Analysis of a Typical Family's Energy Use
Family of 2

Introduction and Basic Assumptions:

For this analysis, I am going to assume a family size of two persons living in a home. Both persons are employed in a family owned business. It is assumed that their work hours overlap but are not exactly the same. It is also assumed that, as in most family businesses, they work more than 8 hours a day. Although they do not have to commute, their usage of the automobile is assumed to be quite large, since most people do commute.

Readers should remember that both the home and the business still have many of their energy needs "on" even during the hours when they are not occupied. For instance, the heating and cooling devices are generally left on. Some lighting is always on. Certain appliances will run at all times of day as in refrigerators and freezers for instance. Businesses have equipment that cannot ever be turned off. This may include computers and many kinds of process equipment, unique to each specific business.

Energy consumption can be expressed in (at least) two ways. These are total use over a period of time (units of watt-hours or equivalent) or rate of use on an average, continuous basis (units of watts or equivalent). Since rate of use is the more demanding metric from the point of view of energy supply and its ability to meet demand, we use rate throughout.

It is the imbalance between rate of supply and rate of demand that has and will continue to cause problems related to energy. For instance, the rate at which gasoline can be refined from crude oil is at present just barely greater than the rate at which gasoline is demanded by drivers. Readers know that this situation has led to a very sharp run up in gas prices, as well as actual shortages at the pump. These same conditions exist in the electricity supply, leading to occasional rolling blackouts and other problems. This confirms the wisdom of focusing on rate of use rather than the total used.

At Home:

Heat	A Typical Home Furnace - Gas - 100,000 BTU/Hr Capacity. That is equivalent to 29,300 watts. But assume 90% efficient. Assume it Runs 13% of the time on average. That is Equivalent to 4232 watts continuous draw.	4232
Cooling	A Typical Home Central Air Conditioner - 6 Tons. Equivalent to 72,000 BTU/Hr or 21,095 watts. Assume it Runs 20% of the time. Assume COP = 2 That is Equivalent to 2109 watts continuous draw.	2109
Lighting	A Typical Home, at Night will have 12 lights on. Assume 2 at 150 watts, 5 at 60 watts and 5 compact fluorescent at 6 watts each. Total of 630 watts draw. Assume on for 6 hours per day = 25% of the time. Equivalent to 158 watts continuous draw.	158
Hot Water	A typical hot water heater will draw 2500 watts when firing. But outside of showers and wash they are seldom on. Assume 15% on time. Equivalent to 375 watts continuous draw.	375
Cold Water	Water must be pumped, chlorinated and filtered.	

	Pumps are huge, but each family uses only a tiny faction of their capacity at any time. Assume 50 watts continuous draw for this purpose.	50
Appliances	Dishwashers, Clotheswashers, Dryers, and the like consume typically from 500 to 3000 watts. Assume 2500 average. Assume all combined are on for 15% of the time. Equivalent to 300 watts continuous draw.	300
Communications	Television, Radio and Phones. Always on, at least one of the above. Assume 100 watts continuous draw.	100
Entertainment	Game machines. All Terrain Vehicles. Powered Toys. All kinds of diverse kinds of similar things. Wild guess of 50 watts.	50
Computers	Almost all families have one. Many have 2 or 3. Especially if there are kids. Assume one on at all times. Power supply in a computer is about 450 watts plus maybe 100 watts for monitor.	550
Food	This is going to require a separate study to get a solid number. For now assume a typical farm consumes as much energy as 25 households, but feeds 200 people. That is, it feeds 100 households. So, the total we obtain here, divided by four, will be used for food production, transportation, and preparation and storage. I am sure this number is very Conservative.	6,223
Waste Disposal	This is also going to require a study to really nail down. For now assume one of the huge diesel garbage trucks can serve 300 households per day (8 hours). Say the engine develops 95 HP on average (much, much more on peaks.) 95 hp = 70,775 watts. On for 33% of the time, one day a week, = 3336 watts. Divided among 300 households = 11 watts	11
Maintenance	New Roof. New Hot Water Tank. Electrical Repairs. Replace the Appliances. Broken faucets, lamps, fixtures, and who knows what else ? Assume 200 watts all the time.	200
	Sub-Total (Using heating only)	11,949
At Work:	I will compute this for a home office plus small shop. Will assume very roughly the same for a person who works outside the home. I will assume the office/shop are in a separate building.	
Cooling	Assume the same as at home.	2109
Heat	Assume you need the same amount at work as at home.	4232
Lighting	Assume 4 times that as at home, as detailed work may need to be done plus light shop floor.	632

Hot Water	Assume almost none compared to at home.	50
Cold Water	Assume the same as at home.	50
Communications	Assume almost none compared to home.	25
Computers	Each two persons will use at least one computer each somewhere in the business office or shop.	1100
Production or Work Equipment	Depends totally on the kind of business. Even a small shop will draw perhaps 4000 watts.	4000
Food	Included in food above.	0
Waste Disposal	At least equal to home waste disposal, probably more.	11
Maintenance	Many times that of the home. Assume at least 4 x.	800
	Sub-Total: (Using Heating Only)	10900

Transportation: Fuel	Even people who commute rarely drive more than an hour each way. Most drive less. Further, the car engine never develops full horsepower, normally cruising at a small fraction of the 200 to 300 horses available. Assume the car is driven 3 hours per day, 6 days per week. Assume you cruise using 25 horsepower (Many use only 15). 25 HP = 18,625 watts, when running. 18 hours running is 10 percent of the time in a week. 10 percent of 18,625 watts is 1865 watts.	1865
Oil	Negligible	5
Maintenance	Expensive, but very little energy.	10
	Sub-Total:	1880
		=====
	Grand Total:	**24729**

(Watts, continuous)

(For 2 people)

This is equivalent to 3.69 Terawatts for all purposes combined. (298.7 million population)

This agrees well with published figures of 3.345 Terawatts seen elsewhere.

Now we chart some of these data:

Home:	11,949
Work	10,900
Transport	1880

Grand Totals:	Heat/Cool	8464
	Light	790
	Hot Water	425
	Cold Water	100
	Appliances	375
	Communications	125
	Entertainment	50
	Computers	1650
	Food	6223
	Waste	22
	Maintenance	1010
	Production	4000
	Transportation	1880

Note:

Please notice that the embedded energy in items is not included in this analysis. For example, a major appliance will have energy embedded in its materials, further energy used in its manufacture (mostly accounted for above), and energy used in moving it to its point of use (Using Trains and Trucks).

The same is true of homes, autos, and the like.

However, aside from the difficulty in applying these numbers on a household by household basis, there is also the fact that these items tend to have a very long life. Homes last 50 years at least, and usually much longer. Major appliances will often last 25 years. Some are legendary for their long service. And modern automobiles have finally reached the point where 200,000 to 300,000 miles of service over 15 years of life is commonplace.

In addition, a significant amount of the embedded energy is reclaimed when these items are either recycled or remanufactured.

For these reasons, we do not feel that these numbers would be greatly altered by adding in these kinds of figures. Perhaps in a more comprehensive study than the present effort, more detail could be included in this area.

Note:

Please notice we do not include the extra energy people use when on vacation or when traveling on business. Most people in average jobs never travel on business at all. Thus to a first order of approximation this can be neglected.

Most people take vacations, but they do so typically once a year only. These days many of them stay at home and relax, because they cannot afford the high cost of vacation travel. Others do travel of course. Again, we have chosen to neglect this for the average person in a first order approximation.

One could, if desired, add a percent to the transport sector to account for these uses.

Note:

The Transport numbers, small as they are, are still likely overstated in the grand total number. That is because we assume that every household (298.7 million/2 = 149.2 million households) drives their car the stated amount. This is certainly not true. Also, it takes no account of mass transit, nor of carpooling, nor of compact cars that cruise on a lesser horsepower.

Despite this, we choose to leave the number at the larger figure, to account for transport not included elsewhere. We did include farm transport, but we did not include Industrial Transport, except to say that it would be included in embedded energy. By leaving the transport number at the higher value, we include embedded transport energy to a large extent, thus making the transport figures more reliable overall, and, as we said, probably overstated. This leads to a conservative estimate, which is good.

Conclusions

The model above is validated by its close agreement with figures for total energy use published elsewhere in the literature.

We use the largest amount of energy at Home.

Most of the rest of it is consumed in our place of Work, or in support of workplace activity.

Energy consumed by the average household in Transportation is almost negligible, when compared to the first two items above.

As individuals, we have a distorted understanding of where we use the lion's share of our energy. We don't pay the energy bills at work, so we don't tend to notice them at all.

We pay the electric bill and the gas bill perhaps once a month, but this is often an automatic payment out of an electronic checking account that we tend not to notice. Plus, financially, these forms of energy have been a pretty good buy economically speaking, and we accept them and are generally conditioned to think of them as normal.

We don't think of our food bill as energy at all. Even though every person who shops for food for the family will tell you that the family food bill every week is BIG !

On the other hand, the gasoline bill for the car tends to sting us out of all proportion. Cars don't carry much fuel, so you have to buy gas over and over and over, every few days. This keeps your constant attention. Plus the recent run up in prices has made gasoline seem like a bad deal financially. The huge unwarranted profits made by the oil companies irritate us. So we all imagine that much - even most - of our energy is used in transportation.

This simply is not so.

If we eliminated transportation completely, it would make little difference overall in our use of energy as a nation. And, of course, this is totally impossible anyway.

But, we ought to be aware of where we use our energy, and this where we ought to concentrate our efforts on new energy sources and on conservation. By comparison with work and home, cars just don't matter very much.

Whether at work or at home, heating and cooling are the biggest energy uses.		35%
The production, transportation, preparation and use of Food is a close second place.		25%
The third highest use is in production at the workplace.		18%
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	Total:	78%

Everything else is a distant last place by comparison.

On the other hand, if we generated the energy used in heating and cooling, and in the workplace, from renewable sources, we would eliminate 53% of our fossil fuel use at one stroke.

That should be the clear priority of the Nation.

It is also clear that the next priority of the Nation should be to employ renewable energy in the production of food, since food production is such a large percentage of our energy use overall. Clearly some forms of energy used in production of food (e.g. fertilizer, transport, working the soil) cannot readily be obtained from renewable sources like wind and solar. But the electricity used on the farm can come from these sources, and can even be produced on the farm itself in many cases. We might be able to cut half of the fossil fuel use on the farm in this way, for a further 12.5% reduction in fossil fuel use.

The total reduction now is up to 53 + 12.5 = 65.5%.

It is also clear that there is one big thing we should NOT do. That is, take valuable foodstocks, like corn, and turn them into motor fuel.

There are two very large reasons for this. First of all, the cost of producing food like corn is very high in energy terms. Producing a lot more corn will cost the farm a lot more energy. And even if every single vehicle in existence is powered with ethanol as a result, it is a losing proposition overall from the energy point of view.

Secondly, there is not enough farmland in the entire nation to produce a sufficient amount of corn to make this amount of ethanol. So, the thing is impossible anyway.

Impossible, and inefficient.

We have already gotten a good look at what is happening to the corn situation, just from the increase in demand caused by using ethanol to replace MTBE in gasoline. (i.e., not even replacing the gas itself, just the MTBE in it).

What is happening ? Reserve stocks of corn, according to published reports, have declined by over 50% this year alone. That is to say, after next year, as demand accelerates, they will be gone. And corn production has been dropping due to droughts and other problems. Supporting still more demand, and it's a much more enormous demand, to replace the gasoline itself is going to run into a brick wall of supply vs. demand in only 3 years. Already poor people in places like Mexico have rioted because they can no longer afford corn for basics like tortillas, one of the few foods the poor (formerly) could afford.

Ethanol produced from cellulostic feed stocks has been held up as an alternative to corn. So have soybeans and other feed stocks. But this does nothing once the existing reserve stocks of such materials are depleted in the same way corn has been. Most cellulostic stocks take years to grow. And regardless of anything else there is simply not enough acreage available to grow the vast required quantities. We'd have no farmland left to grow food for ourselves, much less support our livestock.

What should we do, if anything, about motor fuel ? That answer is clear. Make hydrogen, using only renewable energy from wind and solar, and salt water, and use this to power motor vehicles. This can handle perhaps 50% of our motor fuel needs. The rest of the motor fleet should obviously be all electric. That is, not hybrids, but plug-in electric vehicles powered off the (renewable) grid. This eliminates the use of fossil fuels from the transport sector completely. It is only an 8% gain, but it is the next thing to do, after all of the above are done.

Now the total reduction in fossil fuel use is up to 53 + 12.5 + 8 = 73.5%.

From this point on, it would be relatively easy to replace the rest of the fossil fuels used by renewables. This would leave the remaining fossil reserves available for the valuable applications like plastics, pharmaceuticals, other petrochemical based products, and so forth. Oil, after all, is really too valuable to just burn.

Some Final Notes about this Analysis:

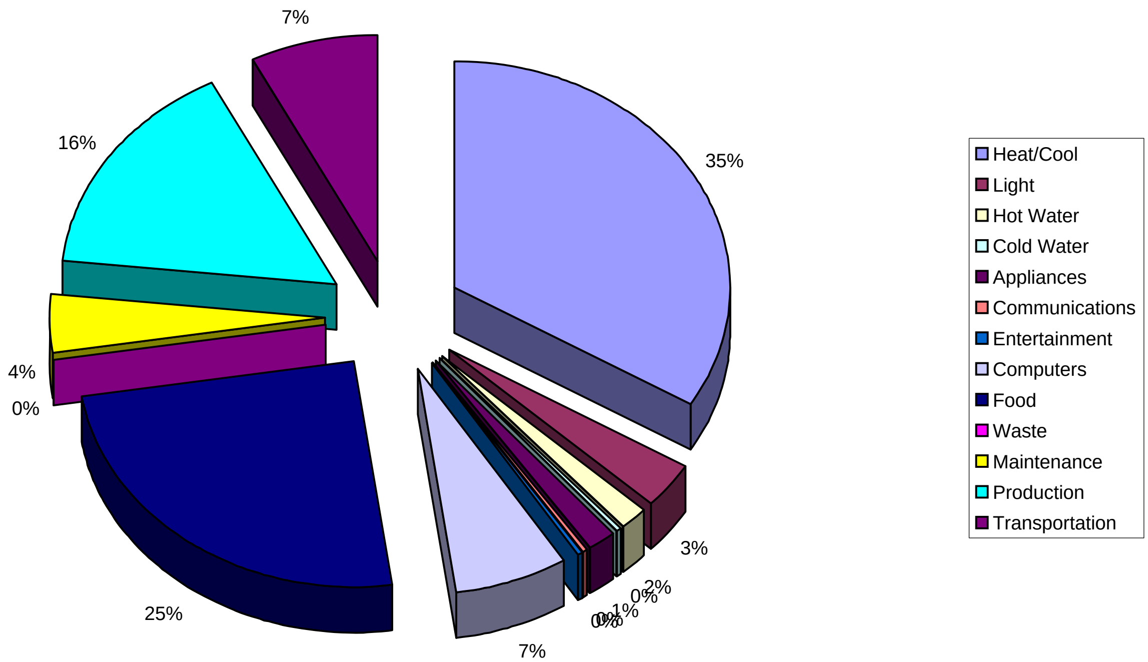
First of all, the facts and figures I present, are just that - facts. They are taken from actual measurements made in a household like the sample household we analyze. Hence they are real data.

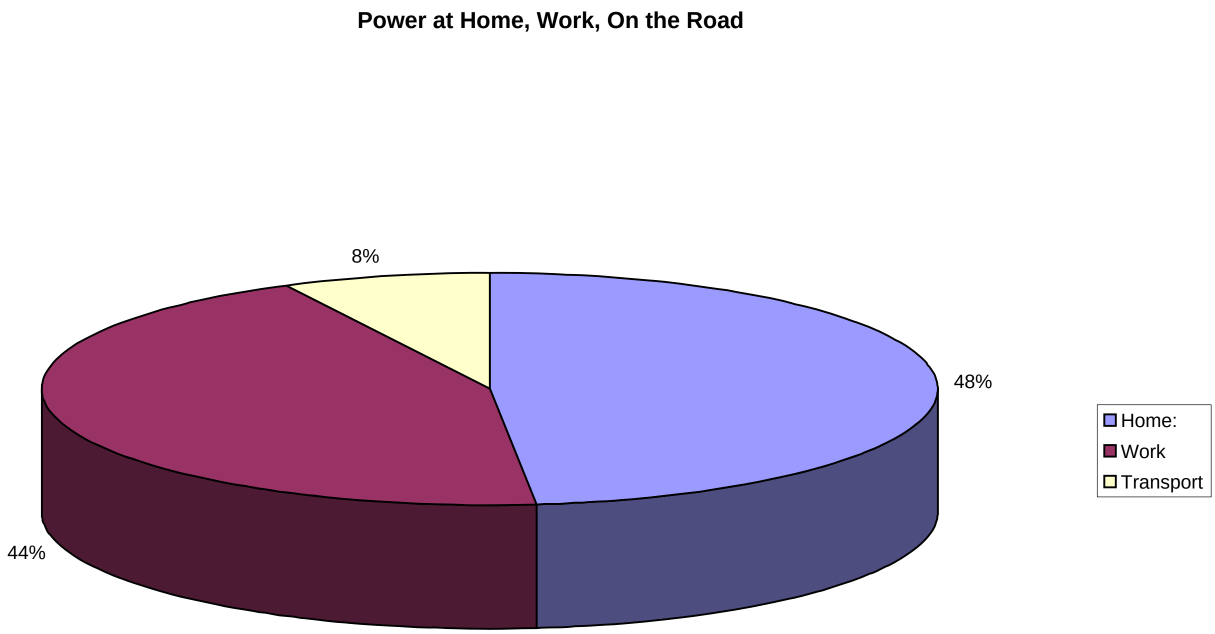
On the other hand, the suggestions made for corrective action reflect my preference for renewable energy, above other forms of energy. But you've been told by "them" that you cannot expect an energy supply of the future to be dominated by renewables. That coal fired and nuclear "base load" plants are an actual requirement, like a law of nature. That renewables are too expensive, and somehow scarce.

None of this is true in the long term, though obviously some of it is so in the short term. So we must engineer a smooth transition. It will take time and investment to build an infrastructure of renewable energy sources.

Ask yourself however, this simple question: Would you rather the nation spend its billions on the building of a renewable energy system sufficient to our needs, or would you rather send the money abroad to nations that hate us, while we fight wars over dwindling oil supplies ?

Total Energy by Specific Use




Power at Home, Work, On the Road
8%
48%
44%
Home:
Work
Transport