Tell Barack Obama the Truth – The Whole Truth

Embers of election night elation will glow longer than any prior election. Glowing even in other nations, and for good reason. We are all tied together, more than ever, like it or not.

Barack Obama's measured words on election night, including eloquent recognition of historic progress, from the viewpoint of a 106-year-old lady, still stoke the embers. But he was already focusing on tasks ahead, without celebratory excess.

Well he should. The challenge he faces is unprecedented. I refer not to the inherited economic morass, as threatening as it is. The human toll due to past failures and excesses may prove to be great, yet economic recessions, even depressions, come and go.

Now our planet itself is in peril. Not simply the Earth, but the fate of all of its species, including humanity. The situation calls not for hand-wringing, but rather informed action.

Optimism is fueled by expectation that decisions will be guided by reason and evidence, not ideology. The danger is that special interests will dilute and torque government policies, causing the climate to pass tipping points, with grave consequences for all life on the planet.

The President-elect himself needs to be well-informed about the climate problem and its relation to energy needs and economic policies. He cannot rely on political systems to bring him solutions – the political systems provide too many opportunities for special interests.

Here is a message I think should be delivered to Barack Obama. Criticisms are welcome.

Climate threat. The world's temperature has increased about 1°F over the past few decades, about 2°F over land areas. Further warming is "in the pipeline" due to gases already in the air (because of climate system inertia) and inevitable additional fossil fuel emissions (because of energy system inertia).

Although global warming to date is smaller than day-to-day weather fluctuations, it has brought global temperature back to approximately the highest level of the Holocene, the past 10,000 years, the period during which civilization developed. Effects already evident include:

1. Mountain glaciers are receding worldwide and will be gone within 50 years if CO_2 emissions continue to increase. This threatens the fresh water supply for *billions* of people, as rivers arising in the Himalayas, Andes and Rocky Mountains will begin to run dry in the summer and fall.
2. Coral reefs, home to a quarter of biological species in the ocean, could be destroyed by rising temperature and ocean acidification due to increasing CO_2.
3. Dry subtropics are expanding poleward with warming, affecting the southern United States, the Mediterranean region, and Australia, with increasing drought and fires.
4. Arctic sea ice will disappear entirely in the summer, if CO_2 continues to increase, with devastating effects on wildlife and indigenous people.
5. Intensity of hydrologic extremes, including heavy rains, storms and floods on the one hand, and droughts and fires on the other, are increasing.

Some people say we must learn to live with these effects, because it is an almost god-given fact that we must burn all fossil fuels. But now we understand, from the history of the Earth, that there would be two monstrous consequences of releasing the CO_2 from all of the oil, gas and coal, consequences of an enormity that cannot be accepted.

One effect would be extermination of a large fraction of the species on the planet. The other is initiation of ice sheet disintegration and sea level rise, out of humanity's control, eventually eliminating coastal cities and historical sites, creating havoc, hundreds of millions of refugees, and impoverishing nations.

Species extermination and ice sheet disintegration are both 'non-linear' problems with 'tipping points'. If the process proceeds too far, amplifying feedbacks push the system dynamics to proceed without further human forcing. For example, species are interdependent – if a sufficient number are eliminated, ecosystems collapse. In the physical climate system, amplifying feedbacks include increased absorption of sunlight as sea and land ice areas are reduced and release of methane, a powerful greenhouse gas, as permafrost melts.

The Earth's history reveals examples of such non-linear collapses. Eventually, over tens and hundreds of thousands of years, new species evolve, and ice sheets return. But we will leave a devastated impoverished planet for all generations of humanity that we can imagine, if we are so foolish as to allow the climate tipping points to be passed.

Urgency. Recent evidence reveals a situation more urgent than had been expected, even by those who were most attuned. The evidence is based on improving knowledge of Earth's history – how the climate responded to past changes of atmospheric composition – and on observations of how the Earth is responding now to human-made atmospheric changes.

The conclusion – at first startling, but in retrospect obvious – is that the human-made increase of atmospheric carbon dioxide (CO_2), from the pre-industrial 280 parts per million (ppm) to today's 385 ppm, has already raised the CO_2 amount into the dangerous range. It will be necessary to take actions that return CO_2 to a level of at most 350 ppm, but probably less, if we are to avert disastrous pressures on fellow species and large sea level rise.

The good news is that such a result is still possible, if actions are prompt. Prompt action will do more than prevent irreversible extinctions and ice sheet disintegration: it can avert or reverse consequences that had begun to seem inevitable, including loss of Arctic ice, ocean acidification, expansion of the subtropics, increased intensity of droughts, floods, and storms.

Principal implication. CO_2 is not the only human-made gas that contributes to global warming, but it is the dominant gas with a lifetime that dwarfs that of the other major gases. Much of the CO_2 increase caused by burning fossil fuels remains in the air ***more than 1000 years.*** So CO_2 must be the focus of efforts to stop human-caused climate change.

It would be easy to jump to the conclusion that solution of global warming is to phase down total fossil fuel emissions by some specified percentage. That approach will not work as a strategy. The reason for that conclusion and an outline of a better strategic approach follow immediately from geophysical boundary constraints.

Figure 1a shows oil, gas and coal reserves, with the purple portion being the amount that has already been burned and emitted into the atmosphere. Despite uncertainty in the size of undiscovered resources, their amounts are certainly enough to yield atmospheric CO_2 greater than 500 ppm. That amount would be disastrous, assuring unstable ice sheets, rising sea level out of humanity's control, extermination of a large fraction of the species on Earth, and severe exacerbation of climate impacts discussed above.

Oil is used primarily in vehicles, where it is impractical to capture CO_2 emerging from tailpipes. The large pools of oil remaining in the ground are spread among many countries. The United States, which once had some of the large pools, has already exploited its largest recoverable reserves. Given this fact, it is unrealistic to think that Russia and Middle East countries will decide to leave their oil in the ground.

A carbon cap that slows emissions of CO_2 does not help, because of the long lifetime of atmospheric CO_2. In fact, the cap exacerbates the problem if it allows coal emissions to continue. The only solution is to target a (large) portion of the fossil fuel reserves to be left in the ground or used in a way such that the CO_2 can be captured and safely sequestered.

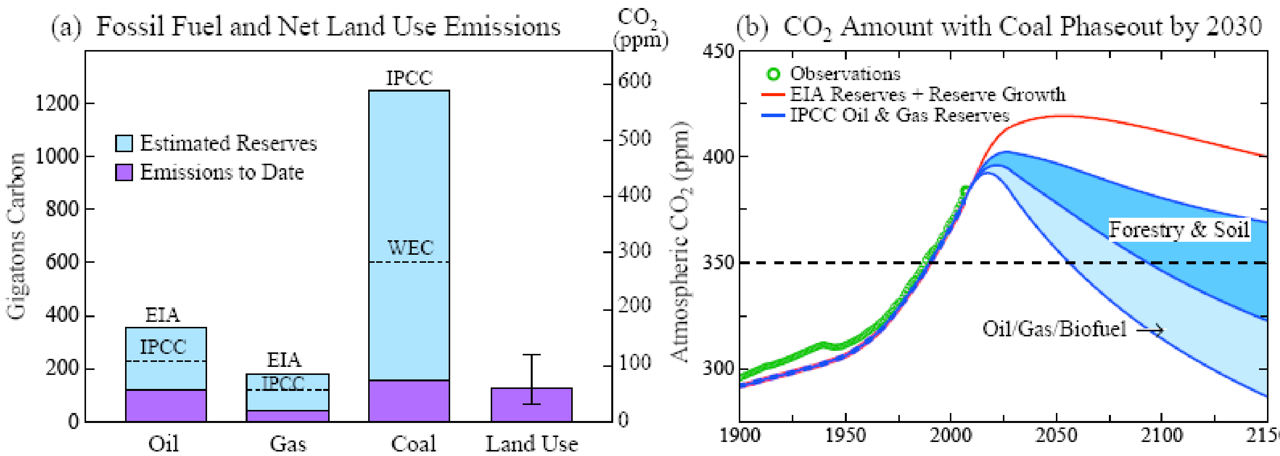

Figure 1. (a) Fossil fuel and net land-use CO_2 emissions (purple), and potential fossil fuel emissions (light blue). Fossil fuel reserve estimates of EIA, IPCC and WEC differ as shown. (b) Atmospheric CO_2 if coal emissions are phased out linearly between 2010 and 2030, calculated using a version of the Bern carbon cycle model. References [EIA (Energy Information Administration), IPCC (Intergovernmental Panel on Climate Change), and WEC (World Energy Council)] are provided in the published paper.

Coal is the obvious target. Figure 1b shows that if there were a prompt moratorium on construction of new coal plants, and if existing ones were phased out linearly over the period 2010-2030, then atmospheric CO_2 would peak during the next few decades at an amount somewhere between 400 and 425 ppm. The peak value depends upon whose estimate of undiscovered reserves is more accurate. It also depends upon whether oil in the most extreme environments is exploited or left in the ground, and thus it depends on the carbon tax (see below).

This coal-phase-out scenario yields the possibility of stabilizing climate. Overshoot of the safe CO_2 level is sufficiently small that improved agricultural and forestry practices, including reforestation of marginal lands, could bring CO_2 back below 350 ppm, perhaps by the middle of the century. But if construction of new coal plants continues for even another decade it is difficult to conceive a practical, natural way to return CO_2 below 350 ppm.

Outline of policy options. The imperative of near-term termination of coal emissions (but not necessarily coal use) requires fundamental advances in energy technologies. Such advances would be needed anyhow, as fossil fuel reserves dwindle, but the climate crisis demands that they be achieved rapidly. Fortunately, actions that solve the climate problem can be designed so as to also improve energy security and restore economic well-being.

A workshop held in Washington, DC on 3 November 2008 outlined options (presentations are at http://www.mediafire.com/nov3workshop). The workshop focused on electrical energy, because that is the principal use of coal. Also electricity is more and more the energy carrier of choice, because it is clean, much desired in developing countries, and a likely replacement or partial replacement for oil in transportation.

Workshop topics, in priority order, were: (1) energy efficiency, (2) renewable energies, (3) electric grid improvements, (4) nuclear power, (5) carbon capture and sequestration.

Energy efficiency improvements have the potential to obviate the need for additional electric power in all parts of the country during the next few decades and allow retirement of some existing coal plants. Achievement of the efficiency potential requires both regulations and a carbon tax. National building codes are needed, and higher standards for appliances, especially electronics, where standby power has become a large unnecessary drain of energy.

Economic incentives for utilities must be changed so that profits increase with increased energy conservation, not in proportion to amount of energy sold.

Renewable energies are gaining in economic competition with fossil fuels, but in the absence of wise policies there is the danger that declining prices for fossil fuels, and continuation of fossil fuel subsidies, could cause a major setback. The most effective and efficient way to support renewable energy is via a carbon tax (see below).

The national electric grid can be made more reliable and "smarter" in a number of ways. Priority will be needed for constructing a low-loss grid from regions with plentiful renewable energy to other parts of the nation, if renewable energies are to be a replacement for coal.

Energy efficiency, renewable energies, and an improved grid deserve priority and there is a hope that they could provide all of our electric power requirements. However, the greatest threat to the planet may be the potential gap between that presumption (100% "soft" energy) and reality, with the gap being filled by continued use of coal-fired power.

Therefore we should undertake urgent focused R&D programs in both next generation nuclear power and carbon capture and sequestration. These programs could be carried out most rapidly and effectively in full cooperation with China and/or India, and other countries.

Given appropriate priority and resources, the option of secure, low-waste 4th generation nuclear power (see below) could be available within about a decade. If, by then, wind, solar, other renewables, and an improved grid prove to be capable of handling all of our electrical energy needs, there would be no imperative to construct nuclear plants in the United States. Many energy experts consider an all-renewable scenario to be implausible in the time-frame when coal emissions must be phased out, but it is not necessary to debate that matter.

However, it would be dangerous to proceed under the ***presumption*** that we will soon have all-renewable electric power. Also it would be inappropriate to impose a similar presumption on China and India. Both countries project large increases in their energy needs, both countries have highly polluted atmospheres primarily due to excessive coal use, and both countries stand to suffer inordinately if global climate change continues.

The entire world stands to gain if China and India have options to reduce their CO_2 emissions and air pollution. Mercury emissions from their coal plants, for example, are polluting the global atmosphere and ocean and affecting the safety of foods, especially fish, on a near-global scale. And there is little hope of stabilizing climate unless China and India have low- and no-CO_2 energy options.

We should also urgently pursue R&D for carbon capture and sequestration. Here too this may be done most expeditiously and effectively via cooperation with China and India. Note that, even if it is decided that coal can be left in the ground, carbon capture and sequestration with other fuels still may be needed to draw down the amount of CO_2 in the air. An effective way to achieve drawdown would be to burn biofuels in power plants and capture the CO_2, with the biofuels derived from agricultural or urban wastes or grown on degraded lands using little or no fossil fuel inputs.

Opponents of nuclear power and carbon capture must not be allowed to slow these projects. No commitment for large-scale *deployment* of either 4th generation nuclear power or carbon capture is needed at this time. If energy efficiency and renewable energies prove sufficient for energy needs, some countries may choose to use neither nuclear power nor coal. However, we must be certain that proven options for complete phase-out of coal emissions are available.

T**ax and 100% dividend.** A "carbon tax with 100 percent dividend" is needed to reverse the growth of atmospheric CO_2. The tax, applied to oil, gas and coal at the mine or port of entry, is the fairest and most effective way to reduce emissions and transition to the post fossil fuel era. It would assure that unconventional fossil fuels, such as oil shale and tar sands, stay in the ground, unless an economic method of capturing the CO_2 is developed.

The entire tax should be returned to the public, equal shares on a per capita basis (half shares for children up to a maximum of two child-shares per family), deposited monthly in bank accounts. No bureaucracy is needed.

A tax should be called a tax. The public can understand this and will accept a tax if it is clearly explained and if 100 percent of the money is returned to the public. Not one dime should go to Washington for politicians to pick winners. No lobbyists need be employed.

The public will take steps to reduce their emissions because they will continually be reminded of the matter by the monthly dividend and by rising fossil fuel costs. It must be clearly explained to the public that the tax rate will continue to increase in the future.

When fuel prices decline, the tax should increase, to retain the incentive for transitioning to the post-fossil-fuel-era. The effect of reduced fossil fuel demand will be lower fossil fuel prices, making the tax a larger and larger portion of energy costs (for fossil fuels only). Thus the country will stop hemorrhaging its wealth to oil-producing nations.

Tax and dividend is progressive. A person with several large cars and a large house will have a tax greatly exceeding the dividend. A family reducing its carbon footprint to less than average will make money. Everyone will have an incentive to reduce their carbon footprint. The dividend will stimulate the economy, spur innovation, and provide money that allows people to purchase low-carbon products and a low-carbon lifestyle.

A carbon tax is honest, clear and effective. It will increase energy prices, but low and middle income people, especially, will find ways to reduce carbon emissions so as to come out ahead. The rate of infrastructure replacement, thus economic activity, can be modulated by how fast the carbon tax rate increases. Effects will permeate society. Food requiring lots of carbon emissions to produce and transport will become more expensive and vice versa, encouraging support of nearby farms as opposed to imports from half way around the world.

Beware of alternative approaches, such as ‘percent emission reduction goals’ and ‘cap and trade’. These are subterfuges designed to allow business-as-usual to continue, under a pretense of action, a greenwashing. Hordes of lobbyists will argue for these approaches, which assure their continued employment. The ineffectiveness of ‘goals’ and ‘caps’ is made blatantly obvious by the fact that the countries promoting them are planning to build more coal-fired power plants.

If the United States accedes to the ineffectual ‘goals’ and ‘caps’ approach, a continuation of the Kyoto Protocol approach, it will practically guarantee disastrous climate change. Instead it should persuasively argued that other countries also adopt tax and dividend. The countries agreeing to this approach will also agree that imports from a country that does not apply a comparable carbon tax will be taxed at the port of entry. That import tax will be a strong incentive for all countries to participate.

A carbon tax is necessary but not sufficient. By itself a carbon tax cannot solve the energy problem and allow rapid coal phase-out. There also must be better efficiency standards in building codes, for vehicles, and in appliances and electronics. Profit incentives for utilities must be changed, so as to encourage efficiency as opposed to selling as much energy as possible. These are only examples of the many things to be done. But all of these things will be done easier and more effectively in the presence of a carbon tax.

Indeed, a carbon tax is essential. It is the tool that will impact people’s decisions and lifestyle choices for the short-term, middle-term and long-term, allowing the world to move as gracefully as possible to the post-fossil-fuel-era. In this way we will leave in the ground the hardest to extract fossil fuels as we move rapidly to clean energy sources of the future.

Nuclear Power. Some discussion about nuclear power is needed. Fourth generation nuclear power has the potential to provide safe base-load electric power with negligible CO_2 emissions.

There is about a million times more energy available in the nucleus, compared with the chemical energy of molecules exploited in fossil fuel burning. In today's nuclear (fission) reactors, neutrons cause a nucleus to fission, releasing energy as well as additional neutrons that sustain the reaction. The additional neutrons are 'born' with a great deal of energy and are called 'fast' neutrons. Further reactions are more likely if these neutrons are slowed by collisions with non-absorbing materials, thus becoming 'thermal' or slow neutrons.

All nuclear plants in the United States today are Light Water Reactors (LWRs), using ordinary water (as opposed to 'heavy water') to slow the neutrons and cool the reactor. Uranium is the fuel in all of these power plants. One basic problem with this approach is that more than 99% of the uranium fuel ends up 'unburned' (not fissioned). In addition to 'throwing away' most of the potential energy, the long-lived nuclear wastes (plutonium, americium, curium, etc.) require geologic isolation in repositories such as Yucca Mountain.

There are two compelling alternatives to address these issues, both of which will be needed in the future. The first is to build reactors that keep the neutrons 'fast' during the fission reactions. These fast reactors can completely 'burn' the uranium. Moreover, they can burn existing long-lived nuclear waste, producing a small volume of waste with half-life of only decades, thus largely solving the long-term nuclear waste problem.

The other compelling alternative is to use thorium as the fuel in thermal reactors. Thorium can be used in ways that practically eliminate buildup of long-lived nuclear waste.

The United States chose the LWR development path in the 1950s for civilian nuclear power because research and development had already been done by the Navy, and it thus presented the shortest time-to-market of reactor concepts then under consideration. Little emphasis was given to the issues of nuclear waste. Today the situation is very different. If nuclear energy is to be used widely to replace coal, in the United States and/or the developing world, issues of waste, safety, and proliferation become paramount.

Nuclear power plants being built today, or in advanced stages of planning, in the United States, Europe, China and other places, are just improved LWRs. They have simplified operations and added safety features, but they are still fundamentally the same type, produce copious nuclear waste, and continue to be costly. It seems likely that they will only permit nuclear power to continue to play a role comparable to that which it plays now.

Both fast and thorium reactors were discussed at our 3 November workshop. The Integral Fast Reactor (IFR) concept was developed at Argonne National Laboratory and it has been built and tested at the Idaho National Laboratory. IFRs keep neutrons "fast" by using liquid sodium metal as a coolant instead of water. They also make fuel processing easier by using a metallic solid fuel form. IFRs can burn existing nuclear waste and surplus weapons-grade uranium and plutonium, making electrical power in the process. All fuel reprocessing is done within the reactor facility (hence the name "integral") and many enhanced safety features are included and have been tested, such as the ability to shut down safely under even severe accident scenarios.

The Liquid-Fluoride Thorium Reactor (LFTR) is a thorium reactor concept that uses a chemically-stable fluoride salt for the medium in which nuclear reactions take place. This fuel form yields flexibility of operation and eliminates the need to fabricate fuel elements.

This feature solves most concerns that have prevented thorium from being used in solid-fueled reactors. The fluid fuel in LFTR is also easy to process and to separate useful fission products, both stable and radioactive. LFTR also has the potential to destroy existing nuclear waste, albeit with less efficiency than in a fast reactor such as IFR.

Both IFR and LFTR operate at low pressure and high temperatures, unlike today's LWR's. Operation at low pressures alleviates much of the accident risk with LWR. Higher temperatures enable more of the reactor heat to be converted to electricity (40% in IFR, 50% in LFTR vs 35% in LWR). Both IFR and LFTR have the potential to be air-cooled and to use waste heat for desalinating water.

Both IFR and LFTR are 100-300 times more fuel efficient than LWRs. In addition to solving the nuclear waste problem, they can operate for several centuries using only uranium and thorium that has already been mined. Thus they eliminate the criticism that mining for nuclear fuel will use fossil fuels and add to the greenhouse effect.

The Obama campaign, properly in my opinion, opposed the Yucca Mountain nuclear repository. Indeed, there is a far more effective way to use the $25 billion collected from utilities over the past 40 years to deal with waste disposal. This fund should be used to develop fast reactors that consume nuclear waste, and thorium reactors to prevent the creation of new long-lived nuclear waste. By law the federal government must take responsibility for existing spent nuclear fuel, so inaction is not an option. Accelerated development of fast and thorium reactors will allow the US to fulfill its obligations to dispose of the nuclear waste, and open up a source of carbon-free energy that can last centuries, even millennia.

It is commonly assumed that 4^{th} generation nuclear power will not be ready before 2030. That is a safe assumption under 'business-as-usual". However, given high priority it is likely that it could be available sooner. It is specious to argue that R&D on 4^{th} generation nuclear power does not deserve support because energy efficiency and renewable energies may be able to satisfy all United States electrical energy needs. Who stands ready to ensure that energy needs of China and India will be entirely met by efficiency and renewables?

China and India have strong incentives to achieve pollution-free skies as well as avert dangerous climate change. The United States, even if efficiency and renewables can satisfy its energy needs (considered unlikely be many energy experts), needs to deal with its large piles of nuclear waste, which have lifetime exceeding 10,000 years.

Development of the first large 4^{th} generation nuclear plants may proceed most rapidly if carried out in China or India (or South Korea, which has a significant R&D program), with the full technical cooperation of the United States and/or Europe. Such cooperation would make it much easier to achieve agreements for reducing greenhouse gases.

Implications. We have already overshot the safe level of greenhouse gases. Things are beginning to crumble – Arctic ice is melting, methane is bubbling from permafrost, mountain glaciers are disappearing. We must move onto a different course within the next few years to avoid committing the planet to accelerating climate changes out of our control. The time has passed for 'goals', half-measures, greenwashing, and compromises with special interests.

Geophysical limits are crystal clear: coal emissions must be phased out and emissions from unconventional fossil fuels (tar shale, tar sands, e.g.) must be prohibited.

Priorities, in order, for solving the climate and energy problems, while stimulating the economy are steps to: (1) improve energy efficiency, (2) develop and deploy renewable energies, (3) modernize and expand a 'smart' electric grid, (4) develop 4^{th} generation nuclear power, (5) develop carbon capture and sequestration capability.

Prompt development of safe 4th generation nuclear power is needed to allow energy options for countries such as China and India, and for countries in the West in the event that energy efficiency and renewable energies cannot satisfy all energy requirements.

Deployment of 4th generation nuclear power can be hastened via cooperation with China, India and other countries. It is essential that dogmatic 'environmentalists', opposed to all nuclear power, not be allowed to delay the R&D on 4th generation nuclear power. Thus it is desirable to avoid appointing to key energy positions persons with a history of opposition to nuclear power development. Of course, deployment of nuclear power is an option, and some countries or regions may prefer to rely entirely on other energy sources, but opponents of nuclear power should not be allowed to deny that option to everyone.

Coal is the dirtiest fuel. Coal burning has released and spread around the world more than 100 times more radioactive material than all the nuclear power plants in the world. Mercury released in coal burning contaminates the world ocean as well as our rivers, lakes and soil. Air pollution from coal burning kills hundreds of thousands of people per year. If such consequences were occurring from nuclear power, nuclear plants would all be closed. Mining of coal, especially mountaintop removal, causes additional environmental damage and human suffering. It is time for all the coal plants to be closed, indeed, averting climate disasters demands that all coal emissions be phased out. Coal is best left in the ground.

Nevertheless, R&D for carbon capture and sequestration (CCS) deserves strong support. It is needed to provide the full range of options in energy choices, for countries that insist on exploiting their coal resources. Moreover, CCS has another potentially more important role to play: it could be used at power plants that burn biofuels, such as agricultural wastes. This sort of 'geoengineering', which draws excess CO_2 out of the air and puts it back in the ground where it came from, may be needed to get atmospheric CO_2 back to a safe level.

Transition to the post-fossil-fuel era with clean atmosphere and ocean, requires a carbon tax. That tax will cause unconventional fossil fuels to be left in the ground, as well as much coal and some oil and gas that resides in remote regions. The public will accept such a tax if the funds are returned entirely to the public, no funds going to Washington and other capitals for politicians and lobbyists to determine its fate. Tax and 100 percent dividend is not sufficient by itself – many other actions are needed – but it is necessary. No time remains for a transition via ineffectual half measures.

Frank communication with the public is essential. At present, all around the world, many governments are guilty of greenwash, an implausible approach of goals and half-measures that will barely slow the growth of CO_2. The world, not just the United States, needs an open honest discussion of what is needed. It is a tremendous burden to place on the President-elect. The only chance seems to be if he understands the truth – the whole truth.

Young people realize that they, their children, and the unborn will bear the consequences of our actions or inactions. They do not blame their parents, who legitimately 'did not know' what they were starting. Young people worked hard to influence the democratic process. Now they expect appropriate actions.