ENVE203
Environmental Engineering Ecology
(Dec 17, 2012)

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'Energy Consumption'

Energy

- Everything humans do requires energy
- We use energy to
  - move and build things
  - heat
  - cool
  - illuminate our living & work spaces
  - plant, water, harvest, process, ship & store food
  - capture energy

    to drill for & pump oil

    to mine coal & uranium

    to build solar panels

    to install wind turbines

Energy

- A few years ago, almost all the energy used by people was derived from agriculture, wind, or water
- Energy sources local
- Activities limited by the amount of useful energy that can be extracted from

A bucket of wood

A bucket of gasoline

Energy

- Concentration of large amounts of useful energy from a wide range of sources
- Problem: concentration of wastes (heat, a range of pollutants) associated with energy

Advantages of an energy source
- How concentrated it is
- Availability
- Safety
- Versatility

Disadvantages
- Hazard potential
- Environmental damage
- Cost

Energy

Examples

Crude oil

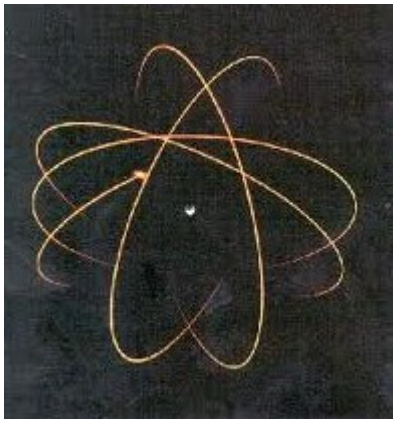
- A versatile energy source
- Easy to transport
- Can be made into a variety of different fuels (diesel, jet fuel, gasoline)
- Gasoline can be stored and used in personal automobiles
- If spilled or ignited, can cause serious injuries & environmental damage

Energy

Examples

Nuclear materials

- Not a versatile energy source
- We use them only to generate electricity
- When used in appropriately designed & managed reactors, they can cause less environmental damage than does coal



Energy

Examples

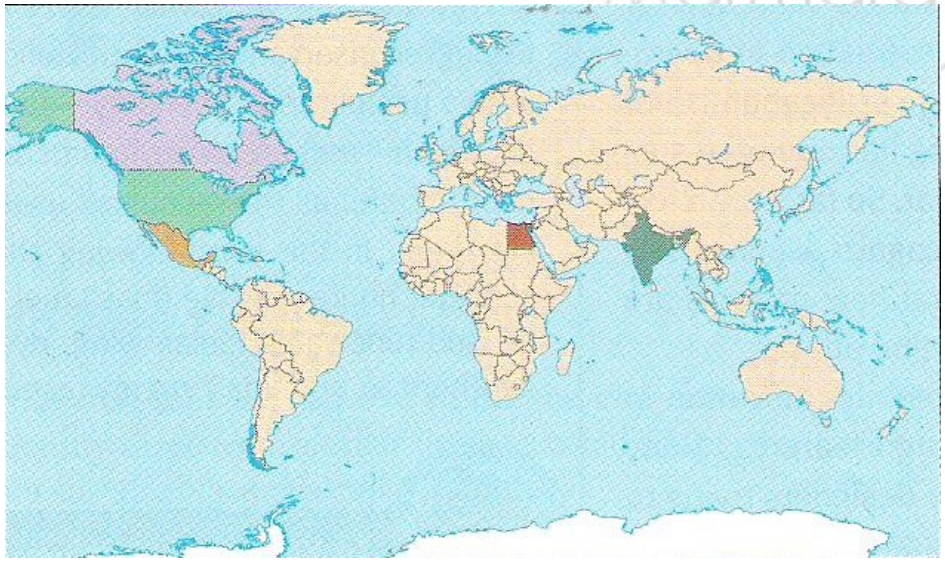
Solar power

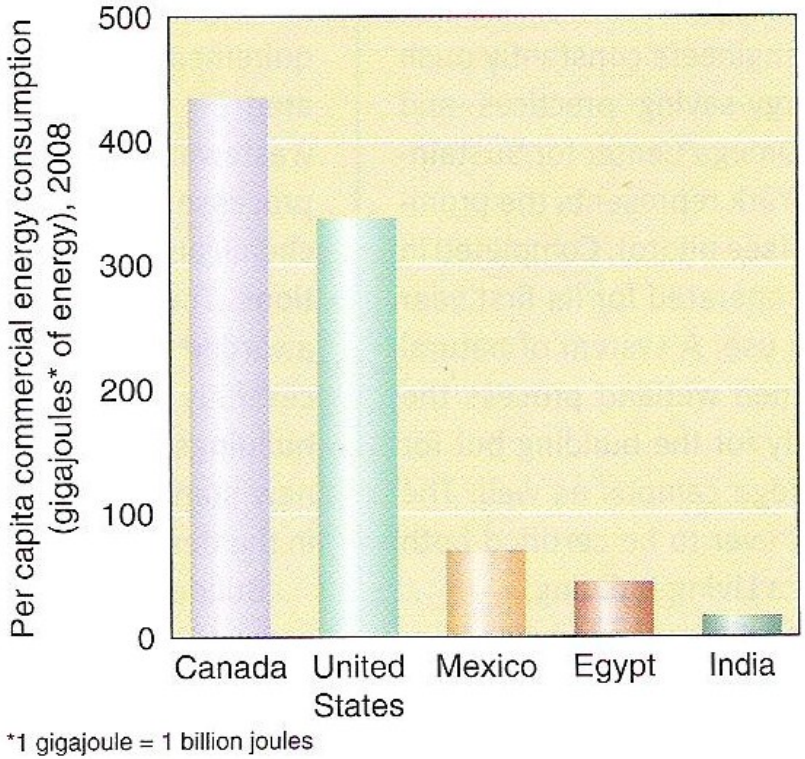
- Crude oil or nuclear resources are found in only a few parts of the world
- Solar power is widely available
- Seasonal & daily variability
- Capturing it requires equipment that can be expensive

Energy Consumption

Difference in per capita energy consumption between highly developed & developing countries

< 20% of the world's population in HDC,
They used 60% of the commercial energy consumed worldwide (2010)





Annual per capita commercial energy consumption in selected countries, 2008

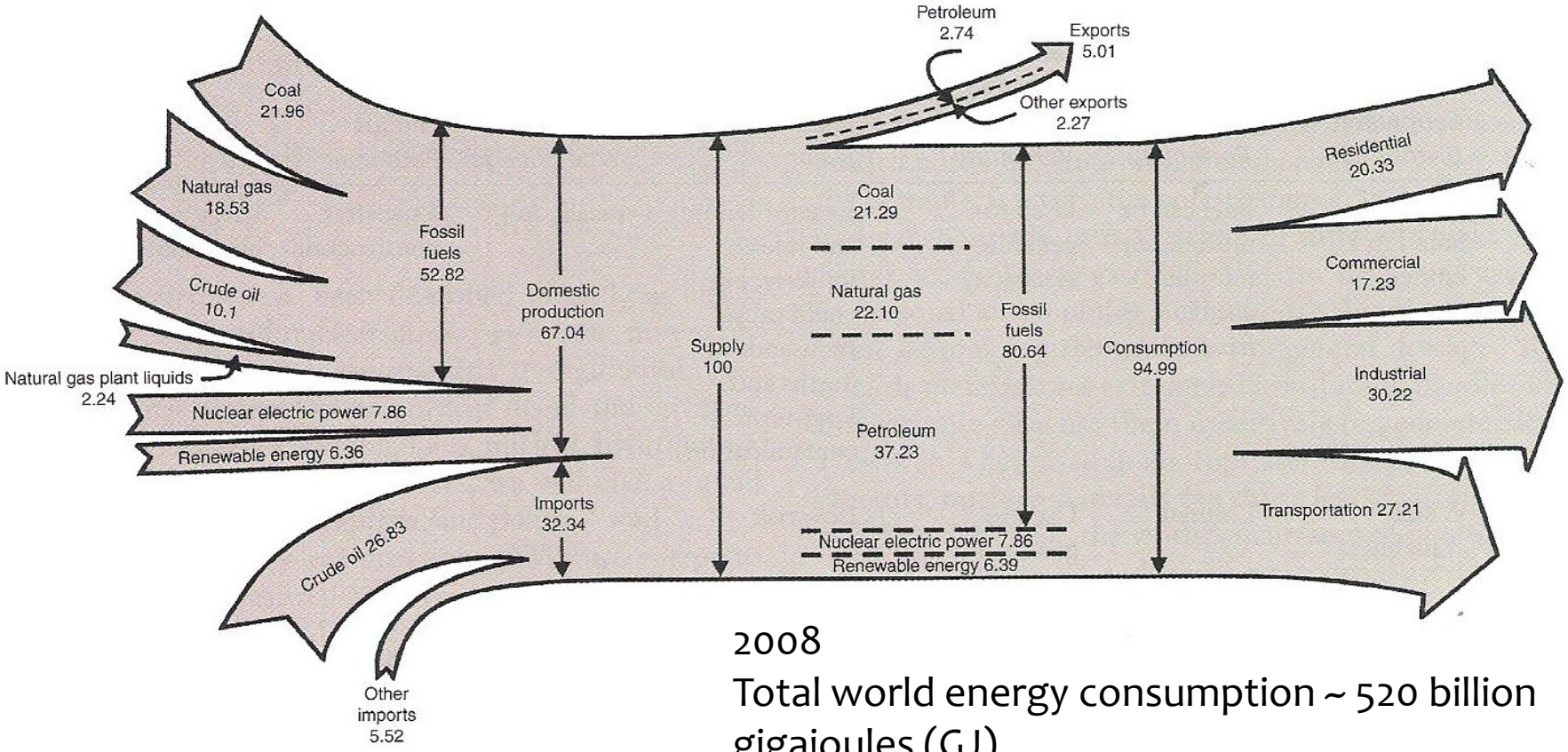
Advantages & disadvantages of several major energy sources

Source	*Geographic Distribution*	*Portability*	*Versatility*	*Worst-Case Event*	*Day-to-day Pollution (Not Climate Change)*	*Climate Change Potential*	*Scale*	*Reliability*
Nuclear fission	Uranium found in a limited number of places	Fuel can be moved, but must be used in a fixed location	Used to generate electricity	Reactor failure and release unlikely, but could cause thousands of deaths and long-term contamination	Typically low	Low after construction	Large power plants only	Can run all the time
Solar photovoltaic	Widely available	Limited	Used to generate electricity	Low risk	Low	Very low	Flexible	Daily and seasonal variability
Hydro-power	Found in a limited number of places	Cannot be moved	Mostly used to generate electricity, but sometimes for mechanical energy	Dam collapse rare, but could cause thousands of deaths	Low, but permanent disruption to upstream and downstream ecosystems	Low after construction	Flexible but depends on location	Can run all the time
Natural gas	Found in a limited number of places	Can be piped or trucked; often condensed	Can be used for heating, cooking, transportation, and industry	Natural gas plant or pipeline explosion unlikely, but could cause hundreds of deaths	Lowest of the fossil fuels; can burn cleanly	High	Flexible	Can run all the time

Advantages & disadvantages of several major energy sources

Source	Geographic Distribution	Portability	Versatility	Worst-Case Event	Day-to-day Pollution (Not Climate Change)	Climate Change Potential	Scale	Reliability
Coal	Found in a limited number of places	Fuel can be moved, but must be used in a fixed location	Used to generate electricity, for heating, and in industry	Power plant failure could cause some deaths.	Difficult to burn cleanly; releases sulfur, nitrogen, and soot to air, land, and water	Highest	Flexible	Can run all the time
Oil	Found in a limited number of countries	Highly portable, especially when refined into gasoline, diesel, and other fuels	Highly versatile; can be used for heating, cooking, transportation, and industry	Refinery accident could cause some deaths	Refining can be dirty, and burning gasoline, diesel, and other fuels releases pollutants	High	Very flexible	Can run all the time
Wind	Available in most countries, but not everywhere in those countries	Cannot be moved	Mostly used to generate electricity, but sometimes for mechanical energy	Low risk	Low	Low	Flexible	Seasonal and unpredictable variability
Geothermal	Available in most countries, but not everywhere in those countries	Cannot be moved	Used to generate electricity, occasionally for heating	Low risk	Low	Low	Usually mid to large scale	Can run all the time

Energy consumption in the United States



2008

Total world energy consumption ~ 520 billion gigajoules (GJ)

United States consumed 22 % of the world total (105 billion GJ)

China 90 billion GJ (17 % of the world total)

Kenya 0.22 billion GJ (0.04 % of the world total)

The amount used per person

United States 56 GJ / person / year

6 times as much as is used in China

60 times as much as is used in Kenya

Energy Efficiency
Energy Conservation

ENERGY EFFICIENCY
Using less energy to accomplish a given task
(e.g. with a new technology)

ENERGY CONSERVATION
Using less energy, as, for example, by reducing energy use and waste

Designing & manufacturing more fuel-efficient automobiles

Carpooling & reducing the number of automobile trips

Both accomplish the same goal

'Saving Energy'

Energy Efficiency
Energy Conservation

Using more energy efficient appliances could cut our CO_2 emissions by millions of tons each year

↓

slowing global climate change

ENERGY EFFICIENCY and **ENERGY CONSERVATION**

Reduce

- air pollution
- acid precipitation
- other environmental damage related to energy production & consumption

Energy Efficiency

- A measure of the amount of available energy in a source that is transformed into useful work

Burning natural gas for household cooking

An efficiency of close to 100%

Almost all the energy contained in the natural gas can be converted into heat in the stove or oven

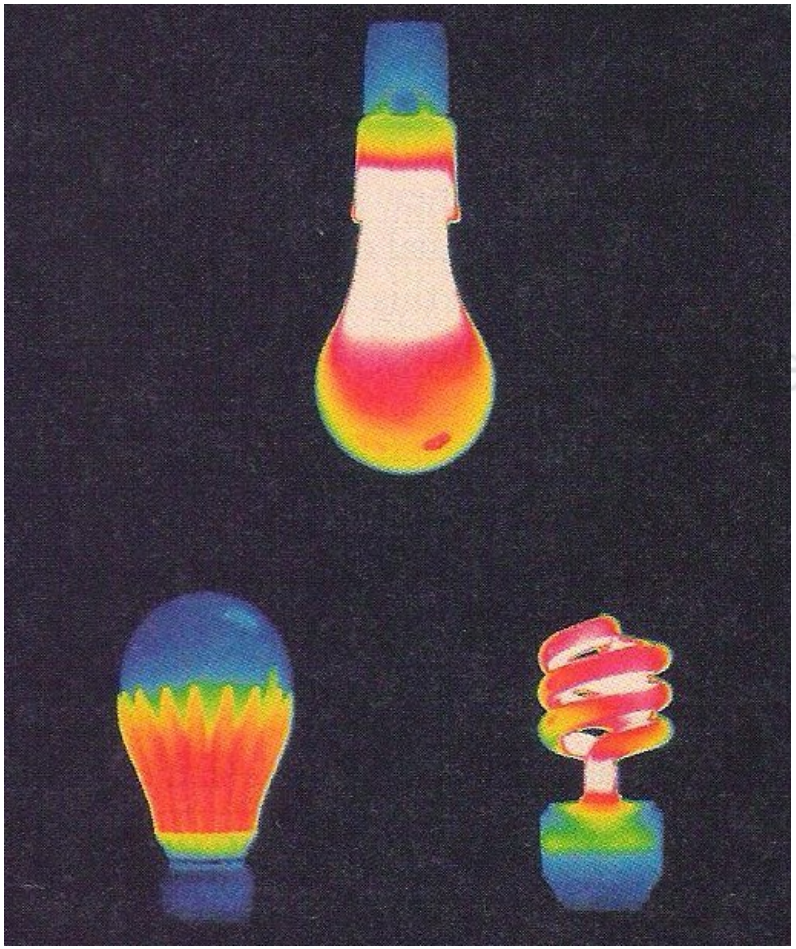
Burning natural gas to generate electricity

Has a maximum efficiency of about 60%

We would need almost twice as much natural gas to generate electricity to cook at home as we would if we burned the gas at the same home

Thermal images of incandescent (top), light emitting diode (left), and compact fluorescent light bulbs (right)

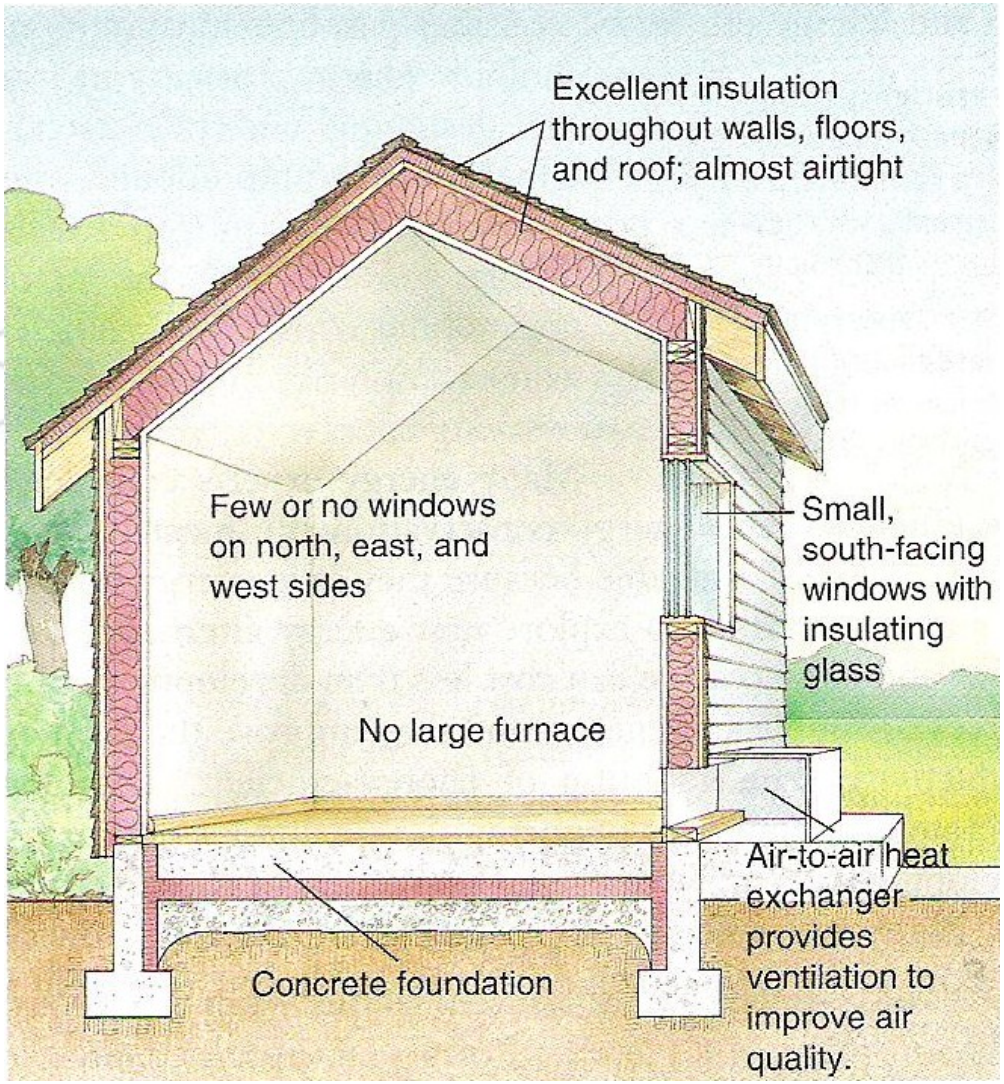
White: hottest
Blue: coolest

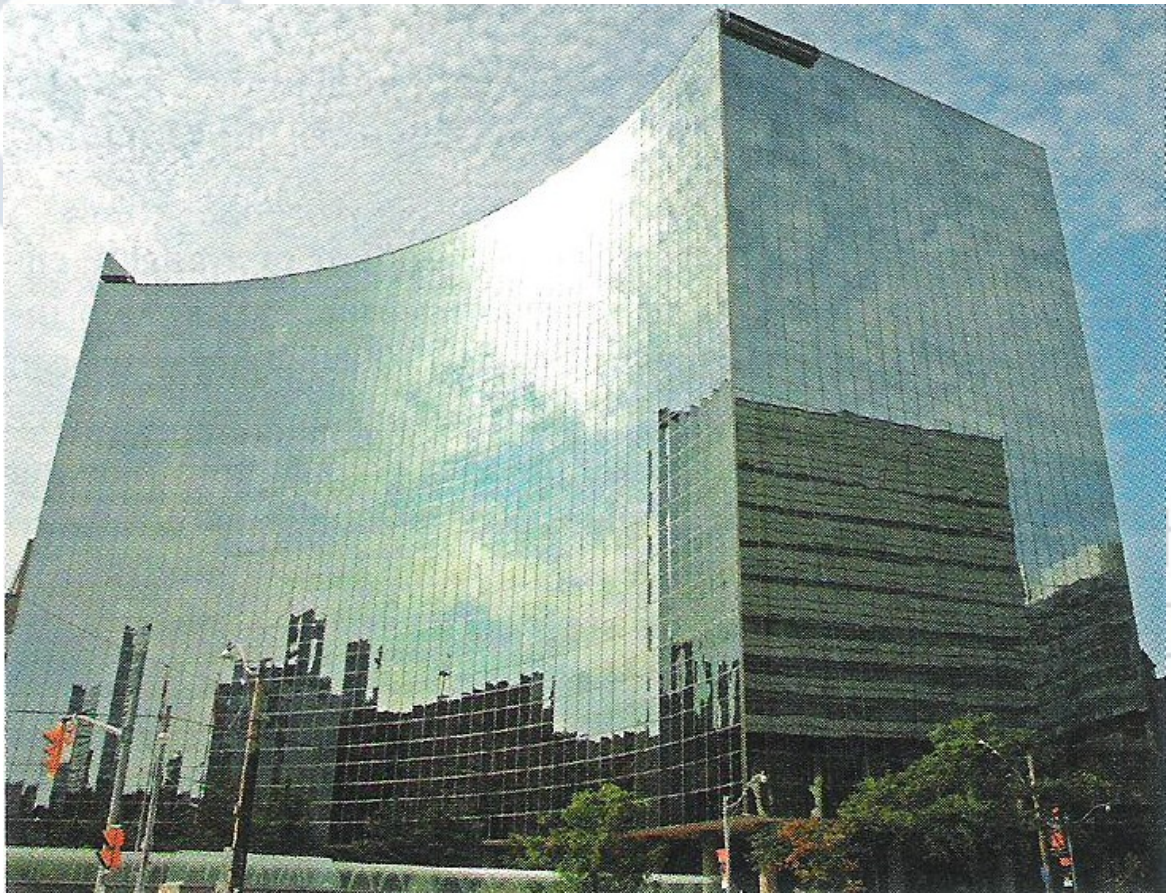


Energy Savings in Commercial Buildings

30 % of a company's operating budget: Energy Costs

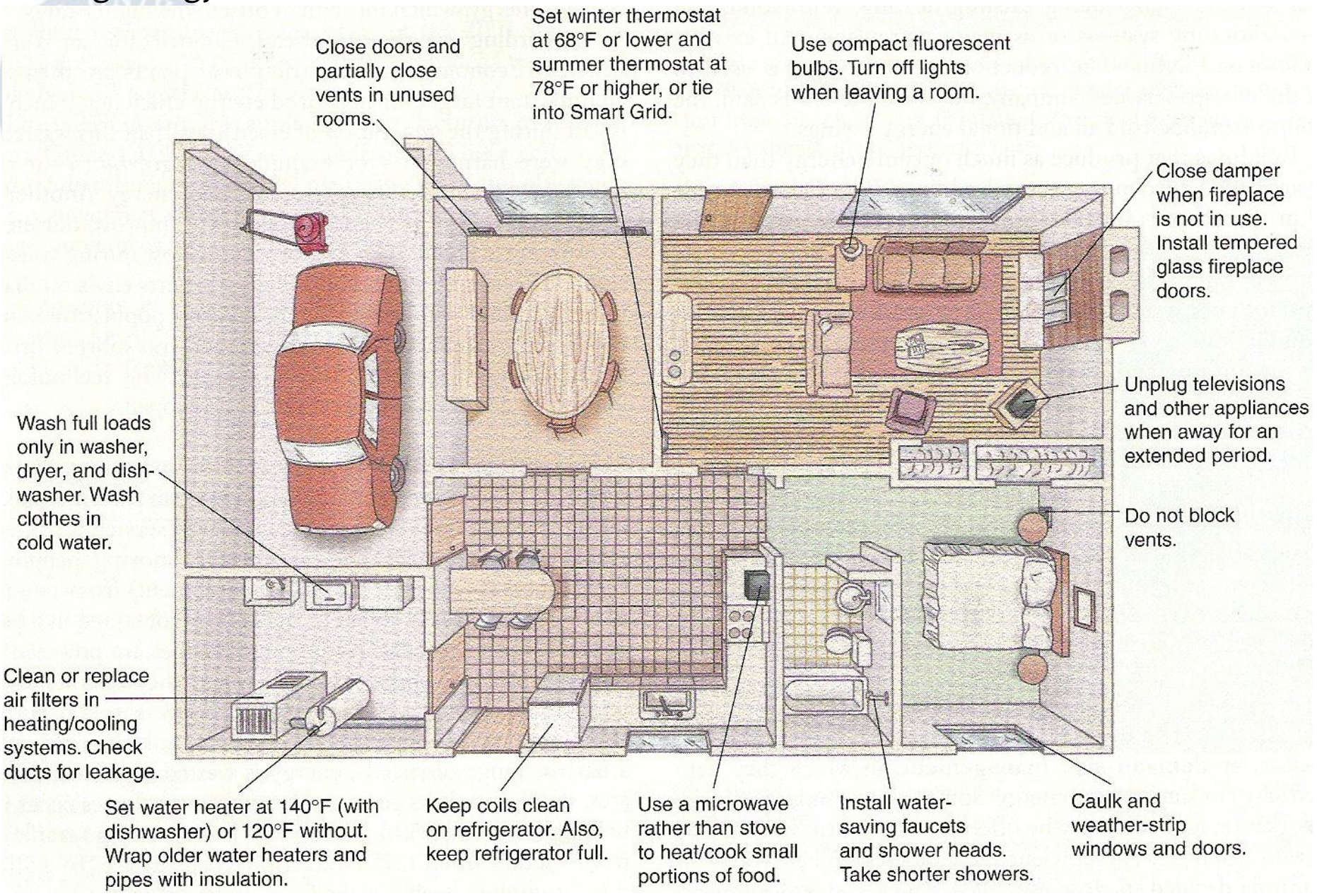
- So well insulated & airtight it does not require a furnace in winter
- Heat from the inhabitants, lightbulbs, stove and other appliances provides almost all the necessary heat





A superinsulated office building in Toronto, Canada
Southfacing windows with insulating glass
Building uses no furnace

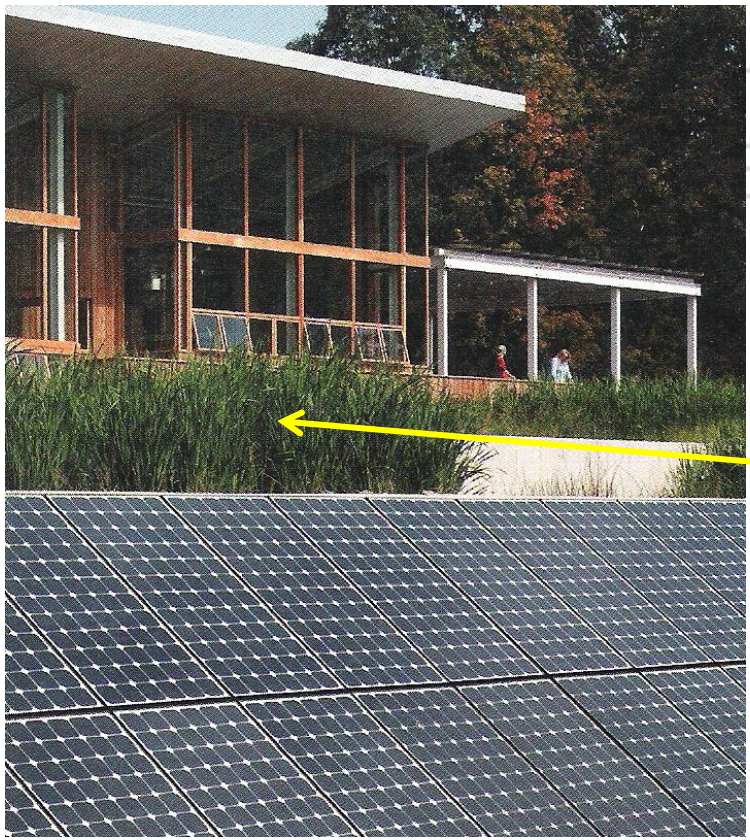
Saving Energy at Home



Energy Savings in Commercial Buildings
zero-net-energy buildings

Buildings that produce as much or more energy than they use

They are rare, and often do not have payback times of less than a few decades



Omega building, New York

The greenery is both decorative & a part of the wastewater treatment system

Electric Power Companies & Energy Efficiency

Some utilities support energy conservation & efficiency by offering cash awards to consumers who install energy-efficient technologies

Some utilities give customers energy-efficient compact fluorescent lightbulbs, air conditioners, or other appliances. They then charge slightly higher rates or a small leasing fee.

Energy Efficiency in Transportation

Using lighter materials for car bodies, frames, and even engines can reduce weight

New gasoline-electric hybrid car: engine does not always run, even when the car is in motion

Electric vehicles operate at much lower temperature than do gasoline engines

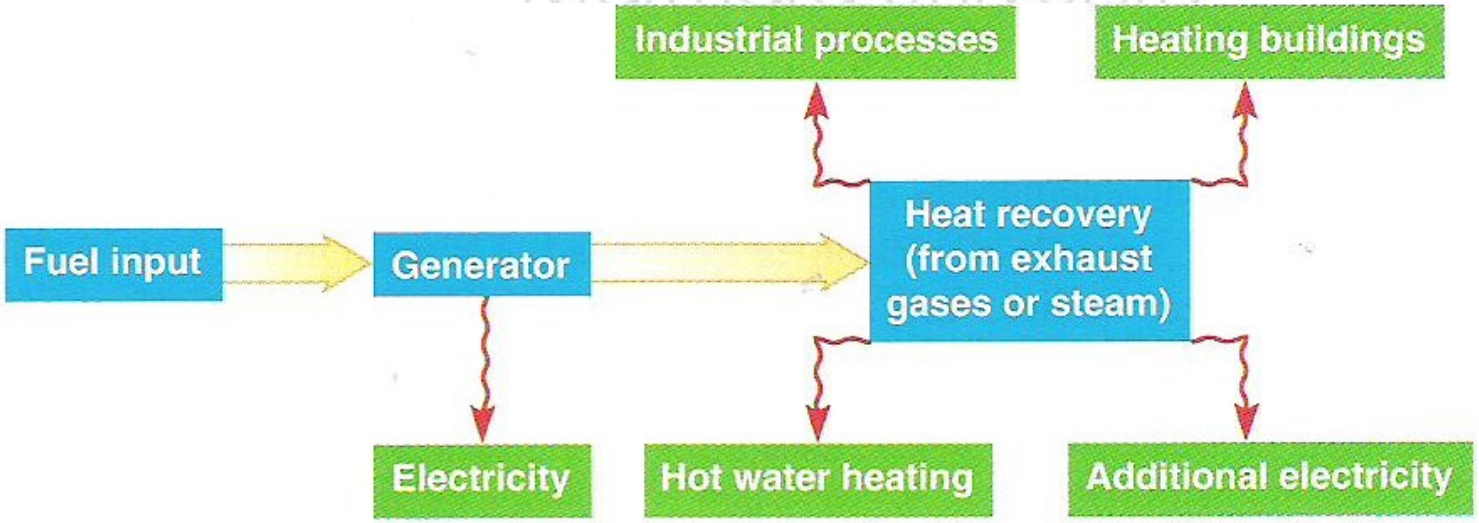
Driving habits: Rapid acceleration requires more energy than smooth acceleration; Changing speed uses more energy

Energy Efficiency in Industry

Energy savings with improvements in technology

Cogeneration (combined heat & power)

The production of two useful forms of energy from the same fuel



Fuel combustion generates electricity in a generator. The waste heat (leftover hot gases or steam) is recovered for useful purposes, such as industrial processes, heating buildings, heating hot water, and generating additional electricity

Energy Conservation

- Change in behaviours, practices, and thus a shift in the services we expect from energy
- Some practices: use less (decreasing indoor temperatures, using less energy to heat buildings → reduce quality of life?
- Shifting from one set of energy services to another, equivalent set

Early or late start times (to avoid wasting hours at traffic)

Working from home or satellite offices

Shorter distances (walking or bicycling)

Energy Conservation

Locally produced and dried foods requires less energy to transport than imports and prepared foods.

Producing meat requires far more energy per calorie consumed than does producing vegetables, fruits, and grains

Homes and buildings

Not heating all the rooms & adjusting thermostats at night & when the building is empty

Automated lightining when a room is not in use

Energy Conservation

Encourage energy conservation by eliminating subsidies

Not keeping energy prices artificially low

When prices reflect the true cost of energy, including the environmental costs, energy is used more efficiently

A comparison of gasoline prices in selected countries (including taxes)

Source: Energy Information Administration

	Regular Gasoline Price (Dollars per Gallon)	
Country	*2001*	*2008*
United States	$1.51	$3.37
Canada	1.78	4.34
Mexico	2.46	3.04
Turkey	3.05	9.35
France	3.58	7.70