Carbon Footprint Analysis

Indiana State University

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1.0 Emission Inventory Details

A greenhouse gas (GHG) emission inventory, often referred to as a carbon footprint, provides a look into the amount of GHG emissions and their origins within the boundaries of an organization's activities. An inventory was calculated for Indiana State University using the processes and procedures outlined for the American Colleges and Universities President's Climate Commitment (ACUPCC) and the associated Clean Air-Cool Planet calculator. Note that all calculation methods are also in accordance with the guidance provided by the internationally acclaimed GHG Protocol developed by the World Resources Institute (WRI). Table 1 provides a summary of total GHG emissions from Indiana State University operations for years 2006 and 2007.

Table 1. Indiana State University Greenhouse Gas Emissions (metric tons CO_2-eq)

Activity	2006	2007
Electricity	72,730	67,804
On Campus Stationary Sources	18,960	19,509
Fleet Fuel	3,049*	3,049
Commuting	4,909*	4,909
Air Travel	2,349*	2,349
Refrigerants	354*	354
Solid Waste	449	92
TOTAL	**102,800**	**98,066**

* Emissions for 2006 for these categories were assumed to be the same as reported for 2007

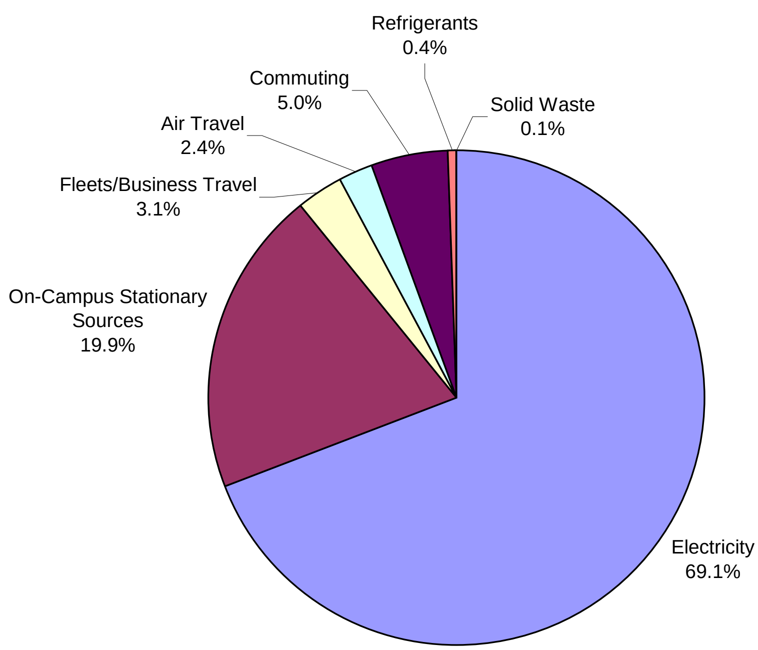
As shown in Figure 1 below, emissions from electricity consumption represent 69 percent of total Indiana State University greenhouse gas emissions for 2007. Combustion of natural gas, fuel oil and propane for building heat contributes nearly 20 percent; fleet fueling, employee commuting, business air travel, refrigerant use, and solid waste disposal make up the remainder of emissions.

2.0 Emissions Breakdown By Category

2.1 Electricity Consumption

Emissions from electricity consumption are often the largest component of a facility's footprint because of the carbon-intensive inputs to electric generation and the inefficient nature of electricity production and transportation. These emissions are called indirect emissions because they do not occur from fuel combustion at the facility, but rather occur remotely as an electric generation facility meets the electricity demand. Emissions were calculated using emission factors representing the power pool average for kilowatt hours consumed in the ECOV (ECAR Ohio Valley) sub-region. This approach is a standard method used by both the World Resources Institute (WRI) in their internationally acclaimed GHG Protocol, and by the U.S. Department of Energy in the recently revised 1605(b) Voluntary Reporting of Greenhouse Gas Emissions Program. This is also a method used by the Clean Air-Cool Planet Campus Carbon Calculator v5.0 (CA-CP), which was utilized to calculate Indiana State University emissions.

Figure 1. 2007 Emissions by Activity at Indiana State University



Using electric grid pool averages rather than site-specific emission rates standardizes calculations with other reporters and can reflect the fact that Indiana State University does not have control of utility choices regarding fuel mix which has a significant impact on greenhouse gas emission rates from electricity consumption. Existing data maintained by the U.S. Department of Energy does a very good job of capturing imports and exports of electricity into and out of each power pool; this is often not the case if individual utility or an imposed boundary such as a state border are used to develop average emission rates per delivered kilowatt hour. Indiana State University may consider re-calculating emissions attributable to electricity demand in the future, particularly if the university begins to contract specifically for purchasing electricity from renewable sources.

2.2 Stationary Fossil Fuel Combustion

Calculation of GHG emissions from natural gas consumption is straightforward. Emission factors are available for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions in the Clean Air-Cool Planet Campus Carbon Calculator v5.0. These emissions factors are multiplied against the annual consumption totals to estimate GHG emission rates. Methane and N_2O emissions are converted to carbon dioxide-equivalents using the Global Warming Potentials from the IPCC's Third Assessment Report (Table 2). Similarly, calculations of GHG emissions from the use of other fuels such as distillate oil and propane are performed using established emission factors.

Table 2. Global Warming Potential of GHG from IPCC Third Assessment

Greenhouse Gas	GWP Relative to CO2
Carbon Dioxide	1
Methane	23
Nitrous Oxide	296
HFCs	12 – 12,000
PFCs	11 – 16,800
Sulfur Hexafluoride	22,200

2.3 Commuting

The energy expended by faculty and staff as they commute to the college contributed nearly 5 percent of the total emissions profile for 2007. To estimate emissions from commuting, Indiana State University provided a list of zip codes for 2,027 faculty and staff. The on-line zip code distance calculator at www.zip-codes.com was used to calculate the distance from the employee home zip code to the University zip code of 47809. This distance was calculated for each employee and totaled. Per this calculation method, the 2,027 Indiana State University employees travel 24,274 miles one way to the campus per day, which is an average of 11.98 miles per person.

Twenty-one employees have home zip codes that are greater than 200 miles from the campus, the greatest of which is 1,859 miles, in Oregon. For our calculations of possible commuting mileage it was assumed that these employees do not commute these great distances daily, but instead stay near campus during the work week. A default value of 5 miles was substituted as the assumed average commute distance for these employees.

Given a lack of detailed information about each driver's habits and vehicle choices, the following assumptions were made: 100% of employees drive their personal vehicle, 100% drive alone, the vehicles are fueled with gasoline; the employees drive 2 trips per day, 250 days per year, 11.98 miles per trip. A standard fuel mileage assumption of 23 miles-per-gallon was employed to convert the miles traveled into a fuel consumption number. Emission factors based on fuel carbon content were then used to estimate emissions. This results in 12,141,730 miles traveled per year or 549,400 gallons of fuel used per year, for total emissions of 4,909 metric tons of carbon dioxide-equivalent from commuting, or 5 percent of total GHG emissions for 2007. It was assumed that emissions from commuting were the same for 2006 as were calculated using 2007 data. Although this assumption will introduce some error we believe that the year-to-year variation in commuting will be relatively small.

2.4 Vehicle Fleets

Emissions from operation of Indiana State University vehicles were determined from mileage statistics reported in the Department of Facilities Management Annual Report for FY 2006-2007. We employed the standard assumption for vehicle fuel efficiency of 23 miles per gallon, taken from the WRI GHG Protocol CO2-mobile.xls spreadsheet for midsize gasoline vehicles. Total fuel consumption was estimated to be 41,995 gallons of gasoline burned during 2007. No data are available on the types of vehicles driven or the fuel types (gasoline, E10, E85 and diesel) purchased, so it was assumed that all gallons were gasoline in the CA-CP Campus Carbon Calculator. Standard emission factors were employed from the GREET Model 1.5a by the US Department of Energy. Combined with business travel, motor vehicle travel led to emission of 3,049 metric tons of CO_2-eq or 3.1 percent of total GHG emissions for 2007.

2.5 Business Travel

Emissions from vehicles used off-campus for University business were determined from mileage obtained from National Car Rental and personal vehicle mileage for reimbursed business travel provided by Indiana State University. Travel totaling 6,882,243 miles was recorded for Indiana State University business in 2007; 41,803 of those miles from the rental cars. We again employed the standard assumption for vehicle fuel efficiency of 23 miles per gallon. The 23 mpg value was taken from the WRI GHG Protocol CO2-mobile.xls spreadsheet for midsize gasoline vehicles, and was used to estimate that a total of 229,228 gallons of gasoline were burned during 2007. No data are available on the types of vehicles driven or the fuel types (gasoline, E10, E85 and diesel) purchased, so it was assumed that all gallons were gasoline in the CA-CP Campus Carbon Calculator. Standard emission factors were employed from the GREET Model 1.5a by the US Department of Energy.

2.6 Air Travel

It is estimated that Indiana State University staff, students, and faculty traveled more than 3,000,000 miles by air in 2007. These figures were estimated from University travel records. CA-CP provides estimates of the average energy required per passenger mile, 3,940 Btu per mile. Standard emission factors for CO_2, methane and N_2O are then applied to the total energy required for the air miles traveled. This results in an estimate of 2,349 metric tons of CO_2-eq, representing about 2.4 percent of total Indiana State University emissions.

2.7 Solid Waste

Indiana State University provided the number of compacted loads of trash transferred to the landfill each year through 1990. For the years 1994-1999 and 1999-2004, a 5-year average number of loads per year was provided so the same number of loads was used for each year in these two 5-year periods. One load is 16 cubic yards of waste and an average cubic yard of waste was assumed to weigh 12,800 pounds. The solid waste is transferred to the landfill operated by Victory Environmental, Inc. in Terre Haute, Indiana. Indiana State University has significantly reduced the amount of waste sent to the landfill. The 358 tons sent to landfill in 2007 represent only 15 percent of the tonnage sent to landfill in 1990.

Landfill waste sent to the landfill for calendar years 1990 – 2006 was added to the CA-CP Campus Carbon Calculator as ‘Landfilled Waste with No Methane Recovery.’ This means that any methane or carbon dioxide generated by the decay of the wastes would be emitted to the atmosphere. Victory Environmental started capturing and flaring the methane gas produced by the landfill in 2006, thus the total waste sent to the landfill for 2007 was included as ‘Landfilled Waste with Methane Recovery and Flaring.’ Starting January 2008, Boral Brick company will use the methane gas from the landfill as a partial power source for their brick facility. Solid waste sent to the landfill for 2008 will be added as ‘Landfilled Waste with Methane Recovery and Electric Generation.’ This means that the solid waste generated by Indiana State University will result in lower emissions in future years because the destruction of landfill methane via combustion reduces the global warming impact since methane is a much more potent greenhouse gas than carbon dioxide.

The emission factors in the CA-CP Campus Carbon Calculator include the emissions associated with transporting the waste to the landfill using a default distance assumption of 20 miles. This default results in slightly higher emissions contributions from the waste transportation since the distance traveled from Indiana State University to the landfill is 14 miles.

2.8 Refrigerants

Refrigerants are routinely used in small quantities to fill coolant systems that have leaked. These materials often have high Global Warming Potentials per unit and extremely long lifetimes in the environment, so they are potent greenhouse gases. Emission estimates are constructed by looking at the amount of each refrigerant purchased during the year. Indiana State University purchased 990 pounds of refrigerant in 2007, but had not used 390 pounds of that purchased by the end of the year. A total of 600 pounds of refrigerant use was included in the CA-CP Campus Carbon Calculator for 2007. It was assumed that all refrigerant was HFC-134a, the most common refrigerant, because no data on the type of refrigerant purchased was provided.

2.9 Land Use Impacts

Indiana State University owns several tracts of land that are off of the main campus. These parcels contain a variety of vegetation that may be sequestering small amounts of carbon through the photosynthesis process. Table 3 summarizes the parcels and the respective vegetation.

Table 3. Summary of Off-Campus Land Use

Parcel	Acreage	Description
Brazil Field Campus	72	60% wooded, 15% open land
Kiewig Property	40	35 acres heavily wooded, old growth
River Campus	76	open land in floodplain
Little Bluestem Prairie	8.5	sand prairie, small trees, shrubs
Landsbaum Woods	unk	mixed hardwood forest, some grasses
Pseudacris Pond	28.4	undisturbed, brushy field and pond
WISU Tower	7	unknown

Forest lands sequester carbon by fixing carbon into woody biomass, root systems, understory, and soils. The amount of sequestration varies among forest types, levels of forest management, and soil types; however, the amounts typically would not exceed 10 metric tons of CO_2-eq per acre per year. Prairie lands also sequester carbon, particularly in soils, and can reach storage rates of 1 – 3 metric tons of CO_2-eq per acre per year when managed intensively. In the case of these lands owned by Indiana State University, we would expect only modest carbon storage rates and with the relatively small acreage involved, total sequestration would likely be inconsequential to the overall net carbon footprint.

3.0 Historical Emissions Profile

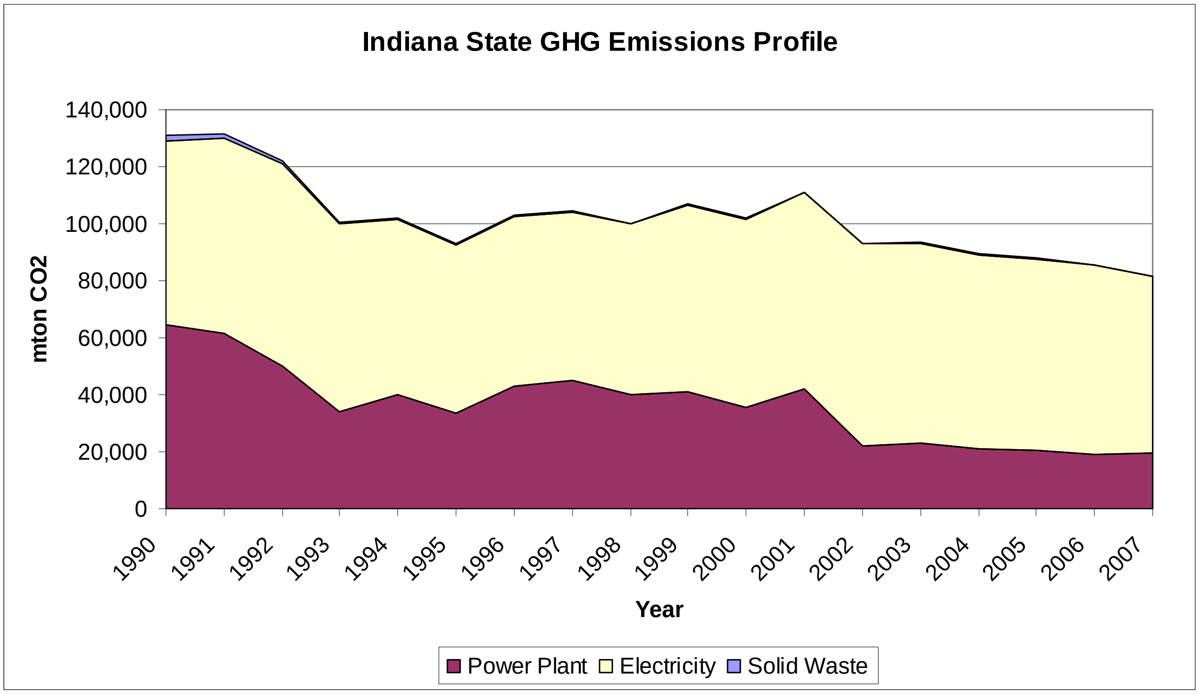
Our study also looked at historical GHG emissions from Indiana State University. A lengthy history is only available for emissions from the categories of electricity use, on-campus stationary sources and solid waste; their historical emissions are summarized in Table 4 and illustrated in Figure 2 below.

Table 4. Historical GHG Emissions from Indiana State University (metric tons CO_2)

Year	Electricity	On-Campus Stationary Sources	Solid Waste	TOTAL
1990	70,308	65,168	2,344	137,820
1991	75,208	61,727	1,780	138,715
1992	77,534	50,364	995	128,893
1993	72,428	34,065	678	107,171
1994	67,170	40,385	380	107,935
1995	64,723	33,780	291	98,794
1996	65,412	43,109	291	108,812
1997	64,807	45,187	291	110,285
1998	65,733	40,129	291	106,153
1999	71,996	41,303	291	113,590
2000	71,993	35,919	386	108,298
2001	75,446	42,210	386	118,042
2002	77,759	21,870	386	100,015
2003	76,835	22,937	386	100,158
2004	74,287	21,309	386	95,982
2005	73,202	20,780	481	94,463
2006	72,730	18,960	449	92,139
2007	67,804	19,509	92	87,405

Emissions from the power plant were reduced by 70% over the time period from 1990 – 2008, from 65,168 metric tons CO_2 to 19,509 metric tons CO_2. This change occurred due to a shift from coal to natural gas firing for the steam plant, and through efforts to reduce demand in University buildings. Electricity use showed a decrease of 3.6% over the same time period, and overall emissions from the power plant and electricity decreased 35.5%. Emissions from decay of solid waste materials deposited in the landfill also decreased substantially due to the University's efforts at reduced the waste streams. Waste tonnage in 2007 was only 15 percent of the waste deposited in 1990. Emissions from the landfill will also be reduced into the future because the landfill has recently installed systems to collect and burn the methane-laden gas that emanates from the landfill.

Figure 2. Historical Emissions of CO_2 for Indiana State University



4.0 Achieving Carbon Neutrality

If Indiana State University were to join the President's Climate Commitment (PCC), they would be taking on a requirement to plot a course toward obtaining zero net greenhouse gas emissions at some point in the future. It is highly unlikely that a college campus could ever achieve a zero emission operation, but zero net emission is possible by reducing energy consumption as much as possible, utilizing renewable energy resources wherever possible, and purchasing environmental credits to make up the difference. The SecondNature protocol, developed by the group that helped develop the technical approach to the President's Commitment, discourages reliance upon environmental credits as a means to achieve compliance with the commitment, but we believe that some use of credits will be inevitable. As SecondNature and the PCC stress in their objections to environmental credits, if credits are to be used, the buyer must be very certain of the quality and longevity of such credits. We believe that there are sufficient quality controls on certain certified credits (either Renewable Energy Credits (RECs) or carbon credits) that trustworthy credits can be found. The level of certification and verification processes supporting the integrity of certain credits is crucial.

4.1 Potential Strategies

Indiana State University will face several strategic decisions when plotting the course to carbon neutrality. Will you use environmental credits? What level of reliance upon environmental credits will you be comfortable with? How much can you rely upon renewable energy sources to meet your needs? Can you exert influence on utilities to invest in renewable energy? Are community-based renewable energy projects available? Can the university influence fueling choices of commuters? Sebesta Blomberg recommends some combination of the following strategies for achieving carbon neutrality.

4.1.1 Electricity and Heat

- Seek renewable electricity/heat sources
  - Install cogeneration to improve efficiency
  - Pay a premium to contract for renewable power
  - Develop a renewable project (wind, biomass, wastes, solar)
  - Investigate using solar thermal technology for domestic hot water
  - Investigate geothermal heating and cooling systems
- Launch a program of continuous improvement in building energy consumption:
  - Improved energy monitoring to pinpoint inefficiencies
  - Auditing and retrofitting program – reinvest savings

- Retro-commissioning of problem buildings
- Installation of Energy Star or better equipment for new and retrofit systems
- Education and awareness programs for faculty, staff and students
- Implementation of LEED® building standards for new and renovated space

4.1.2 Commuting

- Provide incentives for employee car-pooling, vehicle purchases
- Encourage use of renewable fuels
- Provide college-coordinated transportation

4.1.3 College Vehicle Fleets

- Improve efficiency of vehicle fleet
- Move to hybrid vehicles
- Fuel switch to more-renewable E85 or biodiesel fueled-vehicles
- Move to electric vehicles (in concert with green electric purchasing program)

4.1.4 Air and Car Business Travel

- Hard to influence air travel – look to offset via credit purchases
- Specify fuel efficient vehicles through rental companies

4.1.5 Other alternatives

- Purchase of verified carbon credits to offset some level of emission
- Purchase certified RECs to offset emissions from non-green power
- Sequestration on college-owned land (not encouraged by the PCC but can be done through land management)
- Composting of food waste

4.2 Cost of Achieving Carbon Neutrality

Ideally, Indiana State University can institute a program to improve energy efficiency or utilize renewable energy sources that provide cost savings while reducing emissions. Comprehensive energy efficiency programs can typically reduce costs by 10 percent or greater although with Indiana State University's history of pursuing efficiency this may be more challenging. Utilization of renewable energy sources will typically entail some additional cost; however, there may be grants and low-interest loans available to help defray capital costs for electricity, air conditioning, or vehicle fueling systems. Once capital expenditures are made, operating costs for renewable energy systems can often be on par with, or lower than, those for non-renewable sources.

4.2.1 Framing Cost Ranges Through Credit Markets

Regulation of GHG emissions is expected to utilization an emissions trading program to manage costs. The theory of emission trading is that each limited source would act in its best economic interests to reduce GHG emissions. Thus, if the source can reduce its own emissions for less than the price of buying a credit from the market, the source will do so. Conversely, if self reductions are more costly than the market price, the source will enter the market to purchase the credits. Under this theory, the cost of the emission credit then reflects the cost it would take to make the emission reduction. We can then look at credit prices to give an order of magnitude of costs that a source might encounter.

While investing in energy efficiency and renewable energy upgrades can be costly, the cost of inaction could be higher. For example, if Indiana State University wanted to meet the commitment without changing current energy consumption patterns, Indiana State University could simply purchase the necessary off-setting environmental credits. Carbon credits are currently valued in the market place on the Chicago Climate Exchange (CCX). Other avenues are available through brokered, two-party deals, but the cost of carbon credits is most transparent via CCX, where prices have ranged as high as $7.00 per metric ton CO_2-eq over the past year. If we assume a flat $7.00 price per credit and assume that Indiana State University emissions each year would equal those in 2007, you would pay $640,000 annually to purchase carbon credits to completely offset your emissions. Carbon credit costs can be expected to increase dramatically when a formal federal regulatory program is adopted, something that is expected within the next five years.

Alternatively, Renewable energy Credits (RECs) could be purchased to offset emissions from your electricity consumption. As we presented in our earlier study of green power pricing, RECs vary in price from 0.5 cents to more than 5.0 cents per kilowatt hour, depending upon the source of the RECs and certifications. Applying these costs to Indiana State University annual electricity consumption of 69.4 million kWh would predict costs of more than $1.7 million to purchase RECs to completely offset electricity consumption (based on a mid-point price of 2.5 cents per kWh. Premiums paid to contract from specified renewable electricity sources appear to be similar to REC costs.

These gross costing methods offer a range of potential costs that Indiana State University would incur to meet the President's Climate Commitment and are presented for illustration purposes only. The ability to determine cost-effective efficiency improvements, to find opportunities for local development of renewable energy sources, and behavior modification to improve conservation on campus will help mitigate the higher costs of purchasing carbon credits or RECs to provide offsets, and will offer additional, non-carbon-related long-term benefits. The combination of approaches that Indiana State University ultimately selects to work toward carbon neutrality will significantly impact the overall cost of achieving that goal.

4.3 Improving the Estimates

Indiana State University provided solid data for this initial carbon footprint calculation; however, expanding the data collected can refine your numbers. We recommend that Indiana State University try to develop more robust record-keeping processes moving forward now that the new data needs for GHG emission accounting have been identified. Development of air and rental car travel records through employee expense reports, credit card purchases, or a travel agency can bolster confidence in the data. Further detail in tracking refrigerant use, amount and type, would allow for further refinement of emission estimates from refrigerant losses. Collecting data on commuting will remain a tough challenge and may entail a survey to develop a statistical representation of the community's driving habits, or inclusion of a data request each year that helps capture those driving habits. The more complete the data (distance, days, vehicle type, car-pooling, etc.) the better the emission estimate and the stronger the ability to document successes when programs are enacted to reduce commuting activities. Specific vehicle data (year, make, model) and fuel options (E10, E85, biodiesel, diesel) for fleet operations will also help refine emission estimates and enhance Indiana State University's ability to measure and document emission reductions where they occur.

Appendix A

Green Power

Several colleges and universities are using green power purchases through the Green Power Partnership to realize objectives related to renewable energy and/or greenhouse gas initiatives. Such purchasing programs offer flexibility for pursuing energy and environmental objectives without the operational and capital risk of developing on-site capacity for renewable energy. To provide a perspective of the Green Power Partnership, the colleges and universities with the largest purchases of green power are listed below:

Institution	Green Power Usage	%-Campus Consumption	Green Power Resources	Provider
New York University	132,000	100%	Wind	FPL Energy
University of Pennsylvania	112,000	29%	Wind	Community
Pennsylvania State University	83,600	20%	Biomass, Small hydro, wind	3Degrees, Community Energy, Sterling Planet
California State University System	66,189	9%	Biomass, wind, geothermal, solar	APS Energy Services, On-site generation
Duke University	54,075	31%	Small hydro, wind	Sterling Planet
UC Santa Cruz	50,000	100%	Small hydro, wind	Sterling Planet
Texas A&M	43,350	15%	Wind	TXU Energy
City University of New York	41,400	10%	Wind	New York Power Authority
Northwestern University	40,000	20%	Wind	3Degrees
Western Washington University	40,000	100%	Wind	Puget Sound Energy

Green pricing programs offered by electric utilities in Indiana are present in the following table. However, utility green pricing programs may only be available to customers within the respective service territories. Therefore additional green power purchasing options available nationwide are also listed. These options are typically in the form of renewable energy certificates or carbon offset certificates which qualify as green power purchases. The price premiums shown for the green pricing programs or renewable energy credit programs are paid in addition to the standard tariff of the service utility and applied to the amount of green energy being purchased. The price premiums in the flowing tables are typically for residential service, however large users may be able to negotiate price premiums.

Green Pricing Programs Offered by Indiana Utilities			
Utility Name	**Program Name Type of Energy**	**Start Date**	**Price Premium**
Duke Energy	GoGreen Power wind, PV, landfill gas, digester gas	2001	2.5¢/kWh
Hoosier Energy	EnviroWatts landfill gas	2001	2.0¢-4.0¢/kWh
Indianapolis Power & Light	Green Power Option wind	1998	0.35¢/kWh
Wabash Valley Power Association	EnviroWatts landfill gas	2000	0.9¢-1.0¢/kWh

National Renewable Energy Credit Programs			
Certificate Marketer	**Product Name**	**Renewable Resources**	**Residential Price Premiums**
3Degrees	Renewable Energy Certificates	100% new wind	2.0¢/kWh
3 Phases Renewables	Green Certificates	100% biomass, geothermal, hydro, solar, wind	1.2¢/kWh
Bonneville Environmental Foundation	Green Tags Blend	90% new wind, 10% new solar	2.4¢/kWh
Bonneville Environmental Foundation	Green Tags Solar	100% new solar	5.6¢/kWh
Bonneville Environmental Foundation	Green Tags Wind	100% wind	2.0¢/kWh
Carbonfund.org	Carbon Offsets	wind, solar, biomass, efficiency, reforestation	$5.50/ton CO2 (donation)
Carbonfund.org	*My*GreenFuture	99% new wind, 1% new solar	0.5¢/kWh
Choose Renewables	CleanWatts	100% new wind	1.7¢/kWh
Clean and Green	Clean and Green Membership	100% new wind	3.0¢/kWh
Community Energy	NewWind Energy	100% new wind	2.5¢/kWh
NativeEnergy	*Cool*Driver	New wind and biogas	~1.2¢/kWh, $12 per ton CO2 avoided
NativeEnergy	*Cool*Watts	100% new wind	0.8¢/kWh
NativeEnergy	Remooable Energy	100% new biogas	0.8¢/kWh-1.0¢/kWh
Premier Energy Marketing	Renewable Energy Credits	100% wind	1.5¢/kWh-2.0¢/kWh
Renewable Choice Energy	American Wind	100% new wind	2.5¢/kWh

National Renewable Energy Credit Programs			
Certificate Marketer	**Product Name**	**Renewable Resources**	**Residential Price Premiums**
SKY energy, Inc.	Wind-e Renewable Energy	100% new wind	2.4¢/kWh
Sterling Planet	Sterling Green Energy	100% new wind, hydro, geothermal, methane, or bioenergy	1.5¢/kWh
Sterling Planet	Sterling Solar	100% new solar	7.5¢/kWh
TerraPass Inc.	TerraPass	Various (including efficiency and CO_2 offsets)	~$10/ton CO_2