BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
FOR THE MINNESOTA PUBLIC UTILITIES COMMISSION
STATE OF MINNESOTA

In the Matter of the Further Investigation in to
Environmental and Socioeconomic Costs
Under Minnesota Statute 216B.2422, Subdivision 3

OAH Docket No. 80-2500-31888

MPUC Docket No. E-999-CI-14-643

Exhibit __

Direct Testimony and Exhibits of

Dr. Roger H. Bezdek

June 1, 2015

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I. INTRODUCTION

Q. **Please state your name address and occupation.**

A. My name is Roger H. Bezdek, 2716 Colt Run Road, Oakton, Virginia, 22124. I am an economist.

Q. **By whom are you employed and in what position?**

A. I am the president of Management Information Services, Inc., (MISI), an economic research firm specializing in energy, environmental, and regulatory issues.

Q. **On whose behalf are you testifying in this proceeding?**

A. I am testifying on behalf of Peabody Energy Corporation.

Q. **Have you included a description of your qualifications, duties and responsibilities?**

A. Yes. A description of my qualifications is included as Bezdek Exhibit 1.

Q. **Please describe your educational background and professional experience.**

A. I received a Ph.D. in Economics from the University of Illinois (Urbana).

I have 40 years' experience in research, management, and consulting in the energy, utility, environmental, and regulatory areas, and have served in private industry, academia, and the U.S. Federal government. My experience includes Corporate Director, Corporate President and CEO, University Professor, Research Director in the Bureau of Economic Analysis of the U.S. Department of Commerce, Research and Program Director at the Energy Research and Development Administration and the U.S. Department of Energy, Special Advisor on Energy in the Office of the Secretary of the Treasury, and a U.S. energy delegate to the European Community and to the North Atlantic Treaty Organization. While with DOE, I was one of the founders of the Federal Government's Renewable Energy Program.

I have served as a consultant to the White House, the Office of former Vice President Al Gore, Federal and state government agencies, organizations that include the National Science Foundation, NASA, Greenpeace, and EPA, and numerous Fortune 500 businesses and corporations. I also have presented energy briefings to the staffs of multiple presidential candidates, including then-Senator Barack Obama and then-Senator Hillary Clinton in 2008. I am active with the National Research Council of the U.S. National Academies of Science (NAS), and have served on various NAS committees, including, most recently, the joint NAS/Chinese Academy of Sciences Committee on U.S.-Chinese Energy Cooperation and on the NAS Committee on Fuel Economy of Medium and Heavy Duty Vehicles.

I have testified before Federal, state, and city governments. I am the author of six books and over 300 articles in scientific and technical journals. I serve as an editorial board member and peer-reviewer for various professional publications, and I am the Washington editor of *World Oil* magazine.

II. OVERVIEW OF OPINIONS

Q. **What are the purposes of your testimony in this proceeding?**

A. The major purpose of my testimony in this proceeding is to assess whether the Commission should adopt a new environmental cost value for CO_2 based on the benefits of CO_2 emissions and the problems with the federal social cost of carbon (SCC).

Q. **Can you summarize your principal conclusions as to the environmental benefits of CO_2 emissions?**

A. The environmental benefits of carbon dioxide emissions are enormous and have been well documented and estimated.

- CO_2 is not harmful and is actually good for the planet: More CO_2 will be beneficial, crop yields will increase substantially, and greening of the planet due to CO_2 is already occurring.
- The impact of CO_2 emissions on plant growth is highly beneficial: The more CO_2 there is in the air, the better plants grow, as has been demonstrated in literally thousands of laboratory and field experiments.

Q. **Can you summarize your principal conclusions as to the economic benefits of CO_2 emissions?**

A.
- The effect of CO_2 fertilization on agricultural productivity can be quantified, and a doubling of the air's CO_2 content above the current level will increase the productivity of most herbaceous plants by about one-third.
- The economic value of CO_2 fertilization is enormous: The total economic value of the CO_2 benefit for 45 crops cumulatively totaled $3.2 trillion, 1961-2012, and is forecast to total nearly $10 trillion, 2012 – 2050.
- The agricultural, social, and economic benefits of carbon dioxide emissions are increasing rapidly, and there is no limit for the foreseeable future to these benefits as CO_2 emissions increase.
- There is a strong, positive, direct causal relationship between carbon dioxide emissions and GDP.
- Future economic growth requires fossil fuels because these are the only fuels that can provide the abundant, reliable, affordable energy that the world will depend on in the coming decades.
- My findings are even more relevant for Minnesota than for the U.S. as a whole due to the state's northern location and relatively colder temperatures, which makes it exceedingly dependent on fossil fuels.

Q. **Can you summarize your principal conclusions as to the federal government's social cost of carbon?**

A.
- The empirical scientific evidence supports an environmental externality figure for carbon dioxide of approximately zero.
- The federal government's SCC estimates are not credible.
- The federal SCC estimates do not adequately consider the benefits of fossil fuels and CO_2 emissions.
- The integrated assessment models (IAMs) relied upon by the federal Interagency Working Group (IWG) in generating the current federal

SCC do not adequately consider the benefits from carbon dioxide emissions.

- The IAMs relied upon by the IWG have not been shown by a preponderance of the evidence to be reliable, accurate, reasonable, and the best available measures for the cost of carbon -- in fact, just the opposite is true.
- The benefits of CO_2 emissions with respect to economic growth exceed by orders of magnitude the federal SCC figures -- the benefits estimates are so large as to relegate the federal SCC estimates to statistical noise.
- Extensive relevant scientific knowledge on environmental externalities has become available over the 17 years since the Commission first established cost values, and this greatly strengthens my conclusions.
- The federal SCC is not a reasonable measure and the preponderance of evidence demonstrates that it is not the best available measure to determine the environmental cost of CO_2 under Minn. Stat. § 216B.2422.

Q. **Can you summarize your principal conclusions as to the impact of higher energy prices?**

A. The impact of higher energy prices on lower income ratepayers is devastating.

- Higher energy prices greatly harm lower income ratepayers in Minnesota and energy costs are consuming the incomes of Minnesota's low- and middle-income families at levels comparable to other necessities such as housing, food, and health care.
- The impact of higher energy prices on minorities is especially severe because minority families are more likely to be found among the lowest-income households.

- The impact of higher energy prices on minority and elderly ratepayers in Minnesota is disproportionately burdensome, since they are among those most vulnerable to energy price increases, and the benefits of maintaining fossil fuel energy are much greater for these ratepayers.

Q. **Can you summarize your principal recommendations?**

A.
- The benefits of carbon dioxide emissions should be considered in developing any environmental externality figure for CO_2 in Minnesota.
- The benefits of CO_2 greatly exceed the costs, and any regulatory or benefit-cost analysis should take this huge discrepancy into account.
- The federal SCC is not a reasonable measure and should not be used to determine the environmental cost of CO_2 under Minn. Stat. § 216B.2422.
- The federal SCC estimates should not be used in setting regulatory policies in Minnesota or elsewhere.
- If an environmental externality figure for carbon dioxide is to be used in any regulatory proceeding, it should be set at a value of approximately zero.
- The impact of higher energy prices on lower-income, minority, and elderly ratepayers in Minnesota is disproportionately burdensome, and this should be taken into account in any regulatory proceeding.
- The best available measure to determine the environmental cost of CO_2 under Minn. Stat. § 216B.2422 is a metric that considers both the benefits and the costs of CO_2, and the benefit-cost measure described here should be used.

Q. **Have you determined an environmental externality figure for carbon dioxide?**

A. I have not determined a precise externality figure for carbon dioxide. However, from my research (summarized in Bezdek Exhibit 2) and as discussed below, I believe the empirical scientific evidence supports an environmental externality figure for carbon dioxide of about zero.

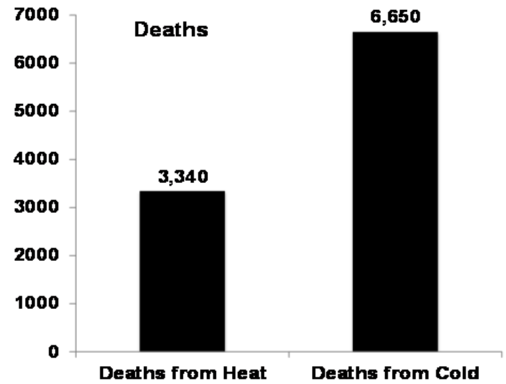
Q. **If you were examining only effects in Minnesota, do you expect that your conclusions would change?**

A. No, not materially. However, my conclusions are even more relevant for Minnesota than for the U.S. as a whole due to the state's northern location and relatively colder temperatures. It is thus exceedingly dependent on fossil fuels.

Minnesota agriculture is highly petrochemical intensive, and to maintain or expand harvests will require more oil, natural gas, and other energy resources – not less. Further, more energy is required to heat a structure than to cool it, and the state's relatively cold temperatures require large quantities of energy to ensure survivability and livability. Transportation – by vehicle, train, boat, or airplane – in a colder climate is more difficult and energy intensive than transportation in a warmer climate. One of the primary hazards during a cold winter is the loss of electrical power and access to energy.[1]

Of special importance, cold is a much greater health danger than heat. As shown in Figure 13-1, exposure to excessive natural cold causes twice as many deaths in the U.S. as heat, and excessive cold is responsible for 63% of the U.S. extreme weather deaths. Thus, for example: "Cold-related deaths are far more numerous than heat-related deaths in the United States, Europe, and almost all countries outside the tropics, and almost all of them are due to common illnesses that are increased by cold."[2] As shown in Part V of Bezdek Exhibit 3, humans would flourish in a warmer climate, and adaptation will increase the benefits even more.

Figure 13-1: U.S. Extreme Weather Deaths From Heat and Cold, 2006-2010



Source: *Los Angeles Times*, 2014.

III. FEDERAL GOVERNMENT'S SOCIAL COST OF CARBON ESTIMATE

Q. What is your opinion regarding the social cost of carbon values that have been calculated by the federal government?

A. In my opinion, the federal government's SCC estimates are not credible and should not be used in setting regulatory policies in Minnesota or elsewhere.

As discussed in Bezdek Exhibit 2, the IWG SCC estimates are not reliable because they are based on highly speculative assumptions and forecasts, flawed IAM simulations, unjustified damage functions, improper discount rates, and other significant problems. The IWG relied critically on IAMs to develop its SCC estimates. However, these models have crucial flaws that make them "close to useless" as tools for policy analysis; for example:[3] i) Certain inputs (e.g. the discount rate) are arbitrary, but have huge effects on the models' SCC estimates; ii) the models' descriptions of the impact of climate change are completely ad hoc, with no theoretical or empirical foundation; iii) the models tell us nothing about the most important driver of the SCC; iv) IAM-based analyses of climate policy create a perception of knowledge and precision, but that perception is illusory and misleading; the damage functions used in most IAMs are completely made up, with no theoretical or empirical foundation -- and yet those damage functions are taken seriously when IAMs are used to analyze climate policy.

Researchers have thus concluded that IAMs are of little or no value for evaluating alternative climate change policies and estimating the SCC. On the contrary, an IAM-based analysis suggests a level of knowledge and precision that is nonexistent, and allows the modeler to obtain almost any desired result because key inputs can be chosen arbitrarily.[4] The National Academies of Science (NAS) found that the SCC assessment suffers from uncertainty, speculation, and lack of information about future emissions of greenhouse gases (GHGs), the effects of past and future emissions on the climate system, the impact of changes in climate on the physical and biological environment, and the translation of these environmental impacts into economic damages.[5] NAS thus concluded, "As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional."[6] As shown in Part VII of Bezdek Exhibit 3, economic analysis of climate change shows that damages are consistently overestimated and overvalued, and that those errors are driven by politics rather than analysis.

Because of its many flaws and overall unreliability, the federal SCC must be rejected.

Q. **Do you think that the federal social cost of carbon estimates adequately consider the benefits of fossil fuels and CO_2 emissions?**

A. No, the federal social cost of carbon estimates do not adequately consider the benefits of fossil fuels and CO_2 emissions.

Q. **Why not?**

A. The federal SCC estimates are highly biased: as demonstrated throughout both the 2010 and 2013 IWG reports, their stated purpose is to estimate the cost of CO_2 emissions, and they devote little attention to CO_2 benefits. For example, on at least a dozen occasions, the 2010 and 2013 IWG reports refer to damages caused by CO_2 and the benefits of reducing CO_2. The SCC estimates fail to adequately consider or incorporate the enormous direct CO_2 benefits – plant growth and agricultural productivity – and the indirect CO_2 benefits – those produced by the fossil fuels from which CO_2 derives. Instead, the few, minor benefits acknowledged by the IWG reports – for example, reduced space heating – are constrained.

IV. ENVIRONMENTAL BENEFITS OF CO_2 EMISSIONS

Q. **What are the environmental benefits of carbon dioxide emissions?**

A. The environmental benefits of carbon dioxide emissions are enormous and well documented.

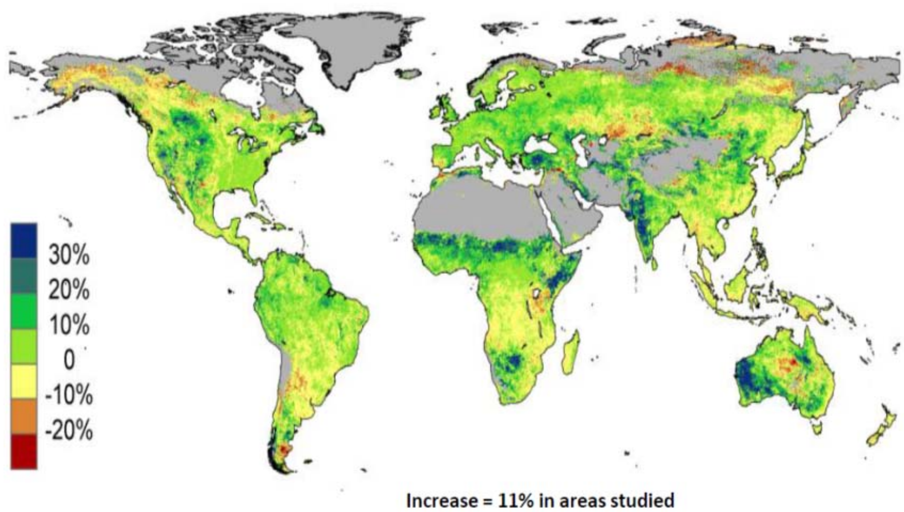
CO_2 is not a pollutant: It is not known to have any negative impacts on human health, it is essential for life, and is the basis of nearly all life on Earth -- without CO_2 life on this planet would not exist. It is the primary raw material or "food" utilized by the vast majority of plants to produce the organic matter out of which they construct their tissues, which subsequently become the ultimate source of food for nearly all animals and humans. Consequently, the more CO_2 there is in the air, the better plants grow, as has been demonstrated in thousands of studies.[7] And the better plants grow, the more food there is available. As shown in Part IV to Bezdek Exhibit 3, plants will flourish under higher CO_2 conditions, becoming healthier and more resistant to pests and disease.

Researchers have identified 55 benefits from increased atmospheric CO_2 concentrations. Plants grow faster; increase their photosynthetic rate by as much as 50%; increase their leaf area, plant branch, and fruit numbers; and decrease their water demands and suffer less air pollution stress. In particular, this decreases soil erosion by expanding plant cover. Biodiversity is also enhanced because it increases the niche security of many different forms of plants, and biomass gains a greater ability to remove that carbon from the atmosphere, creating a natural negative feedback on CO_2.[8]

The implication that CO_2 is a harmful "pollutant" is thus wrong. CO_2 concentrations in the atmosphere have been much higher in the past, even well before any human industrial activities were emitting CO_2.[9] The IWG largely ignored or discounted scientific data demonstrating the likely benefits from increased concentrations of CO_2 in the atmosphere.

Professor William Happer – the former head of basic research at DOE – finds that greening of the planet is already being observed (Figure 17-1), that any modest warming from more CO_2 will be beneficial, and that crop yields will increase substantially.[10]

Figure 17-1: Global Greening From CO_2 Fertilization: 1982-2010



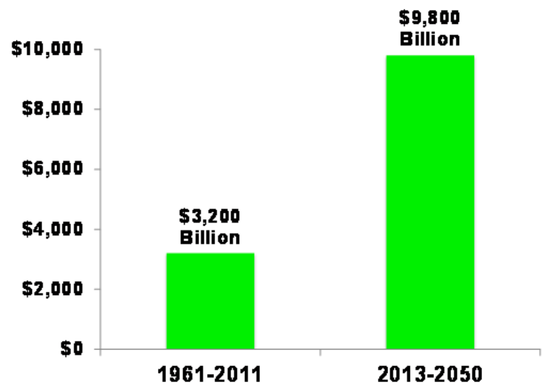
Source: Happer, 2014.

Q. **Has the economic value of these environmental benefits of CO_2 been estimated?**

A. Yes. The increased crop production due to CO_2 above 280 ppm (the level that existed at the beginning of the Industrial Revolution) can be calculated for each year between 1961 and 2011, which can then be used to estimate the annual economic benefit of atmospheric CO_2 enrichment (above the baseline of 280 ppm) on crop production since 1961. The economic benefit of Earth's rising atmospheric CO_2 concentration on global food production is enormous and totaled \$3.2 trillion from 1961 to 2011 (Figure 18-1).[11] I forecast that over the period 2012 - 2050, these

CO_2 benefits will total nearly $10 trillion – Figure 18-1. The IWG essentially ignored these benefits.

Figure 18-1: Benefits of More CO_2 For Global Crop Production



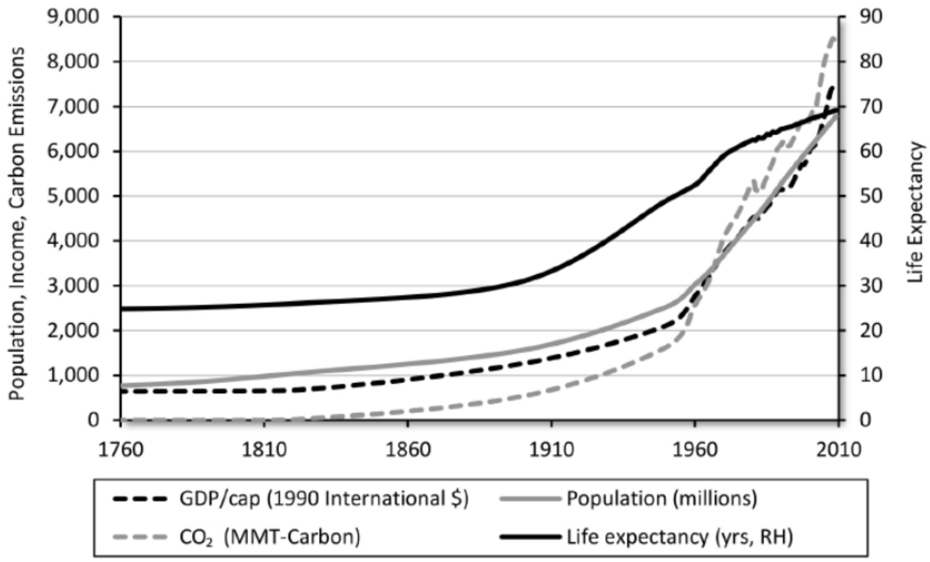
Source: Idso, 2013.

V. ECONOMIC BENEFITS OF CO2 EMISSIONS

Q. What are the social and economic benefits of carbon dioxide emissions?

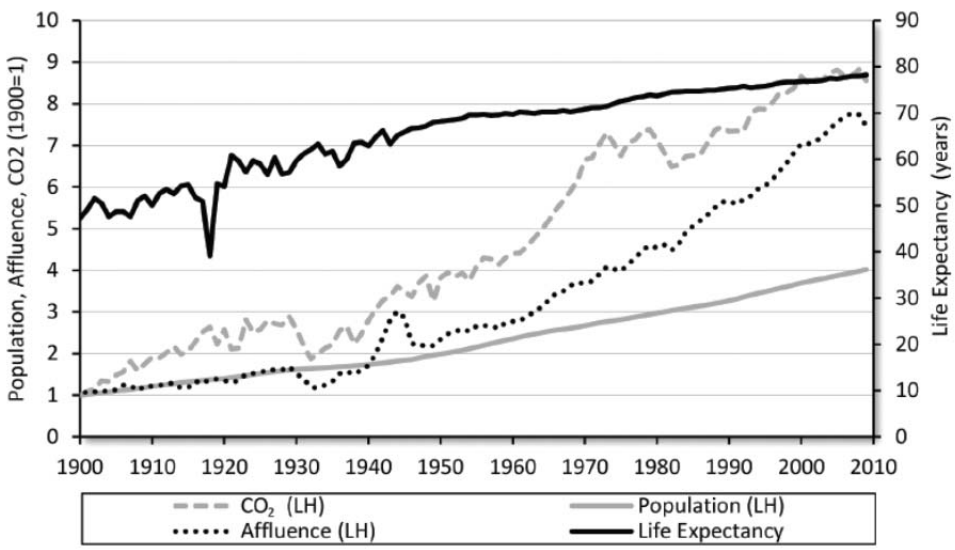
A. The successful utilization of fossil fuels facilitated successive industrial revolutions, created the modern world, created our advanced technological society, and enabled the high quality of life currently taken for granted. World economic and technological progress over the past two centuries would simply have been impossible without the massive use of vast quantities of fossil fuels. For example, from 1750 to 2009, global life expectancy more than doubled, global population increased 8-fold, and incomes increased 11-fold.[12] As shown on Figure 19-1, these increases in living standards correlate with increases in CO_2 emissions. Figure 19-2 shows a similar trend for increases in the United States.

Figure 19-1: Global Progress, 1760–2009: Trends in World Population, GDP Per Capita, Life Expectancy, and CO_2 Emissions From Fossil Fuels



Source: Goklany, 2012.

Figure 19-2: U.S. Carbon Dioxide Emissions, Population, GDP per Capita, and Life Expectancy at Birth, 1900–2009



Source: Goklany, 2012.

Q. Is there a limit to these benefits as carbon dioxide emissions increase?

A. No, not for the foreseeable future.

Q. CO_2 is not harmful and is actually good for the planet. More CO_2 will be beneficial, crop yields will increase substantially, and "Greening of the planet is already being observed."[13] With respect to the "optimum" level of CO_2, at 150 ppm plants stop growing; the pre-industrial level was 280 ppm, and the present level is about 400 ppm. However, compared to the levels of CO_2 that prevailed since the Cambrian, we have been in a CO_2 famine in recent geological times. More CO_2 will be very beneficial to agriculture. CO_2 enrichment at 2, 3, and 4 times natural concentration will cause plants to grow faster and improve plant quality.[14] As Dr. Patrick Moore – a founder of Greenpeace -- notes,

> Plants grow best at a CO_2 concentration of around 1,500 ppm, which increases plant yield by 25-65%. The present CO_2 level in the global atmosphere is about 400 ppm. Thus, trees and other plants would benefit from a level of CO_2 about four times higher than it is today. There is solid evidence that trees are already showing increased growth rates due to rising CO_2 levels.[15]

As Sylvan Wittwer, the father of agricultural research on this topic, stated, the effects of increased CO_2 "know no boundaries and both developing and developed countries are, and will be, sharing equally," for "the rising level of atmospheric CO_2 is a universally free premium, gaining in magnitude with time, on which we all can reckon for the foreseeable future".[16]

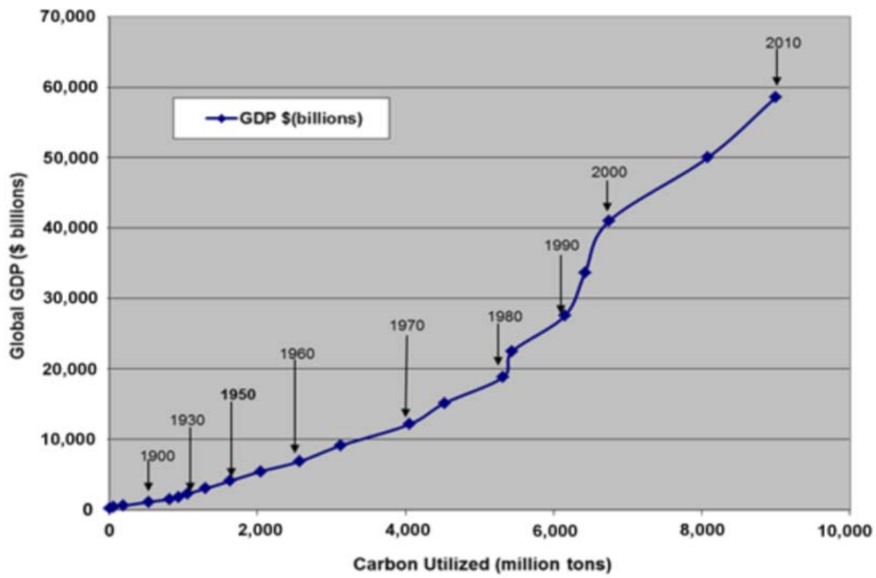
Q. **Please explain the relationship between carbon dioxide emissions and gross domestic product (GDP).**

A. There is a strong, direct causal relationship between carbon dioxide emissions and GDP. Robert Zubrin analyzed the relationship between global GDP per capita and carbon use from 1800 through 2010.[17] He found that the relationship is generally linear, with GDP per capita and carbon use both increasing by a factor of ten between 1910 and 2010. As shown in Figure 21-1, Zubrin also compared GDP to carbon utilization and found the relationship "is not merely linear, but is more nearly quadratic, with total economic output rising as roughly the square of carbon use."[18]

Taking the ratio of current global GDP to carbon use and dividing it out indicates that, at present, each ton of carbon used produces about $6,700 of global GDP.[19] Seven tons denied corresponds to a loss of $47,000, or a good American job.

Figure 21-1: Global GDP vs. Carbon Utilization, 1800 - 2010

(2010 Dollars)

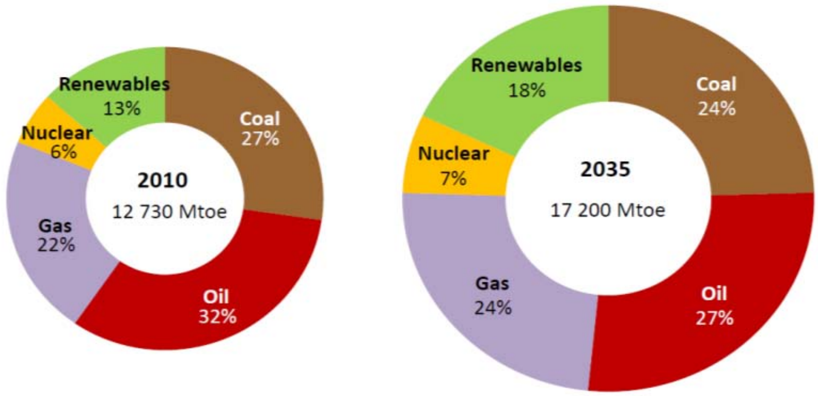


Source: Zubrin, 2013.

Q. Why does future economic growth require fossil fuels?

A. Future economic growth requires fossil fuels because these are the only fuels that can provide the abundant, reliable, affordable energy that the world will depend on in the coming decades. According to all major forecasts available, fossil fuels will remain the principal sources of energy worldwide for the foreseeable future and will continue to supply 75-80% of world energy. For example, Figure 22-1 illustrates the forecast of the International Energy Agency.[20]

Figure 22-1: Energy Demand by Fuel, 2010 and 2035



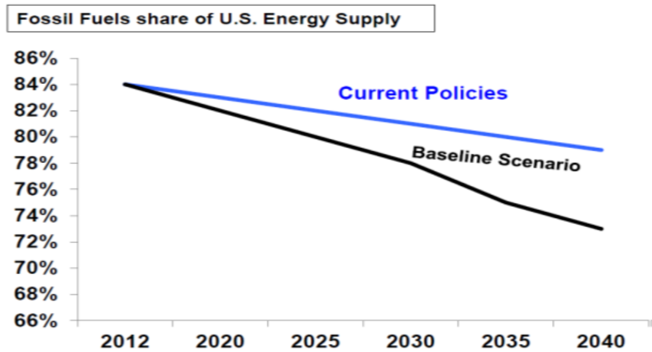
Source: International Energy Agency.

Q. Why can't similar rates of growth be sustained by other fuel sources?

A. Similar rates of growth cannot be sustained by other fuel sources, such as renewables, because they are unreliable, intermittent, expensive, and are not scalable. For example, wind and solar are intermittent energy sources because the power they produce can suddenly disappear when the wind stops blowing, a cloud appears, and/or at night. In just 30 minutes, 1,000 MW — the output of a nuclear reactor — can disappear and threaten stability of the grid. Hydro and geothermal are limited geographically and are not expected to increase their generation or capacity significantly. Liquid fuels such as ethanol and biodiesel have lower energy densities and are thus less energy efficient.[21] According to both IEA and EIA, renewables currently comprise less than 15% of world energy, and by 2040 they will account for only about 15%.

Fossil fuels, oil, coal, and natural gas, are the cheapest and most reliable sources of energy in the world. That is why they supply 85% of U.S energy and over 80% of global energy – and will continue to do so for many decades (Figure 23-1).

Figure 23-1: U.S. Energy Demand: Fossil Fuels Will Continue to Dominate



Source: International Energy Agency, *World Energy Outlook 2014*.

VI. CO_2 FERTILIZATION

Q. What is the impact of CO_2 emissions on plant growth?

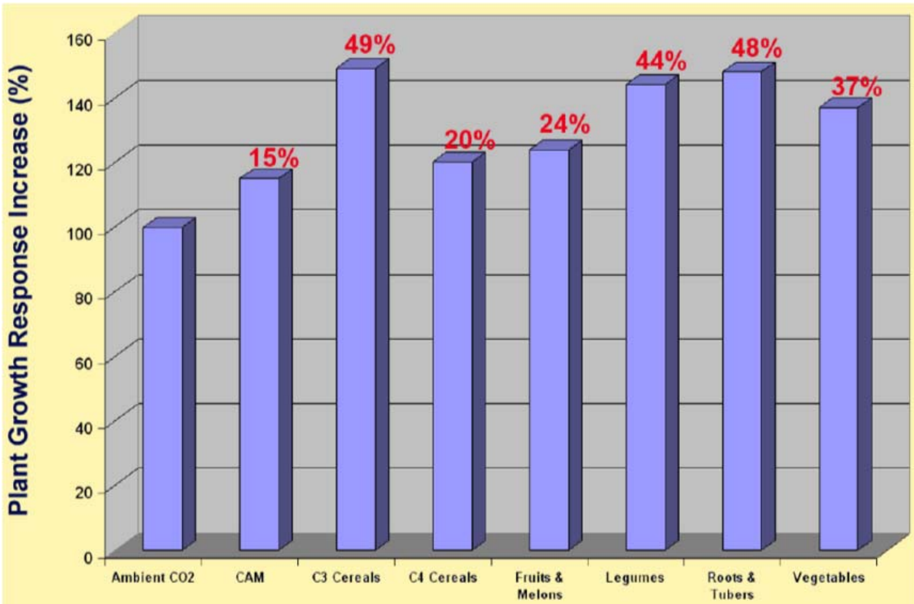
A. The more CO_2 there is in the air – natural plant food – the better plants grow, as has been demonstrated in thousands of studies.[22] More CO_2 also helps plants grow due to more efficient water use because the CO_2 helps plants open their pores wider.[23] Finally, CO_2 allows plants to better compensate for environmental stresses that affect plant growth and development, such as high soil salinity, high air temperature, low light intensity, high light intensity, UV-B radiation, water stress, and low levels of soil fertility.

Q. Can you quantify the effect of CO_2 fertilization on agricultural productivity?

A. Yes. Typically, a doubling of the air's CO_2 content above present-day concentrations raises the productivity of most herbaceous plants by about one-third; and this positive response occurs in plants that utilize all three of the major biochemical pathways (C3, C4, CAM) of photosynthesis. As shown in Figure 25-1, a 300-ppm increase in atmospheric CO_2 will result in significant yield increases for important food sources.[24] Thus, with more CO_2 in the air, the growth and productivity of nearly all crops will increase, providing more food to sustain the biosphere and a growing world population.

Figure 25-1: Plant Growth Response to a 300 ppm

Increase in Atmospheric CO_2



Source: Idso and Idso, 2000.

Q. **What is the economic value of CO_2 fertilization?**

A. The economic value of CO_2 fertilization is enormous. As previously discussed, the economic benefit of Earth's rising atmospheric CO_2 concentration on global food production is enormous and totaled $3.2 trillion, 1961-2012. I forecast that over the period 2012 - 2050, these CO_2 benefits will total nearly $10 trillion.

Q. **How does the CO_2 fertilization factor into your opinions concerning the social benefits of carbon?**

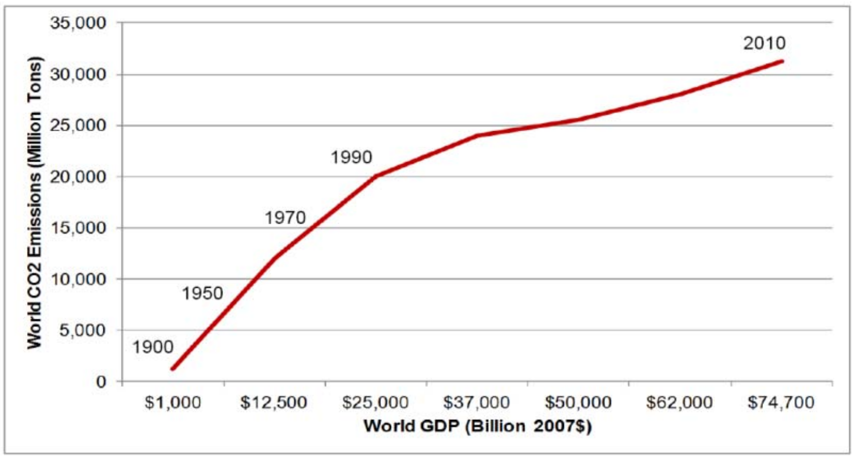
A. The CO_2 fertilization factor strengthens my opinions concerning the social benefits of carbon. As noted, the estimated CO_2 cumulative global fertilization benefits total approximately $10 trillion over the period 2013 – 2050. This is in addition to the cumulative global economic benefits from the use of fossil fuels over the period 2013 – 2040, which total about $2,800 trillion (2005 dollars), as discussed later in more detail. Thus, including the CO_2 fertilization factor into my benefit estimates would increase the estimated carbon benefits by another $10 trillion.

VII. <u>FUTURE BENEFITS OF CO_2 EMISSIONS</u>

Q. **Please explain your methodology for determining future benefits derived from increasing CO_2 emissions.**

A. I first compared CO_2 emissions from fossil fuels with GDP over the past century. Figure 28-1 shows a strong relationship between world GDP and CO_2 emissions from fossil fuels.

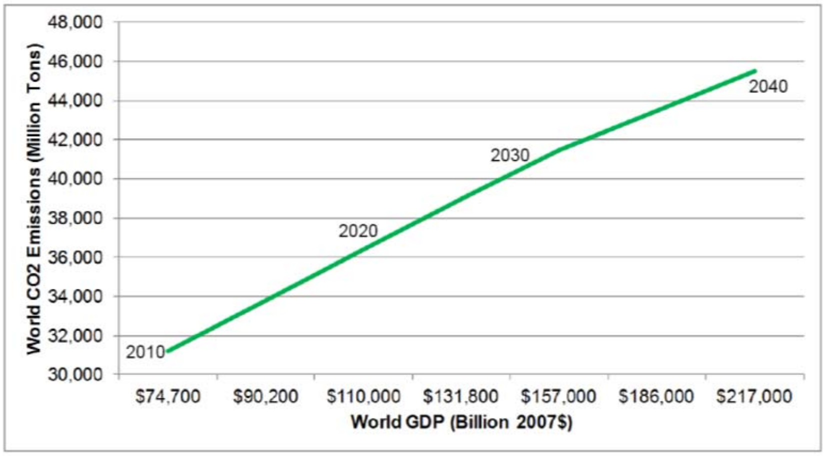
Figure 28-1: Relationship Between World GDP and CO_2 Emissions



Source: U.S. Energy Information Administration, International Energy Agency, U.S. Bureau of Economic Analysis, and Management Information Services, Inc.

Next, as illustrated by Figure 28-2, I prepared the forecast relationship between world GDP and CO_2 emissions in the EIA reference case through 2040, which is forecast to be roughly linear. Once again, future economic growth – as measured by world GDP – requires fossil fuels which, in turn, generate CO_2 emissions. Thus, according to EIA data and forecasts, fossil fuels, which generate CO_2 emissions, are essential for world economic growth, and significant CO_2 emissions reductions will be associated with significant reductions in economic growth.

Figure 28-2: Forecast Relationship
Between World GDP and CO_2 Emissions
(EIA Reference Case)



Source: U.S. Energy Information Administration, International Energy Agency, U.S. Bureau of Economic Analysis, and Management Information Services, Inc.

Q. **What assumptions have you made regarding the economic growth rates?**

A. I followed the assumptions regarding the economic growth rates utilized by IEA and EIA in their forecasts.

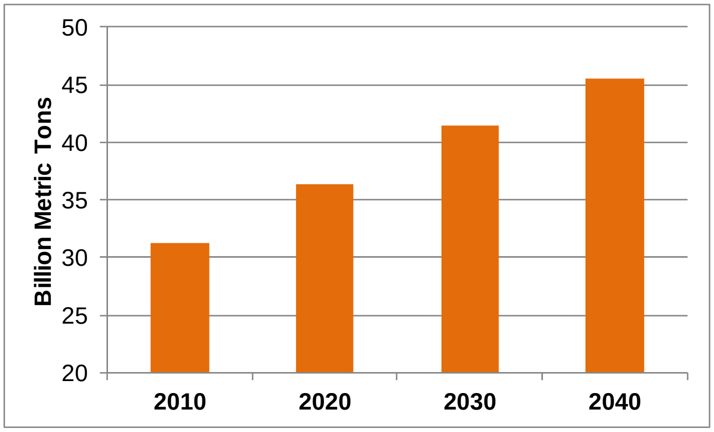
IEA notes that its forecasts are highly sensitive to the underlying assumptions about the rate of growth of GDP; that is, GDP growth requires energy and energy demand is driven by economic growth.[25] IEA assumes that world GDP, in purchasing power parity, will grow by an average of 3.5% annually over the period 2010-2035.[26] It finds that most forecasts of economic growth over the long term fall within a relatively narrow range, even if there may be significant divergence between countries.[27]

Q. **What assumptions have you made regarding the growth rates of carbon dioxide emissions?**

A. I followed the assumptions made by EIA in its forecasts regarding the growth rates of carbon dioxide emissions. EIA notes that energy-related carbon dioxide emissions -- produced through the combustion of liquid fuels, natural gas, and coal -- account for much of the world's anthropogenic GHGs.[28] In the EIA *IEO 2013* Reference case, which I adhered to and is shown in Figure 30-1, world energy-related CO_2 emissions increase by almost 50% between 2010 and 2040.

Figure 30-1: Forecast World Energy-related CO_2 Emissions

(EIA Reference case)



Source: U.S. Energy Information Administration.

Q. **What assumptions have you made regarding future environmental or social costs from increasing carbon dioxide emissions?**

A. I used the Federal government's assumptions regarding future environmental and social costs from increasing carbon dioxide emissions. While, as discussed, the IWG SCC estimates are not credible, I nevertheless used the 2013 IWG assumptions and forecast estimates of SCC costs to ensure objectivity.

VIII. <u>IMPACT OF HIGHER ENERGY PRICES</u>

Q. **What is the impact of higher energy prices on lower income ratepayers?**

A. The impact of higher energy prices on lower income ratepayers is devastating. Table 32-1 shows that households with the lowest incomes spend the largest shares of their disposable income to meet energy needs. For example, for the nine million American households earning less than $10,000 per year, nearly ¾ of their average income was used to meet energy needs. Among the 56 million households making more than $50,000 per year, less than 9% of average income was spent on energy needs. The national average for energy costs as a percentage of household income is about 11%.[29]

Thus, the poorest pay, in percentage terms, nearly nine times as much for energy as the most affluent households – and more than 11 times as much for residential energy.[30]

Table 32-1: U.S. Household Energy Expenditures by Income, 2013

Pre-tax Income	<$10K	$10K - $30K	$30K - $50K	>$50K	Average
Percent of households	7.6%	22.9%	19.4 %	50.1%	
Residential energy	$1,622	$1,719	$1,937	$2,568	$2,117
Transportation fuel	$1,991	$2,473	$3,497	$4,668	$3,730
Total energy	$3,613	$4,192	$5,434	$7,256	$5,907
Average after-tax income	$4,726	$18,261	$33,297	$84,828	$53,092
Energy percent of after-tax income	76.5%	23.0%	16.3 %	8.6%	11.1%
Residential energy percent of after-tax income	34.3%	9.4%	5.8 %	3.0%	4.1%

Sources: U.S. Bureau of Labor Statistics, U.S. Department of Energy, U.S. Energy Information Administration, and U.S. Congressional Budget Office.

These data confirm the extremely regressive nature of energy costs, and Table 32-2 shows the average annual expenditures for U.S. households earning $50,000 or less. These households spend more on energy than on food, and twice as much on energy than on healthcare.

Table 32-2: Average Annual Household Expenditures

Pre-tax annual income (average)	$50,000 or Less	% of Total Expenditures
After-tax income (average)	$36,218	--
Clothing	$1,340	3.7%
Energy – residential & transportation	$5,396	14.9%
Healthcare	$2,861	7.9%
Food	$5,287	14.6%
Housing (ex. utilities)	$10,395	28.7%
Transportation (ex. fuel)	$5,179	14.3%
Entertainment	$1,920	5.3%
Insurance and pensions	$1,956	5.4%
Education and reading	$507	1.4%
Tobacco and alcohol	$761	2.1%
All other	$616	1.7%
Total expenditures	$36,218	100%

Source: U.S. Bureau of Labor Statistics, *Consumer Expenditure Survey 2009*, October 2010.

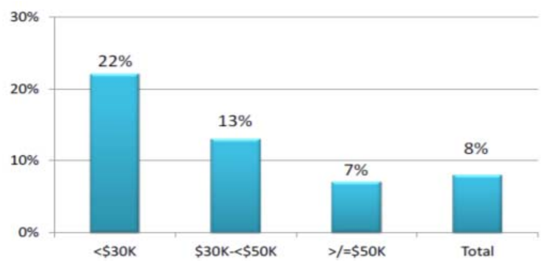
High and increasing energy prices have a detrimental effect on the lives of those with limited incomes.[31] An EPC survey found that 8% of low-income respondents annually experience utility shut-offs due to rising energy costs.[32] Sadly, according to the EPC survey, 70% of those living at or below 150% of poverty reported that they were buying less food in response to increases in home energy costs. About 31% of the poorest families indicated that they purchased less medicine due to high energy costs,[33] and approximately one out of five changed plans for education.[34] Thus, low income Americans are under the greatest strain: "Inability to pay utilities is second only to inability to pay rent as a reason for homelessness."[35]

Q. **What is the impact of higher energy prices on lower income ratepayers in Minnesota?**

A. High and increasing energy prices are straining the budgets of Minnesota's lower- and middle-income families, as shown in Figure 33-1. Minnesota households with pre-tax annual incomes below $50,000, 41% of Minnesota's population spend an average of 16% of their after-tax income on energy. Energy costs for the 24% of households earning less than $30,000 before taxes represent 22% of their family incomes, before accounting for any energy assistance programs.[36]

The 41% of Minnesota's families that have annual incomes of $50,000 or less have an average after-tax income of $23,697, less than $2,000 per month. Measured in constant 2005 prices, residential electricity prices in Minnesota are 20% above 2005 levels, and much of this increase is due to fuel cost changes and the cost of compliance with U.S. EPA Clean Air Regulations. Energy costs are consuming the after-tax household incomes of Minnesota's low- and middle-income families at levels comparable to other necessities such as housing, food, and health care.

Figure 33-1: Minnesota Household Energy Costs as a Percent of Income



Gross pre-tax annual income

Source: U.S. Energy Information Administration.

Q. **What is the impact of higher energy prices on minorities?**

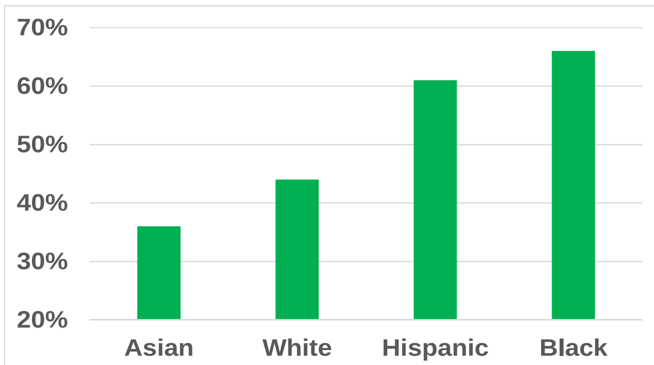
A. Table 34-1 summarizes 2012 household incomes for Asian, Black, Hispanic, and white families by income bracket. The average incomes of Hispanic and Black households were 25% and 33% lower, respectively, than the average income of U.S. households. Asian households, on the other hand, had average annual incomes 28% higher than the U.S. average income. Based on the data in Table 34-1 and Figures 34-1 and 34-2, disproportionate numbers of Black and Hispanic families are significantly more vulnerable to energy price increases than Asian or White families.

Table 34-1: Distribution of U.S. Households by Pre-Tax Annual Income, 2012

Pre-tax annual income: Percentage of households	<$10K	$10-<$30K	$30-<$50K	<$50K	≥$50K	Totals
Asian	7%	15%	15%	36%	64%	100%
Black	15%	30%	20%	66%	34%	100%
Hispanic	10%	28%	22%	61%	39%	100%
White	5%	21%	18%	44%	56%	100%
U.S. average	7%	23%	19%	49%	51%	100%

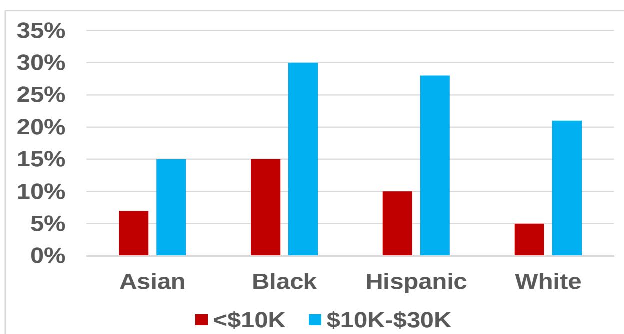
Source: U.S. Bureau of the Census, *Current Population Survey*, August 2013.

Figure 34-1: Percent of U.S. Households with Incomes below $50,000, 2012



Source: U.S. Bureau of the Census, *Current Population Survey*, August 2013.

Figure 34-2: Percentage of U.S. Households with Low Incomes, 2012



Source: U.S. Bureau of the Census, *Current Population Survey*, August 2013.

Q. What is the impact of higher energy prices on minority and elderly ratepayers in Minnesota?

A. The impact of higher energy prices on minority and elderly ratepayers in Minnesota is disproportionately burdensome.

The impacts of high energy costs fall disproportionately on Minnesota's minorities and elderly residents.[37] Social Security recipients comprise

28% of the state's households. Unlike young working families with the potential to increase incomes by taking on part-time work or increasing overtime, many fixed-income seniors are limited to cost-of-living increases that may not keep pace with energy costs. Table 35-1 summarizes Minnesota's 2013 pre-tax median incomes for elderly and minority households, and compares these with the U.S. median household income.

Table 35-1: U.S. and Minnesota Median Pre-tax Household Incomes, 2013

	Median Household Income	MN Pct. Diff. Vs. U.S. Median	Pct. of Households
U.S.	$52,250		
Minnesota	$60,702	16%	
MN: Black	$31,021	-41%	4%
MN: Hispanic	$41,708	-20%	3%
MN: Age 65+	$38,531	-26%	22%

Source: U.S. Bureau of the Census, *American Community Survey 2013*, 2014.

Minnesota's minorities and senior citizens are among the most vulnerable to energy price increases due to their relatively low household incomes. As shown in Table 35-1, Minnesota's minorities and elderly households have median incomes substantially below the U.S. median. These relatively low median incomes indicate that Minnesota's minority and senior households are among those most vulnerable to energy price increases.

Q. **How does any impact on lower income ratepayers factor into your analysis of future social benefits of maintaining fossil fuel energy?**

A. The impact on lower income ratepayers did not factor directly into my analysis of future social benefits of maintaining fossil fuel energy. However, as has been shown, the impact of high energy costs is devastating to lower income ratepayers. Thus, the benefits of maintaining fossil fuel energy are much greater for these ratepayers.

IX. BENEFITS OF CO_2 IN THE FEDERAL SOCIAL COST OF CARBON

Q. **Do the integrated assessment models relied upon by the IWG in generating the current federal social cost of carbon adequately consider the benefits from carbon dioxide emissions?**

A. No. As previously discussed, the models are focused on damages, not benefits.

Q. **Do you think that the integrated assessment models relied upon by the IWG have been shown by a preponderance of the evidence to be reliable, accurate, reasonable, and the best available measures for the cost of carbon?**

A. No. In fact, just the opposite is true. For example: 1) the IWG's SCC estimates are based on the arithmetic average of three IAMs-- DICE, FUND, and PAGE; 2) each IAM has its own damage function, based on estimated damages for each sector (agriculture, sea level rise, etc.); 3) the "damage functions" used in these models are simply a guess about the relationship between changes in temperature and GDP; 4) the average SCC estimates from the models differ by a factor of three to eight, depending on discount rate used; 5) dollar figures for "damage per sector" disagree among the models, reflecting the wide choice of assumptions made by model builders; 6) integrated damage figures differ even in sign (!) for increases in global temperature below 3^o C; and 7) the IWG did not reconcile these and other fatal inconsistencies.

As discussed, rigorous assessment of these IAMs by leading economists have concluded that the IAMs are "close to useless."

Q. **What is the difference between your approach and the integrated assessment models in determining the benefits of carbon dioxide?**

A. My approach is rigorously based on two centuries of historical data, whereas the IWG IAM approach is based on unverified, inaccurate hypothetical models, arbitrary damage functions, and malleable assumptions. As Robert Pindyck notes, the IAM models have crucial flaws that make them “close to useless” as tools for policy analysis.[38] An IAM-based analysis suggests a level of knowledge and precision that is nonexistent, and allows the modeler to obtain almost any desired result because key inputs can be chosen arbitrarily.[39]

In short, the SCC estimates developed and utilized by the IWG have little or no validity and are “close to useless.”[40] I thus conclude that the federal SCCs: 1) Are artificial constructs designed by Obama Administration to penalize fossil fuels; 2) allow the Administration to achieve via regulation what it cannot via Congress – carbon tax, Waxman-Markey, UN commitment, etc.; 3) are a malleable concept dependent on questionable modeling assumptions; 4) lack transparency; 5) lack adequate consideration of CO_2 benefits; 6) rely heavily on computer models that imply levels of knowledge and precision that are illusory; 7) allow a modeler to obtain any desired result; 8) employ arbitrary assumptions that have huge effects on SCC estimates – even their sign.

On the other hand, my CO_2 benefit estimates are simple, straightforward, logical, transparent, understandable, and based on two centuries of historical fact. The CO_2 benefits are largely indirect: They derive from the fossil fuels which produce CO_2.

Q. **Should the benefits of carbon dioxide emissions be considered in developing any environmental externality figure for CO_2 in Minnesota?**

A. Yes. Federal agencies must “assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.”[41] It is thus inexcusable that the IWG process hypothesizes almost every conceivable carbon “cost” – including costs to agriculture, forestry, water resources, forced migration, human health and disease, coastal cities, ecosystems, wetlands, etc. – but fails to analyze potential carbon benefits, either direct or indirect.[42]

Minnesota, and other jurisdictions, should consider the benefits of CO_2 emissions in developing any environmental externality figure for carbon dioxide. Minnesota should also realize that the economic and social benefits of CO_2 exceed by orders of magnitude even the invalid and inflated federal SCC estimates.

Q. **How do your calculations of the benefits of carbon dioxide emissions with respect to crop production worldwide compare to the federal social cost of carbon figures?**

A. The benefits of carbon dioxide emissions with respect to crop production worldwide are not explicitly included in the federal SCC figures. If they were, the federal SCC estimates would be significantly smaller.

Q. **How do your calculations of the benefits of carbon dioxide emissions with respect to economic growth compare to the federal SCC figures?**

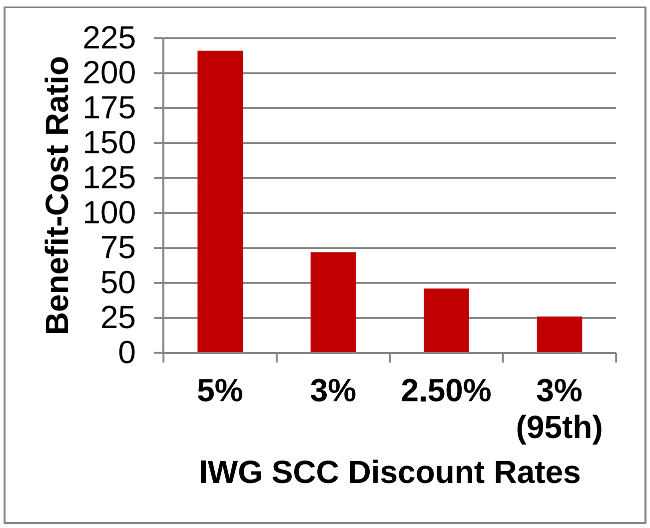
A. My calculations of the benefits of carbon dioxide emissions with respect to economic growth exceed by orders of magnitude the federal SCC figures.

While the federal SCC estimates are of questionable validity, I nevertheless compared the CO_2 costs and benefits (on a normalized per ton basis) using the federal SCC estimates and assumptions. I found that the current benefits clearly outweigh any hypothesized costs by, literally, orders of magnitude: The benefit-cost (B-C) ratios range up to more than 200-to-1 (Figure 42-1). I utilized forecast data to estimate B-C ratios through 2040 and found that future benefits also greatly exceed hypothesized costs by orders of magnitude: In the range of 50-to-1 to 250-to-1. To place these findings in perspective, normally, B-C ratios in the range of 2-to-1 or 3-to-1 are considered favorable. Thus, my main conclusion is that the benefits of CO_2 overwhelmingly outweigh estimated CO_2 costs no matter which SCC estimates are used. In fact, the SCC estimates are relatively so small as to be in the statistical noise of the estimated CO_2 benefits. These findings must inform energy, environmental, and regulatory policies in Minnesota and elsewhere.

I utilized EIA economic and energy forecasts with the forecast Federal SCC estimates to develop estimated future CO_2 B-C ratios, which are shown for the three 2013 IWG report discount rates in Figure 42-2. This figure indicates that the CO_2 B-C ratios remain extremely high through 2040 – up to 250-to-1 – using each of the three discount rates.

Figure 42-1: 2010 CO_2 Benefit-Cost Ratios

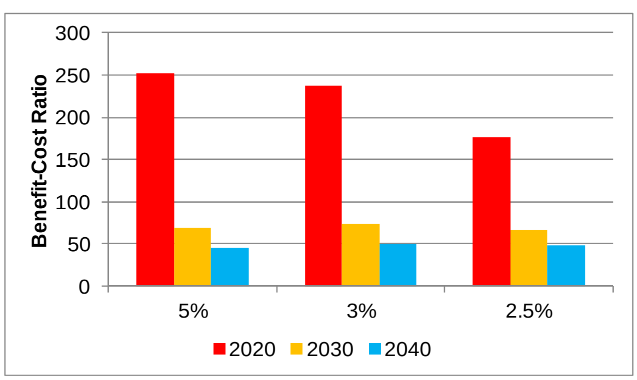
(Based on 2013 IWG Report)



Source: U.S. Energy Information Administration, U.S. Bureau of Economic Analysis, U.S. Interagency Working Group, and Management Information Services, Inc.

Figure 42-2: Forecast Reference Case CO_2 Benefit-Cost Ratios

(Based on 2013 IWG Report)



Source: U.S. Energy Information Administration, U.S. Bureau of Economic Analysis, U.S. Interagency Working Group, and Management Information Services, Inc.

X. BENEFITS VERSUS COSTS IMPLICATIONS

Q. **What are the implications of your calculations of the benefits and costs of carbon dioxide emissions?**

A. The benefits greatly exceed the costs – by orders of magnitude – and any meaningful regulatory or benefit-cost analysis must take this huge discrepancy into account.

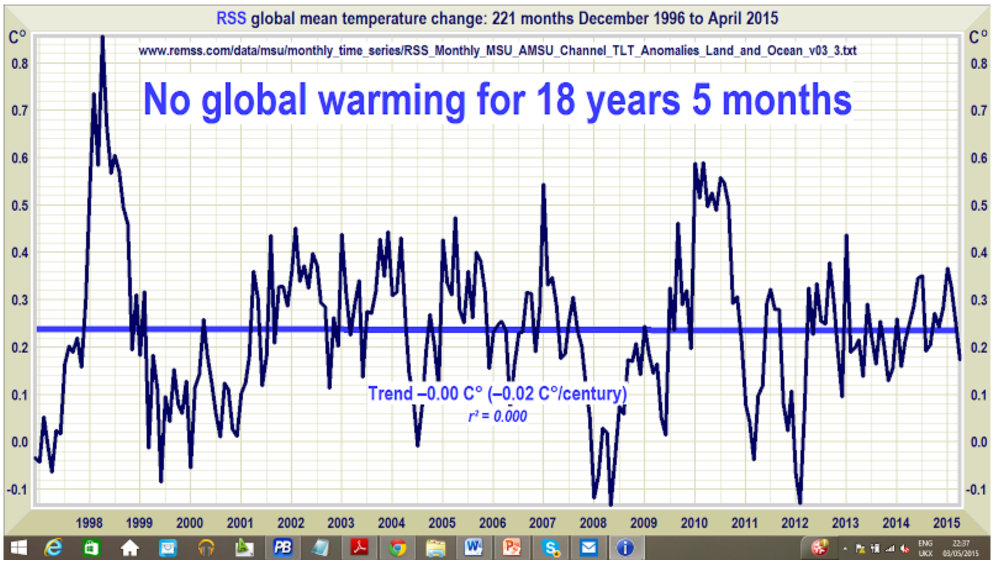
Q. **The Minnesota Department of Commerce, Division of Energy Resources stated that relevant scientific knowledge on environmental externalities has changed over the 17 years since the Commission first established cost values. Does this affect your conclusions?**

A. The Minnesota Department of Commerce is correct: Extensive relevant scientific knowledge on environmental externalities has become available in the last 17 years. The plethora of scientific knowledge and irrefutable empirical data that have become available over the past two decades greatly strengthens my conclusions.

For example, the average global temperature has not increased since the Commission first established cost values. It is frequently contended that increased CO_2 levels are causing global warming and increasing "extreme weather" events, and that this justifies large SCC values. However, there are at least three major problems with this hypothesis. First, the contention is that higher concentrations of CO_2 create a "greenhouse effect" and lead to higher temperatures. But there is no empirical scientific evidence for significant climate effects of rising CO_2 levels, and there is no convincing evidence that anthropogenic global warming (AGW) will produce catastrophic climate changes. Average temperatures in the U.S. and globally have not been increasing in recent decades, and even show a slight cooling trend. As shown in Figure 44-1, according to the Remote

Sensing System satellite record there has been no global temperature increase for 18 years 5 months (October 1996 to April 2015) – despite significant recorded increases in CO_2 emissions over this period.

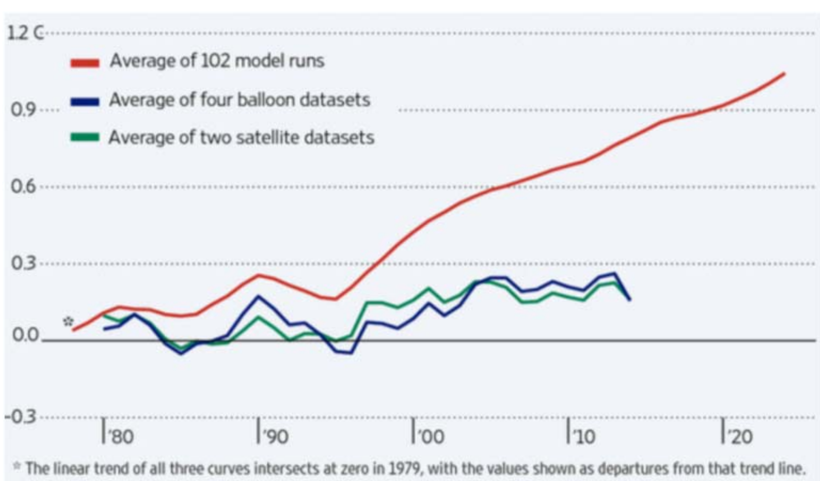
Figure 44-1: RSS Global Mean Temperature Change, Oct. 1996 – April 2015



Source: Remote Sensing System

Due to the absence of warming for almost two decades, Figure 44-2 shows that models predicting increased temperatures on the basis of CO_2 concentrations are increasingly inaccurate.

Figure 44-2: Global Mid-Troposperic Temperature, 5-year Means (Cº)



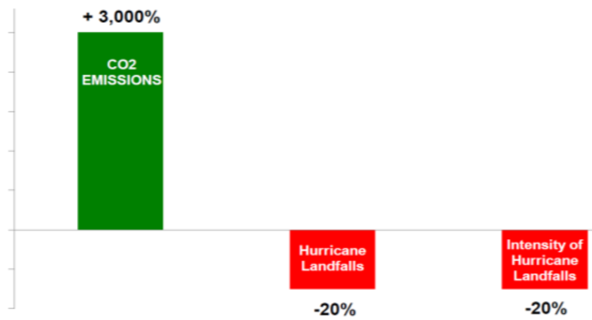
Source: Roy Spencer and American Meteorological Society.

As shown in Bezdek Exhibit 3, climate trends demonstrate that: (i) natural swings in temperature are common and there has been a "hiatus" in warming (Part I-A); and (ii) extreme weather is not increasing, and warming would moderate it further in any event (Part I-B). Climate models are not sufficiently reliable to form a basis for policymaking (Part II). Solar influences on climate have been substantially underestimated (Part I-D). Historical cycles of warming (such as the Medieval Warm Period) have been more significant than predictions today, and historical warming had positive impacts for humanity and culture. (Part I-C).

Although CO_2 emissions have increased, there is no indication of increased hurricanes (Figure 44-3), tornadoes (Figure 44-4), wildfires (Figure 44-5), drought (Figure 44-6), or other extreme weather events. In fact, such events have actually decreased globally over the past century.

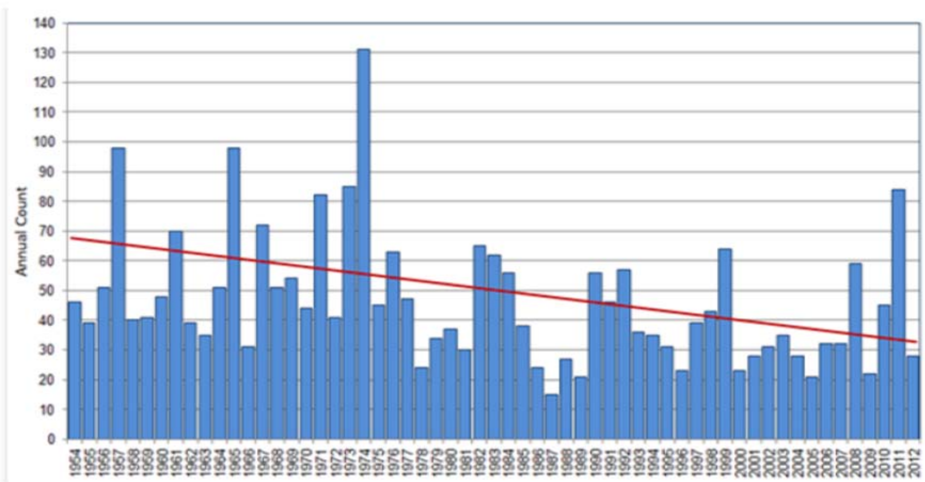
Numerous researchers have found that there has been no increase in extreme weather events over the past century (Figure 44-7). For example, Dr. Judith Curry found that "In the U.S., most types of weather extremes were worse in the 1930's and even in the 1950's than in the current climate, while the weather was overall more benign in the 1970's. This sense that extreme weather events are now more frequent and intense is symptomatic of 'weather amnesia' prior to 1970. The extremes of the 1930's and 1950's are not attributable to greenhouse warming and are associated with natural climate variability."[43] As Dr. Richard Tol noted, "There is a history of exaggeration in the study of climate change impacts."[44] As shown in Part VI of Bezdek Exhibit 3, the evidence does not support asserted ecosystem impacts, including ocean acidification, supposed harms to oceanic and terrestrial life, claimed sea level rise, and alleged melting sea ice and glaciers.

Figure 44-3: Comparison of CO_2 Emissions and U.S. Hurricanes, 1900-2013



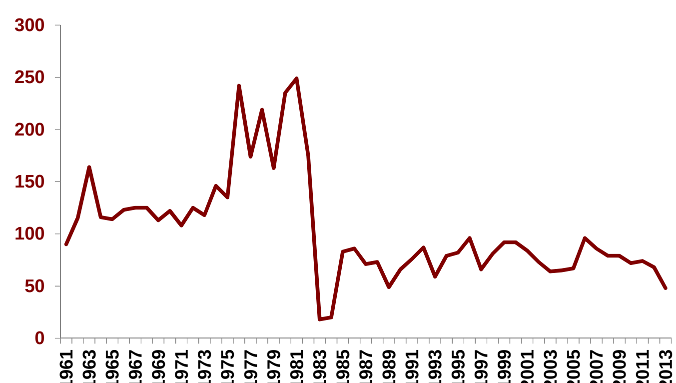
Source: IEA; USA; Earth Policy Institute; *USA Today*.

Figure 44-4: U.S. Annual Count of Strong to Violent Tornados (F3+)



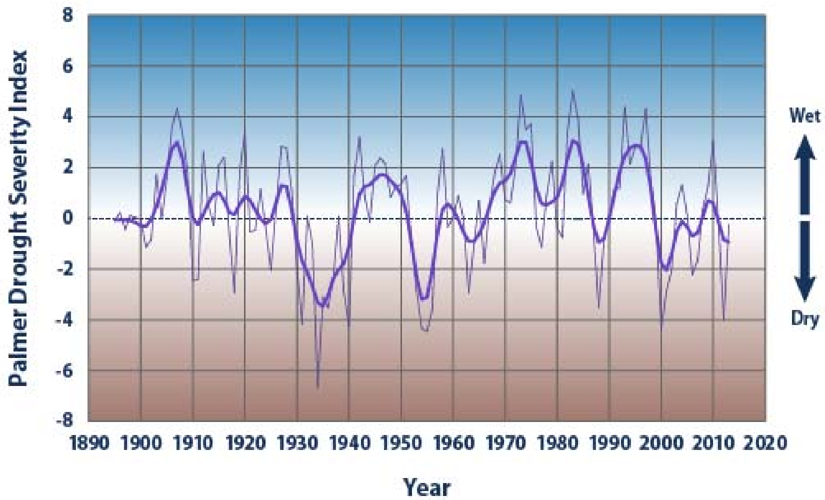
Sources: NOAA; NWS Storm Prediction Center.

Figure 44-5: Number of Wildfires in the U.S.



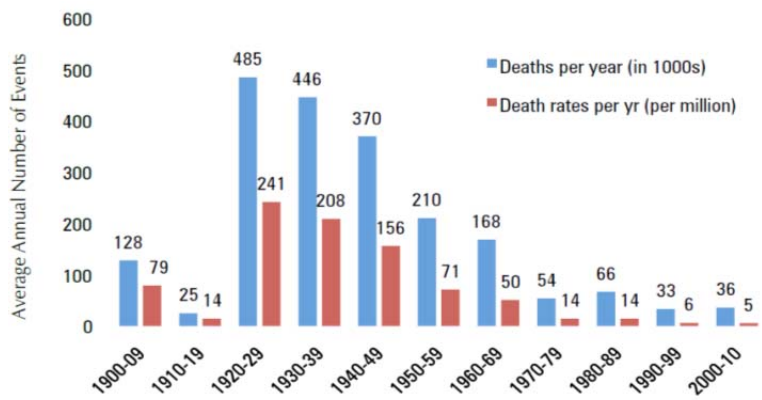
Source: National Interagency Fire Center.

Figure 44-6: Average Drought Conditions in the U.S. 48 States, 1880-2011



Sources: NOAA, National Climatic Data Center, and EPA.

Figure 44-7: Global Deaths Due to Extreme Weather Events



Source: Goklany and Morris.

Q. **Do you accept the alleged scientific consensus that the Earth's climate is unequivocally warming, and that humans are causing most of it through activities that increase concentrations of GHGs, such as burning fossil fuels?**

A. No. In reality, the "scientific consensus" is a manufactured myth, as shown by Part III of Bezdek Exhibit 3.

John Cook, who claims to have reviewed over 11,000 climate science articles,[45] contended that 97.1% of the reviewed abstracts conclude that humans are causing global warming. However, in 2013, Legates, et. al.

published a recount of Cook's data that determined that only 64 – 0.5% – of the 11,944 papers published since 1991 endorse the "consensus" that most warming since 1950 is anthropogenic.[46] Among other problems with Cook's work, Duarte noted that Cook included numerous psychology studies, marketing papers, and surveys of the general public as "scientific" endorsement of AGW – which invalidates Cook's research.[47] IPCC author Richard Tol assessed the Cook paper and concluded that is an incompetent piece of research and "a treasure trove of how-not-to lessons for a graduate class on survey design and analysis."[48]

Another widely cited source for "consensus" is an article by Zimmerman and Doran that reported the results of a two-question online survey of selected scientists.[49] In addition to issues such as question wording, only 79 respondents listed climate science as an area of expertise and said they published more than half of their recent peer-reviewed papers on climate change. Seventy-nine scientists – of the 3,146 who responded – does not constitute a "consensus."

The lack of consensus is evident from other surveys and statistics:

- Since 1998, 31,000 American scientists, including more than 9,000 with PhDs, have signed a petition which states that there is no convincing scientific evidence that human release of GHGs is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate.[50]
- Half of the responses to a 2008 international survey of climate scientists were on the "skeptic" side, with no consensus to support any alarm.[51]
- A survey of meteorologists found that 63% of 571 who responded believe global warming is mostly caused by natural, not human, causes.[52]
- A survey by the American Meteorological Society (AMS) found that only 25% of respondents agreed with UN IPCC claims that humans are primarily responsible for recent warming.[53]

- A survey of 51,000 Canadian scientists found that although 99% of 1,077 replies believed climate is changing, 68% disagreed that "The debate on the scientific causes of recent climate change is settled." Only 26% attributed global warming to "human activity like burning fossil fuels."[54]

These survey results demonstrate that the often-asserted global warming consensus does not exist. While there is thus no consensus, it is important to note that even if there was some sort of legitimate consensus, it would be irrelevant. Science is not based on consensus; it is based on experiments, verifiable data, empirical observations, and facts. There are many examples where "consensus science" has been overturned by experiments and new data, including famous examples of Galileo and Einstein, and science is never completely irrefutable.

Q. **Is the Federal Social Cost of Carbon reasonable and the best available measure to determine the environmental cost of CO_2 under Minn. Stat. § 216B.2422?**

A. No, the Federal Social Cost of Carbon is not a reasonable measure and the preponderance of evidence demonstrates that it is not the best available measure to determine the environmental cost of CO_2 under Minn. Stat. § 216B.2422, for the reasons discussed above.

Q. **Since you found that the Federal Social Cost of Carbon not the best available measure to determine the environmental cost of CO_2 under Minn. Stat. § 216B.2422, what measure is better supported by the evidence?**

A. The best available measure supported by the evidence to determine the environmental cost of CO_2 under Minn. Stat. § 216B.2422 is a metric that considers both the benefits and the costs of CO_2, for the reasons discussed above. This is critical, because effective implementation of state policies related to electricity generation and planning depend upon the accuracy of the cost values required by the statute.

One such measure is the benefit-cost data described here and in Bezdek Exhibit 2. This measure is reasonable, empirically verifiable, and based on scientific and historical fact and thus has irrefutable scientific evidentiary support – unlike the federal SCC. As discussed, regulatory agencies are required to assess both the costs and the benefits of an intended regulation, and legitimate benefit-cost analysis must assess both the costs and the benefits of a proposed initiative, program, or regulation to determine if the benefits exceed the costs. It is thus a self-evident truism that a valid B-C analysis must include both costs and benefits, and the measure I propose does this. It is a reasonable and practicable measure that will result in more accurate energy resource plan evaluation.

Endnotes

[1]See the discussion in Robert L. Hirsch, Roger H. Bezdek and Robert M. Wendling, *The Impending World Energy Mess*, Toronto, Canada: Apogee Prime Press, 2010,
[2]W.R. Keatinge and G.C. Donaldson *Southern Medical Journal*, 2004.
[3]Robert S. Pindyck, "Climate Change Policy: What Do The Models Tell Us?" National Bureau of Economic Research, Working Paper 19244, July 2013.
[4]Ibid.

[5]National Research Council, *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*, Washington, D.C.: National Academies Press, 2009.
[6]Ibid.
[7]C.D. Idso and Singer, S.F., *Climate Change Reconsidered: 2009 Report of the Nongovernmental International Panel on Climate Change (NIPCC)*. The Heartland Institute, Chicago, Illinois, USA, 2009; C.D. Idso and Idso, S.B., *The Many Benefits of Atmospheric CO_2 Enrichment*. Vales Lake Publishing, LLC, Pueblo West, Colorado, USA, 2011.
[8]*Farming, Fishing, Forestry, and Hunting in an Era of Changing Climate: Hearing Before the Subcommittee. on Green Jobs and the New Economy of the Senate Committee on Environment and Public Works,* 113th Cong. 5 (2014) (responses to questions for the record of Dr. David R. Legates).
[9]United States Senate Environment and Public Works Committee, *Critical Thinking on Climate Change Empirical Evidence to Consider Before Taking Regulatory Action and Implementing Economic Policies*, Minority Report, September 4, 2014.

[10]William Happer, "The Myth of Carbon Pollution," presented at the George Marshall Institute, Washington, D.C., October 15, 2014.
[11]The largest of these benefits is noted for rice, wheat and grapes, which saw increases of $579 billion, $274 billion and $270 billion, respectively.
12Indur M. Goklany, *The Improving State of the World: Why We're Living Longer, Healthier, More Comfortable Lives on a Cleaner Planet*, Washington, D.C.: Cato Institute, 2007.
13Happer, op. cit.

[14]Ibid.
[15]Patrick Moore, *Confessions of a Greenpeace Dropout*, Beatty St. Publishing, Inc. 2013, p. 364.
[16]S.H. Wittwer, "*Food, Climate, and Carbon Dioxide: The Global Environment and World Food Production*." Lewis Publishers, Boca Raton, FL, 1995.
[17]Robert Zubrin, "The Cost of Carbon Denial," *National Review*, July 31, 2013.
[18]ibid.
[19]Specifically, Zubrin used the ratio of a recent estimate of global GDP ($60 trillion) to carbon use (9 billion tons) to derive the estimate of about $6,700. Ibid.
[20]International Energy Agency, *World Energy Outlook*, Paris, 2013, and Maria van der Hoeven, "Oil and Gas in the Global Energy Mix," presented at the International Oil Summit, Paris, April 4, 2013.
[21]For example, while diesel fuel has an energy density of about 46 megajoules per kilogram, biodiesel has about 38 Mj/kg, and ethanol has about 25 MJ/kg.
[22]Idso, C.D., and S.F. Singer, 2009: *Climate Change Reconsidered: 2009 Report of the Nongovernmental International Panel on Climate Change (NIPCC)*. The Heartland Institute, Chicago, IL; Center for the Study of Carbon Dioxide and Global Change, 2011 -- Plant Growth Database available at http://www.co2science.org/data/plant_growth/plantgrowth.php.
[23]*Global Climate Change Impacts in the United States*, Center For the Study of Science, Cato Institute, 2012.
[24]Ibid.; C.D. Idso and K.E. Idso, "Forecasting World Food Supplies: The Impact of Rising Atmospheric CO2 Concentrations," *Technology* 7 (suppl), 33-56.
[25]International Energy Agency, *World Energy Outlook*, 2012, op. cit.
[26]Ibid.
[27]IEA bases its medium-term GDP growth assumptions primarily on IMF forecasts, and its longer term GDP assumptions are based on forecasts made by various economic forecasting organizations, as well as IEA's assessment of prospects for the growth in labor supply and improvements in productivity.
[28]Ibid.
[29]Estimates derived from U.S. Bureau of Labor Statistics, *Consumer Expenditure Survey*; U.S. Bureau of the Census, *Current Population Survey*; U.S. Department of Energy, *Residential Energy Consumption Survey*; U.S. Energy Information Administration, *Annual Energy Review*, *Short Term Energy Outlook*, and *Household Vehicle Energy Use: Latest and Trends*; U.S. Congressional Budget Office, *Effective Federal Tax Rates Under Current Law, 2001-2014* and *Effective Federal Tax Rates, 1979-2006*. See the discussion in "Energy Cost Impacts on American Families, 2001-2012," American Coalition for Clean Coal Electricity, February 2012, www.americaspower.org.
[30]Many lower-income families qualify for federal or state energy assistance. However, these programs have been unable to keep up with the increase in household energy costs.
[31]Joy Moses, *Generating Heat Around the Goal of Making Home Energy Affordable to Low Income Americans: Current Challenges and Proposed Solutions*, Center for American Progress, Washington, D.C., December 2008.
[32]Energy Programs Consortium and National Energy Assistance Directors' Association, "2008 Energy Costs Survey," June 2008.

[33]Ibid.
[34]Ibid.
[35]Tennessee Interfaith Power and Light, “Impacts of Fuel Bills upon Lower Income,” Knoxville, Tennessee, 2014.
[36]“Energy Cost Impacts on Minnesota Families,” www.americaspower.org, March 2015.
[37]Ibid.
[38]Robert S. Pindyck, “Climate Change Policy: What Do The Models Tell Us?” op. cit.
[39]Ibid.

[41]“Regulatory Planning and Review, Executive Order 12866 of September 30, 1993,” *Federal Register*, Vol. 58, No. 190, Monday, October 4, 1993.
[42]This should, theoretically, invalidate the IWG methodology and disqualify the use of the SCC estimates in any Federal rulemaking or cost-benefit analysis. However, as was the case with the recent microwave regulation, this is not the case.

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