

## Warmth of the Sun: Active Solar Thermal for Low and Mid Temperature Heat

Electricity represents only about 18% of our end use consumption needs -although we can and must greatly increase this in a renewable scenario. A large portion of the rest may be supplied via active solar. Solar energy can supply space heat and hot water for residential use. (Single family residential cooling is on too small a scale for active solar to be economical, unless someone could integrate it into a solar heating unit without a great deal of additional cost). It can supply space heat, cooling and hot water in commercial buildings. (Commercial air conditioning is definitely done on a large enough scale to be supplied by solar thermal air conditioning.) Similarly the small portion of industrial consumption used for space conditioning could be supplied by solar thermal. Providing up 65% of climate control and hot water is considered normal today; but we are looking at fossil fuel free future where fuel is more expensive than at present. So our goal will be to see that active solar thermal will supply about 85% of all space heating, 85% of commercial and industrial space cooling, and 85% of hot water requirements below boiling temperature - beyond that provided by passive solar. (Note also that these are averages; the best technology can do better than this in California or Arizona, and worse in the Yukon. [Yes, you can get significant amounts of solar thermal energy in Alaska; just don't rely on it as your primary space or water heating source.])

Note that with seasonal storage, this works quite well in cloudy climates with short days. Yes you need more solar panels; but demand is higher, so they usually pay for themselves in almost as short a time as in sunnier climates with lower demand. Active solar can vary from low temperature low cost systems without moving parts (near passive systems) such as the solar wall<sup>297</sup>, to sophisticated selectively coated flat plate systems.

While this is a worthwhile goal, and theoretically possible, it is not one we are likely to achieve. There are densely populated areas where buildings shade one another and buildings where walls are shaded and roofs have the wrong orientation for solar. These are especially discouraging in cold cloudy climates where you need a lot of heat, and don't get that much direct sunlight in any case. As we mentioned in the section on electricity, electric heat, is our backup plan - with ground source heat pumps used whenever possible. (A recent discovery is that ground source heat pumps can draw on space under streets; with cooperation from local governments these can be installed for entire neighborhoods during road repair.)

Now one last point before we add up the numbers on this. Because we incorporated passive solar already into our efficiency scenario, we have saved more in space heating and cooling than other areas. And because hot water uses comparatively low temperature heat, we were able to save more there as well. So it would be reasonable to lower the share of such use as a percent of total energy, thus reducing the amount of low temperature solar thermal we can use. (In other words we will assume less solar thermal than if the shares were the same, to avoid counting the same saving twice.)

Quadrillion BTU Energy in 2050 (not including the additional electricity storage losses)	~36.86
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Commercial space heating as a percent of total energy 2000 <sup>298</sup>	6.96%
Commercial water heating as a percent of total energy 2000 <sup>298</sup>	1.04%
Commercial space cooling as a percent of total energy 2000 <sup>298</sup>	2.63%
Residential space heating as percent of total energy 2000 <sup>299</sup>	9.69%
Residential water heating as percent of total energy 2000 <sup>218</sup>	3.58%
Industrial space conditioning as a percent of total energy 2000 <sup>169</sup>	2.12%
Subtotal	26.02%
However, more intense efficiency savings are possible with space heating and cooling than other sectors due to the use of passive solar. So we reduce this total as a percent of total consumption by 20%	20.82%
Active solar can save about 85% of that at a price less than twice conventional low temperature applications	17.70%
Quadrillion BTU from active thermal solar in 2050	6.47

Shares of total energy are computed as follows. Share of each usage type as percent of the particular sector (in the sources referenced by endnotes in the table) is multiplied by each sectors share of all energy used<sup>258</sup>.

Low temperature solar is almost competitive with natural gas now when supplying from 45%-65% of needs. At 2X the cost of fossil fuel we may be able to supply 85%. To the extent we can't, we can use un-stored, un-backed-up cheap wind electricity to drive heat pumps (ground source where practical, air-to-air where not). When temperatures drop too low for heat pumps to be practical we can rely on high efficiency resistance heating, powered by off-peak renewable electricity, and stored as heat.

## End Notes

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<sup>297</sup>U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, *Combustion Success Story: Solarwall® Air Preheating System | Elegantly Simple System Uses Solar Energy to Heat Ventilation Air or Preheat Combustion Air. Office of Industrial Technology Inventions & Innovations Program*, I-CO-563. December 2001, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, 5/Sep/2004 <<http://www.eere.energy.gov/inventions/pdfs/conserval.pdf>>.

<sup>298</sup>United States Department of Energy, Energy Information Administration, *Preliminary CBECS End-Use Estimates - Preliminary End-Use Energy Consumption Estimates for Commercial Buildings in 1999 Based on Data from the 1999 Commercial Buildings Energy Survey*. 1999, United States Department of Energy, Energy Information Administration, 25/Aug/2004 <[http://www.eia.doe.gov/emeu/cbecs/enduse\\_consumption/intro.html](http://www.eia.doe.gov/emeu/cbecs/enduse_consumption/intro.html)>.

Detailed Tables - Table 1. End-Use Consumption for Natural Gas, Electricity, and Fuel Oil, 1999 (Preliminary Estimates)

<sup>299</sup>These are preliminary numbers released in late 2003, and may change slightly by the time you read this.

U.S. Department of Energy - Energy Information Administration, "2001 Consumption and Expenditures Tables – Total Energy Consumption" *A Look at Residential Energy Consumption in 2001*. 23/October 2003, 23/Dec/2003

<[ftp://ftp.eia.doe.gov/pub/consumption/residential/2001ce\\_tables/enduse\\_consump.pdf](ftp://ftp.eia.doe.gov/pub/consumption/residential/2001ce_tables/enduse_consump.pdf)>.

Table CE1-9c. Total Energy Consumption in U.S. Households by Northeast Census Region, 2001 - Preliminary Data

Table CE1-10c. Total Energy Consumption in U.S. Households by Midwest Census Region, 2001 - Preliminary Data

Table CE1-11c. Total Energy Consumption in U.S. Households by South Census Region, 2001 - Preliminary Data

Table CE1-12c. Total Energy Consumption in U.S. Households by West Census Region, 2001 - Preliminary Data

U.S. Department of Energy - Energy Information Administration, "2001 Consumption and Expenditures Tables - Space-Heating Energy Consumption," *A Look at Residential Energy Consumption in 2001*. 23/October 2003, 23/Dec/2003

<[ftp://ftp.eia.doe.gov/pub/consumption/residential/2001ce\\_tables/spaceheat\\_consump.pdf](ftp://ftp.eia.doe.gov/pub/consumption/residential/2001ce_tables/spaceheat_consump.pdf)>.

Table CE2-9c. Space-Heating Energy Consumption in U.S. Households by Northeast Census Region, 2001 - Preliminary Data

Table CE2-10c. Space-Heating Energy Consumption in U.S. Households by Midwest Census Region, 2001 - Preliminary Data

Table CE2-11c. Space-Heating Energy Consumption in U.S. Households by South Census Region, 2001 - Preliminary Data

Table CE2-12c. Space-Heating Energy Consumption in U.S. Households by West Census Region, 2001 - Preliminary Data

U.S. Department of Energy - Energy Information Administration, "2001 Consumption and Expenditures Tables - Electric Air-Conditioning Consumption Tables," *A Look at Residential Energy Consumption in 2001*. 23/October 2003, 23/Dec/2003

<[ftp://ftp.eia.doe.gov/pub/consumption/residential/2001ce\\_tables/ac\\_consump.pdf](ftp://ftp.eia.doe.gov/pub/consumption/residential/2001ce_tables/ac_consump.pdf)>.

Table CE3-9c. Electric Air-Conditioning Energy Consumption in U.S. Households by Northeast Census Region, 2001 - Preliminary Data

Table CE3-10c. Electric Air-Conditioning Energy Consumption in U.S. Households by Midwest Census Region, 2001 - Preliminary Data

Table CE3-11c. Electric Air-Conditioning Energy Consumption in U.S. Households by South Census Region, - Preliminary Data

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Table CE3-12c. Electric Air-Conditioning Energy Consumption in U.S. Households by West Census Region, - Preliminary Data