Energy Impact Calculator w1.0
Mid-Western Health System Case Study
Executive Summary

www.eichealth.org
eicinfo@practicegreenhealth.org

The not-for-profit Practice Greenhealth operates the Healthcare Clean Energy Exchange. One of its tools is an EPA based, peer-reviewed **Energy Impact Calculator**, which we used in order to get a sense of some of the issues we now consider in business decisions on energy efficiency projects and/or energy purchases.

Our facilities currently use a total of 29,488,474 kWh per year. Because of the fuel mix in our electricity grid region, under our old purchasing practices, our electricity use was responsible for the following annual emissions*:

	Annual Quantity	Generator's Costs for the Right to Emit Pollutants	
SO2 (Tons):	111.4	$61,000	per year
NOx (Tons):	26.7	$78,800	per year
CO2 (Tons):	22,891.9	$732,500	EU pricing
Carbon (Metric Tonnes	5,663.8	N/A	
Mercury (lbs):	1.0738	$69,800	per Year
		$942,100	

There are costs and health impacts resulting from these emissions. According to peer-reviewed EPA data, these emissions result in the following estimated direct health incidents and costs per year, as well as certain external costs paid by our communities, and society as a whole, the value placed on gaining an outcome viewed as desirable, e.g. avoided illness or avoided premature death:

	Number of Incidents/Year	Societal Value/EPA	Direct Medical & Other Costs	
Premature Mortality	0.35	$2,363,784	$105,684	per year
Chronic Bronchitis	0.22	$105,632	$27,232	per year
Hospital + ER Visits	0.32	$4,276	$3,386	per year
Asthma Attacks	7.18	$423	$423	per year
Respiratory Symptoms	342.2	$12,558	$12,558	per year
Work Loss Days	63.2	$11,486	$10,724	per year
Mercury Related Health Impact	NA	$151,541	$151,541	per year
Total Value/Cost (in 2008)		$2,649,701	$311,549	per year
Value of Unintended Societal & Direct Health Impacts per kWh		$ 0.08986	$ 0.01057	

The above list is conservative with respect to both health impacts and costs. Two examples:

A) Not included are significant power plant-related particulate emission health impacts and costs which simply could not be calculated with sufficient accuracy to be included, yet which are recognized clinically, such as non-fatal heart attacks, chronic lung disease (not incl. asthma), pneumonia, various cardiovascular illnesses, respiratory ailments not requiring hospitalization, acute bronchitis, lower respiratory symptoms, upper resp. symptoms, and lung cancer mortality.

B) "Work Loss Day" costs and other dollar amounts do not include the value of illness-attributable activity limitations, pain and discomfort, and quality of life effects.

Embedded in the price we pay is the electricity generator's "Costs for the Right to Emit Pollutants" which turns out to be $942,100 or $0.03/kWh. This figure includes a conservative price for CO2 emissions of $32/ton, which cost will likely apply to our next electricity purchase.

However, our recent HCEE-led energy auction enabled us to purchase 5% clean energy, 4,423,271 kWh over 3 years at no additional cost, which reduces the above impacts and saves:

	Annual Quantity	Generator's Costs for the Right to Emit Pollutants	
SO2 (Tons):	16.7	$9,200	per year
NOx (Tons):	4.0	$11,800	per year
CO2 (Tons):	3,433.8	$109,900	per year EU valuation
Carbon (Metric Tonnes	849.6	N/A	
Mercury (lbs):	0.1611	$10,500	per Year

	Number of Incidents/Year	Societal Value/EPA	Direct Medical & Other Costs	
Premature Mortality	0.05	$354,563	$15,803	per year
Chronic Bronchitis	0.03	$15,909	$4,092	per year
Hospital + ER Visits	0.05	$691	$564	per year
Asthma Attacks	1.08	$0	$0	per year
Respiratory Symptoms	51.3	$1,834	$1,834	per year
Work Loss Days	9.5	$1,679	$1,552	per year
Mercury Related Health Impact	NA	$22,717	$22,717	per year
Total Value/Cost (in 2008)		$397,394	$46,563	per year
Value of Unintended Societal & Direct Health Impacts per kWh		$ 0.08984	$ 0.01053	

We even improved on our current price, locking in $0.07562 for three years. In summation, our future savings on investments in energy efficiency projects and purchase of clean electricity products should factor in the savings of $0.01053/kWh in avoided energy-related health costs, and $0.08984/kWh in avoided external costs born by our facilities and our communities. In addition, we can also take advantage of associated benefits with respect to:

- Recent IRS Form 990 changes in community benefits
- Increased institutional transparency

- Community reputation, public education and outreach
- Competitive positioning
- Senior management and trustee fiduciary responsibility/liability
- Climate change risk.

For more information on the Energy Impact Calculator:

www.eichealth.org
eicinfo@practicegreenhealth.org

To explore buying your healthcare facility's energy through the Healthcare Clean Energy Exchange, contact:

Nicholas DeDominicis
Practice Greenhealth
Director, Healthcare Clean Energy Exchange
(860)395-5333
dedomn@practicegreenhealth.org

*The figures above are estimates based on best-available, peer reviewed national and regional data. Your actual numbers and values may vary. Practice Greenhealth is not responsible for decisions or actions based on the above.

See pp 4-9 below for selected EIC Data Sources, Health Information and FAQ

Selected EIC Data Sources, Health Information and FAQ

Data Sources

Incidence Factors
From an EPA internal memo from Bryan Hubbell to Sam Napolitano, 'Estimated NOx, SO2, and PM Emissions Health Damages for Heavy Duty Vehicle Emissions,' July 2, 2001.

Value of Incidents
From EPA Briefing Materials vis a vis the Clean Air Interstate Rule (CAIR), released October 2005. The briefing materials and background spreadsheets included tables of health impact incidence and valuation. The spreadsheets which were used in these calculations are no longer available on the EPA web site. The values given in the EPA report are in 1999 dollars. We have adjusted these to 2008 dollars using US Bureau of Labor Statistics price indices. While the specific spreadsheets used to calculate the values are no longer available, similar results are shown in EPA's March 2005 document, "Regulatory Impact Analysis for the Final Clean Air Interstate Rule," EPA-452/R-05-002 in Chapter 4. Similar values are also given in the Hubbell memo referenced above.

Cost of Incidents
From a memo from Lauraine Chestnut and David Mills of Stratus Consulting Inc. to Conrad Schneider "Cost of Illness of PM Health Effects," September 9, 2003. These costs represent the direct and indirect costs, but not the value. For example, in the case of mortality, it would include the medical and hospital costs, but not any value for the loss of life. The Particulate-Related Health Benefits of Reducing Power Plant Emissions," Abt Associates, Kenneth Davidson et al (10/2000)

SO2 and NOx Allowance Costs (cost for the right to emit SO2 and NOx)
From "Argus Air Daily", 3/27/2008

CO2 Allowance Costs (cost for the right to emit CO2)
From "Point Carbon", 3/27/2008 (www.pointcarbon.com).

- European Union CO2 Allowance Price = 22.45 euros per metric tonne CO2e
- One euro = $1.578 (on 3/27/2008)
- One metric tonne = 1,000 kilograms = 1.1023 US Tons

We have rounded the cost to $32 per US Ton. We discuss elsewhere why we have chosen to use the European value.

Mercury Allowance Costs (costs for the right to emit mercury)
Mercury allowance costs are based on the cost of removing mercury. The cost of mercury removal varies depending on the type of plant, coal, and other equipment in use. However, various studies tend to show the cost of removal as roughly $0.0025 to $0.0035 per kWh at the controlled plants for 90% removal. The AEO-2007 supplemental tables show 102,500 pounds of mercury from power plants in 2005. 90% removal would mean removing 92,250 pounds. These tables also show that coal-fired generation is responsible for 1,993.53 million MWH of generation in 2005. At an average mercury removal cost of $0.0030 per kWh, the cost of removal is $5.978 billion per year. Dividing by the 92,250 pounds removed gives a cost of removal of $64,978 per pound. We have rounded this to $65,000 per pound, or $130 million per ton. The main study relied on was the EPA's "Control of Mercury Emissions from Coal-Fired Boilers," EPA-600/R-01-109, April 2002.

There is some evidence that the control of SO2 and NOx emissions will lead to significant reductions in mercury emissions at little or no additional cost. Since SO2 and NOx removal will be required as part of the

EPA's Clean Air Interstate Rule, the cost of mercury reduction may turn out to be significantly less than we have calculated here. We have not factored this possibility into our calculations.

Mercury Impact Costs
The health impact costs from mercury are based on "Economic Valuation of Human Health Benefits of Controlling Mercury Emissions from U.S. Coal-Fired Power Plants," Rice and Hammitt, Harvard Center for Risk Analysis, February 2005, prepared for the Northeast States for Coordinated Air Use Management.

Health Info

Pollutant Permit Costs
Pollutant Permit Costs are the costs generators pay to purchase the right to emit pollutants on the open market. This right to emit is called an "emission allowance." There are currently national caps on the right to emit SO2 and NOx, resulting in an existing market in the right to emit for these pollutants. A market for the right to emit mercury may emerge in the near future, but would likely have to address the concern that 'hot spots' with high concentrations of mercury might persist if individual plants could avoid installing controls by buying credits. We expect to see a market for the right to emit CO2 in the future (see Health Info on CO2). We have not totaled the right to emit since it would be a mix of costs currently paid and those that are not. To total them would be misleading. Costs for the right to emit SO2 and NOx are currently embedded in electric rates, either as the cost to purchase that right, or as foregone revenue which could have been collected if zero-cost rights to emit owned by the plant operators had been sold.

Sulphur dioxide, SO2
Sulphur dioxide is a common component of power plant emissions, amongst other sources. "High concentrations of SO2 [has] effects on breathing, respiratory illness, alterations in pulmonary defenses, and aggravation of existing cardiovascular disease. Major subgroups of the population that are most sensitive to SO2 include asthmatics and individuals with cardiovascular disease or chronic lung disease (such as bronchitis or emphysema) as well as children and the elderly... Emissions of SO2 also can damage the foliage of trees and agricultural crops. Together, SO2 and NOX are the major precursors to acid rain." From: (see next page) http://www.epa.gov/Region7/programs/artd/air/quality/health.htm High concentrations of SO2 may cause wheezing, chest tightness, and shortness of breath even among those without asthma.

Nitrous oxide, NOx
"Nitrous oxide is a common component of power plant emissions, amongst other sources. "NOx causes a wide variety of health and environmental impacts because of various compounds and derivatives in the family of nitrogen oxides, including nitrogen dioxide, nitric acid, nitrous oxide, nitrates, and nitric oxide. [These include:]

Ground-level Ozone (Smog) - is formed when NOx and volatile organic compounds (VOCs) react in the presence of sunlight. Children, people with lung diseases such as asthma, and people who work or exercise outside are susceptible to adverse effects such as damage to lung tissue and reduction in lung function. Ozone can be transported by wind currents and cause health impacts far from original sources. Millions of Americans live in areas that do not meet the health standards for ozone. Other impacts from ozone include damaged vegetation and reduced crop yields

Acid Rain - NOx and sulfur dioxide react with other substances in the air to form acids which fall to earth as rain, fog, snow or dry particles. Some may be carried by wind for hundreds of miles. Acid rain damages; causes deterioration of cars, buildings and historical monuments; and causes lakes and streams to become acidic and unsuitable for many fish.

Particles - NOx reacts with ammonia, moisture, and other compounds to form nitric acid and related particles. Human health concerns include effects on breathing and the respiratory system, damage to lung tissue, and premature death. Small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease such as emphysema and bronchitis, and aggravate existing heart disease.

Quality Deterioration - Increased nitrogen loading in water bodies, particularly coastal estuaries, upsets the chemical balance of nutrients used by aquatic plants and animals. Additional nitrogen accelerates "eutrophication," which leads to oxygen depletion and reduces fish and shellfish populations. NOx emissions in the air are one of the largest sources of nitrogen pollution in the Chesapeake Bay.

Climate Change - One member of the NOx, nitrous oxide or N2O, is a greenhouse gas. It accumulates in the atmosphere with other greenhouse gasses causing a gradual rise in the earth's temperature. This will lead to increased risks to human health, a rise in the sea level, and other adverse changes to plant and animal habitat.

Toxic Chemicals - In the air, NOx reacts readily with common organic chemicals and even ozone, to form a wide variety of toxic products, some of which may cause biological mutations. Examples of these chemicals include the nitrate radical, nitroarenes, and nitrosamines.

Visibility Impairment - Nitrate particles and nitrogen dioxide can block the transmission of light, reducing visibility in urban areas and on a regional scale in our national parks."

Carbon dioxide, CO2

Carbon dioxide is produced by burning of fossil fuels, and is the primary greenhouse gas driving climate change. "Concentrations in the atmosphere have historically varied as a result of many natural processes (e.g. volcanic activity, changes in temperature, etc). However, since the Industrial Revolution humans have added a significant amount of greenhouse gases in the atmosphere by burning fossil fuels, cutting down forests and other activities.

Carbon dioxide concentrations in the atmosphere increased from approximately 280 parts per million (ppm) in pre-industrial times to 382 ppm in 2006 according to the National Oceanic and Atmospheric Administration's (NOAA) Earth Systems Research Laboratory, a 36 percent increase. Almost all of the increase is due to human activities (IPCC, 2007). The current rate of increase in CO2 concentrations is about 1.9 ppmv/year. Present CO2 concentrations are higher than any time in at least the last 650,000 years (IPCC, 2007)." From: http://www.epa.gov/climatechange/science/recentac.html

The U.S. currently does not regulate CO2, and there is no price on the right to emit. However, there is a great deal of discussion currently underway at both the national and state level on regulating CO2 emissions, and it is very likely that, in the reasonably near future, there will be such regulations. When/if there are CO2 regulations, there will be a price on the right to emit. As a proxy for what that price might be, we have used an average price from the European CO2 market.

There are currently CO2 emission regulations applicable to the Northeastern and some Mid-Atlantic states. In those states there is a price on the right to emit CO2. However, it would be inappropriate to apply that price to other regions. In order to make the results from one region comparable to another region, we have chosen not to use the Northeast/Mid-Atlantic market price for that region, since to do so would mean the appropriate price for other regions would be zero, and we do not want to use a zero price for CO2.

The carbon emissions are given in metric tonnes because much of the discussion of carbon in world discourse at this time utilizes metric tonnes of carbon as the unit of measurement. One metric tonne equals 1,000 kilograms equals 2,204.6 pounds, or 1.1023 U.S. tons.

Mercury, Hg
Combustion of coal is one of the largest sources of mercury pollution. Mercury is a known neurotoxin, and the US EPA has labeled inorganic mercury and methyl mercury "possible human carcinogens" due to their ability to increase the occurrence of tumors in laboratory animals. The primary exposure for Americans occurs when mercury falls to the earth and runs into our lakes, rivers, and streams and contaminates the fish. Humans can be contaminated when they eat these fish and shellfish.

Mercury is a developmental toxin, primarily affecting fetal development. In unborn children, it can cause brain damage, mental retardation, blindness, and many other problems. Infants are also exposed to these dangers through contaminated breast milk. Impacts on cognitive thinking, memory, attention, language, and fine motor and visual spatial skills have been seen in children exposed to methylmercury in the womb. In addition to the subtle impairments noted above, symptoms of methylmercury poisoning may include; impairment of the peripheral vision; disturbances in sensations ("pins and needles" feelings, usually in the hands, feet, and around the mouth); lack of coordination of movements; impairment of speech, hearing, walking; and muscle weakness. While the dangers of mercury are most often associated with women and children, eating fish high in mercury has also been found to put middle-aged men at a greater risk for coronary heart disease.

From: http://www.sierraclub.org/cleanair/factsheets/power.asp and http://www.epa.gov/mercury/effects.htm

Societal Value
In general, the societal value is based on EPA's analysis of society's 'willingness to pay' (WTP) to avoid each incident of each particular health impact, including the Direct Medical & Other Costs. This is the primary value which EPA uses in its own cost-benefit analysis. However, see 'Mercury' in the section on Pollutants and 'Mercury Related Health Impacts'. Costs are in 2008 dollars, adjusted from the original sources which provided cost estimates in 1999 dollars, using price indices from the Bureau of Labor Statistics.

Direct Medical Costs
The cost per incident is the direct cost of that incident (for example, for medical expenses, lost wages and the like), and does not included any additional value for the societal impact. Costs are in 2008 dollars, adjusted from the original sources which provided cost estimates in 1999 dollars, using price indices from the Bureau of Labor Statistics.

Not included are significant power plant-related particulate emission health impacts and costs which simply could not be calculated with sufficient accuracy to be included, yet which are recognized clinically and scientifically, such as non-fatal heart attacks, loss of quality of life, social problems (e.g. environmentally aggravated learning disabilities), economic losses due to loss of biodiversity, etc.

Premature Death
The cost per incident when applied to premature mortality would include the medical costs related to premature mortality, but not the value which society puts on the loss of life. This is discussed further under "Data Sources."

Chronic Bronchitis
Chronic Bronchitis is defined clinically as a daily cough with production of sputum for 3 months, two years in a row.

In chronic bronchitis, there is inflammation and swelling of the lining of the airways that lead to narrowing and obstruction of the airways. The inflammation stimulates production of mucous (sputum), which can cause

further obstruction of the airways. Obstruction of the airways, especially with mucus, increases the likelihood of bacterial lung infections.

Hospital + ER Visits
Hospital + ER Visits include admissions for chronic obstructive pulmonary disease, pneumonia, asthma, cardiovascular and Asthma-Related ER Visits.

Asthma Attacks
"Asthma is a chronic condition with two main components: constriction, the tightening of the muscles surrounding the airways, and inflammation, the swelling and irritation of the airways. Constriction and inflammation cause narrowing of the airways, which may result in symptoms such as wheezing, coughing, chest tightness, or shortness of breath. Furthermore, there is increasing evidence that, if left untreated, asthma can cause long-term loss of lung function."

Paraphrased from http://www.healthcaresouth.com/pages/asthmadef.htm
Respiratory Symptoms
This includes upper respiratory (throat, sinus, larynx, trachea) and lower respiratory symptoms (related to the lungs, trachea, and bronchi, including cough, phlegm, chest pain on deep inhalation, and wheeze), and minor restricted activity days (not including asthma attacks).

Work Loss Days
Work Loss Day uses a very conservative national average of $141 per incident per year. This cost and other dollar amounts do not include the value of illness-attributable activity limitations, pain and discomfort, and quality of life effects.

Mercury Related Health Impact
See also the notes under mercury emissions, above. The value and cost of mercury-related health impacts are not EPA values, but rather come from a 2005 study prepared by the interstate-state group North East States for Coordinated Air Use Management (NESCAUM) and Harvard University. We are not aware of studies linking Hg emissions to particular health incidence rates. It would be illuminating to have comparisons between Hg emissions from power generation, and the mercury health care facilities have and use in their lighting, electrical controls, and --decreasingly-- in medical equipment and supplies. for information on mercury elimination, go to http://www.noharm.org/us/mercury/issue.

Total Value/Cost
The life enhancing benefits of energy use are widely acknowledged. However, the social, human health, and environmental impacts of energy production from coal, natural gas, and oil begin with exploration and continue through extraction of the raw material from the earth, fuel processing, transportation, storage, burning, emissions products of combustion, and waste disposal.

Depending on the fuel, there are typically human health problems (and reductions in the capacity of the living systems upon which all life depend) that vary with:

- local and regional geography;
- methods of extraction;
- processing; and
- transportation system, etc.

These problems include occupational illness and injury, soil erosion, habitat loss, widespread pollution of rivers and streams, air pollution, climate change, water over-use, and resource conflicts. Moreover, in many cases, those who most directly bear these burdens are ethnic minorities and/or people living in disadvantaged socio-economic circumstances.

The health impacts monetized in this calculator are strictly limited to those that are directly attributable to emissions at the time the fuel is burned. Because of uncertainties and data gaps, wide variability and the complexity of full life cycle analysis, no attempt has been made here to included the impacts mentioned above, even though those impacts may well be far greater than those estimated here. We look forward to the days when such impacts are included in business decisions in rigorous and consistent ways, leading to a much cleaner and more equitable energy sector.

FAQs

What is this based on? What is the quality of the data?
The Energy Impact Calculator (EIC) is based on US government data and arranged by power grid regions. The US EPA and the Department of Energy record the fuels used, amounts and emissions profiles of "stationary sources," e.g. power plants, across the country. The EPA also reviews medical literature and conducts its own documentation of the health impacts of these emissions, with a special emphasis on mercury and respiratory impacts. It uses this information for various cost-benefit analyses, such as those used in establishing the Clean Air Interstate Rule (CAIR), national legislation which sets limits on pollution from such sources.
The CAIR's development and promulgation is very closely scrutinized by industry and environmental health organizations such as the American lung Association, and so uses very conservative numbers for the impacts and costs.

What does "EPA peer reviewed data" mean?
The data must be from peer-reviewed medical and scientific journals, then reviewed and approved by the EPA's own internal experts.

What is the basis of the EIC's cost projections?
The US EPA conducted cost analyses in developing the 2005 Clean Air Interstate Rule (CAIR), which were summarized in public briefings following CAIR becoming law under the heading, "Annual Monetary Health Benefits of Reducing Fine Particles and Ozone." These include diagnoses, medicines for treatment, and healthcare administration, amongst others. Since these are national averages, your costs may be higher or lower. We encourage EIC users to adjust the values based on their institution's experience.

How is each number calculated?
To get emissions for a given region of the power grid (or "NERC region" which stands for North American Electric Reliability Council) we multiply and pro-rate the user's kWh by that region's power plant emissions in tons per million kWh. For health impacts and costs we then multiply the emission tons by the number of incidents per ton, and the costs per incident.

I've used a different calculator to estimate my CO2. Why are my EIC CO2 numbers different?
There are many different factors used by the dozens of calculators now available. Variations can occur from the use of national emissions averages instead of regional ones; from different numbers for the emissions per ton of fuel, (e.g. CO2 varies by the kind of coal or oil used); from inclusion of emissions from fuel extraction, processing, and distribution, etc.

#END#