PRAXAIR

Making our planet more productive

Doing More with Less: Praxair Energy Efficiency

Renewable Energy vs. Energy Efficiency: Comparing the Energy ROI

Version 2 updated May 2015

Renewable Energy vs. Energy Efficiency: Comparing the Energy ROI

Executive Summary:
A comparative energy ROI study was conducted between Praxair's own investments in improving the energy efficiency of our plants and a range of alternatives for sourcing renewable energy. **Energy efficiency is the best investment we can make to reduce our global energy footprint and reduce natural resource consumption.** Praxair's energy efficiency program returns are 10 times those of typical solar projects and more than twice the energy ROI of wind alternatives.

Praxair's business model frequently provides environmental and energy savings to customers and the planet. Applications improve the energy efficiency of industrial processes from cement production to steelmaking, and are components of several clean and/or renewable energy solutions such as solar panels. Praxair is a major industrial gas supplier to the polysilicon market, and currently serves more than 50 photovoltaic manufacturing facilities worldwide. Industrial gases are crucial ingredients in second generation biofuels such as jet fuel produced from non-food animal fat. Praxair is an eager participant in innovating and building the marketplace in clean and renewable energy, which is an important business driver for Praxair.

As a large energy user, Praxair receives interest from investors and the sustainability community concerning our investment in renewable energy sources. Several companies, our competitors among them, are investing in wind and solar energy sources. Praxair actively and frequently considers proposals for these investments, but requires that these projects meet our normal investment hurdle rates.

A comparative energy ROI study was conducted between Praxair's own investments in improving the energy efficiency of our plants and a range of alternatives for sourcing renewable energy. Energy efficiency is the best investment we can make to reduce our global energy footprint and reduce natural resource consumption. **Praxair's energy efficiency program returns are 10 times those of typical solar projects and more than twice the energy ROI of wind alternatives.**

- For each $1,000 invested, Praxair's energy efficiency program reduced power demand by 0.46 kW. By contrast, each $1000 invested in solar PV provided 0.043 kW of power.

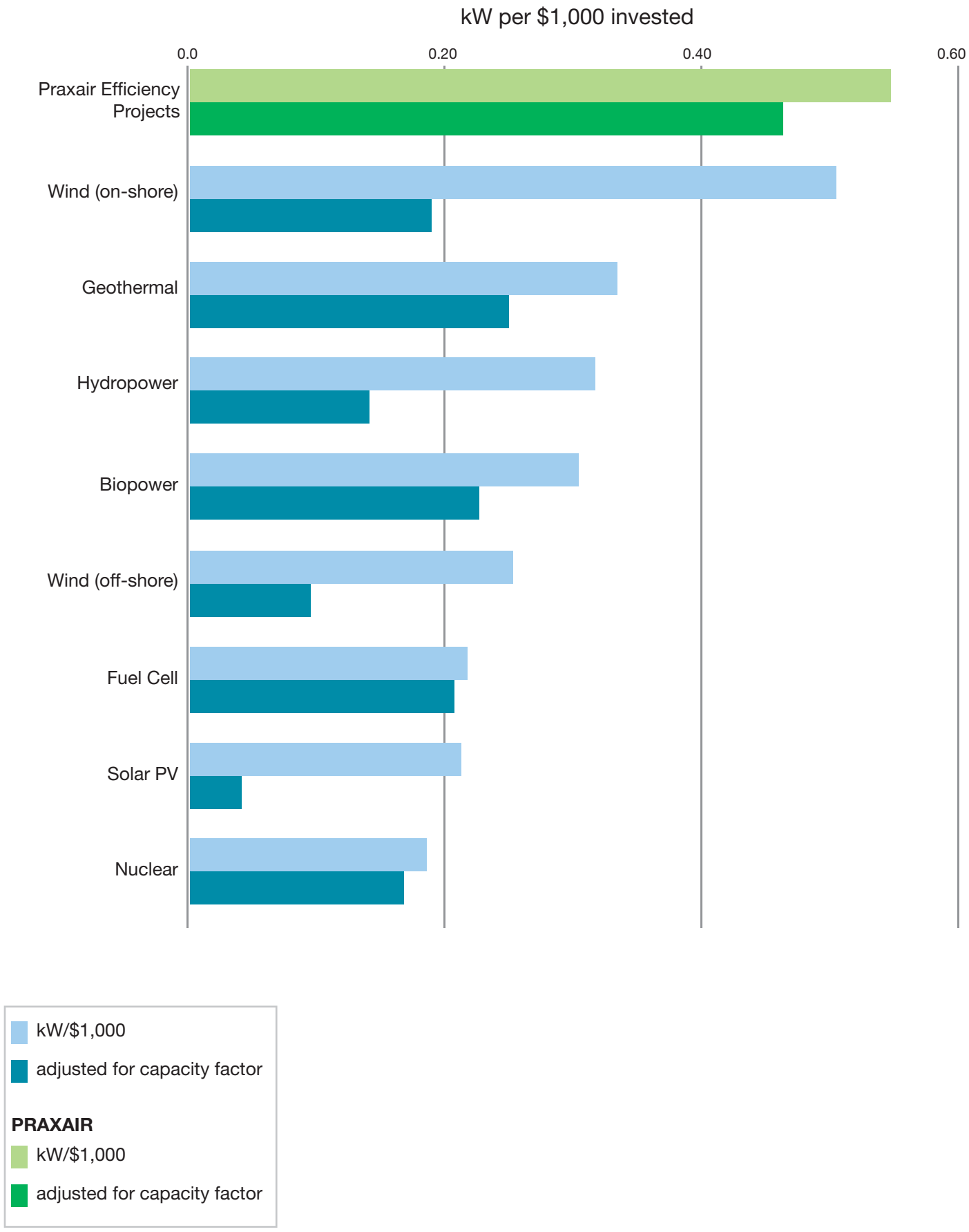
- Many renewable energy solutions depend on the wind or sun and run at much less than full capacity. On the other hand, Praxair's energy efficiency investments provide benefits almost 100% of the time. In terms of energy saved or produced, Praxair's energy efficiency program is 10 times more effective than solar, when adjusted for capacity factors (three times more when unadjusted).

- Energy efficiency projects reduce greenhouse gas emissions while not contributing to other negative key environmental and resource impacts such as eco-toxicity, land occupation and consumption of iron, cement, copper and aluminum. Wind and solar energy have significant impacts in these areas. www.pnas.org/cgi/doi/10.1073/pnas.1312753111

- Energy efficiency is consistent with Praxair's ongoing business model and value proposition.

  In addition, Praxair energy efficiency investments have proven benefits: Praxair has demonstrated the ability to manage costs and schedules to a very tight tolerance. In 2014, our engineering team delivered more than a dozen new major projects around the world within one percent of budget and three percent of schedule. Praxair's energy efficiency is recognized as beneficial by the public, environmental groups and government agencies.

Praxair energy efficiency: 10X the energy return vs a solar investment



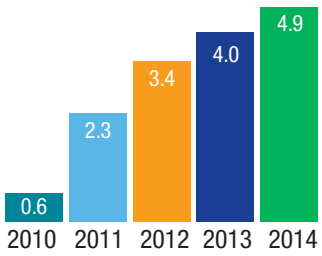
Five Project Energy Efficiency Examples:

1. Operations: Continuous Improvement in Energy and GHG Intensity

Praxair invests continuously in improving the operational energy and Greenhouse gas (GHG) intensity of our products. In 2009 Praxair established corporate targets for all the material energy and GHG intensive aspects of our business: Air Separation Unit (ASU) energy and GHG Efficiency, Hydrogen facilities (HyCO) GHG efficiency, and trucking GHG efficiency. Praxair annual energy efficiency savings since then have exceeded 400,000 MT CO2e.

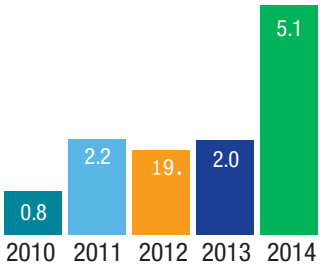
ASU Energy Emissions Intensity

% improvement per unit of product



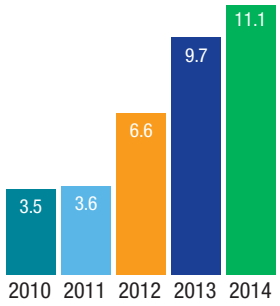
H2 GHG Emissions Intensity (9)

% improvement per unit of product



Sustainable Transportation

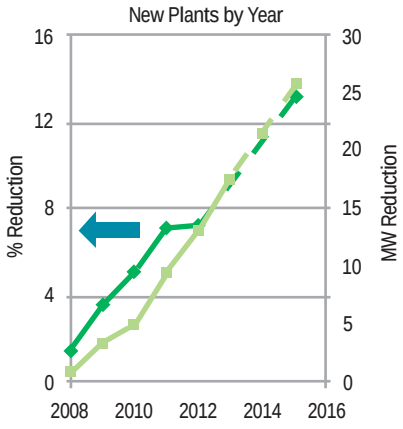
Transport GHG emissions intensity:
% improvement per unit of product



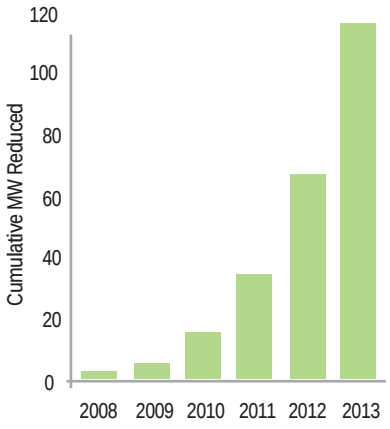
2. New Plant Design: Continuous Reduction in Power Use

Annual power reduction is designed into new plants each year which improves the energy intensity of products manufactured in those plants. Praxair energy efficiency in design reduces the energy cost per unit of product, more than 1% each year.

Annual Power Reduction



Power Avoided

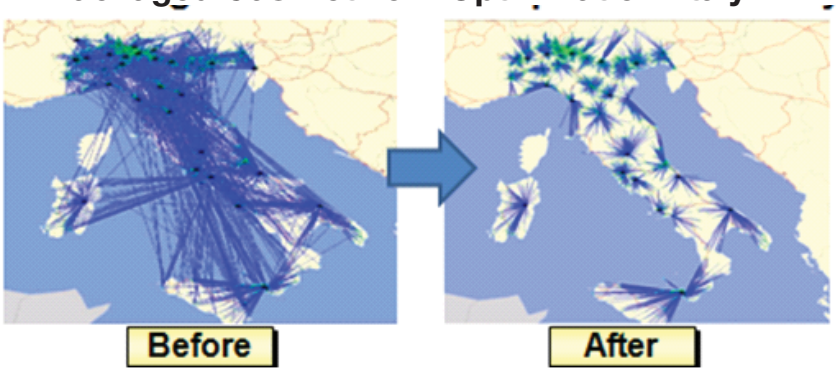


3. Logistics: Systematic Optimization for Fuel Efficiency

Praxair and contractor trucks drive 250 million miles a year, equivalent to 27 times around the earth each day. Praxair strategies here include route network optimization and Fleet Asset Efficiency. Tactics include production planning and predictive vehicle maintenance; and operations are managed with prudent trip scheduling and investments in driver education.

In one project in Italy, Praxair saved 14% in distribution costs and reduced 1.5 million km driven for an annual reduction of 1,750 MT/yr CO2, equivalent to electricity used by 200 homes in the USA.

Packaged Gas Network Optimization: Italy



4. Operations: Turbine Machinery Upgrades to Reduce Energy Use

Praxair designed and tested a new liquefier turbine/booster unit to provide at least 150 kWh power savings per installation. The pilot project at Inver Grove, MN (USA) had an Investment of approx. $100K and resulted in > 2 MM kWh energy avoided per year; i.e. KW demand reduced per $1000 invested was > 2 kW. Project full year savings or energy demand reduced > 1200 MT CO2e: equivalent to annual CO2e emissions from the electricity use of 170 homes in the USA.

As this equipment is used in multiple global operating plants, the development cost can be spread over the entire fleet. This helps to drive down the payback periods for individual projects, and improve the energy savings overall.

5. Operations: Recycle Compressor Upgrades to Optimize Energy Efficiency

In Hatfield, PA (USA) Praxair invested to upgrade a Nitrogen recycle compressor to improve efficiency. The upgrade included the aerodynamic redesign of impellers; an upgrade of mechanical seals to reduce losses; and the replacement of other compressor and gearbox internals. For an investment of less than $1MM, the project resulted in > 3 MM kWh energy avoided.

Project full year savings resulted in > 0.5 KW demand reduction per $1000 invested or 2,000MT CO2e avoided per year, equivalent to annual CO2e emissions from the electricity use of 260 homes in the USA.

Reference: http://www.nrel.gov/analysis/tech_cap_factor.html

A Global Leader

Praxair is one of the largest industrial gases companies in the world, and the largest in North and South America. We operate in more than 50 countries and serve one million customers in a wide variety of industries including: energy, manufacturing, chemicals, metal production, and healthcare. To learn more about Praxair's gas supply expertise, call us at 1-800-PRAXAIR or visit our website at www.praxair.com.

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