AWARD WINNING MULTI-DISCIPLINED ENGINEERING DESIGN FIRM

Electrical * Mechanical * Plumbing * Fire Protection * Commissioning*Renewable Energy Systems * Energy Analysis * Energy Auditing

Optima Engineering was formed in 1992 in Charlotte, North Carolina as a Professional Association. 31 employees (22 are LEED Accredited professionals and 14 licensed Professional Engineers). Optima Engineering is a member of the 7x24 Exchange, NCHEA, PENC, ASHRAE, IES, U.S. Green Building Council (USGBC), Progress Energy Trade Ally and educated in the Duke Energy's Save-A-Watt Program.

Optima Engineering specializes in designing educational facilities, data center facilities and other mission critical sites, healthcare facilities, office buildings, high-rise buildings, hotels, fire stations, churches, restaurants, commercial/retail. The variety of projects has enabled our team to develop skills and experience with various engineering systems.

Optima Engineering utilizes the building information modeling (BIM) software Revit, which helps us explore early design concepts and forms, and more accurately maintain your vision through design, documentation, and construction. We use BIM data to support sustainable design, clash detection, construction planning, and fabrication. We also use Trace 700 energy analysis software to predict energy use of systems and facilities and to perform life cycle cost analysis.

The below information provided September 6, 2011 deals with changing technology and all numbers are time sensitive. To be used as a general guideline only

Energy Consumption Facts

- The earth's population uses energy at the rate of 15 trillion watts
  - 500 quadrillion Btu per year
    - By burning 1 wood match, 1 Btu of energy is released
    - 99.89 quadrillion Btu of energy are used in the United States every year
  - 80 billion barrels of oil per year
    - 2,500 barrels of oil per second
    - 216 million barrels per day
    - 1 barrel = 42 gallons
  - Each person uses 2000 watts
  - The human body produces an average energy of 100 watts
    - Each person uses energy at 20 times the amount that their body outputs energy
- Global Energy Breakdown
  - 28% used for transportation
  - 32% used for industrial purposes
  - 22% used for residential
  - 18% used for commercial
- 30 billion barrels of oil are used each year worldwide
  - The United States consumes more oil than the next four leading consumers combined
  - Every gallon of gasoline contains 33,000 watt-hours of energy
  - The internal combustion engine only converts 12.6% of gasoline's energy into work
  - It is predicted that there will be 2 billion automobiles on the planet by the year 2050
- The United States ranks 9th in the average power used per capita
  - Iceland ranks 1st at 3,152 watts per person
  - Chad is ranked last at 1.03 watts per person
  - There are 28 countries that use less than 10 watts per capita
- The United States along with China, India, the Russian Federation, Indonesia, Nigeria, Brazil, and Pakistan use 50% of the world's water
- The United States contributed 20% of the total amount of greenhouse gas emissions, but the US only has 5% of the total population

Solar Photovoltaics

- Typical Costs per Watt = $5.00 for small installations (<50kw), $3.50 installed for large systems.
- Average size of a residential system is 5kw
- An unobstructed roof can provide about 10W/sf with PV panels.
- A typical PV panel is 40"x64", and weighs about 45 pounds.
- NC Tax Credit is 35% with a $2.5 million cap for commercial. SC Tax credit is 25% with $3,500 cap. Federal Tax Credit is 30%. Go to www.dsireusa.org for individual state tax credit information.
- The typical payback of a small system in North Carolina is 8 years with State and Federal Tax Credits.
  - Credit applies to federal income tax that can be spanned over multiple years
- Payment from NC Greenpower is $0.10 /kwh for small systems.
  - Max capacity of 5kw
- You can expect approximately 1,318 kwh/yr per KW installed in the piedmont region of NC and SC.
- View http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/ for an industry calculator for PV energy available in a geographic region.

Solar Thermal

- Residential Size – 80 Gallon Storage – cost approximately $6,500, not including tax credits (same as Solar PV), with a payback of approximately 3 years with new construction
- Commercial Size – Shell and Core – cost approximately $9,500, not including tax credits, with a payback of less than 5 years with new construction
- Provide 4-5 times the power density of a PV system
- Hot water accounts for 25-45% of a household's energy use
- A solar thermal heating system has a 70% energy capture efficiency versus solar pv (15%)

1927 SOUTH TRYON STREET - SUITE 300 - CHARLOTTE, N.C. 28203
PHONE 704-338-1292 WWW.OPTIMAPA.COM

Wind Generation

- You must have a good site for wind – almost nonexistent in the Carolinas except on mountain ridges and along the coast. You need approximately 12 mph constant wind.
- Visit www.windpoweringamerica.gov/wind_maps.asp for region wind maps
- The output of a wind generator can be calculated as:
  - Output(kwh/year) = 0.0138(d2)(v3)
  - Where d = blade diameter in meters
  - And v= average yearly wind speed in meters per second
- A typical residential 10KW tower (100 ft. tall tower) will cost approximately $60,000, not including tax credits

Fuel Cells

- A 400KW fuel cell costs approximately $1.1 million, installed (per UTC Power). They are very reliable (99.9999%), but still not very efficient. The goal is an efficient Micro CHP (Combined Heat and Power) device that produces electricity as well as hot air (for heating buildings) and water. This type of fuel cell exists, but the efficiencies are still low.
- Large quantities of heat are generated from a fuel cell
- As more power is drawn from the fuel cell, efficiency drops
- Energy storage systems are formed from combining a fuel cell and electrolyzers
- For every 0.5kw installed, a $500 Federal tax credit is given

Mechanical Systems

More Efficient Mechanical Systems: Use of energy recovery (waste energy from water or exhaust air systems) equipment in conjunction with more efficient cooling (EER) and heating (AFUE or COP) equipment is usually required. Standard mechanical system types (i.e. 4-pipe chiller/boiler, 2-pipe cooling tower/boiler and even direct expansion unitary equipment) may still be used to achieve LEED prerequisites, but higher initial cost equipment is required. Air and water economizers utilizing free cooling based on outdoor conditions should always be utilized.

Indoor Air Quality (IAQ): The minimum requirements of ASHRAE 62.1 require close analysis of temperature and humidity control. Energy performance can go right in the face of the required amounts of fresh air (ventilation) brought into a building due to energy needed to condition it as needed (cooling, dehumidification, heating) before delivery into the space. Natural ventilation (unconditioned ventilation air) is not a valid option in the southeast due to higher humidity levels.

Geothermal Heat Pump Systems: A building served by geothermal heat pumps immediately increases energy performance by providing a 2-pipe water loop without the need of cooling towers and boilers. Piping is buried underground using the earth as a natural heat exchanger. Heat is transferred between the ground and the pipes to either cool or warm the pipes. The ground always stays between 50^{o} and 60^{o}. Initial site evaluation and test wells are required to determine initial cost requirements for burying the piping.

Plumbing: Water is one of our earth's precious resources. While agriculture uses 39% of the fresh water in the US, power generation uses 38%. Designing, building, and operating a energy efficient facility reduces water consumption by reducing the amount of electrical energy needed to be produced from the utilities. Other options to reduce water consumption include:

- Low flow fixtures – cost is approximately 10% over standard fixtures, with prices coming down
- Waterless fixtures – cost is approximately 20% over standard fixtures.
- Low flow fixtures are quickly becoming the industry standard, and with the cost of brass fittings rapidly increasing, the waterless fixtures will gain more acceptance as they become less expensive. Payback is less than 1 year.
- Rainwater Harvesting: while expensive, it does have benefits: reduces water needed, which saves energy. A recent study of Wake County Schools showed that even in the worst drought last year, the average school used 85 gallons/student/month, but a school with rainwater harvesting used less than 32 gallons/student/month. These can cost from $150,000 to over $500,000.
  - Be sure to check state regulations on "who owns the rain".
  - 1" of rainfall on a 2,000 sf roof generates 1250 gallons of water
  - The Piedmont region of North Carolina has an average of 45" of rain per year, creating a potential of 56,250 gallons of water (assuming a 2,000 sf roof)
  - The average household uses 127,400 gallons of water every year.

Net Zero Buildings

- Two general definitions:
  - Net Zero Energy Consumed Building: The building produces the same amount of energy in a year that the building consumes
  - Net Zero Energy Cost Building: The building produces the same amount of income for energy produced in a year that the building spends for energy. If you are spending $0.06/kwh and are receiving $0.15/kwh (for typical solar PV), then you actually only produce 40% of the total energy consumed, but the costs are equal.
- Using PV to create Net Zero Energy Consumed, after building is 50% below ASHRAE 90.1 standard: cost is approximately $30/sf of building square footage.