POLICY MEMO

progressive policy institute ppi

Getting Real About Energy:

A Balanced Portfolio for America's Future

BY JAMES CONCA AND JUDITH WRIGHT

FEBRUARY 2011

EXECUTIVE SUMMARY

The failure by Congress to pass energy and climate legislation has left U.S. energy policy adrift, with no clear direction or guiding concept of how we are going to address the long-term questions about the energy resources we elect to use and their impact on the environment. Rather than pursuing new approaches and policy proposals in the wake of the political defeat of cap-and-trade legislation, energy and environmental advocates have largely splintered into chaotic scrambles for subsidies or resigned their strategies to calling for increased research and development spending for energy, perhaps hoping technology can succeed in finding solutions where politics failed. Meanwhile, foreign nations continue to announce bold plans that set clear strategies for managing their future energy resources, leaving the U.S. farther behind every day in planning for leadership of tomorrow's economy.

This paper aims to reorganize our discussions about energy and the environment around a very basic idea: the U.S. needs a new framework for identifying the goals of our energy policies and for laying out a vision of what our energy future should look like. Our current debates are too narrowly focused on incentives or regulation of specific fuels, pollutants, and technologies. We are losing sight of the forest in our fights over so many trees, and we need to take a step back and first address the broader question of where we ultimately want to be decades from now as a country and as an energy leader in the global economy. When we have an idea of the where we want to be decades from now, we can have a much more strategic and deliberate process for making policy decisions.

So what should this framework look like? By rejecting both the climate denialism and obstruction of the right and the wishful thinking and anti-nuclear biases of the far left, we outline a realistic plan to finally get the U.S. on track to a new, green economy and lead the world to a cleaner energy future. As an immediate and bold step toward setting real goals for clean and balanced growth, we propose a balanced energy portfolio that moves us toward a 30-year target energy mix for electricity generation of one-third fossil fuels, one-third renewable sources (wind, solar, biomass, hydro), and one-third nuclear generation. Such a target is an ambitious

departure from our current mix of 69 percent fossil fuels, 11 percent renewable energy, and 20 percent nuclear energy.[1] But it is doable – and setting the target is essential to serve as the polestar for all energy policy discussions.

The plan is built upon a set of principled arguments about our country's role in managing global energy supplies:

* **As the world's largest economy, the United States can show meaningful energy leadership for the developing world by demonstrating that a pragmatic path to clean growth is possible.** The world's energy needs are considerable–and they will only grow in the coming decades, doubling from the current level of about 15 trillion kilowatt hours (kWh) per year to 30 trillion kWh by 2040.

* **Leading by example means acknowledging the realistic growth needs of other nations.** A frequently ignored aspect of the energy agenda is how intricately tied energy consumption is to human development. Increased energy use is a major index of growing human prosperity. If progressives are serious about reducing global poverty, we must confront the fact that doing so will demand more energy from realistically available resources.

* **Our energy needs must be balanced with our concern for the environment.** Simply put, we need to stop pumping more carbon into the atmosphere. If we are to provide the world's billions with energy without resorting to more fossil fuels, we need to scale up nuclear and renewable energy sources.

* **A realistic energy plan that supplies the world's billions with sufficient energy in the decades to come – without polluting the atmosphere – will necessarily have to include a major expansion of nuclear energy.** While renewables should also be pursued, there simply is no way to scale them up to meet the world's needs by 2040. Whether some progressives like it or not, nuclear is one of the keys to meeting the world's energy needs in the 21st century.

Our balanced energy portfolio proposal is not meant to be exhaustive in its specific policy prescriptions. We offer this proposed portfolio as a framework for assessing what our needs are and for setting parameters and mileposts for policy proposals that are responsive to those needs. Such a framework is a starting point, and it will be up to policy makers to take the critical next steps by enacting meaningful policy changes that will get us there.

This means that we can not simply pin our hopes only on open-ended research and innovation initiatives—such programs are certainly worthwhile and absolutely necessary to find better long-term energy solutions, but they are not a substitute for responsible energy resource planning that recognizes we have real choices to make for the foreseeable future. While research and innovation continue, we must also return our focus to policy proposals that will directly affect our portfolio of new and existing energy resources: renewable energy standards, tax credits, loan guarantees, direct subsidies, cap-and-trade regulation, direct carbon taxes, or specific fuel taxes.

INTRODUCTION

In many ways, the story of energy production since the 1970's can be understood as a tale of two countries. In 1973, the major Arab oil exporters proclaimed an embargo to protest U.S. policies towards Israel, causing the price of oil to quadruple. France, which relied on oil for most of its electricity at the time, responded to the embargo by launching the most comprehensive nuclear energy program the world has ever seen. The United States, by contrast, did little to change its energy habits.

As a starting point for a national energy plan, we suggest a balanced energy portfolio for all U.S. electricity generation by 2040: one-third fossil fuels, one-third renewables, and one-third nuclear.

The consequences of these divergent paths are extraordinary and plain to see.[2] Today, France generates 80 percent of its power from nuclear energy and has clean skies and low carbon emissions. France, along with Britain and Germany, has also led the way on energy efficiency, using 50 percent less electricity per capita than the United States. Meanwhile, the U.S. is more dependent than ever on "cheap" fossil fuels. We still rely on fossil fuels for about 70 percent of our energy, and we are the second largest emitter of CO_2 in the world, only recently surpassed by the growing energy behemoth that is China. About half of our electricity comes from burning coal, which has taken its toll on both public health and the Earth's ecosystem.[3, 4, 5]

Other countries have also shown remarkable initiative in adopting long-term energy plans and acting on them. Korea is on its way to getting 70 percent of its electricity from non-fossil fuel alternatives, and Japan 50%. China recently announced that it will expand its renewable resources to 500GW of capacity by 2020 (including 300MW of hydro), which will be roughly one-third of its total energy production.[6]

The Deepwater Horizon disaster in the Gulf of Mexico was a graphic reminder that oil is becoming harder and harder to obtain, and at a greater and greater cost economically, environmentally, and politically. Yet despite this calamity, and despite mounting concerns about sustainability, public health, climate change, and national security, Americans seem incapable of following the French example by dramatically changing their patterns of energy consumption.

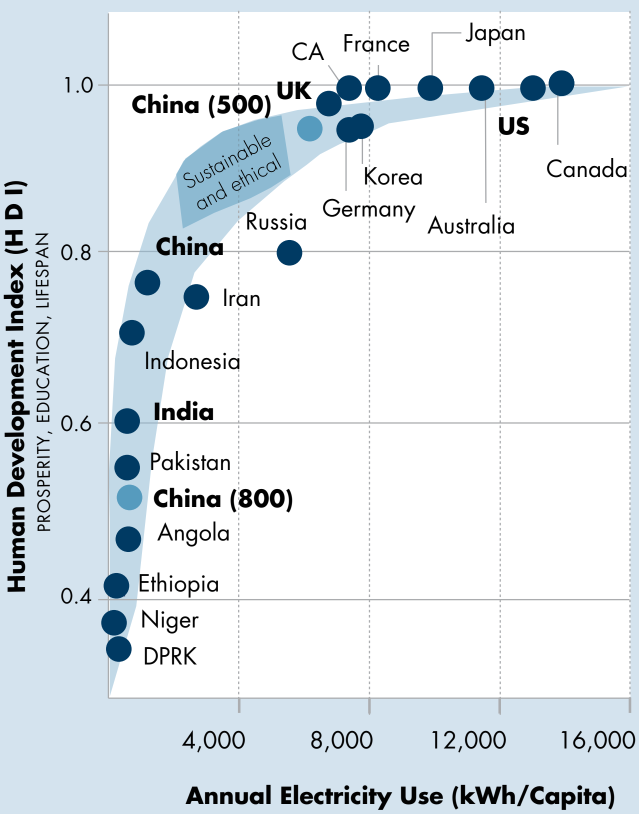
Conservative *drill-baby-drill* partisans stand foursquare for preserving the status quo, in which America is almost wholly dependent on fossil fuels to power our way of life. But environmentalists and progressives also bear responsibility for the lack of progress. They have failed to map a realistic course toward a new energy mix for America, imagining instead that we can easily leap to an economy powered mainly by renewable fuels. Such projections ignore the high costs, vast physical footprint, extensive environmental impacts of another sort, output intermittency (requiring coupling with gas), enormous material requirements, and the sheer logistical impossibility of rapidly scaling up wind, solar, and hydro power to supply the world's energy needs. Too many on both the left and the right embrace emotional and pseudo-scientific positions that avoid historic and scientific facts, economic realities, complex ethics, and a true understanding of earth systems. Our collective approach to energy and the environment needs to be more holistic and more science-based.

THE FORMULA FOR CLEANER GROWTH: $^1/_3 + {}^1/_3 + {}^1/_3$

As a starting point for a national energy plan, we suggest a balanced energy portfolio for all U.S. electricity generation by 2040: one-third fossil fuels, one-third renewables, and one-third nuclear. This resource allocation is intended as both a domestic policy proposal for managing America's energy mix, and an aspirational goal for global energy consumption. As the world's largest economy and

FIGURE 1. THE UNITED NATIONS HUMAN DEVELOPMENT INDEX (HDI).[7]

80 percent of the world's population of 6.5 billion people is below 0.8 on the HDI. It is no coincidence that the bulk of these people live in the regions of the world's greatest social problems. We will not end global poverty, terrorism, war or genocide until everyone is above 0.8 HDI or about 3,000 kWh per person per year. If we raise everyone in the developing world up to 3,000 kWh per person per year, and rein in the industrialized world to about 6,000 kWh per person per year, then the total sustainable energy requirement for the world will level at about 30 trillion kWh per year by 2040. Note that China is a combination of 500 million above 0.9 at over 5,000 kWh and 800 million below 0.5 at less than 1,000 kWh. Secondary effects from the form of government are seen in Russia and Iran who are lower on the HDI than is warranted by their energy use.



Source: UNITED NATIONS, Human Development Index, http://hdr.undp.org/en/statistics/ (2009).

largest polluter, the United States must play the role of world leader on cleaner energy consumption. The rest of the world is waiting for us to act. We must set an example.

From a global perspective, the stakes could not be higher. As billions of the world's poor move into the middle class, global energy use is projected to grow massively in the next 30 years, from the present 15 trillion kWh per year to at least 30 trillion kWh per year.[7, 8] The United Nations' Human Development Index (HDI) tracks the close relationship between per capita energy use and quality of life (Figure 1).[9] According to the HDI, humans need 3,000 kilowatt hours per year per person to have what we consider a good life (Americans average 13,000 kilowatt hours per year per person). Currently, 80 percent of the world's 6.5 billion people are below the 3,000 kilowatt hours per year mark. But as developing nations like China and India consume more and more energy—and lift billions out of poverty—their energy needs will also grow exponentially.

The reality of *energy poverty* poses a particularly thorny paradox for progressives. On the one hand, progressives deeply believe in helping the world's poor. On the other hand, moving billions into the middle class in the coming decades without a realistic plan for ramping up non-carbon energy sources would essentially mean a drastic rise in fossil fuel use, since fossil fuels are still the cheapest, most plentiful source of energy. More than 90 percent of the energy currently used in developing countries comes from coal, oil and gas. Without fundamental changes in how the world produces energy, global use of fossil fuels will effectively double, or even triple, by 2040. This process has already played out in China, where five hundred million people have been lifted out of poverty in less than twenty years—a development that has coincided with China's emergence as the world's biggest carbon polluter.

If progressives are to pursue their aspirations for human development and a low-carbon world, we need to put in place a balanced energy plan. Barring advances in clean coal technology, resorting to even more coal must not be the answer.

Meanwhile, wind, solar, and hydroelectric power are not yet up to the task. Without a progressive embrace of nuclear energy, the twin goals of poverty alleviation and carbon emission mitigation cannot be simultaneously achieved.

To meet those goals, we need to prevent fossil fuel generation from exceeding today's level of 10 trillion kWh per year. At the same time, the world will have to generate the additional 20 trillion kWh from other sources by 2040. It's an ambitious target, but an achievable one – so long as we make the necessary changes in policy and lifestyle.

> Even if we have not agreed on the path that we have to follow to reach these goals, at the very least we need to declare that we have goals and begin planning to achieve them. It is well past time that we take those first steps.

By adopting our balanced portfolio proposal, the United States can set an important standard that, if adopted globally, could cap fossil-fuel electricity production at its current 10 trillion kWh per year output. Another 10 trillion kWh per year would be generated by renewable sources including wind, solar, hydroelectric, geothermal, and biomass – a feasible target (Figure 2), so long as the proper policies are enacted. And another 10 trillion kWh would be produced by nuclear power, which is likely the most practical and impactful of the three targets outlined here.[10]

Global implementation of the portfolio proposal would result in a 50 percent reduction in global CO_2 emissions over baseline estimates by 2040. That means overall worldwide emissions would remain about the same, even as global energy use doubles. It would require countries with major carbon footprints, like the U.S., China, and Japan, to significantly reduce their emissions by becoming more energy efficient and transitioning to lower-carbon energy sources. Additional global emissions reductions are possible through increased conservation and efficiency, and even further reductions may be possible depending upon the success of still unproven carbon sequestration technologies. But the centerpiece of any comprehensive energy policy should be a shift away from fossil fuels toward carbon-free sources like wind, solar, biomass, hydro, and, most important, nuclear.

GETTING REAL ABOUT OUR ENERGY MIX

Setting the world on a path of clean growth and poverty alleviation must be a project that the U.S. spearheads. While the problem obviously goes beyond the U.S., and developing countries like China and India need to sign on to the effort as well, changing both how much energy Americans consume and how we produce that energy will have a significant impact globally. To put the impact of the world's largest energy consumers into perspective, if the U.S., Canada, Japan, and Australia were to reduce their annual per capita electricity use to the levels of Britain, France, and Germany, the energy saved would equal about 15 percent of all fossil-fuel use worldwide.

More importantly, while the rest of the world has moved ahead with implementing plans to ramp up nuclear energy production, the U.S. has remained a laggard. We cannot afford to do so for much longer. Like the rest of the world, two thirds of U.S. electricity comes from fossil fuels. To reach the targets proposed in our proposal by 2040, the U.S. needs a running start now on all alternatives.

THE FIRST THIRD: FOSSIL FUELS

The first step in our effort to rebalance global energy consumption begins with banishing wishful thinking and accepting an inescapable fact: We are not going to completely wean ourselves off fossil fuels any time soon.

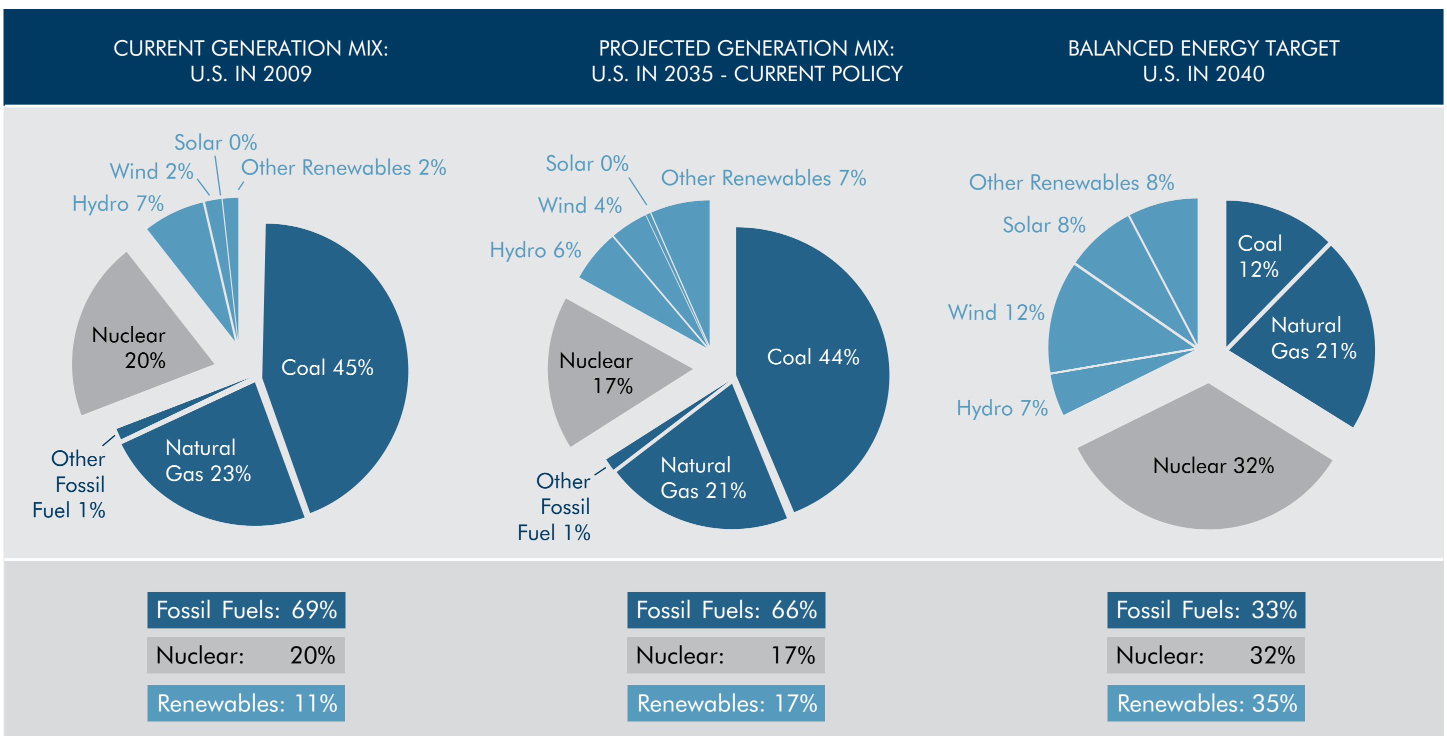
In the United States, almost half (46 percent) of the electricity we use comes from coal-fired power plants.[ii] And the United States has the largest coal deposits in the world, a fact which is increasingly important as energy independence becomes more of an economic and national security priority. Coal is cheap and abundant, and it will be with us for a long time.

But that doesn't mean we have to accept coal as-is. We can make it cleaner. Certainly recent advances in scrubbing out NO_x, SO_x, and other contaminants; pressurized fluidized bed boilers; and coal gasification all need to be expanded and become standard methods throughout the world.[11] But the biggest challenges will be to reduce the environmental damages from coal mining, regulate coal waste impoundments and disposal, and capture the carbon released during coal firing.

Natural gas, which accounts for about 22 percent of our domestic electricity production, also must be part of any progressive energy strategy. The CO_2 direct emissions from gas are 43 percent less than that of coal, although leakage during collection and transport increase than significantly. Unlike coal, gas has no particulates and few contaminants such as sulfur, nitrogen, uranium, thorium, and heavy metals. Collecting natural gas involves drilling wells, which is less environmentally intrusive than coal mining. There are great quantities of natural gas in the U.S. and the world, especially since the recent success in hydrofracking gas

> While the rest of the world has moved ahead with implementing plans to ramp up nuclear energy production, the U.S. has remained a laggard. We cannot afford to do so for much longer.

FIGURE 2: COMPARING TWO POSSIBLE ENERGY FUTURES FOR THE U.S.



"Actual 2009" source: U.S. Energy Information Administration, Electric Power Annual with data for 2009, released November 23, 2010
Projected 2035 source: U.S. Energy Information Administration, Annual Energy Outlook 2010 with Projections to 2035, released April 2010

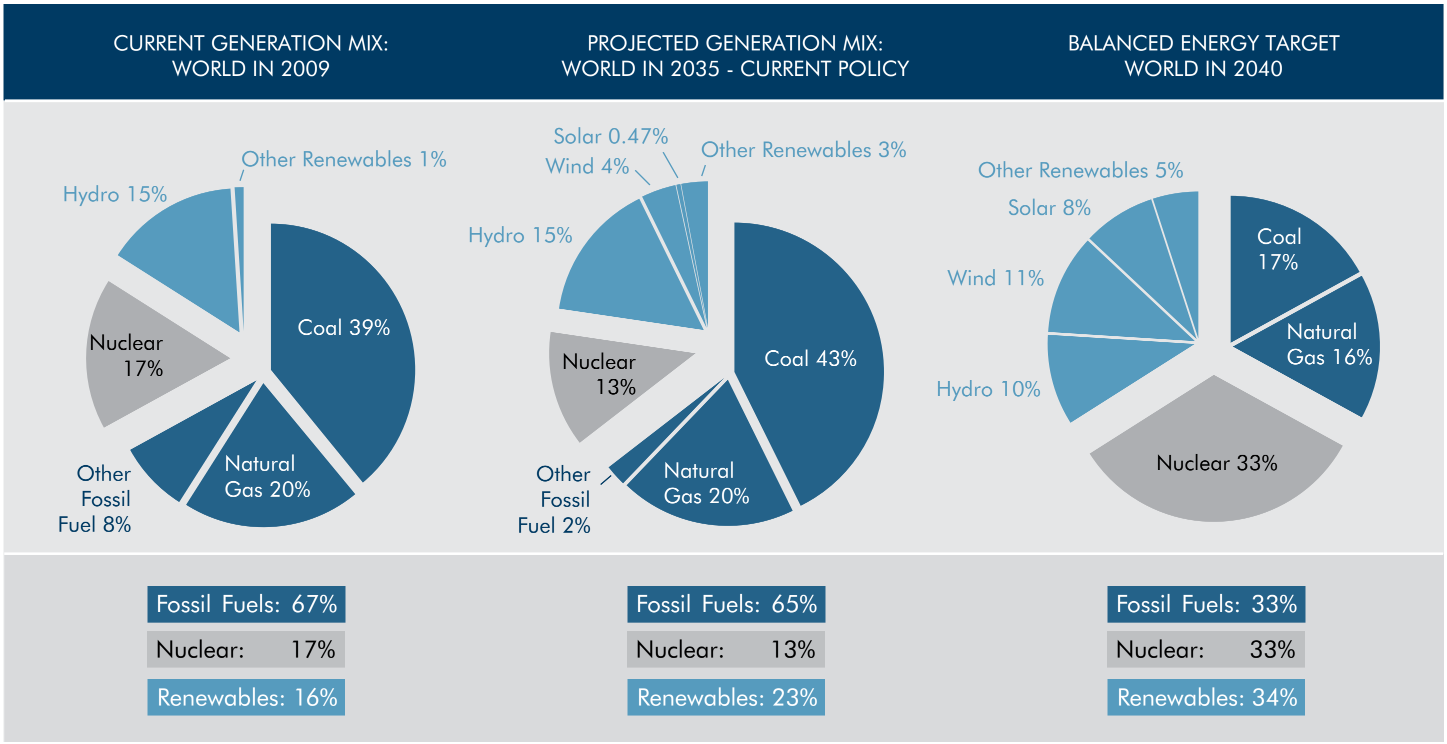
shales has greatly increased our usable gas deposits.[12] That said, natural gas is more expensive than coal–extraction and transportation are costly–but by current estimates its price should remain relatively stable for the next decade. Also, the recent breakthroughs in hydrofracking have caused unanticipated environmental effects which are still being evaluated.[13] Clearly, we need to be vigilant of these effects and adopt appropriate regulations where they are needed, even as we scale up our use of natural gas.

THE SECOND THIRD: RENEWABLES

In recent years, renewables have become a part of the American landscape. Images of wind turbines churning on mountaintops and off shorelines, and of solar panels blanketing desert floors, have become part of our vision for a green economy and a post-carbon future. The public embrace of renewables has been heartening. But optimism cannot be allowed to inflate our expectations and outpace the realities of development and deployment. Encouraging as the rise of green power has been, there remain plenty of obstacles in the way of scaling up renewables to their third of the mix.

Currently, renewables – and by renewables we mean primarily wind, solar, and biomass – produce only one percent of the global energy output. Hydroelectric, which is in a renewable category of its own, produces 15 percent of the world's electricity. The plan outlined in this paper, if expanded globally, would call for producing 10 trillion kWh per year globally using renewable sources by 2040, including hydro, an amount equal to the amount of power presently supplied by all fossil fuels. It's an ambitious goal, but in line with other renewable targets that have been proposed, such as the president's call for an 80 percent reduction in U.S. CO_2 emissions by mid-century, the American Council on Renewable Energy's push for 50 percent renewables by 2050,[14] or the European Union's goal of 50 percent alternatives by 2040.[15]

FIGURE 3: COMPARING TWO POSSIBLE ENERGY FUTURES FOR THE WORLD



"Actual 2009" source: U.S. Energy Information Administration, Electric Power Annual with data for 2009, released November 23, 2010
Projected 2035 source: U.S. Energy Information Administration, Annual Energy Outlook 2010 with Projections to 2035, released April 2010

But as we prepare to dramatically increase renewable energy production, we must be cognizant of the limits of renewable energy. The technologies are changing constantly, and different renewable sources are at different stages of development and efficiency. There are three acknowledged hurdles: intermittency, connectivity to the grid, and material resources.

Intermittency. Because it depends on wind to create energy, a wind turbine produces electricity only a fraction of the time. Theoretically, it can produce about 35 percent of its capacity (i.e., a one-megawatt wind turbine can produce about a third of a megawatt over time if located in an optimal area for wind). On average, however, wind turbines in the U.S. operate at about 20 percent of their capacity, and the production is as unpredictable as the weather. Solar, dependent on sunlight, has even less availability, theoretically having a capacity factor of 25 percent but averaging nationally about 10 percent. In comparison, coal has a capacity factor of about 70 percent, and nuclear is consistently over 90 percent. So, to produce the same amount of energy as a single 1,000 MW nuclear reactor operating over its lifetime requires 7,600 1-MW wind turbines operating intermittently over their lifetimes.[16]

Connectivity to the electric grid. Renewable resources like wind and solar are generally far from population centers, and peak generation does not follow peak demand. Renewable systems require large geographical footprints that are not presently connected to the electric grid. Solar has an advantage if placed on existing structures or incorporated into new buildings, called distributed solar, as this reduces costs and covers few new or pristine surfaces. But wind has no such distributing ability. To produce one billion kilowatt hours requires wind farms covering about 30 square miles -- compared to, say, a coal plant covering about four square miles, or a nuclear plant covering about 1 square mile.[17]

The difference is larger if mining and fabrication facilities are included, as wind requires 10 times the steel, copper and cement as nuclear, and a hundred times that of gas.[18] Connecting large solar arrays and wind farms to the grid usually requires hundreds of miles of high-voltage lines, and there has been fervent opposition to siting them across populated areas, near-shore or on unpopulated lands that are often protected or pristine.[19]

Material resources. The biggest hurdle for renewables in producing a one-third share of the energy mix under our proposed portfolio is the sheer volume of material needed to scale them up, particularly for wind. Table 1 compares the material needs of wind, coal, nuclear and natural gas power plants to install one megawatt of energy capacity.[20]

TABLE 1. COMPARISON OF MATERIAL REQUIREMENTS PER MW FOR VARIOUS ENERGY SOURCES

Energy Source	Steel (tons/MW)	Concrete (cubic meters/MW)
Wind	460	870
Coal	98	160
Nuclear	40	90
Natural Gas	3.5	30

P. F. Petersen, H. Zhao and R. Petroski. 2005. Metal And Concrete Inputs For Several Nuclear Power Plants, Report UCBTH-05-001, University of California, Berkeley, 20 p.

Wind energy requires over four billion tons of steel just to construct, not connect, the turbines necessary to produce the three trillion kWh of electricity per year needed for wind's contribution to the renewable $^1/_3$ of the balanced global energy portfolio. That is more than the total annual steel production worldwide. Concerted stockpiling and other resource measures are needed and are especially difficult in the developed world. Only China has developed a plan to meet its huge material needs, and it is struggling to keep to that plan, the consequence of which has been a steep rise in global commodity prices for construction materials.

A note on hydroelectric power is warranted here. Hydro is the most established renewable energy source, and has historically provided about 15 percent of the world's electricity, in the U.S. six percent or about 250 billion kilowatt hours per year. Hydroelectric power is among the cheapest sources of energy and produces minimal amounts of CO_2. But the footprint is large because of the flooding required behind the dam, especially affecting aquatic habitat. And we are almost at world capacity in large hydroelectric dams.

> As we prepare to dramatically increase renewable energy production, we must be cognizant of the limits of renewable energy. There are three acknowledged hurdles: intermittency, connectivity to the grid, and material resources.

Although existing dams can be upgraded with respect to their turbines and efficiencies, and some small non-hydroelectric dams can have turbines added to produce electricity, there is a limit to how much more hydroelectric power the world will see in the decades ahead. One of the best applications of hydro is in small hydropumping, or pumped-storage hydroelectricity, as a way to store intermittent renewable energy.

THE FINAL THIRD: NUCLEAR POWER

We need to reduce our dependence on fossil fuels, but the technologies do not yet exist for renewables to fill the gap. That's why the final piece to the balanced energy portfolio is allocating one third of our electricity production to nuclear generation. In order to address the destructive impact of fossil fuels, the U.S. must follow the French, Japanese and Korean models and make a major investment in nuclear energy.

Nuclear power is already a crucial part of our energy mix. Most Americans are surprised to learn that the U.S. is already the largest consumer of nuclear energy in the world, with some 104 nuclear plants producing about 20 percent of our electricity and 73 percent of our non-carbon electricity. Indeed, we have the science and technology to scale up nuclear in a safe and efficient way. The only remaining obstacles are political.

PPI has addressed nuclear energy's merits in past papers, but it's worth revisiting some of those arguments again.[21] More than the lack of resources or support among policy makers, it is public misconceptions that have prevented nuclear from being scaled up to a level we need to shift to a post-carbon economy. Objections to nuclear energy deserve to be taken seriously, but fact must be separated from myth. There are four frequently cited concerns regarding nuclear power, each of which is based on misinformation:

Health and Safety. Perceptions of nuclear power have been dominated by the mishaps and by misguided comparisons to nuclear weapons. That is certainly understandable, but health and safety data simply don't support the idea that nuclear is a public health threat. The fact is no one has ever died from the use of nuclear energy in the U.S., whether from working at or living near a nuclear plant or from handling nuclear waste.

In the U.S., the 1979 Three Mile Island accident in Middleton, Pennsylvania has greatly influenced Americans' negative views on nuclear energy. What rarely gets mentioned is that the safety systems in place for the nuclear plant *worked* as planned. The plant had a faulty valve in the cooling system, but the rest of the system, particularly the massive containment structure, worked as designed. The problem was resolved by highly trained engineers and personnel. There were no injuries, no adverse health effects, and no environmental contamination beyond the site above the normal background levels of radioactivity.

Nonetheless, Three Mile Island was a wake-up call spurring sweeping changes, including new rules about how nuclear plants must operate and necessary improvements in government oversight and regulation. Since 1979, U.S. nuclear plants have become even safer, and there have been no serious incidents at nuclear plants since Three Mile Island. As Andrew Klein, a professor of nuclear engineering at Oregon State University, wrote for PPI in a previous paper, "the safety culture at U.S. plants is so strong that working at a U.S. nuclear power plant is safer than working in the manufacturing sector" – a fact that most Americans are all too unaware of.[22]

Nuclear Security: No one in the world has ever made a weapon from spent commercial nuclear fuel. A nuclear bomb requires far greater uranium or plutonium enrichment than does the production of nuclear fuel – over ninety percent – and nuclear fuel itself cannot become a weapon or cause a nuclear explosion.

> environmentalists and progressives also bear responsibility for the lack of progress. They have failed to map a realistic course toward a new energy mix for America, imagining instead that we can easily leap to an economy powered mainly by renewable fuels

Of course, there are legitimate proliferation concerns involved with the production of nuclear energy. Iran's pursuit of nuclear weapons under the guise of a quest for energy and North Korea's overt weapons program, using a weapons reactor that cannot even produce electricity, have raised concerns. To deal with this, the U.S. and other nuclear powers should create a world energy partnership allowing countries that already have nuclear programs to become supplier nations that use their enrichment facilities to provide nuclear fuel to other nations. The nuclear powers should also consider establishing waste take-back programs in large-user nations that prevent spent fuel from small-user nations from roaming the world looking for a home.

Nuclear reactors are also not particularly vulnerable or attractive targets for terror attacks. The containment structures used in the U.S. are designed and constructed to safely withstand a direct impact from a commercial passenger jet. The fuel and materials stored on-site for nuclear reactors also do not include the types of radioactive materials typically sought after to make "dirty bombs." Nuclear power plants are better secured against terror attacks and security breaches than any other type of infrastructure in the U.S. today.

Cost. Nuclear power is competitive with all other energy sources, and, together with wind and hydro, nuclear is cheaper over time than the other sources. Most of the cost of nuclear is an upfront investment; once a nuclear power plant is constructed, it becomes far and away the cheapest source of electricity. As with other large construction projects, from bridges to wind farms, these costs often require public loan guarantees that allow reasonable financing to be obtained from private credit markets. But nuclear power is one of the least subsidized energy sources in the U.S., particularly when compared to subsidies for renewable resources.

Of course, the true cost of an energy source cannot simply be measured in dollars and cents. The hidden costs of energy sources—the so-called externalities like environmental damage, physical footprint, and CO_2 emissions—need to be accounted for as well.[23] Doing so only serves to bolster the case for nuclear. For example, nuclear power has the smallest footprint of any energy source, meaning it requires the least physical space to produce electricity: four times less than coal, eight times less than natural gas, over 20 times less than hydroelectric, and over 30 times less than wind.[24, 25]

Nuclear looks even better under a cap-and-trade or carbon tax system. While the prospects for passing such legislation appear dim at the moment,

previous bipartisan support and industry buy-in make it likely, if not necessarily certain, that carbon will be priced at some point in the future. Assuming a carbon cap or tax in which carbon is priced at $15/ton—a reasonable estimate—we can calculate a cents-per-kilowatt-hour carbon tax for each source.

Just as nuclear compares favorably to coal and gas in terms of its carbon footprint, the actual land footprint required for nuclear facilities is a significant advantage compared to wind, solar, and hydroelectric resources. And with new resin methods for extracting uranium from seawater being developed by the Japanese, the land needed for mining of uranium may no longer be a factor for the industry in the future. The physical footprint for solar can be reduced by distributing it over existing facilities and structures, but wind cannot be so distributed and many ideal wind sites are in pristine ecological areas. The footprint impact for hydro is also difficult to define, as the ecological effects of hydroelectric are widespread and include upstream submergence, changes in downstream sediment supply, impacts on fish and wildlife, and accumulation of contaminated sediments, none of which are typically reflected in cost estimates.[26]

Looking at different energy sources over their entire lifespan, including construction, fuel, operation and maintenance, and decommissioning, the cheapest energy sources are wind, nuclear and hydro, 3.60¢/kilowatt hour, 3.51¢/ kilowatt hour, and 3.46¢/ kilowatt hour, respectively, in 2009 dollars, while natural gas is the most expensive at over 10¢/kilowatt hour.[27]

Nuclear Waste. Nuclear waste is another topic where confusion runs rampant. Nuclear power produces far less waste than is commonly believed. In the U.S., nuclear provides 20 percent of our power while producing only 2,000 tons of waste each year, which would not even fill a 3,000 square-foot house. Compare that to coal, which generates over 2,000 tons of hazardous waste every *five minutes* or over 400 million tons of waste each year, while emitting two billion tons of CO_2. Coal-fired power plants even produce 25,000 tons of *radioactive* waste because of the abundance of uranium, thorium, and their daughter products in coal. Most Americans would no doubt be surprised to learn that all of the commercial nuclear waste ever produced in the five-decade history of U.S. nuclear power would fit in a single landfill.

Moreover, we know exactly how to dispose of nuclear waste safely and cheaply. Unknown to most people even in the field, the U.S. already has an operating, permanent, deep geologic repository for nuclear waste. The Waste Isolation Pilot Plant (WIPP) is in the Permian salt beds that lie under 10,000 square miles of New Mexico, Texas, Oklahoma, and Kansas. Massive salt was chosen by the National Academy of Sciences way back in 1957 as the best rock type for all nuclear waste,[28] and a small 16-square-mile portion of this salt in southeastern New Mexico was set aside in 1992 for permanent nuclear waste disposal.[29]

> If progressives are serious about reducing global poverty, we must confront the fact that doing so will demand more energy from realistically available resources.

WIPP is located one-half mile below the surface of the earth in the Salado Formation, a particularly massive and optimal segment of these salt beds that has never been deformed, folded, faulted, or otherwise had any disruptive geologic activity in 225 million years. The Salado Formation has only one percent water, and that water is not mobile but trapped as small fluid inclusions of 225-million-old seawater that have not moved a millimeter in that entire time.[30]

Right now, WIPP is permitted only for defense-generated transuranic waste—basically bomb waste—that includes everything from low-activity to high-activity waste like recycled spent fuel waste from old weapons reactors. It has been operating safely and efficiently for 11 years and when finished will have used up only one-half of a square mile of the original 16 square miles allocated for it.[31] In a future paper, PPI will discuss in greater detail the idea of using massive salt for commercial nuclear waste, which would contribute to solving the vexing problem of nuclear waste disposal and eliminating one major obstacle to the scaling-up of nuclear energy.

FORTY YEARS, NOT FOUR

The present energy and environmental crises require long-term planning—a look ahead to 40 years or more, not two to four. During our early to mid-20th century rise to prominence, the U.S. planned long and well, with national plans for building codes, electricity and telephone, rail and interstate roadways, agriculture, education, and in the 1970s, environmental protection. However, in the 1980's this long-term planning slowed to a trickle. Even as it has become apparent that urgent action is needed, Washington continues to kick the can down the road, aided by obstructionist conservatives on the right and unrealistic environmentalists on the left.

It is the role of government to care about the future and the next generations. This paper charts a course for an energy program that will provide the world's population with clean energy while keeping a lid on carbon emissions over the next few decades. The balanced portfolio proposed here is not a magic elixir that will solve our fossil fuel addiction. Rather, it makes concrete what our aspirations should be: an energy mix of $^1/_3$ fossil fuels, $^1/_3$ renewables, and $^1/_3$ nuclear by 2040.

Of course, actual policies need to be enacted to meet that target. Deciding which policies to pursue to achieve our balanced energy portfolio is beyond the scope of this paper, though PPI has released many papers throughout the years proposing specific policies to accelerate our shift to a green economy. Among the many policies that lawmakers should consider include:

- Imposing a price on carbon emissions, either via cap-and-trade or a direct carbon tax.
- Implementing a low-carbon energy standard that requires utilities to supply a fixed portion of their electricity from renewables, nuclear, and energy-efficiency resources such as demand-side management programs.

- Fully funding and improving administration of the DOE Loan Guarantee Programs for both nuclear and renewable energy projects.
- Supporting continued development of small modular reactor (SMR) nuclear technology, through public cost-sharing partnerships with U.S. manufacturers.
- Extending the successful Section 1603 Treasury cash grant program for renewable energy projects, which provides a valuable financing alternative to the federal Investment Tax Credit (ITC) and the Production Tax Credit(PTC).
- Scale up Property Assessed Clean Energy (PACE) bonds that can help finance energy efficiency projects and enact a national Energy Efficiency Resource Standard (EERS) to expand incentives for investments in energy efficiency.
- Establish a Federal Energy Bank or "green bank" like the proposed Clean Energy Deployment Administration, or a National Infrastructure Bank that can facilitate long-term financing for new energy resources.
- Create a syndicated loan securitization program (Nukie Mae and Renewie Mae)[32] to convey debt financing obligations from the public to the private sector, that could, or could not, be part of the Energy Bank or National Infrastructure Bank.
- Mandate and enforce aggressive green building practices and codes.

The details will be worked out as we go, but without some national energy plan in place, the details become a chaotic contest of special interests. This problem of scattered priorities may become even more pronounced as the president seeks to find specific areas of common ground with a politically divided Congress, without first defining a broader vision of our energy future to frame the discussions and search for compromise.

Ultimately, no plausible energy proposal can deny that we will be burning fossil fuels for many years to come—or that we simply will not be able to scale up wind and solar to meet most of our energy needs. Most important, any serious energy agenda for the coming decades needs to include nuclear power—it is, quite simply, the most promising source of non-carbon energy for an ever-more energy-hungry world.

The balanced energy portfolio we have presented here requires nothing less than fundamentally changing how we make the world run. It is going to take time and commitment. Even if we have not agreed on the path that we have to follow to reach these goals, at the very least we need to declare that we have goals and begin planning to achieve them. It is well past time that we take those first steps.

About the authors

Dr. James Conca is director of the WSCF radiological labs operated by RJ Lee Group at the Hanford Site in Washington State, under the Mission Support Alliance. Previously, he was director of the NMSU Carlsbad Environmental Monitoring and Research Center. He came to NMSU from Los Alamos National Laboratory where he was Project Leader for Radionuclide Geochemistry. Before that, Conca was on the faculty at Washington State University. Conca obtained a Ph.D. in Geochemistry from the California Institute of Technology in 1985, as well as a Masters in Planetary Science in 1981, and a BS in Geology and Biochemistry from Brown University in 1979.

Dr. Judith Wright is a geologist, earth-systems scientist, entrepreneur, and eco-philosopher. She became a staff scientist at the Pacific Northwest National Laboratory before becoming President of UFA Ventures, Incorporated, an environmental remediation and characterization company. Wright received a PhD in geochemistry from the University of Oregon and a BS in geology from CalState Northridge with a minor in Philosophy. Dr. Wright is author of the book The Geopolitics of Energy: Achieving a Just and Sustainable Energy Distribution by 2040.

ENDNOTES

1. EIA, *Electric Power Monthly, September 2010, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html*
2. EIA. 2010. Annual Energy Outlook, Energy Information Administration, www.eia.doe.gov/oiaf/ieo/index.html.
3. NAS. 2010. Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use, National Academy of Scioences Press, Washington, D.C. ISBN-13: 978-0-309-14640-1, 506 p. http://www.nap.edu/catalog.php?record_id=12794
4. J. Scott. 2005. The Clean Air Act at 35: Preventing Death and Disease from Particulate Pollution, Report by the Environmental Defense, New York. www.edf.org/documents/4932_CAAat35ExecSum.pdf
5. H.L. Falk and W. Jurgelski, Jr. 1979. Health effects of coal mining and combustion: carcinogens and cofactors, Environmental Health Perspectives, 33:203–226.
6. Need better cite for Chinese plan: http://cleantechnica.com/2010/12/04/china-adding-500-gigawatts-of-renewable-power-by-2020/
7. J. M. Deutch and E. J. Moniz. 2006. "The Nuclear Option", Scientific American 295:76-83.
8. United Nations. 2004. World Population Monitoring, ST/ESA/SER.A/228, United Nations, New York.
9. UNITED NATIONS, Human Development Index, http://hdr.undp.org/en/statistics/ (2009).
10. J. Wright and J. Conca. 2007. The GeoPolitics of Energy: Achieving a Just and Sustainable Energy Distribution by 2040. BookSurge Publishing, North Charleston, SC. ISBN 1-4196-7588-5. http://www.amazon.com/gp/product/1419675885/sr=1-10/qid=1195953013/
11. DOE. 2010. Clean Coal Technology, the United States Department of Energy, http://fossil.energy.gov/education/energylessons/coal/coal_cct4.html
12. New York State Department of Environmental Conservation. 2010. Albany, NY. http://www.dec.ny.gov/energy/46288.html
13. It's been found that hydrofracking can push gas and drilling fluids through fractures beyond the target formations into adjacent drinking water aquifers in sufficient volumes to cause widespread concern. The issue is the focus of a recent documentary film, *Gasland*, by Josh Fox and has become a major political issue, especially in New York State.
14. Mike Eckhert. 2009. personal communication. President of the American Council on Renewable Energy (ACORE) http://www.acore.org/
15. EREC. 2010. *Renewable Energy Scenario to 2040: Half of the Global Energy Supply from renewables in 2040*. European Union Energy Council, 26, rue du Trône - 1000 Brussels, http://www.erec.org/fileadmin/erec_docs/Documents/Publications/EREC_Scenario_2040.pdf
16. J. Conca and J. Wright. 2010. "The Cost of a Sustainable Energy Future", *Proceedings of the 2010 Waste Management Symposia*, Phoenix, AZ, paper #10494, p. 1-14. http://www.wmsym.org.
17. R. McDonald, J. Fargione, J. Kiesecker, W. M. Miller and J. Powell. 2009. "Energy Sprawl or Energy Efficiency: Climate Policy Impacts on Natural Habitat for the United States of America", PLoS ONE doi:10.1371/journal.pone.0006802 http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0006802
18. P. F. Petersen, H. Zhao and R. Petroski. 2005. Metal And Concrete Inputs For Several Nuclear Power Plants, Report UCBTH-05-001, University of California, Berkeley, 20 p.
19. McDonald, Fargione, Kiesecker, et. al. "Energy Sprawl or Energy Efficiency."
20. Petersen, Zhao and Petroski. Metal And Concrete Inputs For Several Nuclear Power Plants.
21. A. Klein. 2009. "Why Progressives Should Be More Open to Nuclear Energy," Progressive Policy Institute, http://www.progressivefix.com/why-progressives-should-be-more-open-to-nuclear-energy
22. Ibid.
23. P. Bickel and R. Friedrich. 2005. Externalities of Energy. European Union Report EUR 21951, ISBN 92-79-00423-9, Luxembourg.
24. POST, Carbon Footprint of Electricity Generation, Parliamentary Office of Science and Technology, London, October 2006 Number 268 (2006).
25. J. Conca and J. Wright. 2010. "The Cost of a Sustainable Energy Future."
26. P. McCully. 1996. *Silenced Rivers: The ecology and politics of large dams*, Zed Books Ltd., London.
27. J. Conca and J. Wright. 2010. "The Cost of a Sustainable Energy Future."
28. NAS–NRC (1957), 'Disposal of radioactive waste on land', Report by the Committee on Waste Disposal, Division of Earth Sciences, The National Academies Press, Washington, DC.

29. J. Conca, S. Sage and J. Wright. 2008. "Nuclear Energy and Waste Disposal in the Age of Recycling," New Mexico Journal of Science, vol. 45, p. 13-21 http://www.nmas.org/NMJoS-Volume-45.pdf

30. J. D. Griffith, S. Willcox, D. W. Powers, R. Nelson and B. K. Baxter. 2008. Discovery of Abundant Cellulose Microfibers Encased in 250 Ma Permian Halite: A Macromolecular Target in the Search for Life on Other Planets, *Astrobiology,* Vol. 8, No. 2, p.1-14, Mary Ann Liebert, Inc. DOI: 10.1089/ast.2007.0196

31. Conca, Sage and Wright. 2008. "Nuclear Energy and Waste Disposal in the Age of Recycling."

32. James Peach. 2010. personal communication. NMSU, Department of Economics and International Business.

About the Progressive Policy Institute

The Progressive Policy Institute (PPI) is an independent research institution that seeks to define and promote a new progressive politics in the 21st century. Through research, policy analysis and dialogue, PPI challenges the status quo and advocates for radical policy solutions.

Progressive Policy Institute
1730 Rhode Island Avenue
Suite 308
Washington, DC 20036

Tel 202.525.3926
Fax 202.525.3941
Email info@ppionline.org
www.progressivefix.com