

By Tom Arendshorst

"ODE TO OUR AIR, #1"

OH, TO HAVE A STRATOSPHERE
THAT PROTECTS US FROM THE FEAR
OF BEING LEFT TO BROIL ALONE
WITHOUT OUR CANOPY OF OZONE.

O₂, NO MATTER HOW CLEAR AND FREE,
MUST NOT REPLACE OUR LOVING O₃
ABOVE THE CLOUDS; TRANSMITTED U.V.
WILL EXTINGUISH EVERY BUG AND TREE,
NOT TO MENTION YOU AND ME.

IT'S URGENT NOW TO FIND THE WAYS
TO ENSURE LIFE ON EARTH FOR FUTURE DAYS.
FOR OUR BLUE AND GREEN STAR TO NOT BE BAKED BRONZE,
WE MUST END OUR USE OF CHLOROFLUOROCARBONS!

O₂ KEEP OUR STRATOSPHERE CLEAR AND FREE,
CHOCK-FULL OF PROTECTIVE, FRIENDLY O₃,
LIFE-GUARDING INVISIBLE SHIELD OF OZONE,
TO INSURE THAT THIS WORLD WON'T BE GOD'S ALONE.

"ODE TO OUR AIR, #2"

IN THE DEPTHS OF FEBRUARY'S WINTRY DESPAIR
IT'S EASY TO DREAM OF DAYS WARM AND FAIR,
OF NUBILE TANNED HONEYS DECORATING THE SAND,
AND OF A GOLF CLUB OR HALYARD INSTEAD OF A SHOVEL IN HAND.

TAKE HEART! HAVE HOPE! STEPS HAVE BEEN TAKEN
SO OUR DREAMS OF CALIFORNIA MAY COME TRUE WHEN WE WAKEN
IN A FEW YEARS, BUT -- OOPS! -- IT MAY HURT
TO FIND THAT INSTEAD OF CARMEL WE GET THE MOJAVE DESERT!

THE FARMERS OF IOWA WILL ROAM THEIR WASTELAND LIKE ARABS,
AND INSTEAD OF PIGS AND CORN THEY'LL GROW CACTUS AND SCARABS;
THE OCEANS WILL RISE AS THE POLAR ICE HEATS,
AND SEWER GATORS WILL EMERGE TO SWIM NEW YORK'S STREETS.

WE MAY STARVE WHEN CROPS FAIL AS FLORIDA DROWNS,
ALL BECAUSE IN OUR AUTOS AND HOUSES AND TOWNS
WE STILL MAKE HEAT AND POWER AND LIGHT LIKE FOOLS
FROM ANCIENT OIL, COAL AND GAS -- THE FOSSIL FUELS!

FOR EONS PLANTS GREW, COMBINING CO₂ AND THE SUN,
BUT WHEN THE VEGGIES WERE BURIED AND THE EONS WERE DONE,
THE CARBON DIOXIDE WAS BURIED DEEP IN THE SOIL,
WHERE IT STAYED WHILE THE GREENS BECAME GAS, COAL, AND OIL.

SO, WHEN WE BURN GAS WE ADD CO₂ TO OUR AIR,

ABOVE AND BEYOND THE AMOUNT THAT IS FAIR,
AND THE CO2 CAUSES TROUBLE BY NOT LETTING OUT
ENOUGH HEAT ABSORBED BY THE EARTH WHEN THE SUN IS ABOUT.

OUR PLANET IS WARMING, AND FOR A FEW YEARS
WE CAN BASK, TAN, AND SMILE, BUT THEN THE FEARS
OF A WITHERED, SCORCHED WORLD WILL BRING US TO TEARS,
AND WE'LL WISH WE'D CONSERVED, AND USED OTHER SOURCES
OF ENERGY WHILE LIVING WAS STILL ONE OF OUR CHOICES.

TWIN PLANETARY ATMOSPHERIC CRISES:
THE GREENHOUSE EFFECT AND THE DESTRUCTION OF THE OZONE LAYER

IT'S BEEN TWENTY-FIVE YEARS OR SO SINCE THE DAMNED
ENVIRONMENTALISTS BEGAN MAKING LIFE DIFFICULT FOR US, TELLING US WE
HAD TO TAKE BACK OUT OF OUR GAS THE LEAD WE'D SO THOUGHTFULLY STARTED
ADDING 30 YEARS BEFORE, STIRRING UP SILLY CONCERNS OVER POISONS
LEAKING INTO OUR WATER SUPPLIES, SHOWING US THAT
INDUSTRY-CONTAMINATED RAIN WAS DISSOLVING BUILDINGS AND KILLING FISH,
STIMULATING LAWSUITS OVER VARIOUS COLORS OF LUNGS, INDUCING FEARS
ABOUT SLOPPILY-RUN NUCLEAR PLANTS, AND EVEN SUGGESTING THAT CERTAIN
POSSIBLE ERRONEOUS OR INADEQUATE DECISIONS NOW OR SEVERAL YEARS AGO
MIGHT BE LEADING TO (OF COURSE) TERRIBLE CONSEQUENCES FOR FUTURE HUMAN
GENERATIONS.

AND NOW WE'RE HEARING IT AGAIN. DIVERSE THEORIES AND STUDIES
AND EXPERIMENTS RELATED TO THE EARTH'S ATMOSPHERE AND MAN'S
INADVERTENT EFFECTS ON THE ATMOSPHERE HAVE BEEN BROUGHT INTO SHARP
FOCUS BY RECENT DISCOVERIES ABOUT OUR CHANGING BLANKET OF SKY, AND THE
NEWS IS NOT GOOD.

A NASA SCIENTIFIC EXPEDITION SENT TO CONDUCT THE AIRBORNE
ANTARCTIC OZONE EXPERIMENT HAVE COME BACK WITH CONCLUSIVE EVIDENCE
THAT CHEMICALS CALLED CHLOROFLUOUROCARBONS ARE DAMAGING THE UPPER
LEVEL OF OUR ATMOSPHERE.

OZONE IS A RATHER FRAGILE COMPOUND MADE UP OF THREE OXYGEN
ATOMS. IN THE LOWER ATMOSPHERE, OZONE IS A NUISANCE, A SPICY
INGREDIENT IN THE RECIPE OF SMOG. BUT IN THE STRAOSPHERE, THE COLD
THIN AIR WAFTING 10 TO 30 MILES ABOVE THE EARTH'S SURFACE, THE THIN
CONCENTRATION OF OZONE MOLECULES, FLOATING LIKE SPECKS IN A BOUNDLESS
SEA, IS VITALLY PRECIOUS. BY ITS ABILITY TO ABSORB ULTRAVIOLET
LIGHT, OZONE IS THE EARTH'S ONLY DEFENSE AGAINST THE EFFECTS OF
POTENTIALLY HARMFUL ULTRAVIOLET RADIATION FROM THE SUN.

VISIBLE SUNSHINE IS ONLY PART OF THE RADIATION THE EARTH
CONSTANTLY RECEIVES FROM THE SUN. WE ARE EXPOSED TO SOLAR
ULTRAVIOLET LIGHT, TOO. CERTAIN WAVELENGTHS OF ULTRAVIOLET
RADIATION CAN WREAK HAVOC WITH LIVING THINGS; UV IS KNOWN TO CAUSE
SKIN CANCER AND POSSIBLY DISRUPT THE IMMUNE SYSTEM IN HUMANS AND TO
STIMULATE MUTATIONS AND CRIPPLE PHOTOSYNTHESIS IN PLANTS. WERE SOLAR
UV RADIATION TO REACH THE EARTH UNFILTERED, THE BASIC FOOD PRODUCTION

AND RENEWAL WHICH MAKES ALL FORMS OF LIFE POSSIBLE WOULD BE DAMAGED AND THROWN OUT OF BALANCE. FOR EXAMPLE, IF THE TINY OCEANIC PHYTOPLANKTON PLANT LIFE WERE EXPOSED TO INCREASED LEVELS OF UV, THE PRODUCTION OF OCEANIC PLANT FODDER AND OXYGEN WOULD BE REDUCED, DESTABILIZING THE AQUATIC FOOD CHAIN.

THE OZONE WHICH FLOATS HIGH OVERHEAD PROTECTING LIFE FROM UV RADIATION IS PRODUCED AND SUSTAINED IN BALANCE BY MOTHER NATURE. BUT WE HAVE BEEN FOOLING AROUND WITH MOTHER NATURE.

CONCERN HAS EXISTED FOR YEARS THAT MAN-MADE CHEMICALS, ESPECIALLY A FAMILY OF CHEMICALS CALLED CHLOROFLUOROCARBONS, MIGHT BE DISRUPTING THE STRATOSPHERIC OZONE EQUILIBRIUM. THE FIRST CHLOROFLUOROCARBONS (CFCs) WERE INVENTED IN 1928 TO BE USED AS A REFRIGERATOR COOLANT. SINCE THAT TIME, CFCs HAVE BEEN FOUND TO BE ENORMOUSLY USEFUL, AND HAVE BECOME A UBIQUITOUS INGREDIENT IN OUR MODERN CIVILIZATION. CFCs ARE FOUND IN AEROSOL SPRAYS, SOLVENTS FOR CLEANING COMPUTER CIRCUIT BOARDS, BEDDING, PLASTIC FOAM PADS AND COFFEE CUPS, AUTO AIR CONDITIONER COOLANTS, AND HOME INSULATION.

BUT CFCs ARE ALSO BEING FOUND IN INCREASING CONCENTRATIONS IN OUR STRATOSPHERE. AND, BECAUSE CFC MOLECULES ARE INCREDIBLY STABLE AND INERT, ONCE THEY'RE UP THERE, THEY'RE THERE TO STAY. FOR 50 TO 200 YEARS.

THE PROBLEM IS, ONE CFC MOLECULE IN THE STRATOSPHERE CAN CATALYZE THE DESTRUCTION OF 100,000 MOLECULES OF OZONE. BROKEN APART BY UV RADIATION, A CHLORINE ATOM FROM A CFC MOLECULE WILL BREAK UP AN OZONE MOLECULE, THEN IS RELEASED TO ATTACK OTHER MOLECULES OF OZONE, ONE AFTER ANOTHER.

KNOWING THAT THIS WAS PROBABLY HAPPENING, SCIENTISTS HAVE TRIED FOR FIFTEEN YEARS TO CONVINCING THE WORLD'S INDUSTRIES AND GOVERNMENTS TO STOP PRODUCING CFCs AND TO DEVELOP SUBSTITUTES. BUT THE CFC INDUSTRY HAS CRIED "FOUL," DEMANDING THAT THEY FIRST SEE CONCLUSIVE PROOF THAT THEIR PRODUCTS WERE SERIOUSLY ENDANGERING THE FUTURE OF LIFE ON THIS PLANET. THE UNITED STATES IN 1978 BANNED THE USE OF CFC PROPELLANTS IN SPRAY CANS, BUT LEFT THE CFC INDUSTRY OTHERWISE UNCHECKED; IN EUROPE NOTHING WAS DONE AT ALL.

IN 1985 A BRITISH SCIENTIST, JOSEPH FARMAN, PUBLISHED HIS FINDINGS THAT THE STRATOSPHERE OVER ANTARCTICA LOSES HALF OF ITS OZONE EVERY YEAR. THIS, IN TURN, TRIGGERED THE RECENT NASA EXPEDITION, WHICH FOUND 500 TIMES THE NORMAL CONCENTRATION OF CHLORINE RADICALS AND MARKEDLY REDUCED OZONE LEVELS IN THE ANTARCTIC STRATOSPHERE. THE PROOF OF CFC DESTRUCTION OF STRATOSPHERIC OZONE, THE "SMOKING GUN," WAS THERE.

IN SEPTEMBER, FIVE YEARS AFTER BEGINNING NEGOTIATIONS AND DAYS AFTER THE NASA EXPERIMENTS, MORE THAN 30 NATIONS SIGNED A PROTOCOL CALLING FOR A FREEZE AND EVENTUAL REDUCTION IN CFC PRODUCTION IN DEVELOPED COUNTRIES. THIS WILL ESCALATE THE EFFORTS TO FIND SAFE ALTERNATIVES TO THE CHLOROFLUOROCARBONS, BUT DOES NOT AT ALL END THEIR USE AND THEIR ESCALATING DAMAGE TO OUR PROTECTIVE OZONE. ALTHOUGH EACH CFC MOLECULE PRODUCED CAN DESTROY OZONE FOR A CENTURY, THIS INITIAL ACCORD CALLS ONLY FOR A 50% REDUCTION IN PRODUCTION AND USE OF

CFCs BY 1999.

I BELIEVE THAT, REGARDLESS OF THE ECONOMIC COSTS OR INCONVENIENCE, ALL PRODUCTION AND USE OF CFCs SHOULD BE IMMEDIATELY ENDED WORLDWIDE. GIVEN THE DIRE CONSEQUENCES WHICH ARE LIKELY IF NOT CERTAIN, I CAN FIND NO JUSTIFICATION FOR SLOWER ACTION. OUR JUDGES WILL BE OUR CHILDREN AND THEIR CHILDREN.

IN ORDER TO DO WHAT WE CAN TO SAVE THE STRATOSPHERIC OZONE LAYER, WE MUST DELETE ONE FAMILY OF NONESSENTIAL CHEMICALS FROM OUR WORLD SOCIETY. AT THE SAME TIME, WE ARE FACED BY ANOTHER ATMOSPHERIC POLLUTION PROBLEM WHICH, BECAUSE IT DEMANDS A MUCH MORE COMPLEX AND DIFFICULT SOLUTION, MAY PROVE TO BE AN EVEN GREATER THREAT. IT IS THE GREENHOUSE EFFECT, A DANGER PRODUCED PRINCIPALLY BY CARBON DIOXIDE.

CARBON DIOXIDE DOESN'T SMELL, DAMAGE OUR LUNGS, OR CHANGE THE COLOR OF THE SKY. BY ITSELF, CO2 IS NOT HARMFUL. IT IS A NORMAL CONSTITUENT OF THE ATMOSPHERE, COMPRISING ABOUT 0.03% OF THE AIR WE BREATHE.

PLANTS NEED CO2 FOR PHOTOSYNTHESIS, THE PROCESS WHICH COMBINES CARBON DIOXIDE AND WATER IN THE PRESENCE OF CHLOROPHYLL AND SUNLIGHT IN ORDER TO MANUFACTURE CARBOHYDRATES, AND WHICH ULTIMATELY PROVIDES ENERGY FOR ALL FORMS OF LIFE ON EARTH, SINCE ALL ANIMALS FEED EITHER ON PLANTS OR ON OTHER ANIMALS WHICH EAT PLANTS.

NEVERTHELESS, BECAUSE INDUSTRIALIZED CIVILIZATION IS ALMOST TOTALLY RELIANT ON FOSSIL FUELS -- OIL, COAL, AND NATURAL GAS -- FOR ENERGY, CARBON DIOXIDE MAY BE FAR MORE DANGEROUS THAN ANY OF THE OTHER GASEOUS OR SOLID ATMOSPHERIC POLLUTANTS WE CONTINUALLY SPEW INTO OUR AIR.

THE PROBLEM IS, THERE IS A LOT MORE CO2 AROUND NOW THAN THERE USED TO BE, AND THAT, SCIENTISTS NOW REALIZE, WE DON'T NEED. THE SOURCE OF THIS SUPERABUNDANCE OF CARBON DIOXIDE IS THE COMBUSTION OF FOSSIL FUELS.

FOSSIL FUELS, REMEMBER, ARE THE MINERALIZED REMAINS OF PLANTS AND TREES BURIED IN THE EARTH FOR MILLENIA UNDER PRESSURE. WHEN WE BURN COAL AND OIL, THE CO2 THAT WAS ABSORBED BY PLANT LIFE EONS AGO IS RELEASED BACK INTO OUR ATMOSPHERE. BUT IT IS BEING RELEASED AT A MUCH FASTER RATE THAT THE WORLD'S PLANT LIFE CAN USE IT.

THE RESULT IS THAT THE CONCENTRATION OF ATMOSPHERIC CO2 ANNUALLY INCREASES AT AN ESCALATING RATE, NOW ALMOST ONE PERCENT A YEAR. ALTOGETHER, THE AIR NOW HOLDS ABOUT 25 PERCENT MORE CO2 THAN IT DID FOR THE MILLIONS OF YEARS BEFORE THE INDUSTRIAL REVOLUTION BEGAN AROUND 1860. AND WE ARE JUST BEGINNING TO RIDE UP THE STEEP SLOPE OF THE ATMOSPHERIC CO2 CONCENTRATION CURVE; FROM NOW ON, THE AMOUNT OF CO2 PUSHED INTO THE AIR BY FOSSIL FUEL BURNING INCREASES MORE DRAMATICALLY EVERY YEAR.

THE WORLD'S POPULATION IS GROWING BY 80 TO 90 MILLION PEOPLE PER YEAR, AND, AT THE SAME TIME, THE WORLD'S PER CAPITA UTILIZATION OF ENERGY IS INCREASING. THE GLOBAL DEMAND FOR ENERGY IS GROWING AT AN

EVER-ACCELERATING RATE, AND MORE OIL, COAL, AND NATURAL GAS ARE BEING BURNED EACH YEAR TO SATISFY THAT DEMAND, AND EXPONENTIALLY INCREASING AMOUNTS OF CARBON DIOXIDE ARE BEING FORCED INTO THE ATMOSPHERE.

WELL, SO WHAT? IF IT DOESN'T STING OR SMELL OR HURT OR LOOK BAD, WHAT'S THE PROBLEM? THE ANSWER LIES IN A PHYSICAL PROPERTY OF CARBON DIOXIDE;

IT IS RELATIVELY TRANSPARENT TO SOLAR RADIATION -- SUNSHINE -- BUT RELATIVELY OPAQUE TO THE EARTH'S HEAT RADIATION. CO2 ALLOWS SUNSHINE TO HEAT THE EARTH, BUT THEN TRAPS MUCH OF THE HEAT NEAR THE EARTH'S SURFACE, RATHER THAN PERMITTING IT TO RADIATE BACK INTO SPACE. THIS GREENHOUSE EFFECT WARMS THE EARTH. THIS ISN'T A PROBLEM, OF COURSE, AS LONG AS THE AMOUNT OF CO2 IN THE ATMOSPHERE REMAINS FAIRLY CONSTANT AND NORMAL; THEN THE AMOUNTS OF INCOMING SUNSHINE AND OUTGOING HEAT REMAIN IN BALANCE, AND OUR CLIMATE REMAINS RELATIVELY COMFORTABLE.

HOWEVER, THE AMOUNT OF ATMOSPHERIC CO2 IS INCREASING, AND SCIENTISTS NOW ARE IN VIRTUAL UNANIMITY THAT THIS WILL LEAD TO A SIGNIFICANT WARMING OF THE EARTH'S CLIMATE. RECENTLY, A TEAM OF FRENCH AND RUSSIAN SCIENTISTS STUDYING ANTARCTIC ICE FOUND WORLD-WIDE AVERAGE TEMPERATURES TO BE INTIMATELY RELATED TO THE CONCENTRATION OF ATMOSPHERIC CO2. USING COMPLEX CLIMATE MODELS, RESEARCHERS ESTIMATE THAT THE CO2-INDUCED WARMING WILL ACCOUNT FOR AT LEAST A 2 DEGREE F. RISE IN GLOBAL TEMPERATURE BY THE EARLY 21ST CENTURY; WITHIN A HUNDRED YEARS, GLOBAL WARMING COULD BE ON THE ORDER OF MORE THAN 11 DEGREES F., WITH TEMPERATURE INCREASE IN POLAR REGIONS AS MUCH AS THREE TIMES THAT.

THIS RISE IN THE EARTH'S TEMPERATURE WOULD BE GREATER THAN ANYTHING EXPERIENCED IN THE LAST MILLION YEARS, AND COULD AMOUNT TO A GLOBAL CLIMATIC CATASTROPHE IN THE COMING CENTURY. GLOBAL WARMING IS NOT JUST A MATTER OF ADDING X-DEGREES TO DAILY TEMPERATURES; 2 OR 4 DEGREES DOESN'T SOUND LIKE SO MUCH; MOST DAYS I COULD ACCEPT A COUPLE OF DEGREES AND LIKE IT JUST FINE. BUT THERE IS A DIFFERENCE OF ONLY ABOUT 5 DEGREES BETWEEN THE EARTH'S TEMPERATURE TODAY AND TYPICAL ICE-AGE CONDITIONS!

A GLOBAL RISE IN TEMPERATURE OF A COUPLE OF DEGREES WOULD HAVE DRAMATIC EFFECTS. AGRICULTURAL BELTS WOULD BE SHIFTED BY CHANGING WEATHER PATTERNS. FOR COUNTRIES WITH MARGINAL AGRICULTURE, THE IMPACT ON FOOD PRODUCTION WOULD BE SEVERE. SUCH A CLIMATE CHANGE WOULD CAUSE A MAJOR, AND ARBITRARY, REDISTRIBUTION OF THE WORLD'S WEALTH AND POWER. IF THE CO2 GREENHOUSE EFFECT WERE TO PERSIST OVER A NUMBER OF CENTURIES, THE GREENLAND AND ANTARCTIC ICE CAPS WOULD MELT, THE OCEANS WOULD RISE, AND THE WORLD'S COASTAL CITIES WOULD BE FLOODED.

WHEN WILL WE START TO FEEL THE EFFECTS OF THE CO2 GREENHOUSE EFFECT? WHEN WILL THEORY BECOME REALITY? HAS IT ALREADY STARTED?

THERE ARE NATURAL CYCLES OF WARMING AND COOLING WHICH DOMINATE OUR WEATHER AND CLIMATE. BASED ON WEATHER RECORDS AND STUDIES OF GREENLAND ICE CORE SAMPLES, IT IS EVIDENT THAT A DRAMATIC COOLING PERIOD OCCURS IN THE NORTHERN HEMISPHERE ROUGHLY EVERY 180 YEARS, AND PERSISTS FOR SEVERAL DECADES. THE 1980s WERE EXPECTED BY CLIMATE SCIENTISTS TO BE, GENERALLY, THE COLDEST WEATHER PERIOD IN OUR COUNTRY SINCE THE EARLY 1800s.

THE RUGGED WINTERS OF 1976-77, 77-78, AND 78-79 APPEARED TO BE PART OF THIS PATTERN. HOWEVER, IN RECENT YEARS OUR ACTUAL HEMISPHERIC TEMPERATURES HAVE 'BEGUN TO MEASURE HIGHER THAN EXPECTED. OUR OWN RELATIVELY MILD WINTERS IN RECENT YEARS HAVE REPRESENTED A DEVIATION FROM LONG-ESTABLISHED WEATHER PATTERNS. IT MAY WELL BE THAT THE GREENHOUSE EFFECT IS ALREADY WARMING THE EARTH SIGNIFICANTLY, ITS IMPACT DISGUISED SOMEWHAT BY THE NATURAL COOLING CYCLE. IT IS WORTH NOTING THAT, BEFORE THE END OF THE CENTURY, A NATURAL WARMING TREND IS PROJECTED BY THE 180-YEAR COMPOSITE CYCLE; AT THE SAME TIME, THE CO2 EFFECT WILL BE HITTING ITS STRIDE, AND WE SHOULD EXPECT HEMISPHERIC TEMPERATURES HIGHER THAN ANY FOR HUNDREDS OF YEARS!

HOW FAST THE GREENHOUSE EFFECT WILL AFFECT OUR CLIMATE WILL DEPEND ON OUR USE OF FOSSIL FUELS. BASED ON CURRENT PROJECTIONS, OUR ATMOSPHERIC CONCENTRATION OF CO2 WILL HAVE DOUBLED BY THE YEAR 2050. THE GREENHOUSE EFFECT PRODUCED BY ASSORTED OTHER GASES, METHANE AND NITROUS OXIDE AND THE CFCs, ADD TO THE PREDOMINANT ROLE OF CO2, AND WILL PRODUCE THE EQUIVALENT OF A DOUBLING OF ATMOSPHERIC CO2 BY THE YEAR 2030. BY THEN OUR CLIMATE MAY BE WARMER THAN AT ANY TIME IN THE LAST 125,000 YEARS, 4 OR 5 DEGREES F. HIGHER THAN "NORMAL." THIS CHANGE WOULD COME ABOUT IN JUST A FEW DECADES, INSTEAD OF THOUSANDS OF YEARS AS IN THE PAST. ADJUSTING TO IT WOULD BE EXTREMELY TOUGH, IF POSSIBLE AT ALL.

IN REALITY, EVEN VERY SMALL CHANGES IN GLOBAL TEMPERATURE PRODUCE DRAMATIC CHANGES IN WEATHER PATTERNS. GLOBAL WIND PATTERNS SHIFT, COMPLETELY RECASTING WEATHER REGIMES OVER PARTICULAR REGIONS. SOME SPOTS, IN FACT, TURN COOLER. OTHERS BECOME DRIER, SOME WETTER, AND MANY WARMER. SEVERE STORMS AND SWINGS IN WEATHER OCCUR.

STUDIES OF PAST PERIODS OF WARMING IN WHAT IS NOW THE UNITED STATES REVEAL A CONSISTENT AND FOREBODING PATTERN. TIMES USEFUL FOR COMPARISON TO THE CLIMATE PROJECTED FOR US IN THE COMING CENTURY INCLUDE THE MOST RECENT WARM INTERVAL, THE DEPRESSION 1930's; THE MEDIEVAL WARM PERIOD 900 YEARS AGO, WHEN HEMISPHERIC TEMPERATURES WERE ALMOST 2 DEGREES F. HIGHER THAN NOW; AND THE ALTITHERMAL PERIOD BETWEEN 4000 AND 8000 YEARS AGO, WHEN TEMPERATURES WERE 4 OR 5 DEGREES ABOVE CURRENT LEVELS. DURING ALL OF THESE PERIODS OF CLIMATIC WARMING, THE MIDWESTERN PLAINS OF NORTH AMERICA SUFFERED PROLONGED DROUGHTS AND TURNED INTO DESERT-LIKE WASTELAND; IF CO2-DRIVEN GREENHOUSE WARMING CONTINUES, THE CONSEQUENCES FOR AMERICA WOULD BE FRIGHTENING.

SIMILARLY, MUCH OF EUROPE AND WESTERN RUSSIA WOULD LIKELY BECOME HOTTER AND DRIER, WITH SERIOUS, NEGATIVE IMPLICATIONS FOR AGRICULTURE. IN TERMS OF THE ABILITY OF THE WORLD TO FEED ITSELF, THE THREAT OF THE GREENHOUSE EFFECT IS REAL AND ENORMOUS; WE MAY FACE NO MORE IMPORTANT ENVIRONMENTAL CHALLENGE IN OUR LIFETIME.

WHAT MUST WE DO TO AVERT THE CATASTROPHE OF RUNAWAY CO2 GREENHOUSE OVERHEATING OF THE EARTH? AND, EVEN IF OUR GLOBAL POLITICAL-ECONOMIC LEADERS COME THROUGH AND MAKE WISE AND COURAGEOUS DECISIONS, HOW FAST CAN THE WORLD BE EXPECTED TO STOP PUSHING CARBON DIOXIDE INTO OUR ATMOSPHERE?

IF WE ASSUME THAT, THROUGH UNPRECEDENTED FORESIGHTEDNESS, THE WORLD WILL LIMIT ITS ENERGY GROWTH RATE TO AROUND 3 PERCENT OR A LITTLE LESS PER YEAR FOR THE NEXT SEVERAL DECADES, AND THAT NONFOSSIL ENERGY SOURCES WIDELY REPLACE OIL, COAL, AND GAS WITHIN 20 YEARS, THE END RESULT WOULD BE A GLOBAL WARMING OF SLIGHTLY OVER 2 DEGREES F. BY THE YEAR 2030. THE ENSUING CLIMATE WOULD COMPARE TO THAT OF THE MEDIEVAL WARM PERIOD OF 800 TO 1200 A.D., WHEN VIKING FARMERS GREW VEGETABLES AND HOUSED CATTLE IN BARNES ON GREENLAND, WHEN VINEYARDS FLOURISHED IN ENGLAND, AND WHEN THE GREAT AMERICAN GRASSLANDS DRIED UP DURING A 200-YEAR DROUGHT.

BUT, REALISTICALLY, EVEN GIVEN FOCEFUL LEADERSHIP, THE ECONOMICS OF FUEL AND ENERGY PRODUCTION CANNOT BE EXPECTED TO CHANGE "OVERNIGHT": ANALYSES OF "MARKET PENETRATION TIME," THE TIME REQUIRED TO ADVANCE A NEW ENERGY SOURCE'S SHARE OF TOTAL ENRGY PRODUCTION FROM 1 TO 50 PERCENT, SUGGEST THAT IT MAY TAKE AT LEAST 50 YEARS TO REPLACE FOSSIL FUELS WITH NON-CO2-PRODUCING ALTERNATIVES. MODERN ECONOMICS AND TECHNOLOGY MAY ENABLE US TO MAKE THIS TRANSITION MORE QUICKLY THAN THIS PROJECTION, BUT THE OBVIOUS IMPLICATION REMAINS CLEAR: EVEN THE OPTIMUM SCENARIO HAS NO CHANCE UNLESS MANKIND ACTS SWIFTLY.

IS IT POSSIBLE TO REMOVE EXCESS CO2 FROM THE ATMOSPHERE? IF WE WERE TO STOP BURNING FOSSIL FUELS, NATURAL PROCESSES WOULD REQUIRE CENTURIES TO DO THE JOB. THEORETICALLY, MAN COULD DO IT -- BUT THE COST WOULD BE STAGGERING. IT WOULD TAKE 1000 CHEMICAL PLANTS, EACH OVER 300 FEET HIGH AND 1000 YARDS LONG, OPERATING FOR 30 YEARS TO REMOVE EXCESS CO2 FROM THE AIR IF WE ALLOW THE CO2 CONCENTRATION TO DOUBLE.

IT MIGHT BE POSSIBLE TO STOP THE ADDITIONAL CO2 POLLUTION OF OUR ATMOSPHERE BY REMOVING CARBON DIOXIDE FROM COMBUSTION GASES BEFORE THEY ARE RELEASED. IF CO2 WERE CLASSIFIED AS A POLLUTANT, AND ITS RELEASE GOVERNED BY LAW, CO2 "SCRUBBERS" COULD BE DEvised AND EMPLOYED, BUT THIS, TOO, WOULD BE VERY COSTLY, ENERGY INTENSIVE, AND TERRIBLY COMPLEX TO EFFECTIVELY GOVERN. GROWING MORE TREES WOULD HELP SOME, BUT NOT MUCH; ONE MATURE ONE-TON TREE MIGHT BE ABLE TO CONSUME THE CO2 PRODUCED BY BURNING ONE BARREL OF OIL PER YEAR (AND THE WORLD IS RAPIDLY DESTROYING, NOT EXPANDING, ITS FORESTS).

UNQUESTIONABLY, THE BEST SOLUTION IS TO QUICKLY DIMINISH OUR RELIANCE ON FOSSIL FUELS, AND REMOVE THE PROBLEM BEFORE IT GAINS ENOUGH MOMENTUM TO OVERCOME US. IN THE UNITED STATES, 90% OF OUR ENERGY IS DERIVED FROM FOSSIL FUELS. EVEN THOUGH OUR ANNUAL ENERGY GROWTH RATE HAS SLOWED, HOWEVER, AND THE USE OF NUCLEAR, SOLAR, AND OTHER ENERGY SOURCES HAS INCREASED SOME, OUR NET FOSSIL FUEL CONSUMPTION HAS CONTINUED TO RISE SLIGHTLY. THIS ISN'T ENCOURAGING, ESPECIALLY WHEN YOU CONSIDER THAT ENERGY CONSUMPTION IN LESS DEVELOPED COUNTRIES IS INCREASING RAPIDLY -- AND THE REST OF THE WORLD, PARTICULARLY DEVELOPING NATIONS, ARE LESS LIKELY THAN WE ARE TO SWITCH FROM CHEAP COAL AND OIL TO ALTERNATIVE ENERGY SOURCES.

IT IS LIKELY THAT OUR USE OF OIL WILL GRADUALLY DECLINE, AS SUPPLIES PEAK AND DIMINISH. PROVED RESERVES OF U.S. OIL PEAKED 18 YEARS AGO, AND AS OF 1980 WE WERE ABLE TO PROVIDE ONLY 60% OF WHAT WE USED OURSELVES. MOST OF OUR IMPORTED OIL COMES FROM UNSTABLE OR

RELATIVELY HOSTILE FOREIGN COUNTRIES, LEAVING US VULNERABLE. AS WEATHER SCIENTIST HAROLD BERNARD OBSERVED, "THE UNITED STATES IS STANDING ON THE GALLOWS, THE NOOSE AROUND ITS NECK, JUST WAITING FOR SOMEONE TO YANK OPEN THE TRAP DOOR. IF THE GREENHOUSE THREAT ALONE IS NOT ENOUGH THE TRIGGER AND URGENT NATIONAL RESOLVE TO KICK THE FOSSIL HABIT AND DEVELOP CLEAN, RENEWABLE ENERGY SOURCES, THE ADDITIONAL THREAT OF BEING STRUNG UP BY AN EMPTY GASOLINE HOSE SHOULD BE."

RESERVES AND PRODUCTION OF NATURAL GAS, THE CLEANEST OF THE FOSSIL FUELS, HAVE BEEN DECLINING FOR 15 YEARS. AS OIL SUPPLIES DWINDLE IN THE FUTURE, IT IS ALMOST CERTAIN THAT THE WORLD'S ENERGY NEEDS WILL BE MET FIRST BY A RAPIDLY INCREASING USE OF COAL. THE UNITED STATES IS SITTING ON ENOUGH COAL TO LAST US THROUGH THE NEXT CENTURY, AND CHINA, AMONG OTHER COUNTRIES, HAS HUGE COAL RESERVES. BUT COAL IS 30% DIRTIER, IN TERMS OF CO2 RELEASE, THAN OIL, AND ALSO FOULS THE AIR WITH LARGE AMOUNTS OF SULPHUR AND SOOT. COAL IS DANGEROUS TO MINE, AND IS OFTEN VERY DIFFICULT TO GET TO MARKET. OUR OWN DECREPIT RAILROAD SYSTEM WILL SEVERELY LIMIT OUR COAL INDUSTRY FOR YEARS. COAL SLURRY PIPELINES, AN ANSWER TO THE COAL TRANSPORT PROBLEM, REQUIRE HUGE WATER SUPPLIES WHICH DO NOT EXIST IN OUR COAL-RICH WEST. FINALLY, COAL-FIRED UTILITIES ARE EXPENSIVE TO OPERATE. GIVEN THE ARRAY OF ENVIRONMENTAL, HEALTH, TRANSPORTATION, AND ECONOMIC PROBLEMS WHICH ACCOMPANY COAL USE, ITS FUTURE AS A MAJOR ENERGY PRODUCER IS DUBIOUS.

UNTIL RECENTLY, I PERSONALLY HAVE BEEN SKEPTICAL OF THE DEVELOPMENT OF NUCLEAR POWER; THE EARLY RECORD OF CONSTRUCTION, ADMINISTRATION, AND OPERATION OF NUCLEAR FACILITIES SEEMED, TO ME, TO BE DANGEROUSLY POOR. BUT THAT RECORD HAS IMPROVED MARKEDLY. FRANCE, JAPAN, AND CHICAGO, FOR EXAMPLE, HAVE SUCCESSFULLY MADE SIGNIFICANT CONVERSIONS TO NUCLEAR POWER. THE RISKS OF NUCLEAR POWER ARE REAL, BUT I BELIEVE THAT, COMPARED TO THE RISKS OF CONTINUING ENERGY DEPENDENCE ON OIL AND COAL, THE NUCLEAR RISKS ARE PREFERABLE. HOPE REMAINS, TOO, THAT THE NONRADIOACTIVE PROCESS OF NUCLEAR FUSION MAY BECOME A PRACTICAL ENERGY SOURCE IN THE NEXT 20 TO 30 YEARS.

THERE ARE OTHER SIGNIFICANT ENERGY SOURCES WHICH ARE CLEAN AND SAFE, BUT NOT YET GENERALLY COST-COMPETITIVE WITH OIL, COAL, AND GAS. SOLAR, GEOTHERMAL, WIND, AND HYDROELECTRIC POWER SOURCES WILL NEED TO BE EFFICIENTLY UTILIZED; IF AND WHEN OUR SOCIETY CURTAILS ITS USE OF FOSSIL FUELS, THESE ENERGY SOURCES WILL BECOME MORE ECONOMICALLY ATTRACTIVE. EACH POSSESSES MAJOR POTENTIAL, AT LEAST FOR CERTAIN REGIONS. AN ADDITIONAL VALUABLE ENERGY SOURCE IS BIOMASS, ORGANIC MATTER WHICH CAN BE BURNED OR GASIFIED. WOOD AND MY PERSONAL FAVORITE, GARBAGE, CAN PROVIDE HUGE AMOUNTS OF ENERGY. MANY LARGE CITIES IN THE UNITED STATES ALREADY ARE BURNING MUNICIPAL GARBAGE TO PRODUCE ELECTRICITY. BECAUSE THE CO2 RELEASED FROM BIOMASS COMBUSTION IS FROM PLANTS WHICH ARE PART OF THE ONGOING ENVIRONMENTAL CARBON CYCLE, IT DOES NOT ADD TO THE TOTAL ATMOSPHERIC CO2.

IN ATTEMPTING TO FIND ALTERNATIVES TO FOSSIL FUEL COMBUSTION, MANKIND HAS ONE FINAL RESOURCE, AND IT IS THE RESOURCE WITH BY FAR THE GREATEST SHORT-TERM POTENTIAL OF ALL: CONSERVATION. BASED ON ENERGY CONSUMPTION PER UNIT OF GROSS NATIONAL PRODUCT, WE AMERICANS DEVOUR TWICE AS MUCH ENERGY AS WEST GERMANY OR SWEDEN. OUR CARS BURN UP 35 TO 40 PERCENT OF ALL THE OIL IN THE UNITED STATES -- 10% OF THE

WORLD'S OIL -- EACH YEAR. WE HAVE MADE SOME STRIDES -- INDUSTRIAL CONSUMPTION HAS DECREASED, AND CARS ARE MORE FUEL EFFICIENT, MASS TRANSIT SYSTEMS HAVE BEEN BUILT, HOME CONSTRUCTION HAS IMPROVED -- IN RESPONSE TO RISING ENERGY COSTS, BUT WE HAVE LOTS OF ROOM TO DO BETTER. ANY CHANGE FROM FOSSIL ENERGY WILL BE EXPENSIVE AND WILL SOMEHOW COMPROMISE OUR STANDARD OF LIVING. ENERGY CONSERVATION IS THE CHEAPEST, CLEANEST, AND MOST READILY AVAILABLE OF OUR ALTERNATIVES; IT CAN FLATTEN THE EXPONENTIAL ENERGY GROWTH CURVE, BUY TIME TO DEVELOP ENERGY ALTERNATIVES, AND HELP AVERT THE DISASTROUS ECONOMIC INFLATION THAT WILL ACCOMPANY SOARING ENERGY COSTS.

I BELIEVE THAT THE SPECTRE OF THE CARBON DIOXIDE GREENHOUSE EFFECT IS REAL, A PRESENT AND COMPELLING DANGER TO LIFE ON THIS PLANET. I BELIEVE THAT THE URGENCY OF THE GREENHOUSE THREAT REQUIRES THAT WE, AND OTHER PEOPLES OF THE WORLD, MAKE RAPID AND DRAMATIC CHANGES IN OUR SOCIETIES.

WE NEED TO ENCOURAGE THE DEVELOPMENT AND USE OF NON-FOSSIL ENERGY SOURCES, AND TO DISCOURAGE THE USE OF OIL, COAL, AND GAS. TAXES ON FOSSIL FUELS COULD FUND INCENTIVES FOR DEVELOPMENT AND UTILIZATION OF ALTERNATIVES. LEGISLATIVE AND SOCIAL INCENTIVES AND RESTRICTIONS CAN STIMULATE ENERGY CONSERVATION AT ALL LEVELS OF THE ECONOMY. SUCH ALTERATIONS IN THE MACHINERY OF SOCIETY, NO MATTER HOW NECESSARY, WILL ONLY BE MADE BY RISING ABOVE A "BUSINESS AS USUAL" MENTALITY. LEGISLATORS MUST BE PRESSED TO ADDRESS THE PROBLEM; FORWARD-THINKING CANDIDATES MUST BE SUPPORTED; POWERFUL SPECIAL INTERESTS MUST BE CONFRONTED; EVERYONE WILL HAVE TO MAKE SACRIFICES FOR THE FUTURES OF THEIR CHILDREN AND GRANDCHILDREN.

WE CANNOT SIT AROUND AND COUNT ON "TECHNOLOGY TO SAVE US." THE TECHNOLOGY IS HERE! BUT IT WILL TAKE IMMEDIATE, DETERMINED POLITICAL, SOCIAL, AND ECONOMIC EFFORT TO BRING THE STRENGTH OF THAT TECHNOLOGY TO BEAR ON THE PROBLEM. WE HAVE ALREADY PROCRASTINATED A DECADE; IF WE HEM AND HAW ANOTHER TEN YEARS, TECHNOLOGY MAY NOT BE ABLE TO BAIL US OUT. IN THAT CIRCUMSTANCE THE GREENHOUSE THREAT MAY WELL CONTROL OUR DESTINY.

THOMAS RL ARENDSHORST