Immigration and the U.S. Energy Shortage

by Donald Mann, President
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Summary

Growing dependency on foreign oil is rapidly pushing our nation toward major economic disruption. The oil crisis is one element of a long term energy shortage whose effects will increasingly be felt as we near the end of an era of cheap and abundant energy. That era was made possible by large - but nonetheless finite - fossil fuel resources.

Estimates of the amounts of oil and coal that will be ultimately recoverable (and burnable because of environmental constraints) vary widely. The exact amounts are almost irrelevant, however, since how long remaining stocks will last is more a function of the rate at which consumption is growing than it is of the size of the stocks.

There is an amazing difference in the length of time a given resource will last when consumed by static, non-growing demand, compared with the time it will last if consumed by demand growing exponentially. The central focus of our national energy policy should be to stabilize demand for energy at a level that would be sustainable for the very long term - a level that would need to be far lower than it is today.

To do so, we need to reduce per capita consumption of energy by continuing to find ways to use energy more efficiently. Above all, however, we need to stabilize the size of our U.S. population at a far lower level than it is today, after a prolonged period of population decrease.

Such a reduction could be achieved without undue hardship if our present total fertility rate is maintained, or lowered slightly, and if we substantially reduce immigration so that it is balanced with emigration (out-migration), and thus no longer contributes, as it does now, to our annual population growth.

The Coming Oil Crisis

An oil crisis that will imperil both our economy and our national security is close upon us as demand for oil arises, domestic production falls, and imports fill the growing gap.

According to a February 1987 report[1] by the Energy Research Advisory Board to the United States Department of Energy, proven U.S. oil reserves recoverable with today's technology and price are only 30 billion barrels of oil. That is roughly equivalent to 10 years production at current rates, and would be sufficient to meet total U.S. oil consumption for only about five years!

According to the Energy Research Advisory Board (ERAB) report cited above, we now import more than 40 percent of U.S. oil needs. Many specialists say this figure could reach a dangerous 60 percent by 1995, only a few years from now. This would be far above the 33 percent rate at the time of the 1973-74 Arab oil embargo, and would exceed the peak of 48 percent dependency reached in 1977.

Such dependency would represent a threat to our national security, and could well lead to economic chaos if imports were disrupted for any considerable time. It is widely agreed that within less than a decade the OPEC countries will be back in control of the world oil market.

We will then find ourselves in the precarious position of being heavily dependent on countries in the world's most volatile region for a supply of vitally needed oil. Needless to add, such a situation would heighten significantly the risk of a great power confrontation.

U.S. Oil Production and Resources

There are those who hold out hope that U.S. oil production can be maintained with proper incentives to the oil industry. This appears to be extremely unlikely. In any event, it could not be maintained for long. Known reserves are 30 billion barrels, and, according to Department of the Interior estimates[2], oil resources that remain to be discovered in both U.S. onshore and offshore deposits are 69 billion barrels.

The combined total of roughly 100 billion barrels for reserves plus ultimately recoverable resources is only enough to supply U.S. needs for less than two decades at even the current demand. We should also bear in mind that even if U.S. oil production could be maintained at the present level, our dependency on foreign oil would continue to grow as long as our total usage continues to increase.

The ERAB study cited above states that the United States has a large petroleum resource base, and estimates the remaining total oil resource as approximately 625 billion barrels. Such estimates are highly speculative, and involve a great deal of guesswork about geology, technology and price. Much of the oil resource base can never be extracted at any rational cost.

It would be far more prudent to err on the side of caution in estimating the total amount of oil that is available. If we double the Department of Interior estimate cited above for oil resources that remain to be discovered, we would arrive at a figure of 168 billion barrels for the total of reserves plus ultimately recoverable resources. That would doubtless represent the upper limit.

At the present level of U.S demand, even that vast resource would be exhausted in less than three decades, and much sooner if demand for oil continues to grow steadily, as it has done in the past.

Moreover, potential environmental constraints make it impossible to accurately foresee what portion of the total oil resource base can ever be recovered and utilized. The ERAB report states that "unacceptable environmental damage is a potential impediment to the extraction and utilization of all existing energy resources, including oil and gas." The day may be close at hand when, in order to avoid unacceptable and irreversible damage to the global environment, we will be required to slow down the rate at which oil and coal are recovered and consumed.

Finally, any estimates of the quantity of oil ultimately recoverable must take into account the net energy barrier. One recent study, (*Beyond Oil,* Ballinger Publishing Co., 1986), estimated that, within a few more years, the energy cost of exploring and drilling for new oil will exceed the energy content of the oil produced. When that happens - when we have run into the net energy wall - all other factors, including the size of our remaining undiscovered oil resource, and the per barrel price of oil, will simply become irrelevant. We would then have to depend, for our domestic oil production, on our rapidly dwindling known reserves that were already discovered.

As we have seen, present known reserves plus resources are only sufficient to meet total U.S. demand for a few decades. One would think that this alarming situation would be more than sufficient to cause panic in the streets. With rare exceptions, however, our national leaders, the media and the general public show few signs of concern.

An End to Growth

A sensible and prudent national energy policy should have, as two of its primary goals, 1) maximizing the lifetime of our remaining resources of fossil fuels, and, 2) making sure that the harmful by-products of energy utilization (waste heat and pollution) do not exceed the long range carrying capacity of our environment.

To achieve those goals, we need to stabilize demand for energy at a level that would be sustainable for the very long term. From the viewpoint of the environment there is mounting evidence - e.g. the greenhouse effect and acid rain - that today's level is already far too great to be sustainable.

From the point of view of maximizing the lifetime of our remaining fossil fuel resources so that they will be available for future generations of Americans for hundreds, or even thousands, of years, it is readily apparent that growth in energy demand must be halted. The reason for this is quite simple: any finite resource, no matter how vast, will be quickly consumed by steady growth in the rate of consumption of the resource.

The Awesome Power of Exponential Growth

In a paper[3] published in 1978, entitled *Forgotten Fundamentals of the Energy Crisis,* Albert A. Bartlett, Professor of Physics at the University of Colorado, examined the concept of exponential growth, and calculated how long our fossil fuels would last at various rates of growth.

Some of the points Professor Bartlett brought out are as follows:

When the rate of consumption of a resource is growing at a fixed percent each year, the growth is said to be exponential. *Exponential growth is characterized by doubling, and a few doublings can lead quickly to enormous numbers.*

Another important aspect of exponential growth emphasized by Professor Bartlett (and one that is astonishing to the non-mathematician), is that the increase in any doubling time is approximately equal to the sum of all the preceding growth!

For example, when the rate of consumption is growing at seven percent a year, the consumption in one decade exceeds the total of all the previous consumption. "The reader can suspect," Professor Bartlett writes, "that the world's most important arithmetic is the arithmetic of exponential function. *One can see that our long national history of population growth and of growth in our per-capita consumption of resources lie at the heart of our energy problem.*"

Professor Bartlett makes it clear that when consumption is rising exponentially, *new discoveries that double the size of the remaining resource result in only a small increase in the life expectancy of the resource.* He goes on to draw a general conclusion of great importance: *"When we are dealing with exponential growth we do not need to have an accurate estimate of the size of a resource in order to make a reliable estimate of how long the resource will last."*

We often read that the vast coal resources we have are sufficient to last for many hundreds of years. *This would only be true if there is no annual growth in consumption.* By contrast, Professor Bartlett has calculated that, with a five percent annual growth in consumption, our "superabundance" of coal would be totally exhausted in less than 100 years!

Professor Bartlett's letter[4] on this subject, written in 1976, is reproduced on page three.

One does not need to be either an energy expert or a mathematician to realize that, if we want our vast coal resources to last for hundreds, or even thousands of years, we need to stabilize demand at a level substantially lower than it is today.

A Smaller U.S. Population

We need, of course, to reduce energy consumption per capita by continuing to find ways to use energy more efficiently. That alone, however, will not be sufficient to reduce and then stabilize energy demand at a level that will be sustainable for the very long term.

We must recognize that the greater our numbers, the more energy we will consume each year. The cornerstone of a sensible national energy policy, therefore, must be a program to halt, and eventually to reverse, our population growth until, after a prolonged period of gradual reduction, it can be stabilized at a far lower level than it is today.

As noted demographer Kingsley Davis pointed out some years ago, ". . . we still construe energy policy as producing or saving energy for however many people there are, not as producing fewer people so as to give each one as much energy as he or she needs. Yet is is people who use energy. With fewer people, less energy is needed. This may seem obvious, but so far we have tragically postponed acting upon it."[5]

Smaller Would Be Stronger

In an age where energy and other vital resources are in scarce supply, the smaller our numbers (to a certain point, of course) the stronger our nation would be, because the less we would be dependent on outside, often precarious sources, for supplies of energy and other resources vital for the functioning of our industrial economy.

What if U.S. population had stopped growing just after World War II (when there was no shortage of manpower or womanpower to fight a prolonged global war with conventional weapons - conditions that are unlikely ever to be repeated)?

In 1946 our population was about 145 million, or less than 60

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Coal: no superabundance for US

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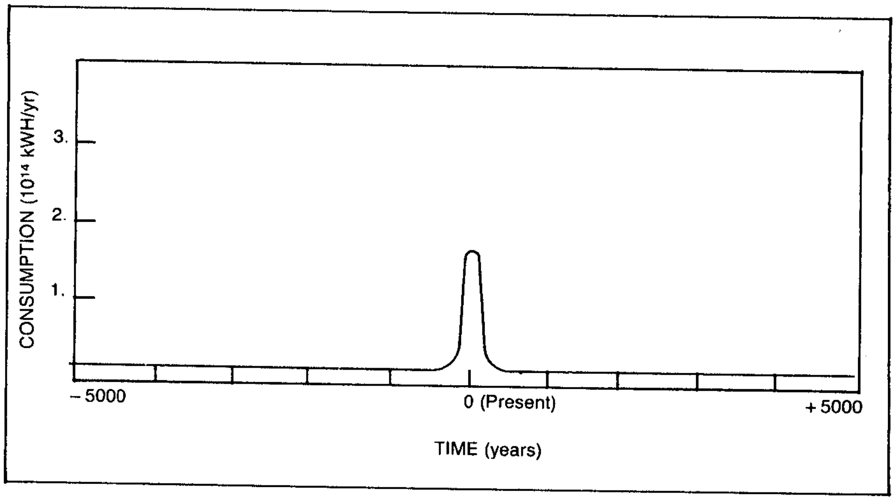

The rise and fall of the world's rate of consumption of fossil-fuel resources is like the flame of one match in the long night — a delta function in the darkness.

I wish to call attention to a very simple and striking aspect of the energy crisis. M. King Hubbert has given a distant look (see figure) at the rise and fall of the consumption of the Earth's fossil-fuel resources.[1] Since it is clear that our enormous agricultural production is totally dependent on artificial fertilizers and on fuel to power mechanized equipment, we may define modern agriculture to be "the use of land to convert fossil fuel (petroleum) into food." We then note that the rise and fall of world population can be expected to follow the curve in the figure.

The devastating consequences of the growing crisis in petroleum is causing massive efforts to be made to shift as much as possible of our domestic energy consumption from petroleum to coal. Two estimates of the magnitude of US reserves of coal are cited by Hubbert:

$$R_1 = 0.39 \times 10^{12} \text{ metric tons}$$

$$R_2 = 1.49 \times 10^{12} \text{ metric tons}$$

Our 1972 rate of consumption of coal was

$$C_0 = 5 \times 10^8 \text{ metric tons per year}$$

This rate of consumption has remained approximately constant since 1920; but for the 50 years between 1860 and 1910 the rate of consumption grew at a rate of 6.69% per year.

The length of time T that a quantity R of a finite resource will last when the present consumption rate is C_0 and the consumption is changing according to the exponential growth curve
$C = C_0 \exp(kt)$ is

$$T = \frac{1}{k} \ln\left(\frac{kR}{C_0} + 1\right) \qquad (1)$$

The results of calculating the times T for various values of k and for the quoted values of C_0, R_1 and R_2 are given in the table. These figures must be contrasted with the impressions given by the great energy companies, which advertise that we have a "superabundance" of coal whose rate of consumption we must vastly increase if we are to achieve "self-sufficiency."

"Coal, the only fuel in which America is totally self-sufficient."[2]

If we put our coal consumption on the same increase (6.69% per year) that occurred for the 50 years following the Civil War, the larger estimate of US coal reserves will be gone in 80 years! If we restrict our rate of increase of coal consumption to the rate at which world consumption of coal is increasing (3.03% per year) the larger estimate will last only 150 years! If we want US coal to last through our nation's second 200 years our rate of increase of coal consumption can not exceed 2% per year! In each of these cases it is interesting to speculate what life will be like the day after the reserves run out.

The most interesting aspect of the table is that it shows how the coal (or any finite non-renewable resource) may be made to last forever! If we set the argument of the logarithm of equation 1 equal to zero, the time T will equal infinity. This gives $k = -C_0/R$, which for R_2, is a decrease of 0.0336 percent per year. *United States coal would last forever if we let our consumption decrease at a rate of 3.3% per century. This is the ultimate self-sufficiency! It would provide adequate time for us to develop alternate energy sources.* Alternatively, if we put our coal consumption on an annual increase of 10% then we have barely 50 years in which to develop new sources of energy.

We see many public figures and many representatives of large energy companies speaking and writing about "energy self-sufficiency" and "energy independence." Although these people speak with authority on the complex aspects of the energy situation, I have seen no evidence to suggest that any of these experts understand the simple and fundamental arithmetic of the problem about which they speak with such great self-confidence.

I hope that all members of the physics community will use every means at our disposal to educate our business and government leaders to the magnitude and long-range implications of the problem.

It has been predicted that if there are paleontologists ten million years from now they will characterize our period (the present) as the "age of extinction."

References

1. "US Energy Resources, a Review as of 1972, Part I"; Serial No. 93-40 (92-75) prepared by M. King Hubbert, Office of Energy Resources, US Geological Survey at the request of Henry M. Jackson, Chairman, Committee of Interior and Insular Affairs, US Senate, June 1974. US Government Printing Office 1974, (31-8200).
2. American Electrical Power Company, Inc. advertising in *Newsweek*, 3 Nov., 1975; page 67.
3. J. I. Shonle, *Environmental Applications of General Physics*, Addison Wesley, Reading, Mass. (1975); page 377.

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Life expectancy of US coal reserves, R_1 and R_2

Annual growth in consumption (%)	Years R_1 will last	Years R_2 will last
30	18.2	22.7
20	25.3	32.0
10	43.7	57.0
6.69	59.4	79.2
5	73.8	100
3.03	105	149
2	140	205
1	217	342
0	780	2980
-0.010	812	3538
-0.020	848	4531
-0.030	888	7481
-0.03356	904	infinity
-0.05	988	
-0.10	1514	
-0.11	1744	
-0.12	2290	
-0.1282	infinity	

percent of our present population of 245 million. If our population size had been stabilized at 145 million, our current oil production would have been largely sufficient for our *total oil needs,* and our known reserves would have been ample far into the future. In short, we could have avoided the precarious position we will soon find ourselves in with regard to dependency on foreign oil.

National power is, and is likely to be even more so in the future, a function primarily of scientific knowledge, technological skills and industrial capacity. These in turn must be firmly based on the twin pillars of resource adequacy and a sound environment, both of which are fostered by a smaller rather than by a larger population.

To Reduce U.S. Population Size

Our annual population growth is now about 2.2 million (illegal immigration excepted), or slightly under one percent. At that rate our population would double in about 80 years, from the present 245 million to nearly half a billion.

Of that annual growth, the so-called "natural" increase of our population, that is, the excess of births over deaths, accounts for about 75 percent. Legal immigration accounts for the balance.

Our present total fertility rate is about 1.8 which is slightly below the long term replacement level. If that rate is maintained, in several more decades our natural increase will come to a halt, and then be followed (assuming a net migration of zero) by a slow and gradual decline in our numbers.

A slightly lower total fertility rate would be desirable in the interest of halting our population growth sooner, and that might be achieved if our federal government encouraged couples, by non-coercive means, of course, to have not more than two children.

For example, a largely symbolic measure such as limiting tax deductions to not more than two children, and a declaration by the President and the Congress that our national goal was to halt and then reverse our population growth as soon as possible, might well be sufficient to lower the fertility rate slightly. Even if this reduction occurred, however, its effect on our population growth would be gradual, and would only make itself felt over a considerable period of time. But we need an *immediate and substantial* reduction in our yearly population growth, and we can achieve this by limiting legal immigration.

Legal Immigration

Legal immigration has averaged about 570,000 a year in recent years, and accounts for roughly 25 percent of our annual population growth. Immigration is thus a basic and important determinant of our population size and growth.

In order to reduce our annual population growth immediately, and hasten the day when it is halted completely and then reversed, we believe that *legal* immigration should be reduced substantially to an *overall ceiling* of 100,000 a year, *including all relatives and refugees.*

In this way, immigration would be in rough balance with emigration (out-migration) and would no longer contribute to our annual population growth, thus aggravating the severity of the coming oil crisis, and the long term U.S. energy shortage. Such a balance between immigration and emigration would result in **zero net migration.**

An overall ceiling of 100,000 a year would still be generous. It could be considered small or inadequate only by comparison with the present level, which is simply no longer compatible with today's realities, or the vital interests of our nation, in an era of energy shortage.

The coming oil crisis, and the long term U.S. energy shortage, will be with us far into the future. The problems that they are sure to bring in their wake can only be intensified by *any* further population growth, from whatever source.

As Professor Bartlett has pointed out, our past population growth, and growth in our per capita consumption of energy lie at the heart of our energy problem. Our national interest requires that we act decisively *now* not only to halt, but to reverse, their growth. Only by doing so will we be able to eventually stabilize our annual energy consumption at a level that will be sustainable far into the future.

References

1. *Geoscience Research for Energy Security;* A Report of the Energy Research Advisory Board to the United States Department of Energy. February 1987. DOE/S-0056.
2. Colin Norman in *Science,* Vol. 228, page 974.
3. *Forgotten Fundamentals of the Energy Crisis,* by Albert A. Bartlett. American Journal of Physics, Vol. 46, No. 9, September 1978.
4. *Physics Today,* December 1976, page 9.
5. *Science,* Vol. 211, page 439, January 30, 1981.

Below-Replacement Fertility
by Kingsley Davis

It needs little perspicacity, however, to see that in a finite world the twin forces of population and per capita consumption cannot both long continue to increase. Neither one can grow indefinitely, but the two together can grow for only a brief moment in history. To see this, one can take any basic resource and calculate the drain on it under certain assumptions regarding growth. For example, if the entire world were to consume energy at the rate the United States did in 1980, total world consumption would be 5.6 times what it actually was. If one assumes that the world not only reaches the U.S. 1980 level but surpasses it by a rate of increase corresponding to that for the United States between 1950 and 1980, one finds that by 2010 the world consumption would be more than 12 times the actual 1980 level. Even if quantities of coal, oil, and uranium, or new substitutes, could be found sufficient to meet this enormous demand, it is doubtful whether the environment could withstand the assault of the resulting contaminants.

In industrial societies, then, the combination of ever more goods and services per person and ever more persons is creating an impossible situation in terms of congestion and environmental damage. It is this situation to which below-replacement fertility is an adjustment. People cannot, or will not, limit the goods and services supplied by their ever more complex technology, but they can forgo children, who if produced in abundance, would greatly add to the congestion.

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