

## Comparisons of various energy sources

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As the world's population increases and there is continued comparison to the current western European, Japanese, and North American living standards, there is likely to be demand for more electrical power. Energy sources available in the world include coal, nuclear, hydroelectric, gas, wind, solar, refuse-based, and biomass. In addition, fusion had been originally proposed as the long-term source.

Every form of energy generation has advantages and disadvantages as shown in the table below.

<i>Source</i>	<i>Advantages</i>	<i>Disadvantages</i>
<i>Coal</i>	<ul style="list-style-type: none"> <li>• Inexpensive</li> <li>• Easy to recover (in U.S. and Russia)</li> </ul>	<ul style="list-style-type: none"> <li>• Requires expensive air pollution controls (e.g. mercury, sulfur dioxide)</li> <li>• Significant contributor to acid rain and global warming</li> <li>• Requires extensive transportation system</li> </ul>
<i>Nuclear</i>	<ul style="list-style-type: none"> <li>• Fuel is inexpensive</li> <li>• Energy generation is the most concentrated source</li> <li>• Waste is more compact than any source</li> <li>• Extensive scientific basis for the cycle</li> <li>• Easy to transport as new fuel</li> <li>• No greenhouse or acid rain effects</li> </ul>	<ul style="list-style-type: none"> <li>• Requires larger capital cost because of emergency, containment, radioactive waste and storage systems</li> <li>• Requires resolution of the long-term high level waste storage issue in most countries</li> <li>• Potential nuclear proliferation issue</li> </ul>
<i>Hydroelectric</i>	<ul style="list-style-type: none"> <li>• Very inexpensive once dam is built</li> <li>• Government has invested heavily in building dams, particularly in the Western U.S.</li> <li>• Most areas that could be have already been dammed.</li> </ul>	<ul style="list-style-type: none"> <li>• Very limited source since depends on water elevation</li> <li>• Many dams available currently exist (not much of a future source[depends on country])</li> <li>• Dam collapse usually leads to loss of life</li> <li>• Dams have affected fish (e.g. salmon runs)</li> <li>• Environmental damage for areas flooded (backed up) and downstream</li> </ul>
<i>Gas / Oil</i>	<ul style="list-style-type: none"> <li>• Good distribution system for current use levels</li> <li>• Easy to obtain</li> <li>• Better as space heating energy source</li> </ul>	<ul style="list-style-type: none"> <li>• Very limited availability as shown by shortages during winters several years ago</li> <li>• Could be major contributor to global warming</li> <li>• Expensive for energy generation</li> <li>• Large price swings with supply</li> </ul>

and demand

### *Wind*

- Wind is free if available
- Good source for periodic water pumping demands of farms as used earlier in 1900's
- Generation and maintenance costs have decreased. Wind is proving to be a reasonable cost renewable source.
- Well suited to rural areas.
- This is a rapidly growing source.

- Need 3x the amount of installed generation to meet demand
- Limited to windy areas.
- Limited to small generator size; need many towers.
- Highly climate dependent - wind can damage equipment during windstorms or not turn during still summer days.
- Can affect endangered birds, however tower design can reduce impact.
- In some areas residents object because of the visual impact (e.g. Cape Cod).

### *Solar*

- Sunlight is free when available

- Limited to southern areas of U.S. and other sunny areas throughout the world (demand can be highest when least available, e.g. winter solar heating)
- Does require special materials for mirrors/panels that can affect environment
- Current technology requires large amounts of land for small amounts of energy generation

### *Biomass*

- Industry in its infancy
- Could create jobs because smaller plants would be used

- Inefficient if small plants are used
- Could be significant contributor to global warming because fuel has low heat content
- Can produce noxious emissions (e.g. carbon monoxide, unused fuel, hydrocarbon byproducts).

### *Refuse Based Fuel*

- Fuel can have low cost
- Could create jobs because smaller plants would be used
- Low sulfur dioxide emissions

- Inefficient if small plants are used
- Could be significant contributor to global warming because fuel has low heat content
- Flyash can contain metals as cadmium and lead
- Contain dioxins and furans in air and ash releases

### *Hydrogen*

- Combines easily with oxygen to produce water and energy

- Very costly to produce
- Takes more energy to produce hydrogen than energy that could be recovered.

<i>Fusion</i>	<ul style="list-style-type: none"> <li>• Hydrogen and tritium could be used as fuel source</li> <li>• Higher energy output per unit mass than fission</li> <li>• Low radiation levels associated with process than fission-based reactors</li> </ul>	<ul style="list-style-type: none"> <li>• Breakeven point has not been reached after ~40 years of expensive research and commercially available plants not expected for at least 35 years.</li> </ul>
<i>Waves</i>	<ul style="list-style-type: none"> <li>• New promising source being tested</li> </ul>	<ul style="list-style-type: none"> <li>• Cables carrying electricity must be protected against saltwater corrosion and surf action</li> <li>• Costs to be determined.</li> </ul>
<i>Free-standing River Turbine-Generators</i>	<ul style="list-style-type: none"> <li>• New promising source being tested</li> </ul>	<ul style="list-style-type: none"> <li>• Cables carrying electricity must be protected against water corrosion and surf action</li> <li>• Costs to be determined</li> </ul>

### Conclusion:

Throughout the world, we need *every energy source we can get - including nuclear*. As one can see from the table above, *all energy sources have BOTH advantages AND disadvantages*. Nuclear has a number of advantages that warrant its use as one of the many methods of supplying an energy-demanding world. Even with conservation efforts, energy demand has been and will continue to increase. Other factors can accelerate that increase, e.g. the proposed shift to electric cars to meet environmental air quality goals. In using **each and every one** of these forms of energy production, we need to make sure we conserve as much as we can so we leave sources for future generations. Energy suppliers need to ensure that they do not contribute to short and long-term environmental problems. Governments need to ensure energy is generated safely to that neither people nor the environment are harmed.

In the United States, many of the existing nuclear plants will reach the end of their currently authorized U.S. Nuclear Regulatory Commission license during the next 25 years. If nuclear is not used, other energy sources must be obtained.

Additional insights into reasons for considering nuclear power as part of the energy supply mix are outlined in [\*Reasons for Using Nuclear Power As An Energy Source.\*](#)

### Information Resources:

A good perspective of future energy demands and environmental impacts is provided by the following [Energy Information Administration](#) reports:

- International Energy Outlook Reports (with projections) - [Current](#)
- Annual Energy Outlook Reports (with projections) - [Current](#)
- Emission of Greenhouse Gases in the US - [Current Report](#) - [Database](#)
- [Energy Information Administration](#) - ([Environmental](#) - [Forecasts](#) - [Nuclear](#) - [Electricity](#) - [Energy Topics \(A-Z\)](#) - [Coal](#) - [Natural Gas](#) - [Renewables](#))

### Nuclear Fuel Cycle Calculators

The [World Information Service on Energy Uranium Project](#) has numerous uranium fuel cycle-related pages (covering Radiation and Health, Uranium Mining and Milling, Statistical Data · Current Issues · Impacts · Tailings Management · Further Information, Uranium Enrichment, Military Use of Depleted Uranium Phosphate Tailings). Particularly valuable tools are calculators for:

- [Nuclear Fuel Material Balance](#)
- [Nuclear Fuel Cost](#)
- [Nuclear Fuel Population Health Risk](#)

### **Questions to Raise and Address:**

There is a perception that there is a vast supply of natural gas; this source is being promoted as a way to meet air quality objectives by some government agencies. If gas is to be used, several questions or issues need to be addressed:

- Why, during recent years, have natural gas and LP gas prices increased substantially (even up to a factor of 2x)? Will the increased demand for gas by utilities drive prices up further?
- Natural gas is ~ 95% efficient for home heating, but only 33 to 60 % when used in gas boilers or turbines to generate electricity. Why should lower efficiency applications be used?
- Can the gas transmission infrastructure handle the increased gas demand without greatly reducing the amount available for residential home heating?
- Gas heating releases carbon dioxide to the air. Will this increase global warming?

Other questions to address are:

- Is use of Electrical powered cars which depend on charging from a process that is 33-60% efficient really a prudent use of energy?
- Will coal costs increase based on recent Environmental Protection Agency air quality regulation changes?
- Will electrical deregulation really result in lower prices?
- If nuclear is not used, where is the electrical power to come from; how much of a cost increase is the customer willing to pay? how much environmental impact will the public tolerate?

These are the questions that should be answered by federal legislators and state utility regulatory agencies. If you want to query your federal legislator, click the appropriate link- [Congressman](#) - [Senator](#).

In some cases it has been stated that nuclear has benefited from government subsidies during the early development. That is true. However, that does not mean we should throw away the investment. In fact, many governments have invested heavily in the capital infrastructure for making use of all energy sources. As an example, electricity costs in the Tennessee Valley and Pacific Northwest are lower because of previous government subsidizes of hydroelectric power - through the building of the dams and the support of the Tennessee Valley Authority and Bonneville Power Administration. Solar, coal, and wind programs have also received government funding. In general, the United States government has promoted inexpensive energy by taxing energy use at lower rates than in a number of other countries.

### **Renewables and Conservation Issues**

To ensure that energy resources will be available for future generations, we need to take actions in the following areas:

- improve home and building designs to conserve energy and take advantage of passive renewable resources
- conduct research to ultimately lead to significant cost reductions for renewable energy sources

- design industrial parks for those energy-intensive industries that take advantage of cogeneration concepts
- ensure that power plants use cogeneration methods to minimize waste heat
- develop uses for nuclear waste products
- significantly reduce use of those energy production methods that are major contributors to global warming, or develop technical solutions that curb releases of those materials that produce global warming

Key WWW sites providing information on renewables include:

- [National Renewable Energy Laboratory](#)
- [Energy Efficiency and Renewable Energy Network](#)
- [Center for Energy Efficiency and Renewable Technologies](#)
- [Renewable Energy – Sustainable Development](#)

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