Keynote Address: Population and poverty, energy and technology: Coal, mining and a proper start for the century

by R.L. Lawson*

I've been asked to appraise the global role of coal and mining, and the best place I can think of to begin is with the Worldwatch Institute, which purports to monitor all things global.

Last fall the institute's magazine, entitled *World Watch*, in a cover story called for a worldwide campaign to outlaw the use of coal before this century's end. To my mind the article began the campaign.

However, the institute had to admit that no such ban will be possible unless there is special help and heavy intervention—that is, novel policies and punitive taxes.

I'll quote directly from the magazine to underscore the point: 'without them the market will continue to deceive us into thinking coal is cheap, abundant and irreplaceable'.

The Worldwatch proposal is worth mention only because the institute is in part supported by the United Nations Population Fund, and its founder is a foremost member of a movement that is much more political than environmental.

The facts say that if there is deception in the Worldwatch syllogism the deceiver is not the market: Coal is cheap, coal is abundant, and coal is more than irreplaceable—it is indispensable.

The facts say the world will need all the energy it can find or economically bring into being—the facts of population growth in the developing nations and of individual aspirations in those same nations to rise out of subsistence and poverty.

The experience of the last century testifies that if population is to stabilize, then aspirations must first begin to be realized.

Some are beginning to call it a trilemma: Energy, population, and the environment. It's a problem of three factors, many sub-factors, and several unknowns. The critical factors are those which cause the others to change for the better, especially population and the unknowns.

I invite you to join me in reflecting on coal the resource and, in addition, on the workings of the world's energy markets in the contexts of the world's many related concerns, requirements and vulnerabilities.

As we move forward I urge you to keep in mind the role of technology in keeping coal cheap, abundant and environmentally friendly despite the ambitions of Worldwatch and all the like-minded.

Some initial guideposts may be useful. I propose that we examine the pertinent and current factors in steps as follows:

- First, population and the world energy requirement
- Next, world energy resources and capabilities
- Then, the clean-coal initiative and the potential of the technologies
- Then, the Kyoto Protocol, the climate postulation and like concerns and
- To conclude, I propose that we think about what constitutes effective and constructive action.

From time to time I'll have to refer to specific developments in the United States. I do this for only two reasons.

First: The U.S. economy is the largest component of the world economy and a critical factor in it. Changes here cause changes elsewhere—changes for the better or for the worse. We are the market of first resort for many developing nations in their drive to develop.

Second: As the largest component, The U.S. also requires the most energy. The energy is required to keep this economy strong and innovative—especially strong enough to keep Americans willing to remain the open market of first resort. This means policy decisions of the U.S. will be critical factors in shaping the course of events in world energy and the world economy.

I've gathered some numbers and projections to the point from the U.S. Government report *International Energy Outlook 2000*.

In the next 20 years world population is expected to pass 7.5 billion human beings. Primary growth will be in 130 developing nations where most people now have little or no access to what is called commercial energy—the energy that replaces the muscle power of humankind and beasts.

Their drive and their aspirations mean that global economic output should grow by almost 90 per cent to $55 trillion. This surge of human beings and activity will require the following:

- 60 per cent more energy of all kinds, including
- 45 per cent more coal
- 55 per cent more oil—an increase to 113-million barrels a day and
- 105 per cent more natural gas—an increase to 167-trillion cubic feet a year.

To restate the proposition: If sufficient energy is not available neither the surge of economic activity nor any other constructive surge is likely to take place; but population and

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related pressures are likely to continue growing. Adequate energy is a critical factor, it causes other factors to change.

World reserves of fossil fuel compare as follows:

- Natural gas is 14 per cent of the total
- Oil is 17 per cent
- Coal is 69 per cent
- There is four times as much energy in world coal as in oil
- There is almost five times as much energy in world coal as in natural gas and the current reserves-to-production ratios are
- Oil—40 years
- Natural gas—60 years
- Coal—210 years.

In the United States in fossil fuels the following generally applies:

- Oil is 2 per cent of the entire domestic reserve
  - U.S. oil is 4/10ths of 1 per cent of the world reserve
  - The R/P ratio for oil is 10 years
  - Gas is 3 per cent of domestic energy
  - U.S. gas is 5/10ths of 1 per cent of the world reserve
  - The R/P ratio for gas is 9 years and
  - Coal is 95 per cent.

The 275-billion ton U.S. reserve of currently recoverable coal is the rough equivalent of the following;

- 17 per cent of all the world's fossil energy
- 25 per cent of world coal
- 102 per cent of world oil—more than 1-trillion barrels
- 120 per cent of world gas—more than 5,000 trillions of cubic feet.

The R/P ratio for U.S. coal is about 250 years. More than half of America's electric power comes from coal. Generation last year required 940-million tons of coal. The government's short-term outlook foresees a generation requirement next year of 1-billion and 19-million tons.

In the global economy, oil is the energy of dominant use. The dominant energy news of the last nine months is the rise in the price of imported oil on the world market; of greater significance, the sustainability of higher prices.

On 1 June 2000 the world spot-price of oil was $24 a barrel, and it has lingered there: Not as high as it has been, but almost double that of 1 June 1999. Just this rise caused stirrings and murmurings of political discontent in nations around the world; and acts by some governments to mollify the discontented.

The cause was a coordinated curtailment in production of only 4-million barrels a day by the Organization of Petroleum Exporting Countries and a few non-OPEC collaborators in the face of rising demand. The demand is attributed to rising economic activity around the world and the revival in Asia.

The curtailment put production about 6 per cent below former averages. Some speculate the price will respond up or down to as little as 500,000 barrels a day on or off the market—about 7/10ths of 1 per cent of the averages.

The world's several reactions ought to be taken as a timely reminder of the abiding geo-economic liabilities and greater geopolitical dangers of rising demand and low diversity—a reminder of what the lack of flexibility really means.

World oil has poor geopolitical and geographic distribution. Almost 65 per cent of reserves occur in a region of social and political volatility—the Persian Gulf. The R/P ratio there is 8-to-90 years.

Gulf nations dominate OPEC, whose 11 members together control almost 80 per cent of reserves. The OPEC ratio is perhaps 70 years.

Meanwhile, the ratio for the rest of the world is less than 20 years—less than 20 years including the heralded recent discovery in the Caspian region.

The experience of the last 20 years and the dynamics of the next 20 emphasize the following:

- The perception of availability moves the market for imported oil—often dramatically
- Reserve position influences both perception and availability
- Economic competition or cooperation among OPEC and a few others can influence both perception and availability
- Political stability among dominant producers and in the dominant region influences both perception and availability
- Price influences world economic and political stability
- World stability influences war and peace
- OPEC and the Gulf nations will have increasing influence over world markets and stability.

Today the presence or absence of 4-million barrels a day can influence the decisions of the market. Will the market be any less anxious in 20 years when demand has gone from 73-million barrels a day to 113-million?

In the foreseen future, 90 per cent of energy will have to come from fossil fuel if there is to be adequate and reliable energy. The remaining fossil fuels are gas at 14 per cent and coal at 69 per cent of reserves.

The report *International Energy Outlook* and other authorities find that the following applies in natural gas:

- There is no world market, although one may evolve over time
- There is no infrastructure to support such a market, although it too may grow up over time—ports, pipelines, and so on
- Building the infrastructure will require unprecedented capital, which suggests a need for much higher prices
- A great deal of natural gas occurs in conjuction with oil
- And, thus, if a true market is established, inflexible dependence on gas imports may bring with it some of the same liabilities that attach oil, although perhaps in milder form.

In the U.S., the National Petroleum Council reported to the Secretary of Energy that heroic efforts will be required to meet expectations attached to natural gas in the activities that conjecture associates with climate—heroic efforts of discovery, of production, of infrastructure, and of capital investment: and, in the case of capital, heroic almost beyond imagination.

This report attached expenses of about $1.5-trillion—of $1.5 trillion in U.S. dollars—to the expectations of gas in the United States; more than $780 billion in capital investment, and more than $700 billion in operating expenses. That's just in the U.S.

Even then, the council found, periodic curtailment of

supply must be expected at times of peak demand.

Much of the increased requirement for primary energy is associated with electric power. In the future electric power will be the energy of greatest usefulness; and around the world the steepest rises in requirement will be for electric power.

Electric power is now the essential commodity of both advanced and advancing economies. It causes innovations in existing activity. It causes new kinds of activity. It displaces imported oil in many applications and multiple ways.

New kinds of activity such as the computer and the Internet re-emphasize the importance of availability on demand and of reliability in delivery—the need for power of high quality.

If the power's not there when it's needed, everything either slows down or goes down. As the per-capita requirement for power rises so does the importance of lower cost.

The 20-year expectations for electric power are approximately as follows:

- World requirement—up by 9-trillion kilowatt-hours and 75 per cent
- United States—up almost 35 per cent
- Japan—almost 35 per cent
- Western Europe—50 per cent
- Developing nations—165 per cent
- Developing Asia—185 per cent
- India—190 per cent
- And, China—260 per cent.

Some say that conservation through demand management is the answer. But, so far, demand in the United States has persisted in ignoring all attempts to manage it despite an accumulated expenditure of about $20-billion since 1990.

Conservation and end-use efficiency have useful roles to play; but they can't turn back increments of national demand like these or a worldwide tide of 9-trillion kilowatt-hours. And doing without isn't an option.

The United States at present has two dominant concerns in power—the restructuring of the industry and the quality of supply: that is, the combination of volume, ready availability, high reliability, and low cost.

Restructuring is required by the National Energy Policy Act of 1992. The Act was passed in consequence of the Persian Gulf War, which involved the world's energy security and economic stability.

The mechanism of restructuring is the introduction of regional and national competition in the production and sale of electric power. The objectives are to lower costs and, thereby, to invite power to displace imported oil in important applications throughout the economy.

International statistics show that current average prices for industrial power in the largest economies compare as follows:

- The U.S.—4.4 cents per kilowatt-hour coal predominating, the lowest of the majors
- France—4.9 cents
- United Kingdom—6.5 cents
- European average—6.5 cents
- Germany—7.2 cents
- And Japan—14.6 cents.

Coal is the key to price in U.S. power. A recent survey of the best U.S. power plants found the average costs of production and maintenance to be as follows:

- Natural gas—1.4 cents a kilowatt-hour
- Nuclear—1.35 cents
- Coal—1.02 cents.

This survey predates the recent increases in the price of both imported oil and, in the United States, natural gas. The spot price of natural gas in the U.S. on Tuesday of last week was $4.79 per million British Thermal Units: or almost 190 per cent above the same day in 1999. Conjecture in the trade press has begun on a price of $6 per million BTU's somewhere in the offing.

Meantime, in electric power, first stage restructuring is under way as companies reorganize themselves and choose roles—wholesale generator, or independent producer, or distributor, and so on. Detailed supplemental legislation is pending.

As this takes place, other concerns are entering play. They are prompted by regional power failures in the summer of 1999; and by spikes in the wholesale price at a time of unprededented demand—the $7,500 Megawatt-hour being the highest spike.

An inquiry into the failures returned findings as follows:

- Requirement is running above forecasts in many areas
- New generation and transmission have not kept up with load growth in many areas
- Reliability levels are eroding
- Historic levels of reliability may not be adequate for the future.

This summer much of the unrest has centered on spikes in the retail price of electricity in States such as California, our most populous. Since it is an election year, the political system is stirring as well.

Meantime, in world power, the report *International Outlook* foresees a slight contraction for nuclear generation over the next few years.

Since publication Germany has committed to a phase-out of nuclear generation over about the next 30 years due to pressure of its Green movement. Questions are said to be on the rise in Canada, Scandinavia, Japan and China.

A contraction is foreseen in the United States, the venue of earlier political and intellectual campaigns against nuclear generation. In the U.S. a little more than 70 per cent of power production comes from coal and nuclear generation combined.

U.S. nuclear generators made an heroic contribution to power supply last year. They ran at an average of 85 per cent of capacity and set a record for production despite the recent retirement of some units.

The other possibilities for power are hydro-electric generation and the broad category of renewable generation. The nations will handle these matters in different ways.

In the United States, the forecasts say the renewables of wind and solar generation are not expected to make a significant contribution through 2020; that at present they are unlikely to compete reliably despite tax credits running above 1.5 cents a kilowatt-hour.

Meantime, hydro-electric generation in the U.S. also has become the object of campaigns by intellectual and political

movements. These campaigns may well go worldwide through the participation of the movement's non-governmental organizations in the affairs of international institutions.

To the point: For at least the next 20 years the only choice for many nations, the U.S. included, for the electric power they require in the increments they require when they require it will be fossil fuel. Nine-tenths of future energy will have to come from fossil fuel.

For the foreseeable course of that future, the nations that turn to coal are likely to have lower and declining power costs, and a secure, reliable, and readily available source of primary energy.

Nations that turn elsewhere will be subject to whatever the perceptions of the world market, the requirements of competition in a global economy, and the realities of geopolitics bring to them.

Coal is almost 7/10ths of the world's fossil energy, more than 9/10ths of America's fossil energy. It enjoys wide geographic and geopolitical distribution. Many nations produce it. It is traded freely and competitively.

We've touched on the population, energy requirements, resources and capabilities. Let's think about technology.

Appropriate to thinking about concerns and technology, it's been said that science can fascinate; but it takes engineering to change the world.

In the century just ended the trajectory of technology in the U.S. coal-powered electricity-generation industry has been roughly as follows:

- Average thermal efficiency, early 1900s 8 per cent
- Mid-century average 16 per cent
- Current average 33 per cent and
- State-of-the-art pulverized coal 38 per cent.

Some of the world's generation is at the U.S. mid-century average, or only a little higher. Quite a bit is below. In these cases simply cleaning the coal before use would raise generating efficiency significantly. Coal preparation is established technology.

The International Energy Agency estimates that every 1-per cent increase in thermal efficiency causes a 3-to-4 per cent decrease in CO_2 output per unit of power produced.

To achieve higher efficiency in this standing capacity would immediately alter the long-term carbon projections; and this would alter the findings of the computer models on climate. It also would deliver immediate economic improvement—more power at lower cost. And it would at once extend the life of the resource—less fuel in, more power out.

The *Clean Coal Technology* programme of the United States picks up engineering's chain of achievement and adds new links.The objectives were higher efficiency, lower costs, better controls.

The formal purpose was to demonstrate and perfect the commercial readiness of, at present, 40 applications of technology. The deeper purpose was to balance resources and requirements and concerns.

The initiative was a $5.4-billion dollar joint-venture of government and industry that may be unique in two regards—first, 2/3rds of the money came from industry; and, next, the federal share was to be repaid in full as applications found success in the market. The commitment was deep.

The depth of commitment and the breadth of participation say much about the need for power and balance. Participants include engineering companies, equipment makers, power producers, coal producers, State governments, and so on.

The clean-coal programme includes the following applications:

- 5 demonstrations of advanced processing for cleaner fuel
- 5 demonstrations of industrial processes, including steel-making
- 19 demonstrations of new means to control both sulphur and nitrogen emissions either separately or in combination
- 2 demonstrations of advanced combustion heat engines
- 9 demonstrations of advanced power-production applications—four involve integrated-gasification-combined-cycle generation and five involve fluidized-bed combustion, both atmospheric and pressurized.

Twenty-four demonstrations have been completed, a number are under way, and some are in planning or design.

The advanced-generation applications are for the economic and efficient repowering of old plants and for new, or greenfield, plants. The sulphur-nitrogen demonstrations are generally retrofits for existing plants at lower costs in both dollars and power output.

Phase Two of the U.S. Clean Air Act, and the federal government's regulations for the performance of new sources, require that coal-fired power plants achieve what may be the world's most stringent limits for sulphur and nitrogen emissions.

The rules are complex; but in general terms the pertinent restrictions for most plants are as follows:

- On sulphur dioxide, limits ranging from 1.2 pounds per million British Thermal Units of fuel down to 6/10ths of a pound
- On nitrogen, limits from 6/10ths of a pound per million BTU down to 5/10ths and
- The law caps sulphur output in 10 years—as of 2010.

Also, in general terms: The advanced-generation technologies will deliver power at fractions of these limits—most often minor fractions. Both the results of demonstrations and the expectations of oncoming projects point to sulphur at 1/6th to 1/4th the most stringent limit; and to nitrogen at 1/5th to 1/2. The retrofits also perform generally below the limits—well below. In addition, the technologies also over-achieve alternative requirements that are sometimes applicable under the standards.

Efficiency of 45-to-50 per cent is in the near offing with advanced technology in the programme and making ready to come to market.

The retrofit technologies allow economic improvement of existing plants. The advanced-generation technologies provide for growth in power supply under the cap.

There is legislation now moving in Congress to establish incentives for early deployment of these technologies, as appropriate, in the 40 per cent of America's standing capacity represented by coal; and also as the need for new baseload power comes on.

Meantime we believe 60 per cent efficiency and zero-emission power with coal are both possible—indeed, that

they are probable. We'll revisit this in a moment.

All of the foregoing comes to bear on the Kyoto Protocol and the climate postulation.

Here are some facts and findings that have influenced the U.S. Senate's policy considerations of climate until just recently:

- Not even full compliance by all the industrialized nations can usefully reduce or slow the accumulation of carbon dioxide in the atmosphere
- Full compliance might shave 4/10ths of 1 per cent off CO_2 projections
- Full compliance would not change the projected rise in temperature by 1/10th of 1 degree Fahrenheit (through 2050)
- Developing nations are exempt from the protocol
- China with more than 1.3 billion persons at present must rely on coal
- India with 1 billion persons must rely on coal
- Carbon dioxide from the developing nations would nullify and swamp even full compliance by all industrialized nations alone
- Only one of five major European economies is likely to come close to compliance—the findings of a recent study by the Pew Center
- The Protocol's limits on energy would impose deep and enduring dislocations on the U.S. economy
- The dislocations would impose personal hardship on American workers and their families
- Rigorous enforcement of the Protocol would stabilize carbon dioxide about the year 2150 at great harm to the world economy
- But the diligent advancement of technology also would stabilize carbon dioxide about 2150 and benefit the world economy.

A member of the climate treaty's scientific advisory panel put it this way in a recent briefing in Washington, and I paraphrase him:

> *If there's one area of scientific consensus on climate it's this: The Kyoto Protocol will not do much about global warming.*

Now there are new considerations. Last month the scientist whose testimony initiated the movement of the U.S. toward the treaty entered new findings on carbon dioxide and the Protocol.

We touched on some of this Tuesday, but I'd like to refresh your memory and add some details.

In the paper *Global Warming: An Alternative Scenario*, Dr James Hansen, of the National Aeronautics and Space Administration, presents the following case:

- First, that carbon dioxide from the combustion of fossil fuel cannot be the main cause of the warming measured so far
- Next, that gases and influences other than carbon dioxide are the probable main cause of the warming measured so far
- That some of these causes are in decline
- That it should be possible to eliminate the influence of these causes over the next 50 years
- That it should be possible to do so without restructuring either national economies or the global economy
- Finally, that in the same 50 years it should be possible to bring forward improved energy efficiency and advanced technologies that will at one time retard carbon emissions and expand policy options.

Dr Hansen was joined in writing the paper by scientists of the Center for Climate Systems Research, Columbia University, and the Center for Environmental Prediction, Rutgers University.

The findings in Dr Hansen's paper are certain to be of new influence when the U.S. Senate returns to its customary routines, and in national capitals around the globe.

Sixty-seven of the 100 members of the United States Senate must approve provisions of the Kyoto Protocol and vote affirmatively to bind the U.S. to them if they are to apply here. This is in our organic law: The Constitution.

As the Protocol was being put forward there was a test vote in the Senate—a formal vote on a resolution of caution.

By this formal vote, 96 Senators of both the administration's party and the opposition warned the administration they will reject any protocol that: first, does not apply to developing nations; and, second, harms American workers. No Senators opposed the warning. The test rejection was unanimous. No Senator would vote for the Protocol.

The administration elected not to submit the Protocol for consideration. This administration's term of office is expiring and by organic law cannot be renewed. This year the U.S. chooses a new President in a national election.

Meantime, the composition of the Senate has not changed significantly since the test vote, nor does it seem likely. Nor does it seem likely that our federal election in November is likely to change it significantly. Senators sit for six-year terms.

As compliance deadlines draw nearer and nearer, it gets clearer and clearer that even the European nations most enthusiastic for the protocol will not and cannot comply.

The newly released findings of Dr Hansen and his colleagues will certainty give them reasons to re-evaluate their positions if not recommend outright changes.

Time is running out on the Kyoto Protocol. It seems and feels like new approaches are rising and being considered both in the U.S. and internationally.

In the U.S. there is the feeling of rising pressure in the course of events—a mounting up of developments that include:

- Pressures on the availability, price and security of energy sources as follows:
  - On the world's oil market and global energy security
  - On the world's political and economic stability
  - On possible future calls for U.S. National Security involvement
  - On the narrow and ever-narrowing U.S. reserve of electric power
  - On the requirement for new power
  - On the social, economic and political expectations of the people
  - Finally, the pressure of how to balance all of these things, and more.

In response, a sense of new direction and purpose is rising in Congress.

The stirring can be felt in the hearings and the activities and the proposals of influential members of both the Senate and the House of Representatives, the only policy-making components of our government. They reflect a determination to balance concerns and move forward with constructive action.

Here in summary are features from some legislative-policy proposals:

- Incentives to deploy technologies that reduce greenhouse gases as the market needs them, with emphasis on carbon dioxide
- Intensified research to determine the influence of anthropogenic CO_2 on climate and
- Intensified research, development and demonstration involving all energy, specifically to include the following:
  - Advanced nuclear energy
  - Renewable and alternative energy
  - Higher efficiency in the generation, transmission and end-use of electric power
  - Improved fossil-energy technology, including coal
  - Fuel-cells
  - The removal of carbon from both emissions streams and the atmosphere and its subsequent sequestration
- Plus, the export of long-established, efficiency-building technologies like coal preparation, and of the new technologies that exist, or that will soon be developed, with special emphasis on the developing nations.

As it touches on coal this evolving approach is outlined in the Department of Energy's new *Vision 21* programme, which picks up the chain of achievement from the *Clean Coal Technology* programme.

Pertinent elements of the *Vision 21* initiative include the following:

- Higher efficiency generation with coal—60 per cent as soon as possible, with emphasis on gasification
- Carbon removal and sequestration
- Low and no-emissions coal-fired power plants
- Development of the coal refinery concept—electric power gas, other energy, and by-products from coal
- With reuse of heat, total energy efficiency of 85 per cent.

In the matters of technology and the coal resource, in less than a century generating efficiency in the U.S. moved up from 8 per cent to a state-of-the-art 38 per cent.

The consequences were: Extended life for the resource; efficiency-driven reduction of emissions by 80 per cent per unit of power produced; and a dramatic decline in the price of power.

Indeed, when adjusted for inflation, the kilowatt-hour that Edison sold from his Pearl Street station for the equivalent of $3.89 in U.S. dollars now goes at an average industrial rate of 4.4 cents in the U.S.

This is the power of efficiency. None of this was forced. It was achieved by the workings of the market—the diligent advancement of technology and its orderly deployment as the market called it into use.

Now technology is poised to achieve 60 per cent efficiency in generation and 85 per cent in total energy efficiency.

This is how it stands with coal and technology in the global context from my perspective.

The mining of metals and minerals and kindred activities cannot expect to go much longer without the kind of attention that coal has been receiving in climate and from Worldwatch and the like-minded.

Indeed, in a policy tract entitled *Mining the Earth*, this institute already has defined mining as inherenty destructive and, in effect, in need of some heavy supervision and correction.

Of late the director Herr Topfer of the UN Environment Program has begun to advocate a 90 per cent cut in the flow of raw material to industrial nations. The resources seem to be fossil fuels and the primary minerals delivered by mining.

Others have advocated control of production to prevent depletion—control in the name of sustainable development.

In technology the mining industry of the United States has joined in a cooperative effort with the federal Department of Energy that we call *The Mining Industry of the Future* programme.

Among the objectives and priorities pertinent to this discussion are:

- Improved discovery
- Higher recovery
- Improved capability to develop small, difficult, and low-grade deposits.

All of these things would expand the estimates of recoverable reserves, and perhaps induce discussion about a concept of durable development.

The programme draws into one effort all forms of mining; it links them with the system of national laboratories that once served defense needs almost exclusively, and with research universities, and with others.

Their purpose is to identify, develop and deploy the kind of technology that will advance the human condition in the 21st century.

And so, our answer to Worldwatch and the like-minded is this: Join us in defining the problem, and then we'll find the technology to resolve it.

If a goal of zero emissions is not good enough, tell us what you really want. If doubling and redoubling and again doubling the utility and durability of the resource base is not sustainability, tell us why; and what you really want.

Technology is good energy policy, good economic policy, good environmental policy, and good National Security policy.

Right now young Americans stand guard in the Persian Gulf to underwrite the continued flow of the world's dominant energy. Young Americans have been in harm's way on this mission for almost 30 years now, beginning with the oil-supply crisis of the 1970s.

Because of the inflexibility and the threat to the world's stability, we had the Gulf War in 1991. Just a few years before there was a major expedition to keep open the Strait of Hormuz during the Iran-Iraq war.

The United States has led, but dozens of nations have made major military or financial contributions, including most of those represented here.

World population now is 6-billion human beings. Half have only limited electric power, the stuff of economic growth. Another 2 billion have none at all. Many must burn

dung to cook. Soon there will be 7-billion people. Before the century is of middle age there may be 8-billion or even 9-billion.

Both the developing nations and their people have aspirations. For the overwhelming majority of these people life will be a seemingly never-ending struggle against extreme poverty.

Each nation will be striving for internal stability and external security. Within every nation the people will be striving for a better life: Enough food, good shelter, sufficient clothing, and a little comfort.

The nations and the people must be given that opportunity; neither the people nor the nations can be denied it.

Where living standards begin to rise, population rates begin to fall. When people begin to prosper, they quickly look to making ther own improvements to the environment.

We must let the system work. It begins with energy and the basic commodities for economic growth. It delivers the improved standards that fight poverty and produce stability, which reduces populations; and the populations, in turn, come to find and emphasize their own versions of environmental improvement and sustainable growth.

From the first half of the 20th century—history's bloodiest—we know these things:

- When aspirations are thwarted or fail, governments fall and policies change
- Sometimes the changes are peaceful, sometimes not
- When nations become unstable, then aircrews sortie, navies put to sea and armies march.

Some say big wars are not possible today due to economic interdependence and international enlightenment—that a big war is no longer a realistic danger.

It's appropriate to note, as we approach the end of this discussion, that this assertion was first popularized in the English-language book *The Great Illusion*.

However, *The Great Illusion* was published in 1910, only months before the events of 1914 gave the 20th century its enduring direction and momentum. It took until 1991 to sort out all that began in 1914.

We cannot by any action we take now in the year 2000 ordain from this time the shape of the world in 2050 or 2100 as is argued by the intellectual and political movements that drive the climate controversy. The possibilities for misadventure are beyond numbering and counting up.

What we can do is impart the right direction and momentum to the opening years of the 21st century.

We can by the decisions we make today establish the wellsprings of economic strength and the foundations of capital and the portfolios of technology that will provide the oncoming generations the wherewithal to work out the subsequent decades themselves—perhaps to have it worked out entirely in fewer years than the time between 1914 and 1991.

I ask you to hear me now from the perspective of my former profession of military general officer.

We have only a moment of opportunity to put things in the right order—a few precious years, two decades at most.

If we don't get things in the right order, and soon, this century will make the past one look like a Sunday afternoon excursion to the countryside.

If we don't get it right, there'll be much greater demand for generals than for the makers of syllogisms; and much, much more work for soldiers of the rank and file.

Isn't it time to move on?

Necessity draws near.

Population is the challenge of the 21st century.

Poverty is the problem.

And energy is the answer: Energy and the flexibility that comes from technology and ample reliance on all sources of energy—but most certainly including our most abundant source: Coal!

This is the proper order.

These are the critical factors—the indispensable factors.

Thank you for your attention, and good fortune to all of us in the years to come. ◆