KYOTO & OUR COLLECTIVE ECONOMIC FUTURE
ECONOMIC & ENERGY UNDERPINNINGS

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PREFACE

Both supporters and opponents of the Kyoto Protocol generally agree on one thing – the Protocol would not harm and may even benefit the economies of the world's developing nations. Indeed, the assessment that Kyoto would be a net plus for developing countries almost seems self-evident. The Protocol would subject the United States and other industrial countries – but not the world's developing nations – to binding emission reduction targets and timetables. And since all emission reduction schemes would make it more expensive for the regulated parties to use energy, the Kyoto Protocol would appear to create competitive advantages for developing country firms, which would be exempt from such regulation.

However, the conventional wisdom that assumes Kyoto would benefit or at least not harm developing countries is wrong. The "interdependence" of nations and the "globalization" of the world economy may be cliches, but they are also powerful realities that nations ignore at their peril. The United States is the primary market for developing country exports. The growth of developing country economies is thus tightly linked to the health of the U.S. economy. Any downturn in the U.S. economy caused by Kyoto-inspired regulation would wipe out billions of dollars annually in U.S. purchases of developing country goods. As CEI President Fred Smith put it, if Kyoto's energy-suppression mandates give the U.S. economy a cold, developing countries, especially in Latin America, are likely to contract pneumonia.

In the following pages, energy analyst Mark Mills provides ample evidence that Kyoto would seriously harm developing country economies. He also explains why developing countries must electrify their economies in order to grow, and why, for both economic and environmental reasons, renewable energy technologies like wind and solar power cannot replace, or even significantly supplement, fossil fuel-based electricity in the foreseeable future. Mills' lecture, presented to an audience of developing country embassy officials, makes a compelling case that an energy-starved world would be a world of starving people.

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MARK P. MILLS

INTRODUCTION

In my remarks I will be illustrating the tight linkage between the impact of global warming policies on the U.S. economy and future economic growth for those nations exempt from the Kyoto Protocol, with an emphasis on those in Latin America.

Some very basic background facts provide a starting point for understanding the enormous economic risks for all nations inherent in Kyoto-inspired restrictions on energy use in the United States.

Analysts across the board are pointing to the economic promise of the 21st century, and the increasing linkage of the economies of the world's nations. The four key factors that point to the continuation of economic growth and growing global interdependence are: first, the widespread availability of low-cost energy; second, the acceleration of the telecommunications industry,

Remarkably, little credit has been given to the importance of cheap energy.

Figure 1

21 century economic growth & trade accelerate from...

- **Low-cost energy**
- **Telecommunications**
- **Transportation**
- **Opening markets**

which has created the current "Global Village"; third, the increase in the use of and decrease in the cost of global transportation; and finally, fourth, the trend towards open markets. Much has been written about the last three of these issues in the business and general press. Remarkably, little credit has been given to the importance of cheap energy.

Before focusing on the energy part of this equation for economic growth, let me briefly turn to some key indicators.

Figure 2 illustrates a trend of profound importance to those nations that may believe that some economic insulation, or even advantage, could lie in

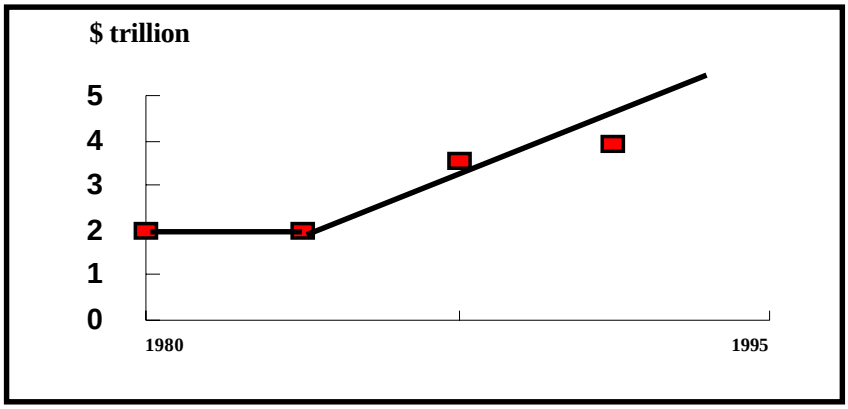
being exempt from Kyoto-style energy restrictions. The figure tracks the growth in total world merchandise trade since 1980. As you can see, world trade in goods has *increased* by over $2 trillion. A continuation of this trend will be critical to the continued economic growth of virtually every nation.

World trade in goods has increased *by over $2 trillion.*

Figure 3 illustrates a critical surrogate measure of increased global commerce — the total number of civil air travel miles undertaken each year. World civil air travel has essentially doubled in the past 15 years. This increase in travel is both an indicator of growing interdependence of the world's economies, and growing affluence of those economies. It is also quite

Figure 2

World Merchandise Trade



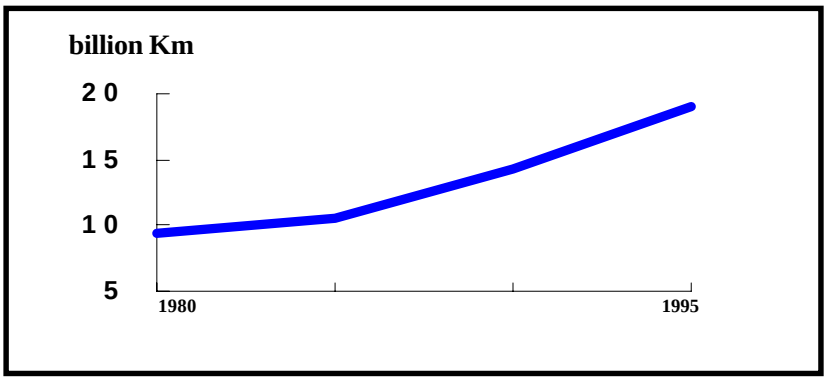
obviously highly dependent on the availability of increasing supplies of low-cost oil.

World civil air travel has essentially doubled in the past 15 years.

With these simple indicators of the core economic progress of the world's economies in mind, I will turn in figure 4 to the pivotal role that the U.S.

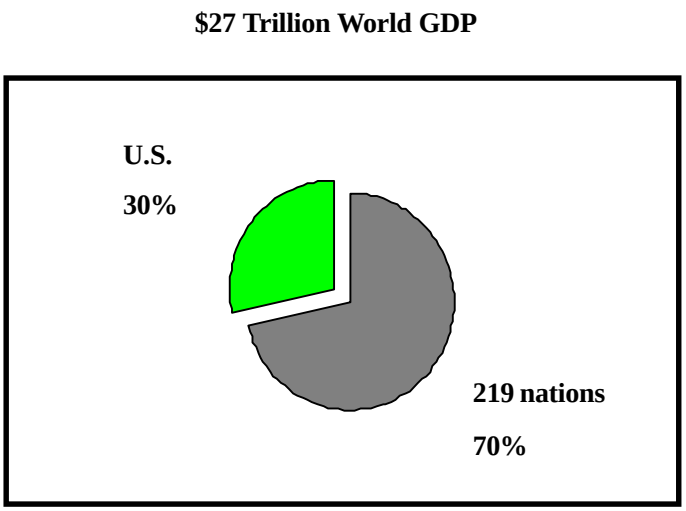
Figure 3

World Civil Air Travel



economy plays in the world markets, and thus by extension to the risks to the world's economies from Kyoto-related damages to the U.S. economy. This figure shows the widely known fact that the U.S. economy is the largest on

Figure 4

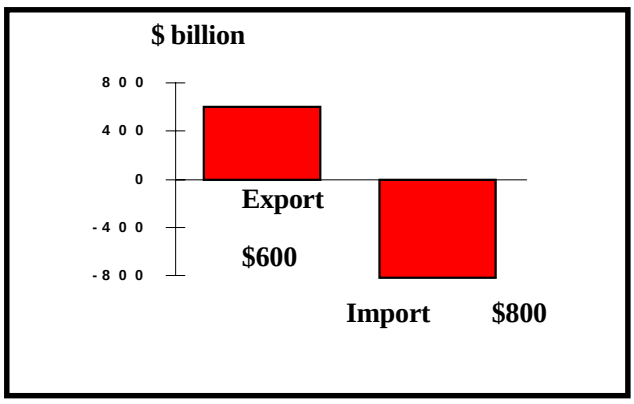


It is just not possible to contemplate the future economic health of the world without considering economic factors in the U.S.

the planet, accounting for nearly one-third of the GDP of all nations combined. Regardless of one's political or social views of this simple reality, it is just not possible to contemplate the future economic health of the world without considering economic factors in the U.S.

Figure 5 illustrates the most salient economic link between the United States and many nations. The U.S. is widely known as a net importer of goods. The United States currently buys, each year, about $800 billion worth of other countries' goods. That's a lot of buying power. It's self-evident that if we

Figure 5



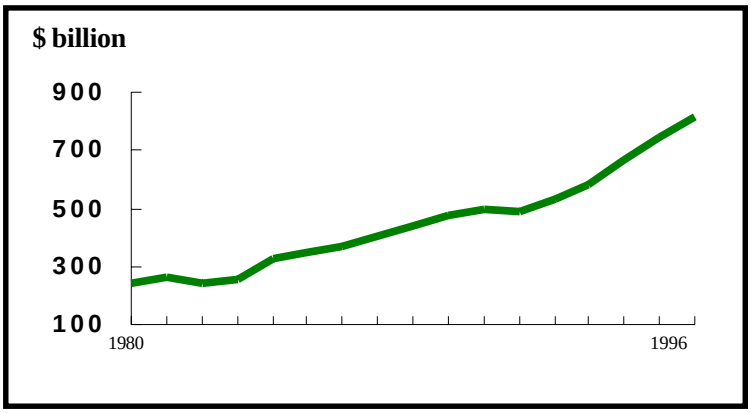
were to constrain the U.S. economy and make it difficult for the American consumer to buy more, the folks that get hurt first are the exporters to this country. Eight hundred billion dollars worth of purchases is, to put it humorously, the gorilla buyer of global goods in the world economy.

The U.S. economy 14 years ago bought only $300 billion worth of the world's goods. Consider this fact: the growth in U.S. purchases of foreign goods over the last 14 years has been $500 billion thanks to the strength of this economy. That, by definition, spurs growth and is, in many cases, the

Without continued U.S. import growth there cannot be significant opportunity for internal growth in many developing and intermediate nations.

Figure 6

U.S. Purchases of Foreign Merchandise



primary contributor to the economic growth for many nations. Without continued U.S. import growth there cannot be significant opportunity for internal growth in many developing and intermediate nations. So, nations everywhere count on growth in the U.S. economy.

Figure 7 illustrates the growth in U.S. purchases of foreign goods by taking a few examples from Latin American nations. Argentina, for example, sends $2 billion worth of goods to the United States each year. For a country

Figure 7

	U.S. Purchases From... ($ billion/ yr)
Argentina	**2**
Brazil	**10**
Chile	**2**
Costa Rica	**2**
Mexico	**86**
TOTAL	**102**

the size of Argentina, this is not trivial. Americans buy $10 billion worth of Brazilian goods each year. We buy $2 billion worth of Chilean goods annually. We buy $2 billion worth of goods from Costa Rica. And, we buy $86 billion worth of goods from Mexico. That's a lot of money being sent by American consumers to the economies of Latin America.

To put this in perspective, the collective U.S. purchases from just these five Latin American countries totals $102 billion a year. This is a lot of money

Figure 8

	U.S. Purchases From... ($ billion/ yr)
Indonesia	**9**
Korea	**23**
Malaysia	**18**
Philipines	**10**
Thailand	**13**
TOTAL	**73**

The collective U.S. purchases from just these five Latin American countries totals $102 billion a year.

flowing south. By comparison, the U.S. purchases a total of $73 billion from five representative Asian nations (Indonesia, Korea, Malaysia, Philippines and Thailand) each year.

Another way to consider the importance of the U.S. economy to Latin American nations appears in figure 9, which shows the percentage of all

Figure 9

	U.S. % All Exports From...
Argentina	**10%**
Brazil	**20%**
Chile	**15%**
Costa Rica	**60%**
Mexico	**90%**

national exports that are purchased by the United States. We can see that the percentages are significant. What's more, while Brazil, for example, obtains about 20 percent of all of its export revenue directly from the United States, it is equally important to consider (although more difficult to quantify) the role of U.S. purchases in the entire economic food chain. In fact, 50 percent of Brazilian exports are sent to other Latin American nations. If you follow the statistics, you find that many of those nations, especially Mexico, obtain much of their revenue, and thus power to buy Brazilian goods, by selling goods to the Untied States.

Similar economic interdependence and linkages are found in Asian countries as figure 10 shows where the U.S. is either the single largest direct purchaser of their goods or indirectly so.

Figure 10

U.S. % Of All Exports From...

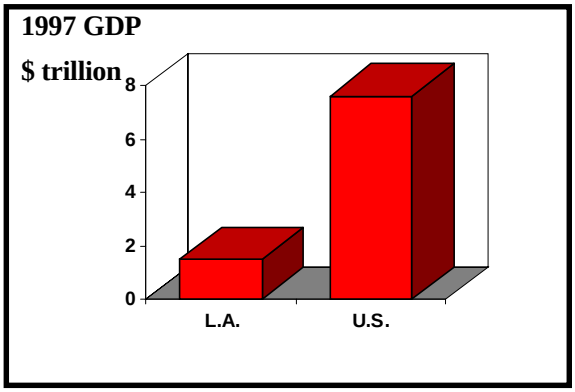
Indonesia	**18%**
Korea	**18%**
Malaysia	**21%**
Philippines	**51%**
Thailand	**22%**

What happens to U.S. purchases of foreign goods, especially those from Latin America, if serious damage is inflicted on the U.S. economy?

This review of trade data sheds light on the crucial role of restrictions on energy use attendant to a Kyoto-style regime. But first, one last set of economic statistics. The bar chart (figure 11) is very simple and illustrates the

Figure 11

GDP Comparison



relative size of the U.S. economy and the size of all the Latin American economies combined. The combined annual GDP of 35 Latin American nations illustrated here is less than one-fourth the size of the U.S. economy. Now, consider the obvious. What happens to U.S. purchases of foreign goods, especially those from Latin America in this illustration, if serious damage is inflicted on the U.S. economy? A 4% downturn in the U.S. economy would cost over $300 billion per year. The loss would be felt somewhere. Who would doubt that imports from Latin America would drop?

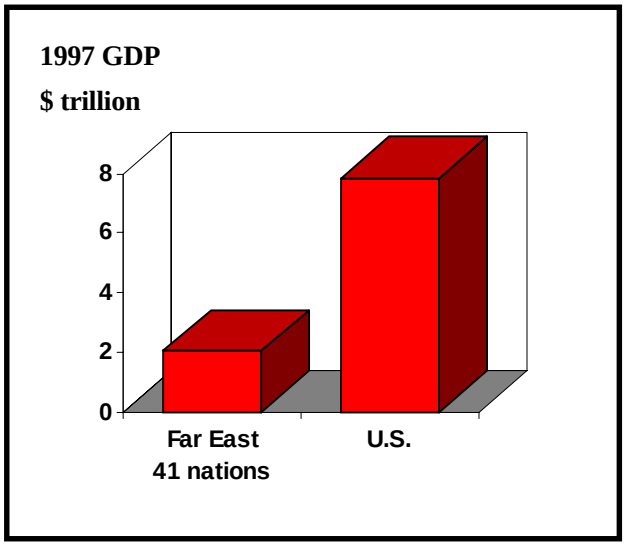
The easiest way to damage the enormous U.S. economy would be to implement anything, in any form, that substantially follows the Kyoto-inspired goals to reduce U.S. CO2 emissions. Anything that messes with

carbon will have a serious consequence on the U.S. economy. It will take the economy down. I'll show you how in a moment.

Again, for perspective from another hemisphere, the data in figure 12 show the same type of economic comparison as the previous graph. Here,

Figure 12

GDP Comparison



Anything that messes with carbon energy will have a serious consequence on the U.S. economy.

instead, the U.S. economy is compared to the combined annual GDP of 41 Far Eastern nations, excluding China, New Zealand, Australia and Japan. Once again, the U.S. economy by itself is some four times the magnitude of all the 41 nations combined.

If the U.S. economy does not grow — it doesn't even have to shrink, if it just doesn't grow rapidly – this hurts all other nations because it will reduce

Figure 13

Carbon Controls & The U.S. economy

Carbon Consequence

→ **Buy less from exporters**

Also lowers:

- **U.S. private investment**
- **U.S. travel & tourism**
- **U.S. federal grants/loans**

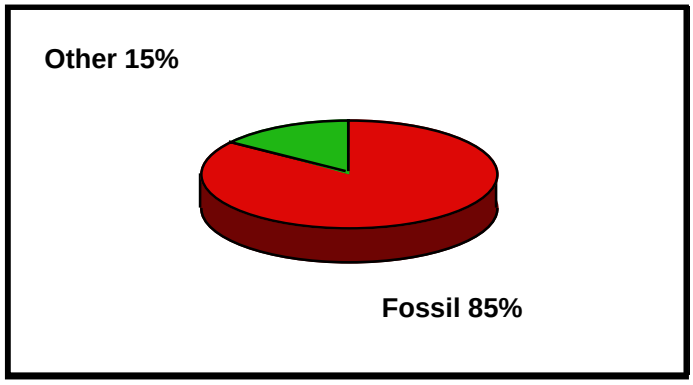
our appetite for imports. It reduces the purchase of goods exported from nations around the world. Incidentally, and this is not incidental financially, it also lowers our ability and willingness to have foreign private investment. We spend tens of billions of year in Latin American nations in foreign private investment. Sluggish growth also limits the U.S. ability to travel for business and tourism, another number that runs in the tens of billions a year. And, economic damage to the U.S. economy also will restrict the political, if not fiscal, capability of the U.S. Congress to provide grants, aids, and loans to developing nations. If the U.S. economy were to suffer a $300 or $400 billion decline because of energy constraints, one can imagine how difficult it would be in Congress to raise money to provide loans and grants to other countries.

We're a fossil-fuel-based economy, there is simply no credible evidence our energy needs can be met in any other way.

The way global-warming-inspired carbon controls affect the U.S. economy is very simple. We're a fossil-fuel-based economy. We use carbon fuels as our primary energy source, period. If you restrict the use of carbon-based fuels, you restrict the use of energy. There is simply no credible evidence in physical reality or technology to suggest that the enormous energy needs of the U.S. economy can be met for the foreseeable future in any other way. We use gasoline, we use fossil fuels.

Figure 14

Sources of U.S. Energy



Carbon fuels have also been the primary source of energy growth and they're projected by the U.S. Department of Energy to constitute 90 percent of all new energy supplied for the next two decades.

Figure 15

Carbon controls impact U.S. economy:

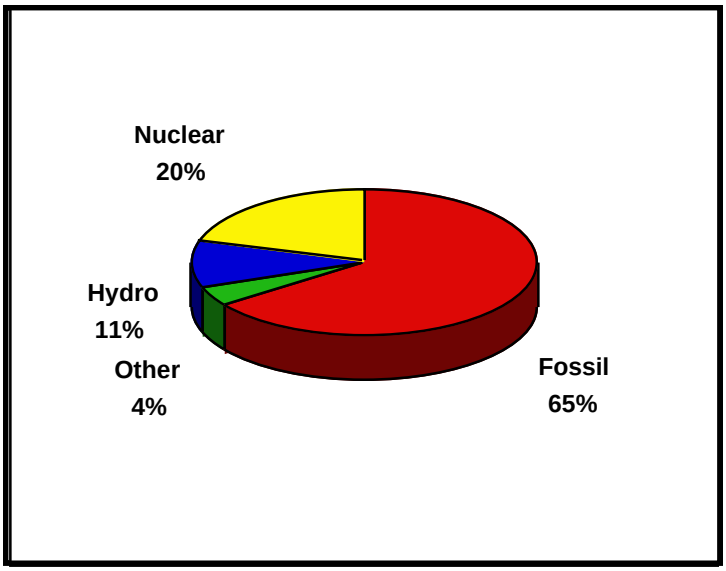
- **Fossil based economy**
- **Electric-based economy**
- **Fossil-based electricity**

- **Controls & regulations: enormous bureaucracy**

And more importantly, the U.S. is an electricity-based economy and our energy system is dominated by fossil fuels. In fact, 65 percent of all U.S. electricity supply is fossil-based. And furthermore, the vast majority of all the

Figure 16

U.S. Electricity



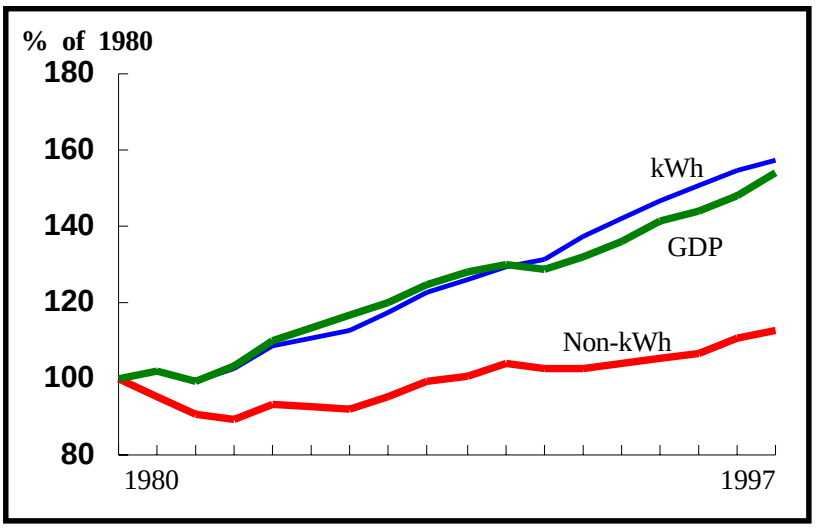
The U.S. is an electricity based economy and the electric system is dominated by fossil fuels.

net new supply of electricity for the next two decades in the United States will be based on fossil fuels.

Figure 17 illustrates the central critical linkage between energy use and the economy. Indexed to 1980, the U.S. economy has grown almost 60 percent

Figure 17

U.S Electric v.s. Non-electric Engery

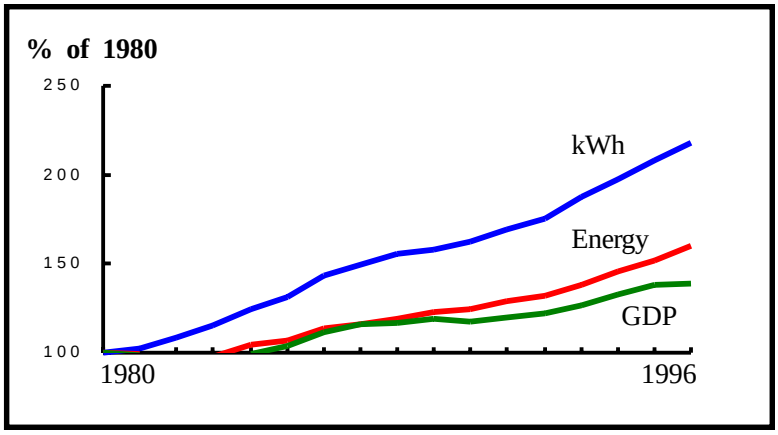


in that time period. As you can see, the consumption of electricity, which is fossil-dominated, has grown in lockstep with the GDP, and the use of non-electric energy has grown very modestly. What this says is very simple: constrain electricity, you constrain the U.S. economy. Electricity is fossil-based. Given the information presented earlier regarding the importance of the U.S. economy to other nations, it is inconceivable that damage to the U.S. economy, the inevitable result of constraining carbon-based energy, would not seriously damage other nations' economies.

65 percent of all U.S. electricity supply is fossil-based.

Figure 18

Latin America

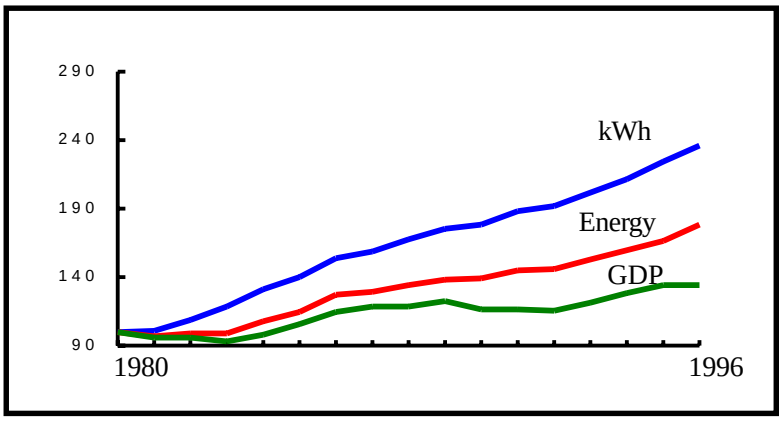


The carbon energy and economic linkage story is not isolated to the U.S. economy. Let me take this another step.

The energy trends for the U.S. in the previous graph are the same as those that can be seen for the Latin American nations. The story is even more serious here, as figure 18 illustrates. The growth in electricity use in Latin American nations has outpaced and will continue to outpace economic growth.

Figure 19

Brazil



In figure 19 we see the trends for Brazil alone. It is worth noting that this relationship, of demand for electricity outpacing growth in the economy, is typical of all developing and emerging nations.

The issue, then, is whether or not we can get adequate growth in electricity use without carbon fuels, which brings me to Costa Rica as the example. I want to consider what it would mean for a relatively small country to select

Figure 20

U.S. & Costa Rica Baseline

	U.S.	Costa Rica
GDP/capita	**$24,800**	**$2,350**
kWh/capita	**11,100**	**1,160**
Growth kWh/capita	**2,000**	**300**
Energy/GDP$	**-30%**	**4%**
1973 - 1995		

The issue, then, is whether or not we can get adequate electric growth without carbon fuels.

an energy path inspired by Kyoto's antipathy to carbon-based energy. How would they do it? Could they do it? And, really, could it even be done?

The data here provide a starting point for understanding the challenge. Costa Rica's per capita GDP is one-tenth that of the U.S. This is typical of all of Latin American countries and all Asian countries on average.

The U.S. economy requires 11,000 kilowatt hours per capita. Countries such as Costa Rica typically use 1,000 kilowatt hours per capita. U.S. per capita electricity use in the last 12 years has grown by 2,000 kilowatt hours. This growth in U.S. electricity use is greater than the absolute use of electricity in almost every other country in the developing and intermediate world. Remember, however, that despite increased use of electricity and fossil fuels, the U.S. economy has become 30 percent more energy efficient. The U.S. has seen enormous growth in the consumption of fossil fuels, enormous growth in use of electricity, and dramatic improvement in energy efficiency. Costa Rica, on the other hand, has had much more modest growth in energy use and actually experienced a worsening energy efficiency.

So, in order to explore a non-fossil fuel path — but an economic growth path — I undertook a simple thought experiment with Costa Rica. I chose Costa Rica because of the track record of that nation in being environmentally sensitive, and because the example yields results on a scale one might be more readily able to visualize.

To achieve just 70 percent of U.S. kilowatt-hour per capita consumption by 2015, Costa Rica would have to increase its current generating capacity ten fold.

Figure 21

Costa Rica Growth Scenario

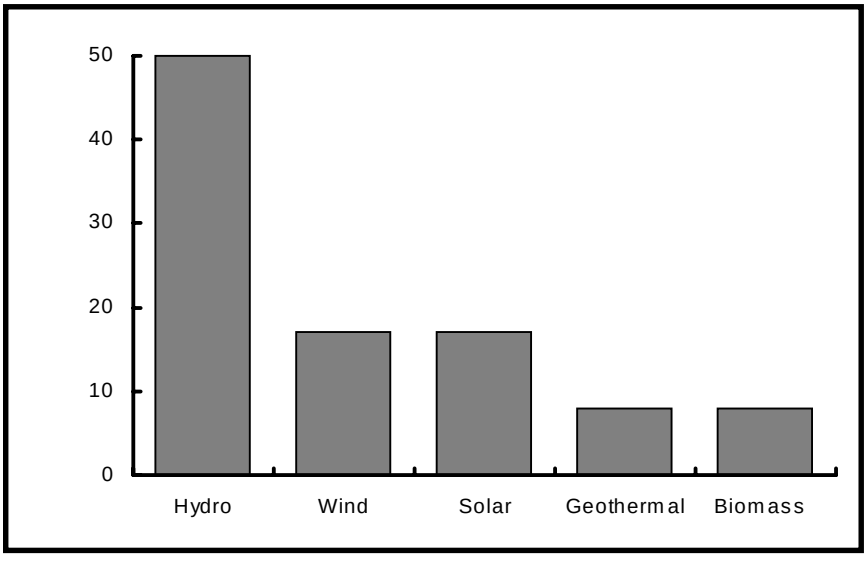
- **Achieve 70% of U.S. kWh/cap. by 2015**
- **Requires 12,000 MW capacity — 10 times current installations**
- **Renewable path or fossil fuels?**

What would it take for Costa Rica to achieve 70 percent of the U.S. kilowatt-hour per capita consumption by 2015? The Costa Rica economy will grow only if Costa Rica's electricity supply grows. So, what kinds of physical resources will it take to reach 70 percent parity with the U.S.? The bottom line is that it would require the construction of 12,000 megawatts of electric generating capacity for Costa Rica. This is ten times the entire generating capacity of Costa Rica today. So, someone will need to build in Costa Rica almost as much new generating capacity every year for the next 15 years as is installed today. That's a pretty big challenge for any country. What are the implications of Costa Rica seeking to meet this challenge with renewable fuels?

Costa Rica has substantial potential for hydropower expansion. Therefore, Costa Rica would probably have to supply half the necessary electric capacity from hydro, about 20 percent from wind, 20 percent from solar, 10

Figure 22

Costa Rica Renewable Fuel Path
(Scenario allocations)



percent from geothermal, and 10 percent from burning wood. Let's see the implications of this energy strategy.

Figure 23 shows the engineering and land use implications of a renewable, non-carbon path for Costa Rica. I should remind you we're talking about a fairly modest-sized economy. First, Costa Rica would have to expand its current hydro capacity by seven fold over the next 15 years. It's my understanding in studying Costa Rica that there's no desire to expand hydro capacity because of the environmental damage from further flooding. In addition to this hydro goal, Costa Rica would have to buy and install 4,000

Under a renewable, non-carbon path, Costa Rica would have to buy and install 4,000 wind turbines, each the size of the Washington Monument

Figure 23

Costa Rica Renewable Path for 12 GW...

6,000 MW hydro	**7x current capacity**
2,000 MW wind	**4,000 1 MW turbines**
2,000 MW solar	**40x U.S. total production**
1,000 MW geo.	**200x current plan**
1,000 MW bio.	**burn wood**
12,000 Total	

wind turbines, each 1 megawatt. A 1-megawatt wind turbine, for your information, is the size of the Washington Monument; 4,000 of them would constitute a swath a half-mile wide and 100 miles long. It's a significant engineering challenge. And it probably wouldn't look very nice in Costa Rica.

On top of the new hydro and wind turbine construction, Costa Rica would require 2,000 megawatts of solar capacity. This represents 40 times the total solar production output of the entire U.S. economy. And they would require 1,000 megawatts of geothermal power, which is 200 times more geothermal capacity than is under construction currently in Costa Rica. And finally we're left with the need to find enough wood to burn to supply another 1,000 megawatts. That would be a lot of rain forest wood per year.

I have not attempted to calculate the monetary costs of this kind of energy path, but the necessary investments obviously would not be cheap.

The alternative is to choose an economically affordable conventional fuel path. A conventional fuel mix would be dominated by fossil fuels. It would

still require tripling the installed hydro capacity in Costa Rica, which I believe may be politically impossible. It would require something like twenty 150-megawatt gas or oil-fired power plants, fifteen 200-megawatt clean coal power plants and fifty 100-megawatt sized cogeneration facilities located at appropriate industrial sites. This path is feasible. Incidentally, this mix of energy sources is more or less what is forecast for expanded electricity supply in Latin America generally: coal, 20 percent; natural gas, 50 percent; oil, 20 percent; and hydro about 20 percent.

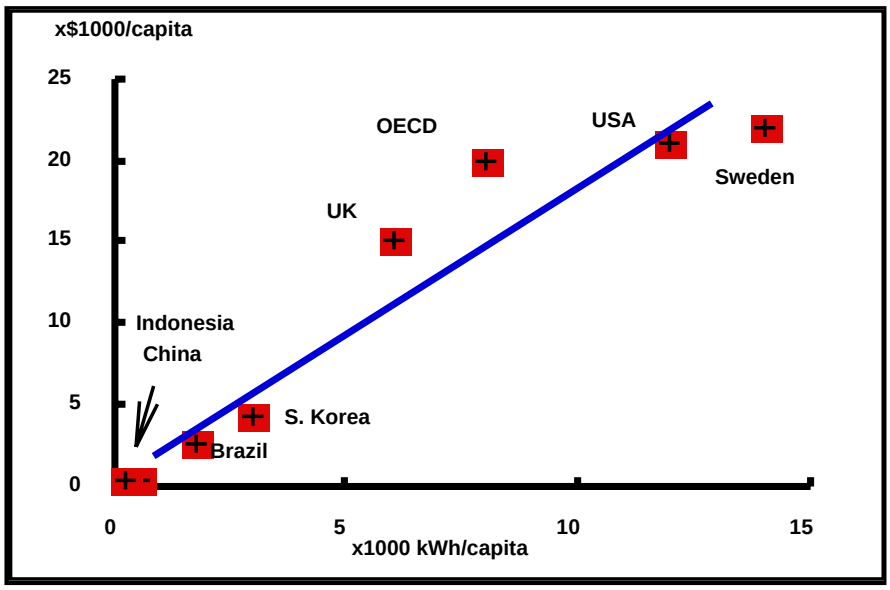
The data show a lockstep relationship between more electricity and more wealth. The only way in which a country moves up that curve towards greater wealth is to use more energy and it must be cheap energy.

There are a lot more data that one could present, but I'm going to end my remarks with this one last graph for you because it summarizes the core economic reality of what we're talking about with respect to Kyoto. Without regard to the science of global warming, which I happen to think is abysmally poor, the world needs cheap energy, and one of the most important ways cheap energy manifests itself is through kilowatt hours.

Figure 24 shows a fascinating data series. The horizontal-axis is the per capita consumption of electricity. I'll remind you that 86 percent of the

Figure 24

Income & kWh



world's electricity is made with fossil fuels. Ninety percent of all projected growth of world electricity consumption and generation will come from fossil fuels. On the vertical axis is the Holy Grail of any nation, rising income per capita. The data show a lockstep relationship between more electricity and more wealth.

What you see here on the bottom left of the graph where per capita incomes are lowest, are countries like Brazil, South Korea and China. The

only way in which a country moves up that curve towards greater wealth is to use more energy and it must be cheap energy. And, the only way those countries can get the money to build power plants, frankly, is through trade. That trade must be with strong and growing western economies and, particularly, the anchor of all those economies, the United States. This is the reality. This is what Kyoto and Kyoto-inspired policies threaten.

I'll end there. I think I have maybe two or three minutes for questions, and then I'll be happy to talk to folks who have questions later. I'll leave this data set with the Competitive Enterprise Institute. By the way, all the basic data come from the CIA World Fact Book, the Energy Information Administration, and the U.S. Department of Commerce.

The only way those countries can get the money to build power piants is through trade, particularly with the United States.

** Some of the data presented in this analysis is based on research undertaken by the author for the Western Fuels Assocation and presented by WFA's President, Frederick Palmer at the Australian Coal Conference in Brisbane, Australia, May 18, 1998.*

ABOUT THE AUTHOR

Mark P. Mills is president of Mills-McCarthy and Associates, Inc. (MM&A). MM&A is a Washington, DC-based research and consulting firm specializing in technology strategy focused on the energy industry. Mills is the founder and publisher of the national newsletter *Breakthrough Technologies*, which covers new and emerging energy-related end-use technologies. He has worked with over 80 utilities in providing strategic plans, marketing support, speeches, seminars, executive briefings, expert testimony and analytic research.

A physicist by training, Mills holds several patents in the fields of integrated circuits, fiber optics, and solid state devices. He also pioneered a quantitative approach to accounting for total fuel cycle energy and environmental benefits of the use of electricity, and has produced groundbreaking research on the role of electrotechnologies and electricity in the economy including a commodity-based model of kilowatt-hours.

A frequent expert witness in hearings before Congress and state legislatures, Mills has served as a staff consultant to the White House Office of Science and Technology Policy (under President Reagan), a number of National Research Laboratories, the Congressional Office of Technology Assessment, and the U.S. Department of Energy.