

Environmental Hierarchy of Waste Management & Energy Production Methods / Fuels / Technologies

Cleanest	← Solid Waste Management →						Dirtiest
<p><u>Redesign</u> <u>Manufacturing</u></p> <p>Make products durable, recycled and recyclable</p> <p>Use materials which are more environmentally sustainable</p>	<p><u>Toxics Use Reduction</u></p> <p>Reduce amounts of toxic chemicals in production</p> <p>Replace toxic chemicals with less toxic or non-toxic alternatives</p>	<p><u>Reduce Consumption Reduction</u></p> <p>Use less</p> <p>Buy less</p> <p>Buy stuff with less packaging</p> <p>Avoid disposables & non-recyclables</p>	<p><u>Packaging Reduction</u></p> <p>Bring your own bag</p>	<p><u>Reuse</u></p> <p><u>Reuse</u></p> <p>Thrift stores</p> <p>Charity collection</p> <p>Dumpster diving</p>	<p><u>Recycle</u></p> <p><u>Recycle</u> <u>Downcycle</u></p> <p>Source Separate</p> <p>Avoid mixing different types of materials</p>	<p>← Solutions →</p> <p><u>Compost</u></p>	<p>Problems→</p> <p><u>Disposal / Dispersal</u></p> <p><u>Landfill</u> <u>Deregulate</u> <u>Incinerate</u></p> <p>Landfill</p> <p>Mine Fill</p> <p>Monofill</p> <p>Land Application</p> <p>Beneficial Use</p> <p>Recycling toxic or radioactive wastes into consumer products or building materials</p> <p>Mass Burn</p> <p>Co-firing</p> <p>Fluidized Bed</p> <p>Gasification</p> <p>Plasma Arc</p> <p>Pyrolysis</p>

Cleanest	← Electricity Production →						Dirtiest
<p><u>Conservation</u></p> <p>Lighting</p>	<p><u>Efficiency</u></p> <p>Lighting</p> <p>Motors</p> <p>Appliances</p> <p>Geothermal heat pumps</p>	<p style="text-align: center;"><u>Clean Renewables</u></p> <p style="text-align: center;">← Solutions → Problems→</p> <p><u>Solar</u> <u>Wind</u> <u>Micro-hydro</u> <u>Ocean</u> <u>Geothermal</u></p> <p>The electric grid can be run 100% on intermittent technologies using storage strategies to balance the load. This can include flywheel energy storage, compressed air, molten salt, hydrogen, batteries or – until we're ready to remove them – hydroelectric dams.</p>			<p><u>Hydroelectric</u></p>	<p><u>Natural Gas</u></p> <p>Simple Cycle</p> <p>Combined Cycle</p> <p>Fuel Cell</p>	<p><u>Dirty Energy</u></p> <p><u>Oil</u> <u>Incineration</u> <u>Coal</u> <u>Nuclear</u></p> <p>(see "biomass feedstocks" list below)</p> <p>Gasification ('Clean coal')</p> <p>Fission [Fusion]</p>

Cleanest	← Transportation & Heating Fuels →						Dirtiest				
<p><u>Conservation</u></p> <p>Mass Transit</p> <p>Carpooling</p> <p>Telecommuting</p> <p>Reduce Sprawl</p> <p>Trails-to-Rails</p> <p>Bicycling</p> <p>Walking</p> <p>Buy/Work Local</p>	<p><u>Efficiency</u></p> <p>Fuel Efficiency Standards</p> <p>Hybrids</p> <p>Weatherization</p>	<p style="text-align: center;"><u>Clean Energy</u> ← Solutions →</p> <p><u>Clean Electricity</u> <u>Sustainable Biodiesel</u></p> <p>Plug-in Hybrids or Full Electric Vehicles; for heating, ground- and air-source heat pumps</p> <p>From used vegetable oils or non-biotech algae [can meet a very small portion of fuel demand]</p>			<p>Problems→</p> <p><u>Biodiesel</u></p> <p>Soybeans</p> <p>Sugarcane</p> <p>Palm Oil</p>	<p><u>Ethanol</u></p> <p>Corn-based ethanol</p> <p>Cellulosic ethanol (from biofuel feedstocks – see below)</p>	<p><u>Natural Gas</u></p>	<p><u>Landfill Gas</u></p> <p>Boiler</p> <p>Piped into natural gas lines</p>	<p><u>Oil</u></p> <p>[and other petroleum products]</p>	<p><u>Waste-Based Fuels</u></p> <p>Trash / sludge-to-ethanol (cellulosic ethanol)</p> <p>Thermal depolymerization</p>	<p><u>Coal</u> <u>Tires</u> <u>Hazardous Waste</u></p> <p>Coal-based liquid fuels</p> <p>Cement Kilns</p> <p>Paper Mills</p> <p>Cement Kilns</p> <p>Chemical Plants</p>

Least Dirty	← Biomass / Biofuel Feedstocks →						Most Dirty	
<p><u>Digester Gas</u></p> <p>Sludge</p> <p>Animal waste</p> <p>Food waste</p>	<p><u>Landfill Gas</u></p>	<p><u>Trees</u></p> <p>Tree Trimmings ("Urban Wood Waste")</p> <p>Forest Cutting</p>	<p><u>Energy Crops</u></p> <p>Phytoremediation plants</p> <p>Biotech</p>	<p><u>Agricultural Crop Residue</u></p>	<p><u>Paper / Lumber Mill Wood Waste</u></p>	<p><u>Animal Factory Wastes</u></p> <p>Poultry litter</p>	<p><u>Construction / Demolition Wood Waste</u></p> <p>Painted/treated wood</p>	<p><u>Sewage Sludge</u> <u>Tires</u> <u>Municipal Solid Waste</u></p>

How to read this complicated chart

There are four rows, each dealing with a different topic: Solid Waste, Electricity, Transportation & Heating Fuels, Biomass/Biofuels. Each row shows a best-to-worst spectrum. The **most** desirable things are on the **left** side of the page, and the **least** desirable things are on the **right** side of the page.



A **solid vertical line** is a dividing line between what are acceptable solutions (to the left) and what are unacceptable problems (to the right).

A **dotted vertical line** separates the types of solutions.

The **squiggly vertical line** in the bottom row simply indicates a division between gasses and solids; but all are still unacceptable: note the solid vertical line at the far left side of that row.

We have much information on our websites that explain why we take these positions. Please see www.energyjustice.net for the energy related topics and www.actionpa.org & www.ejnet.org for waste related topics.

Relationships between the rows

The Three R's = CECR

Notice that the waste row contains, in order of importance, "Reduce, Reuse, Recycle." The parallel concept in the energy rows is: "Conservation, Efficiency, Clean Renewable Energy." It is most important to reduce the need for materials or energy at all. The next priority is to use materials and energy as well as possible. A materials example is: reduce need by carrying a mug, reuse a glass juice bottle as a water bottle, and eventually recycle it when it cracks. An electricity example is: conserve by installing motion detectors on lights, increase efficiency by changing to LED bulbs, and power them with clean solar energy.

Bio...

All rows contain reference to biomass in some way. "Biomass" commonly refers to allegedly "organic" solids (other than coal) that are incinerated to produce electricity (releasing air pollution and creating toxic solid wastes like ash or slag).

"Biofuels" usually refer to 1) liquids such as soy-oil-sourced biodiesel or ethanol made from a variety of materials or 2) methane-containing gasses that result from the anaerobic decomposition of trash, plants, excrement, etc. These can be used in the transportation and heating fuels sectors, though in some cases (like the gas-based forms of "biomass"), they're used to make electricity.

Waste or Energy

Using wastes as an energy source is usually the worst way to deal with the waste. Sometimes the destruction of solid materials is a waste of their embodied energy – the energy that went in to making them useful materials in the first place; they should be recycled or composted so that we don't need to re-create them from raw materials. Often there are toxic consequences to burning wastes. Sometimes the wastes should really not exist in the first place, and their use as an alternative energy source perpetuates waste production. Trying to "solve" waste problems through energy policy typically leads to the worst option for managing materials / wastes.

Solving our energy needs is a separate question that should prioritize demand reduction and fuel-free, zero emission technologies.