an old refrigerator with a new ENERGY STAR-qualified model—with improved insulation and coolant systems made possible by chemistry—**saves enough energy to light an average house for nearly four months**. (GBC)
- **Breakthrough low global warming potential refrigerants** from our industry contribute to reduction in CO₂ emissions while providing societal benefits.



Energy Storage

- **Lithium-ion and lithium-polymer batteries use chemistry to create rechargeable batteries for items such as military equipment, laptops, gaming consoles, and smartphones**. (GBC)
- **Hybrid car batteries** enabled by chemistry recharge during operation and recover energy via regenerative braking, which reduces emissions. (ESPC)



Consumer Products

- **Excellent results at lower temperatures, requiring less energy**. Use of low-temperature detergents saves 9 units of GHGs for every unit emitted to make them. (McK)
- **Renewable-sourced water-repellent textile finish** enhances clothing quality and durability, while helping consumers save water and energy. (SBS)
- **A reactive dye solution** has been developed that can reduce water consumption and save energy in the textile manufacturing process. (SBS)



Packaging

- In addition to increasing the shelf life of foods and beverages, **plastics help lower energy use and GHG emissions**. A life cycle study found that **replacing all plastic packaging in the United States with alternatives would increase energy use by 80% and greenhouse gas emissions by 130%. That's like adding 15.7 million cars to our roads.** (PDACC)
- **Plastic packaging creates fewer GHGs than alternative packaging** – plastic milk jug: 33% less, plastic tuna pouch: 77% less, plastic coffee brick: 76% less. (PDACC)
- **Plastic jars can use up to 90% less material by weight than their glass counterparts. Plastic containers can use 38% less material than similarly sized steel cans.** (GBC)
- **Extremely lightweight, flexible packaging made from plastic or plastic-and-foil composites can use up to 80% less material than traditional bag-in-box packages.** (GBC)
- **Plastics used in packaging help prevent food waste, deliver food safely, and meet FDA safety standards.** (PDACC)
- **By preventing product waste, packaging prevents the waste of all the resources (water, energy, materials) invested in growing and producing products.** (PDACC)



Manufacturing Processes

- **The chemical industry has been a pioneer in the development of catalytic technologies.** Catalysts are added substances that increase the rate of chemical reactions. **Less energy is used per unit of product. Today, about 90% of all chemical processes employ catalysis in production.** (GBC, ACC)
- **The chemical industry is a leader in the use of combined heat and power (CHP), also known as cogeneration, which provides electric power and heat from a single fuel source.** Because energy is generated close to where it's needed, little is lost in transmission. **CHP facilities are often twice as efficient as older coal-burning utilities.** (ACC, U.S. Department of Energy)



Military

- As one of the leading enablers of energy efficient and renewable energy technologies, **chemistry plays a major role in DoD's efforts to implement energy efficiency initiatives.** From **fuel-efficient technology for vehicles to products that contribute to "net-zero" energy building goals**, the chemistry industry continues to develop innovative solutions that improve energy efficiency for DoD and other agencies.

Sources Key:

- GBC = *Guide to the Business of Chemistry, American Chemistry Council, 2020*
- McK = *Innovations for Innovations for Greenhouse Gas Reductions: A life cycle quantification of carbon abatement solutions enabled by the chemical industry, McKinsey & Co. for the International Council of Chemical Associations (ICCA), 2009*
- ESPC = *Energy-Saving Products Enabled By Chemistry, American Chemistry Council*
- SBS = ScienceBehindSustainability.com
- PDACC = *Plastics Division pages of americanchemistry.com*
- ACC = American Chemistry Council