

## Energy Efficiency

The term energy efficiency is ubiquitous, but why is it important? And what can we do to be more energy efficient? Saving energy is critical for several reasons:

1. To reduce or avoid damage to the environment
  - A. Some forms of energy production (fossil-fuel power plants are the largest polluter) cause damage to the air, water, and soil quality; plants and animals in the ecosystem; and to human health.
  - B. Power plants fueled by coal are the most harmful in terms of energy production (especially older plants that do not have pollution prevention technologies installed) but all fossil fuels release the following, to some degree, in the course of combustion:
    - i. Sulfur dioxide ( $\text{SO}_2$ ) and nitrogen oxides ( $\text{NO}_x$ ) are released into the environment as products of fossil fuel combustion. When these gasses mix with water vapor in the air they react to form acidic compounds, which fall to earth as rain or snow, sometimes hundreds of miles from their source. Over time, acid deposition, which includes acid rain and snow, affects lakes and rivers. Many bodies of water across the Northeast have become too acidic to support aquatic life.
    - ii. Mercury (Hg), also a product of combustion, finds its way into the air, waterways, and wildlife, including the fish we eat. Because mercury, even in minute quantities, can cause severe damage to the nervous system; pregnant and nursing women, the fetus, and young children are most vulnerable to mercury exposure. Furthermore, mercury bioaccumulates in our bodies, so it does not decompose, transform into other less dangerous compounds, or evaporate, but stays indefinitely in the environment and in the bodies of animals that consume it.
    - iii. Coal-fired power plants are the primary source of  $\text{SO}_2$  in the atmosphere, while the largest source of  $\text{NO}_x$  is the transportation sector (e.g., motor vehicle exhaust), followed by emissions from power plants. In addition to acid deposition, tropospheric (ground-level) ozone ( $\text{O}_3$ ) is produced by sunlight-induced photochemical processes involving nitrogen oxides ( $\text{NO}_x$ ) and volatile organic compounds (VOCs). These precursor gases are derived from natural and anthropogenic (man-made) sources. Ozone concentrations are generally highest in and around urban areas.
    - iv. Ozone ( $\text{O}_3$ ) and particulate matter (PM) can cause negative human health effects. Ozone is a highly oxidative molecule found in the air. When it forms high in the stratosphere,  $\text{O}_3$  is critical to life on Earth because it absorbs harmful ultraviolet radiation from the sun. But in the low atmosphere (troposphere) or at ground level,  $\text{O}_3$  is considered a health hazard.
    - v. Particulate matter (PM) refers to tiny airborne particles that originate from various natural and anthropogenic sources, some of which are produced

from chemical reactions of sulfur dioxide (SO<sub>2</sub>), NO<sub>x</sub> and certain VOCs. They are composed of many compounds rather than one substance, also referred to as dust, haze, and smoke. PM is regulated in two categories of particle size: particles that are less than 10 micrometers (μ) in diameter (PM<sub>10</sub>), and "fine" particles of less than 2.5μ in diameter (PM<sub>2.5</sub>).

- v. Both ozone and PM have a negative effect on human health and the environment. Ozone is identified with adverse human health impacts, including respiratory stress such as asthma. The environmental effects of PM include reduced visibility, acid deposition, damage to crops and forests, and increased corrosion of materials. Adverse health effects of PM, especially the smaller PM<sub>2.5</sub>, include reduced lung function growth, as well as respiratory and cardiac disease and mortality. Children, the elderly, diabetics and those with underlying heart or lung disease are most susceptible.

Reference: <http://www.nyserda.org/programs/environment/emep/home.asp>

## 2. To forestall climate change

Greenhouse gasses (carbon dioxide, methane, nitrous oxides) are naturally occurring but are also by-products of fossil-fuel combustion and other human activities. When released into the environment in excess these gasses trap the heat, causing the atmosphere to get warmer. This is a simplification of the process as much more complex reactions are occurring. For example, due to the dynamics of ocean currents on the planet, some areas of the planet may cool down, while others will get warmer. Hence the term climate change is more accurate than global warming.

## 3. To become energy independent

Most of the world's fossil fuels are produced in politically volatile regions of the world (Middle East; Nigeria; Venezuela). Although oil production exists in the U.S., the rate at which we are using it is unsustainable and with large developing countries needing increasingly more fuel to power their growing economies (China, India), it is inevitable that fossil fuels will not be sufficient to satisfy our demand in the long term.

## 4. To save YOU money

As energy use increases and supplies are diminished, the cost of fossil fuels increases. The only way to avoid this costly situation is to conserve energy and use non-fossil fuels. Because no one wants to return to the way of life of centuries past, we must find ways of using energy more efficiently, and find alternative energies to fossil fuels.

Buildings are one of the largest sources of energy use (heating, cooling, lighting, appliance use, etc.) in our society. Regardless of the type of building, the following elements of an energy reduction plan apply; which components are replaced or which actions are implemented depend upon the needs of the residents/users, the local weather, and the available budget. Before deciding where to begin, conduct an energy audit yourself (see [http://www.eere.energy.gov/consumer/your\\_home/energy\\_audits/index.cfm/mytopic=11170](http://www.eere.energy.gov/consumer/your_home/energy_audits/index.cfm/mytopic=11170)) or

have one done professionally. Some utility companies will conduct an energy audit of your home for free. NYSERDA programs offer either audit cost reimbursement when suggested improvements are made, or offer cost-sharing programs.

Reference: <http://www.nyserda.org/Programs/energyaudit.asp>

The following items are integral to any energy audit that is performed:

### 1. Lighting

Replacing lighting fixtures or light bulbs in the fixtures is usually the easiest and sometimes the most cost-effective measure to implement. The traditional and oldest type of light bulb is the incandescent bulb, invented by Thomas Edison more than 100 years ago. Fluorescent bulbs use much less energy and last longer than incandescents, but are more expensive. Replacement should be considered based upon the use and time on for the fixtures. For example, even a low wattage lamp when turned on for 24 hours a day, 7 days a week, replacement with a more efficient bulb makes sense. However, if a light fixture is used rarely, it might make more sense to replace it when the bulb burns out.

See the following websites for more detail:

#### 1. Replacing light bulbs

<http://www.getenergysmart.org/buildingowners/energystarproducts/lighting.asp>

#### 2. How to pick a light bulb

<http://www.fightglobalwarming.com/page.cfm?tagID=608>

#### 3. How to find a specific light bulb

<http://www.environmentaldefense.org/page.cfm?tagid=632>

Various lamp technologies exist, other than incandescent and fluorescent. Metal halide and high pressure sodium (HPS) light fixtures are often used outdoors where the lights are on for long periods of time, where replacement is not easy (these are long-life lamps) and where the light color is not as critical. HPS lamps emit an orange glow, often used along highways and as outdoor flood lights; but this lighting, though very energy efficient is not suitable for the kitchen or living room!

A new lighting technology, light emitting diode (LED) lights are on the market and may be suitable for certain applications and settings. The down-side of this lighting is that it is a costly alternative, though prices are coming down as the technology is further developed.

### 2. Lighting controls

An extremely cost-effective method for saving energy on lights, and other electrical equipment and electro-mechanical devices is the motion /occupancy sensors and the photo sensor. Many different designs exist and can be installed in a variety of settings. The basic scheme behind this technology is for a device to be automatically turned on or off when needed. The motion sensor will turn off lights when no one is in the room (very effective in public spaces, such as restrooms,

meeting rooms), or turn on lights (e.g., when a person approaches a house at night). The photo sensor will not allow lights to turn on during the daytime (e.g., floodlights installed outside public buildings will turn off at dawn). Timers are often used in conjunction with the devices described above.

### 3. Heating/Cooling

Heating and cooling systems use a great deal of energy and therefore much energy can be saved in selecting the right system(s). Because this equipment is expensive, difficult to install and technically complex, a professional should be consulted to determine which is most suitable and cost-effective. Always consider the usage before making a final determination.

Factors to take into account when considering an upgrade, replacement or maintenance include:

1. Fuel type (heating oil, natural gas, electricity – or a renewable source)
2. Equipment type – many types of furnaces, boilers and cooling equipment exist.
3. Equipment efficiency – how efficient the unit is – to be weighed against the cost, and its useful life span, for example.
4. Equipment maintenance – this is probably one of the most inexpensive and cost effective methods to maintain energy efficiency of heating and cooling systems
5. Geographical area – depending upon the local weather, utility costs, availability of fuel delivery (e.g., natural gas is not available in every region),etc. choices can be made which system to install
6. Piping insulation – insulation of hot water piping in cool areas of a building and chilled water piping (e.g., in central air conditioning systems) in hot areas is also a cost effective measure to save energy.
7. Hot water heater insulation - insulating the entire heater to avoid heat loss is a great energy saver
8. Purchase of Energy Star equipment is always a wise choice  
[http://www.energystar.gov/index.cfm?c=heat\\_cool.pr\\_hvac](http://www.energystar.gov/index.cfm?c=heat_cool.pr_hvac)
9. Distributed Generation (DG), and Combined Heat and Power (CHP) also known as cogeneration.

CHP is currently promoted by many federal and state agencies (Department of Energy, NYSERDA) because it is more energy efficient and also produces fewer air emissions (better for the environment). The basic concept behind CHP is to use the waste heat that is generated in the course of electricity production. This heat can be used to heat the building, heat the water, or provide cooling through heat exchangers. In traditional power production, excess heat is either cooled (using energy), emitted to the air, or discharged to a water body. By finding an application for this heat instead of using energy to make it go away, energy is conserved and the environment is spared the negative effects. For more information refer to:

<http://www.epa.gov/chp/>

<http://www.nyserda.org/chpnys/>

[http://www.eere.energy.gov/de/chp/chp\\_technologies/](http://www.eere.energy.gov/de/chp/chp_technologies/)

<http://www.energy.ca.gov/distgen/equipment/chp/chp.html>

<http://www.northeastchp.org/nechpi/index.htm>

4. Water usage

Most of the factors discussed in the heating and cooling section, above, apply to water usage as well. Energy Star water heaters can be found at the following website:

[http://www.energystar.gov/ia/new\\_homes/features/WaterHtrs\\_062906.pdf](http://www.energystar.gov/ia/new_homes/features/WaterHtrs_062906.pdf)

Low-flow faucets/showerheads are a very inexpensive measure to include in buildings and are easy to install. The New York City Department of Environmental Protection provides these packages for free to any resident who requests one.

<http://query.nytimes.com/gst/fullpage.html?res=9C0CE1DA1E3FF93AA3575BC0A966958260>

<http://www.nyc.gov/html/dep/pdf/survey.pdf>

5. Building envelope

Heat and cold air can penetrate a building through the windows, walls, doors, floors, etc. It makes sense therefore to check for air leaks and replace or repair as needed.

The most cost-effective measure is installation of weather stripping where doors have gaps around the perimeter. In addition, floor, wall and roof insulation should be appropriate.

6. Appliance/electronic equipment

In addition to purchase and installation of [energy-saving equipment](#) and implementation of a routine maintenance program, timers are great energy savers and should be installed whenever possible.

7. Utilize green building design, if new construction (see Module on Green buildings for information on LEED certification).

8. Consider available alternative energy sources and passive solar improvements, when possible (see module on Alternative Energy).

1. Solar PV and solar hot water
2. Geothermal
3. Wind
4. Biomass

**What can we do?**

A. Lifestyle changes

1. Transportation
  - i. Drive/fly less through appropriate planning
  - ii. Use mass transportation, car pool, or ride a bike.
  - iii. Purchase fuel-efficient vehicles
  - iv. Drive slower
  - v. Reduce idling of your car

2. Turn off lights, computer, TV, appliances when not in use
3. Use power strips and turn off whole strip
4. Make choices on products purchased - choose Energy Star appliances
5. Lower the heat in your house
6. Do not use air conditioners or if necessary, increase the thermostat temperature in the house/office to reduce AC usage
7. Clean or replace air filters of air conditioning units
8. Replace incandescent Lamps with compact flourescents
9. Turn down the thermostat on your hot water heater
10. Take shorter showers

B. Calculate your carbon footprint to see where you can save

1. <http://www.fightglobalwarming.com/carboncalculator.cfm>
2. Follow these energy-saving tips to help fight air pollution, global warming and your high electric, oil or natural gas bill.  
<http://www.nrdc.org/air/energy/genergy.asp>
3. <http://www.getenergysmart.org/AboutNYES.asp>

C. Influence or be in touch with your decision makers; know what your regulators are doing. They are responsible for the following:

1. Efficiency standards
2. Federal/State/Local Incentive programs (See bullets G-H, below)
3. Mandating, promoting renewable energy technologies

D. Organize educational campaigns

E. Organize reduced-cost equipment fairs

1. low-cost CFLs
2. bulk-purchase appliances

F. Reduce energy use <http://www.eere.energy.gov/consumer/>

1. in our home
2. Reduce our energy use – at work
3. Reduce our energy use - in the community

G. Take advantage of Federal and State assistance and incentive programs, which differ based on differing needs and provide a wide assortment of packages, such as loans, grants, rebates, tax credits, utility rebates, etc.

<http://www.dsireusa.org/> , <http://www.energytaxincentives.org/>,  
[http://www.tax.state.ny.us/pdf/memos/multitax/m06\\_4c\\_6i.pdf](http://www.tax.state.ny.us/pdf/memos/multitax/m06_4c_6i.pdf)

H. For New York residents familiarize yourself with New York State Energy Research and Development Authority (NYSERDA) programs. Other states have similar programs.

1. Residential

i. <http://www.nyserderda.org/incentives.asp#Residential>

ii. 1-4 family homes

<http://www.getenergysmart.org/whereyoulive/default.asp>

iii. multi-family residential

<http://www.getenergysmart.org/buildingowners/default.asp>

iv. Home appliances

<http://www.getenergysmart.org/buildingowners/default.asp>

2. Schools

<http://www.nyserderda.org/programs/Schools/default.asp?i=11>

3. Farms

<http://www.nyserderda.org/incentives.asp#Agricultural>

4. Commercial and industrial

<http://www.nyserderda.org/incentives.asp#Commercial%20/%20Industrial>

5. Institutional: prisons, hospitals

<http://www.nyserderda.org/incentives.asp#Hospitals%20/%20Institutions>

6. Municipalities

<http://www.nyserderda.org/incentives.asp#Municipal>

I. Case study – an example to emulate: What one community did in Keene, NH

In 2000, Keene became one of the first communities in New England to pledge to combat climate change, eventually agreeing to reduce greenhouse gas emissions by 10% below 1995 levels by 2015. Without the effort, emissions were projected to rise 26 % over that time because of economic and population growth. Examples of what the city did as part of this effort:

- The city's 78-vehicle fleet is powered by biodiesel fuel to reduce tailpipe emissions of carbon dioxide
- Traffic lights use high-efficiency bulbs
- The Department of Public Works building is heated by geothermal energy.
- Idling of cars is prohibited

Reference:

[http://www.boston.com/news/local/articles/2007/12/16/small\\_nh\\_city\\_takes\\_on\\_global\\_warming\\_challenge/](http://www.boston.com/news/local/articles/2007/12/16/small_nh_city_takes_on_global_warming_challenge/)