“Understanding Earth’s Energy Sources”
Part 2. Renewable Energy

Compiled by
Karen S. Harrell
Dora Moore K-8
Denver Public Schools
July 28, 2006
Energy Sources

Renewable Energy

- Solar
- Hydrogen
- Bioenergy
- Hydroelectric
- Geothermal
- Wind
What is Renewable Energy?

The United States mostly uses coal, oil, and natural gas for its energy. Fossil fuels are *nonrenewable*, that is, they come from resources that will eventually become scarce and run out, becoming too expensive and hard to find. The opposite are *renewable energy* resources—such as wind and solar energy - they are constantly replenished and will never run out.

**Types of Renewable Energy:**

- Hydro
- Bioenergy
- Geothermal
- Wind
- Solar
- Hydrogen
Reasons for Renewable Energy

- Low impact on the planet.
- Will not run out.
- Can be made in the U.S.A.
- National security.
- Available for the entire world.
THE ENERGY CRISIS IS NOW OVER

SoBe
NO FEAR

16oz SUPER ENERGY SUPPLEMENT
Energy Sources

Renewable Energy

Wind
Wind Energy

✓ The harnessing of the power of wind to turn turbines for electricity

✓ Also, wind power turned directly into mechanical energy such as a water pumping.
Wind turbines at Altamont Pass, California.
Antarctica
GE Wind Energy
3.6 MW Prototype Turbine in Spain
✓ Wind farms send their electricity to nearby substations.
America’s First Off Shore Wind Farm: Cape Wind?

Miles from the nearest shore, Cape Wind will use the clean, inexhaustable power of wind to provide three-quarters of the Cape and Islands’ electricity

...helping to clean our environment and the air
...reducing our dependence on foreign energy
...creating new jobs
...lowering electric costs

N.I.M.B.Y
The Debate
Wind Energy - Future Growth

EWEA, 1999
36% rate of growth
Nuclear - 343 GW Worldwide

Installed Capacity [GW]
Inside a wind turbine

National Wind Technology Site
Golden, Colorado
The Turbine

One more ladder to go.
Looking into Coal Creek Canyon, where a nesting pair of Eagles live.
Downtown Denver
# Wind Energy

## BENEFITS
- **Checks**
  - Does little or no harm to the environment.
  - Can supply electricity and water pumping.
  - Small or large systems available.
  - Can be located offshore.
  - Can coexist with farming and other land uses.
  - Energy supply is endless.

## CONCERNS
- **Checks**
  - Currently more expensive than fossil fuels.
  - Most of the costs involved are for start-up infrastructure.
  - Power generation is intermittent.
  - Spoil the view?
Energy Sources

✓ ✓ Renewable Energy

✓ Bioenergy
Bioenergy

**Biomass Energy** - the use of plants and grains to produce useable fuels for cars, heating, or electricity production.
Types of Biomass Available

Corn Stover
Corn Stover
Turning Corn Stover into Fuel
Sugar extracted from corn stover
Additional Biomass Sources

Napier Grass

Switch Grass
Additional Biomass Sources

Sugar Cane
Additional Biomass Sources

Harvesting Popular Trees
Charcoal from Sawdust
Bioenergy

**BENEFITS**
- Little to no harm to the environment.
- Can supply electricity, fuels and heat.
- Energy supply is readily available and sustainable.

**CONCERNS**
- Currently more expensive than fossil fuels.
- Infrastructure to support bioenergy needs expanding.
Energy Sources

Renewable Energy

Hydroelectric
Hydroelectric Energy

Water pulled by gravity can turn a turbine and make electricity
Tapping into Earth’s water cycle

![Diagram of water cycle](http://www.hdprint.co.uk/ftp/CanyonLands/212-%20Glen%20Canyon%20Dam%20from%20plane.jpg)

![Image of Victoria Falls](image)

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![Diagram of hydroelectric power station](image)

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*Image credit: [Hydropower](http://www.hdprint.co.uk/ftp/CanyonLands/212-%20Glen%20Canyon%20Dam%20from%20plane.jpg) and [Victoria Falls](image)*
Hydoelectric Energy

**BENEFITS**

- Can supply electricity at low cost per KWH
- No pollution
- Already in place in many countries
- Very high efficiency (80%)
- Recreation dollars
- Energy supply is sustainable.

**CONCERNS**

- Dams and reservoirs can negatively impact humans and environment

52
Energy Sources

Renewable Energy

Geothermal
Geothermal- the harnessing of the internal heat of the earth’s core to produce heat for homes or electricity.

Geo means **Earth**

Thermal means **Heat**
Plate Boundaries

“Ring of Fire”

Volcano (historical eruption)
Geothermal power plants have no smoky emissions. They emit water vapor.
Easy on the Environment

Geothermal power plants have been built:

- In the middle of crops
- In forested recreation areas
- In fragile deserts
- In tropical forests

First Geothermal Power Plant, 1904, Larderello, Italy
Benefits of Geothermal Power

- Provides clean and safe energy using little land
- Is renewable and sustainable
- Generates continuous, reliable “baseload” power
- Conserves fossil fuels and contributes to diversity in energy sources
- Avoids importing and benefits local economies
- Offers modular, incremental development and village power to remote sites
CO$_2$ Emissions Comparison
(lbs/MW-hr)

Source: EIA 1998; Bloomfield and Moore 1999
Geothermal Power Plants
Residential Heating

Heat Pump in Winter

Heat is collected from underground & transferred to the building
Cooling

Heat Pump in Summer

Heat is collected from the building & transferred to the ground.
Cleaning Up Our Air

Each year 22 million tons of carbon dioxide, 200 thousand tons of nitrogen oxides and 110 thousand tons of particulate matter are not emitted to the atmosphere because we used electricity from geothermal resources rather than burning fossil fuels.
Benefits of Geothermal Heat Pumps

- Can be used almost everywhere worldwide
- Are energy- and cost-efficient
- Conserve fossil fuel resources
- Provide clean heating and cooling -- no emissions from burning fuels
Where do we go from here?

CONSERVE!!
Use Less Energy

What else should be done?
Renewable Energy Review

Types

✓ Solar
✓ Wind
✓ Bioenergy
✓ Hydroelectric
✓ Hydrogen/Fuel Cells
✓ Geothermal
BENEFITS

- Environmentally clean energy.
- Using a variety of sources, all of our energy needs can be fulfilled.
- Provides jobs and economic benefits.
- Diversity of supplies helps national security.
- Reduces geopolitical pressures. (No more war for oil)
- Energy supply is endless.
## Addressing the CONCERNS

- Costs are already going down for renewables and will improve even more with mass production.
- Americans are paying more than ever for gasoline. When will the general public demand the switch to renewables? $4.00/gal? $5.00?
- Start-up infrastructure cost will pay off in short time.
- Progressive approach to diminishing supplies of fossil fuels.
Renewable Energy Cost Trends

Levelized cents/kWh in constant $2000\textsuperscript{1}

Source: NREL Energy Analysis Office

\textsuperscript{1}These graphs are reflections of historical cost trends NOT precise annual historical data.

Updated: October 2002
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