



# A SUSTAINABLE ENERGY FUTURE IS POSSIBLE NOW

ABOLITION  N 2000

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## EXECUTIVE SUMMARY

Today's world energy systems, relying on fossil and nuclear fuels, endanger the very existence of humanity. The world is faced with a crisis that requires a total transformation in the way we create energy, shifting to sustainable energy that flows freely from the sun, the wind, the tides, and the center of the earth. Sustainable energy is energy which has minimal negative impacts, both in its production and consumption, on human health and the environment, and that can be supplied continuously to future generations.

Human beings essentially use energy for two purposes: transportation and stationary power. In industrialized regions stationary power needs are met by electricity (or gas for cooking), which at present is supplied largely by burning coal or natural gas, in addition to using nuclear energy and large-scale hydropower. The exploitation of finite conventional resources for non-transportation energy has been ecologically catastrophic, and these resources cannot be made "green" or "environmentally friendly." Truly sustainable alternatives such as solar, wind, geothermal, and marine energy are abundant, reliable, ecologically responsible and technologically feasible today.

Energy for transportation can also be made environmentally sustainable by using hydrogen for fuel instead of petroleum. Hydrogen fuel cell vehicles produce no polluting emissions and can rapidly replace petroleum-based internal combustion engines if the infrastructure to support them is put into place. Fuel cells combine hydrogen and oxygen to make electricity. Its only byproducts are heat and water vapor, pure enough to drink. Hydrogen can be produced using sustainable energies like solar, wind and geothermal energy, and provides a storage solution to intermittent sustainable energies and a unique method for increasing the contribution of sustainable energy sources. By integrating the energy mix for transportation and non-transportation uses, hydrogen can significantly decrease our impact on global climate change and other environmentally destructive energy processes.

Sustainable energy sources are also good for the global economy. While manufacturers in industrialized countries are downsizing their labor forces, the sustainable energy sector is growing exponentially. Dollar for dollar, investments in sustainable energy provide more jobs and more energy than conventional sources. At the same time, sustainable energy is becoming more affordable to consumers and can be made even more cost-competitive if the market distortions that favor conventional energy sources are reduced or eliminated. These distortions include billions of dollars in direct and indirect subsidies to the fossil, nuclear and industrial biomass industries, as well as the failure to account for external costs to human health and the environment in the price of conventional energy.

This report will demonstrate that:

- Sustainable energy is inexhaustible and can satisfy 100% of the world's energy needs.
- The technology for harnessing its abundance is available now.
- Hydrogen is a storage solution to intermittent renewable energy and a safe, clean alternative for the transportation sector.
- Nuclear power, "improved" fossil fuels and industrial biomass have no role to play in a sustainable energy mix and divert valuable resources that should be applied to the development and promotion of sustainable energy which is abundant and technologically feasible today.
- Relying on "all energy sources" to meet our energy requirements and avoid global warming would actually worsen climate change and increase energy insecurity.
- Sustainable energy offers enormous economic advantages in terms of job creation and sustainable economic growth.
- Sustainable energy is cost-competitive if we level the playing field by eliminating government direct and indirect subsidies for the fossil, nuclear and industrial biomass industries and include even a portion of the quantifiable environmental and health costs as part of the price of unsustainable forms of energy.
- Renewable energy and energy efficiency are the only path to true energy security, assuring stable and reliable energy supplies and expanding energy access across the planet. True energy security requires that we forego attempts to maximize fossil fuel extraction, develop industrial biomass, and revive the nuclear industry.

## INTRODUCTION

We are at a critical moment in history. Accelerating incidences of catastrophic extreme weather—tsunamis, hurricanes, drought, the melting of the polar ice caps—underline the urgency of heeding the scientific consensus that we are endangering our very survival on the planet with the continued use of carbon based fuels. Current international mechanisms to limit green house gas emissions, including the Kyoto Protocol, are proving insufficient to address the urgency of global climate crisis. The world’s dependency on fossil fuels creates political and economic instability across the globe. These tensions are bound to increase as depleting resources and price volatility place growing strains on energy security considerations.

Moreover, the recent failures of the Non-Proliferation Treaty Review Conference, the Millennium Summit and the General Assembly to meaningfully address issues of nuclear disarmament and nuclear proliferation should serve as a wake up call to nations that we cannot continue “business as usual.” The drums of war are beating once again as the United States seeks to deny Iran its “inalienable right” under the Non-Proliferation Treaty to pursue so-called “peaceful” nuclear technology.

The technology to harness the enormous potential of sustainable forms of energy exists today. And so does the funding—by reallocating the hundreds of billions of dollars in annual government subsidies for the world’s energy polluters to the production of clean, safe energy from the sun, the wind and the tides, we can build a self-sustaining earth-friendly energy infrastructure to harvest the earth’s benign and abundant free resources. It is possible now to meet the energy needs of all of humanity through the enormous potential of sustainable energy if resources now funding polluting energy forms are committed to the development of safe, clean energy.

Sustainable energy promises to make a significant contribution to energy diversification and energy security. Tapping the local sustainable energy potential available in each region or country can be the solution to increasing global price and supply volatility, contributing to energy security and political stability around the world. Today some 2.4 billion people still have no access to modern energy services and one quarter of the world’s population lives without electricity. The lack of access to energy is a key factor in perpetuating world poverty and a continued obstacle to economic development. Sustainable sources of energy can have a substantial impact on poverty alleviation in developing countries, offering access to readily available, cost-free energy sources while integrating growing energy needs and sustainable development goals. Sustainable energy coupled with energy efficiency offers solutions to the critical challenges of our time—climate change, energy security, nuclear proliferation risks and economic development. The time to develop a program to ensure a sustainable energy future for all, without reliance on nuclear, fossil, or industrial biomass fuels, is now.

## SUSTAINABLE ENERGY CHOICES: THE FUTURE IS NOW

Sustainable energy is energy which has minimal negative impacts, both in its production and consumption, on human health and the environment, and that can be supplied continuously to future generations.<sup>1</sup>

### Solar Power

Every thirty minutes, enough of the sun’s energy reaches the earth’s surface to meet global energy demand for an entire year.<sup>2</sup> The sun is a fireball of free energy that can be harnessed for hot water and temperature control using solar collectors. In addition, solar energy can be used to provide electricity utilizing photovoltaic (PV) technology, which generates electricity from sunlight without producing green house gases (GHG’s).

The Worldwatch Institute reports that already, “rooftop solar collectors provide hot water to nearly 40 million households worldwide.”<sup>3</sup> Commercial solar PV modules are becoming more and more efficient and require less and less space.<sup>4</sup> One of the benefits of solar PV is that it is extremely versatile, and can either produce stand-alone electricity or connect to existing electricity grids. Solar PV can power equipment as small as an individual laptop, or as large as the 500-megawatt (MW)<sup>5</sup> generator currently under

**THE SOLAR ENERGY AVAILABLE IN A 100-SQUARE-MILE AREA OF NEVADA COULD SUPPLY THE UNITED STATES WITH ALL ITS ELECTRICITY NEEDS**

construction in California's Mojave Desert that will generate enough electricity to power 40,000 average American homes.<sup>6</sup> The solar energy available in a 100-square-mile area of Nevada could supply the United States with all its electricity needs.<sup>7</sup> Grid-connected solar PV has been cited as the world's fastest-growing energy technology.<sup>8</sup>

In addition to large-scale, centralized projects like the one in Mojave, solar energy can be widely distributed and decentralized as well. Fitting the rooftops of America's homes and businesses with solar PV modules could accommodate as much as 710,000 MW of power, nearly 75% of current generating capacity.<sup>9</sup> Solar PV could also be put to use on the 5 million acres of abandoned industrial sites in cities across the country.<sup>10</sup> In March 2006, the city of Brockton, MA, contracted with Global Solar Energy, Inc., to construct New England's largest solar array on such an industrial "brownfield."<sup>11</sup>

Other exciting developments in solar technologies include hybrid solar lighting (HSL), a system by which sunlight is refracted through optical fibers to light building interiors, significantly reducing the need for electricity. Lighting optical fibers also produces less heat than fluorescent or incandescent light bulbs, reducing the need to expend additional energy on cooling systems.<sup>12</sup> HSL systems are integrated with conventional electricity, which could eventually be supplied by other sustainable sources.

## Wind Power

Wind has the potential to satisfy the world's electricity needs 40 times over, and could meet all global energy demand five times over.<sup>13</sup> Wind energy is harnessed using wind turbines – essentially giant fans – that are rotated by the wind and use the kinetic energy from their rotation to charge an electric generator. Like solar panels, windmills can be adapted to small and large uses. Depending on their design, wind turbines can

**WIND HAS THE POTENTIAL TO SATISFY THE WORLD'S ELECTRICITY NEEDS 40 TIMES OVER AND COULD MEET ALL GLOBAL ENERGY DEMAND FIVE TIMES OVER**

generate power as small as a few kilowatts (kW) or as large as several MW of electricity.<sup>14</sup> One study concluded that, "good wind areas, which cover 6% of the contiguous U.S. land area, have the potential to supply more than one and a half times the current electricity consumption of the United States."<sup>15</sup>

It is no wonder, then, that wind is one of the world's fastest growing energy sources. In 2005, wind energy in the United States grew by almost 2,500 MW of installed capacity – a 35% increase in just one year.<sup>16</sup> Total wind-generating capacity in the United States now stands at over 9,000 MW, enough to power more than 2.3 million average American homes.<sup>17</sup> An even larger increase is predicted for 2006, and the opportunity for continued expansion is similarly encouraging.<sup>18</sup> Previously uncharted U.S. wind reservoirs with tremendous generating potential are located "offshore and near shore along the southeastern and southern coasts."<sup>19</sup>

Globally, the wind energy market grew a staggering 40.5% in 2005.<sup>20</sup> Also in Europe, wind installed capacity has already exceeded the European Commission's goals of 40 GW before the end of the decade.<sup>21</sup> Germany is the European leader, with more than 18 GW of installed wind capacity.<sup>22</sup> In Navarra, Spain, half of the electricity consumption is met by wind power and in Denmark wind represents 20% of the electricity production.<sup>23</sup> Wind energy is also developing rapidly around the world. India is now the world's fourth-largest producer of wind energy.<sup>24</sup> In China, wind energy grew at a 60% rate in 2005 and the Chinese government plans to reach 30 GW of wind energy capacity by 2020.<sup>25</sup>

**GLOBALLY, THE WIND ENERGY MARKET GREW A STAGGERING 40% IN 2005 AND WIND POWER'S GENERATING CAPACITY IN EUROPE HAS ALREADY EXCEEDED THE EUROPEAN COMMISSION'S GOALS FOR 2010**

One of the major advantages of windmills is that they can allow for dual use of the land where they are built. This is an especially attractive prospect for farmers and cattle ranchers who can continue to run livestock on their farms while earning thousands of extra dollars in leasing fees or royalties from windmills built on their land. Like solar PV, wind uses essentially no water in its generating process, and can therefore help decrease the estimated 70 trillion gallons of water that the United States consumes every year for thermoelectric power generation.<sup>26</sup>

## Geothermal Power

Geothermal energy is produced when magma rising from the Earth's core towards its outer crust heats nearby water, creating high-temperature water and vapor that collects in reservoirs close to the surface. This energy is converted to electricity by pumping steam out of the ground and through a turbine, which in turn powers a generator. Geothermal energy can also be used to directly heat and cool buildings, and it has agricultural applications as well.<sup>27</sup> The geothermal energy stored in the top six miles of the Earth's crust contains an estimated 50,000 times the energy of the world's known oil and gas resources.<sup>28</sup> Geothermal energy can meet 100% of all electricity needs in 39 developing countries and could serve the needs of 865 million people around the world.<sup>29</sup> Moreover, in many areas in the developing world, small geothermal projects have great potential to satisfy electricity demands of rural populations.<sup>30</sup>

Perhaps the most dramatic example of geothermal power's potential is found in Iceland, which was largely dependent on imported fossil fuels only a few decades ago. Today Iceland obtains more than 70% of its energy from domestic, renewable sources. Nowhere else does geothermal energy play a greater role than in Iceland, corresponding to more than half of its primary energy consumption.<sup>31</sup> Geothermal energy is also widely used in the western United States and Hawaii, where enough geothermal electricity was produced in 2003 to power two million average American homes.<sup>32</sup> This represents but a fraction of America's potential geothermal generating capacity, which could grow tenfold over the year 2000 levels using existing technology.<sup>33</sup>

**THE GEOTHERMAL ENERGY STORED IN THE TOP SIX MILES OF THE EARTH'S CRUST CONTAINS AN ESTIMATED 50,000 TIMES THE ENERGY OF THE WORLD'S KNOWN OIL AND GAS RESOURCES**

Even in regions without heavy geothermal activity, the regular heating of the ground by the sun can be harnessed to heat and cool homes. Geothermal heat pumps (GHP's) operate by transferring heat from the ground into buildings during the fall and winter, and reversing the process to keep buildings cool during spring and summer. GHP's can operate more efficiently than the most energy-efficient conventional furnaces on the market today.<sup>34</sup> There are approximately 500,000 GHP's currently in use in the United States, and they are becoming increasingly popular in countries like Germany, where purchases of GHP's increased by 35% in 2005.<sup>35</sup>

## Tidal Energy and Smaller-Scale Hydropower

Both tidal, wave and smaller-scale hydroelectric projects represent a significant improvement over traditional, "big dam" hydroelectric power. The use of rivers to generate electricity is already a proven technology, and accounts for 10% of America's electricity generation.<sup>36</sup> Large-scale hydropower is constrained, however, because most of the world's large rivers have already been exploited, leaving little room for sustainable growth.<sup>37</sup> Large hydroelectric dams are also environmentally destructive, and their construction has forcibly displaced millions of people from their homes in recent decades.<sup>38</sup> Similarly, large ocean-based tidal barrages such as the one in La Rance, France, have been associated with numerous environmental problems and are not a sustainable source of energy.

Marine turbines, by contrast, are far less intrusive. Similar to windmills, marine turbines are rotated by the movement of water through their fans. The movement of the tides, caused by the gravitational pull of the moon on the earth's oceans, provides a regular source of energy for marine turbines. They can operate especially well in tidal streams (also called marine currents), where water flow is heavily concentrated. While they are often smaller than wind turbines, tidal turbines can produce more energy relative to their size because of water's higher density compared to air. Water-based turbine blades also rotate relatively slowly, and therefore pose little danger to aquatic life.

One marine turbine project underway in Northern Ireland is expected to generate 1,200 kW of electricity. Marine Current Turbines Ltd., the company behind the SeaGen project, estimates that tidal streams could meet 5-7% of the U.K.'s electricity needs. Preliminary tidal stream projects are also underway in the United States, Russia, and China. In New York City, just four sites in the East River have a potential capacity of nearly 40 MW and a tidal turbine project being tested in Roosevelt Island is expected to generate 10 MW.<sup>39</sup>

For regions with riverbanks instead of coastlines, small-scale hydropower projects can be used to produce electricity as well as mechanical energy for agriculture or other uses.<sup>40</sup> Within smaller hydro projects,

so-called micro hydropower (generating less than 1 MW) is especially beneficial to rural communities in mountainous regions or other locations where extending the electrical grid is either technically impractical or expensive. Because smaller hydropower projects are more localized, they are much more easily customized to meet site-specific needs and can often come at a cost comparable or preferable to solar PV.<sup>41</sup>

Micro hydro projects are a promising approach to meet the energy needs of rural communities at a minimal disruption to the surrounding environment in developing countries.<sup>42</sup> In more industrialized scenarios, “advanced hydro” strategies are also being developed to mitigate the toll that large hydropower projects have taken on the environment.

Wave power also has vast potential. The Carbon Trust, an organization set up by the British government to monitor the country’s emissions, estimates that 20% of Britain’s electricity can be provided by wave and tidal energy.<sup>43</sup> The U.S. Department of Energy’s National Renewable Energy Laboratory estimates the potential of global wave power to be 2 to 3 million MW, with wave energy density averages of 65 MW per mile of coastline in favorable places.<sup>44</sup> And the technology to harness the power of the waves is making headway – a new type of wave-power generator allows for high efficiency rates in extracting energy from the sea.<sup>45</sup> The world’s first commercial wave farm will be switched on and connected to the electricity grid in Portugal this summer. The project, the Aguçadoura wave farm, will generate 24 MW of electricity and will provide power to 15,000 households.<sup>46</sup>

## **Intermittency: A Concern of the Past**

One common misconception regarding sustainable energy sources is that they are unreliable due to uneven geographical distribution, weather variations, or changes in the season, also known as variability and intermittency. There are a number of strategies that can compensate for days when the sun doesn’t shine or the wind doesn’t blow. A recent International Energy Agency (IEA) report concluded that intermittency is not a technical barrier to renewable energy.<sup>47</sup> Right now, there are two major solutions for intermittency concerns – diversification and hydrogen fuel cell storage.

One way to minimize intermittency is to integrate or “mix” sustainable energy sources by both type and location so that they are mutually supportive. The IEA report said interconnection of renewable energy sources over a wide area was an important way of dealing with intermittency issues.<sup>48</sup> Wind farms, for example, can provide steadier and more reliable power when they are networked in areas with high average wind speeds.<sup>49</sup> In addition to centralized electricity generation, solar PV can also produce electricity on-site, making it “harder to disrupt, more stable, and less brittle than full reliance on centrally generated power.”<sup>50</sup> Geothermal energy is unaffected by weather patterns and tidal patterns can be predicted centuries into the future.

The ability to store surplus energy for later use is a crucial step towards making sustainable energy widely available. One of the most promising solutions to intermittency is the use of hydrogen. The most abundant element on earth, hydrogen contains a tremendous store of energy that can be used to produce electricity. In order to tap into this potential, pure hydrogen must first be separated out of other materials, notably water. By passing electricity through water containing a catalyst in a process known as electrolysis, hydrogen can be produced from water at up to an 80% efficiency rate.<sup>51</sup> The hydrogen can then be stored either as a liquid or as a highly compressed gas and either be combusted like conventional fuel or used in fuel cells to produce electricity. The only byproducts of the fuel cell recombination process are heat and water vapor, thereby reducing a significant source of GHG’s and other pollutants. Importantly, electrolysis can be performed using any sustainable generated electricity processes, creating a complete circle of sustainable energy while

further protecting consumers against energy intermittency.<sup>52</sup>

**POWER OUTAGES FROM CONVENTIONAL ENERGY MAY COST THE U.S. ECONOMY AS MUCH AS \$80 BILLION A YEAR**

It is also important to note that fossil fuels have their own intermittency problems. For example, the power outage rate of fossil-fuel power plants is about 8%, whereas the outage rate of modern

wind turbines is about 2%.<sup>53</sup> Power outages from conventional energy may cost the U.S. economy as much as \$80 billion a year.<sup>54</sup> Fossil fuel supply lines are also vulnerable to political instability as has been witnessed in Nigeria, where internal turmoil has decreased oil production by 20%.<sup>55</sup> Decreased oil production raises prices, which further limits access to fossil fuel resources. Indeed, regional and international conflicts have helped drive oil prices to record levels, and any interruption in supply could push them even higher.<sup>56</sup>

Even the perceived possibility of a dip in supply can dramatically increase oil prices, as was recently demonstrated by a failed terrorist attack on a Saudi Arabian petroleum facility.<sup>57</sup> An actual oil shortage, even a temporary one, would have long-lasting effects on the global economy. One study conducted in 2005 predicted that a mere 4% drop in daily global oil supplies would push the price of oil above \$160 a barrel, more than twice the current (May 2006) levels.<sup>58</sup> If energy prices persisted at that level for a sustained period, a global recession would likely ensue, slowing or halting everything from manufacturing and trade to modern agriculture, which relies on petroleum for fertilizers, pesticides and herbicides, not to mention tractors and delivery trucks.<sup>59</sup>

**A MERE 4% DROP IN DAILY GLOBAL OIL SUPPLIES WOULD PUSH THE PRICE OF OIL ABOVE \$160 A BARREL**

But temporary energy shortages are still a lesser concern when compared to the larger problem of what could be called “perpetual intermittency” – the point at which demand for conventional energy sources irreversibly outstrips their availability. Most

geologists agree that the world’s oil production will “peak” in the very near future, after which global supply will be unable to keep up with demand.<sup>60</sup> Others believe that global production has already peaked, or that it is happening at this very moment. Regardless of specific timing, the realization of this peak will have unprecedented and devastating economic, political, and social consequences.<sup>61</sup> Without a rapid transition away from petroleum dependence, a sustained global energy crisis could trigger bloody resource wars over access to remaining fossil fuel reserves.

Some analysts have suggested that nuclear energy could compensate in part for a reduction in fossil fuel consumption. This is an unrealistic view because viable uranium resources are also limited and may be depleted as soon as fifty years from now.<sup>62</sup> However, there has yet to be a weather forecast predicting the imminent disappearance of the sun, wind, or tides. Switching to reliable, clean, abundant and sustainable sources of energy now can help avert the collision for which the world is now headed while assuring economic and political stability for future generations.

## **HYDROGEN: THE KEY TO SUSTAINABLE TRANSPORTATION**

In addition to solving the problem of intermittency, hydrogen offers tremendous benefits to the transportation sector. Hydrogen fuel is suitable for vehicles in the same way that it can be used as a backup for sustainable electricity generators. A recent U.S. Department of Energy (DOE) report asserts that by 2030, “wind- and solar-based hydrogen systems...can produce enough hydrogen to virtually eliminate petroleum energy use and greenhouse gas emissions from the light-duty transportation sector.”<sup>63</sup> One area that shows promise for sustainable hydrogen generation is wind-rich northeastern Spain, where “hydrogen production for transportation is now considered as an alternative to costly grid reinforcements, as a way of exploiting the [region’s] vast wind resources.”<sup>64</sup> Scotland, Ireland, and North Dakota are also considered desirable locations for wind-based hydrogen production.<sup>65</sup>

**FUEL CELLS OPERATE AT A 60% EFFICIENCY RATE, MAKING THEM TWO TO THREE TIMES AS EFFICIENT AS INTERNAL COMBUSTION ENGINES**

Hydrogen fuel is preferable to fossil fuels not only because of its abundance but also because it mitigates the GHG’s burden produced by the current carbon-based transportation system. Even with water as its source, producing hydrogen fuel for an American light-duty fuel cell vehicle (FCV) fleet would consume about the same amount of water that is currently used to produce conventional gasoline.<sup>66</sup> In addition, water is already a part of the Earth’s existing hydrologic cycle, and any water that is split to produce hydrogen will be returned to that cycle in the form of fuel cell water vapor emissions. Hydrogen fueled FCV’s are valuable because they produce zero GHG emissions. Current transportation methods are responsible for 27% of America’s GHG emissions<sup>67</sup> and 14% of GHG emissions worldwide.<sup>68</sup> Fuel cells operate at a 60% efficiency rate, making them two to three times as efficient as gasoline-powered engines.<sup>69</sup> Cars running on hydrogen can travel several times farther on a gallon-equivalent of hydrogen than a gallon of gasoline.<sup>70</sup> Manufacturers are consistently improving the distances that FCV’s can go without refueling, and some prototypes can travel as far as 300 miles before refueling.<sup>71</sup> In addition to these benefits, fuel cells make less noise and require less maintenance than internal combustion engines.

The fastest way to establish hydrogen transportation is to mass market hydrogen to the public. According to Pete Pithers of Ford Motors, “it’s not a question of what the fuel is in the future; it’s a question of the pace of change.”<sup>72</sup> Installing hydrogen fuel pumps at gas stations around the nation can significantly accelerate this pace. This process is already under way in California’s Vision 2010 project which will create a preliminary network of 150-200 hydrogen fuel stations, making it available to the majority of Californians by the end of the decade.<sup>73</sup>

**ICELAND COULD SOON BECOME THE FIRST HYDROGEN SOCIETY IN THE WORLD, ACHIEVING A COMPLETE SWITCH FROM FOSSIL FUELS TO GREEN HYDROGEN BY 2050**

Other governments are taking action to promote hydrogen vehicle use. In preparation for the Winter Olympics, Canada plans to build a Hydrogen Highway in British Columbia by 2010.<sup>74</sup> The European Union is working to develop a hydrogen infrastructure as well, and is conducting preliminary demonstrations under the auspices of the Zero Regio program in Frankfurt, Germany and Mantova, Italy. HyWays – an integrated project co-funded by research institutes, industry, national agencies and the European Commission – predicts that hydrogen vehicles could represent between 40% and 74.5% of the region’s fleet by 2050.<sup>75</sup> A study commissioned by the Germany-based Linde Group estimated that the infrastructure could be established to make hydrogen fuel for motor traffic available to a third of the continent’s population by 2020.<sup>76</sup>

In preparation for the switch to hydrogen, every major car manufacturer is either developing or beginning to deploy a line of hydrogen vehicles. The following are but a few examples:

- Honda has recently announced that it will have a commercially available hydrogen FCV’s by 2010<sup>77</sup> and has already leased an FCV to a family in California.<sup>78</sup>
- In February 2006 Mazda began leasing “dual-fuel” rotary engine vehicles (which can run on either gasoline or hydrogen fuel) to corporate clients in Japan.<sup>79</sup>
- In April 2006 DaimlerChrysler, which has the world’s largest fleet of FCV’s, debuted the world’s first FCV police car in Michigan.<sup>80</sup>

Hydrogen is quickly gaining popularity in other sectors as well. One country that has made significant progress towards advancing a fossil-fuel free economy is Iceland. Having overcome its reliance on unsustainable sources for non-transportation energy, the government of Iceland has now endorsed moving “towards a carbon-free future in which indigenous renewable energy will replace fossil fuels as far as possible.”<sup>81</sup> Icelandic New Energy – a public-private partnership for hydrogen research projects and the advancement of an hydrogen economy in Iceland – believes that Iceland could soon become “the first hydrogen society in the world,”<sup>82</sup> achieving a complete switch from fossil fuels to hydrogen produced by geothermal and hydropower energy sources by 2050.<sup>83</sup> A preliminary step in this ambitious project was the deployment of hydrogen fuel cell buses (FCB’s) in Reykjavik under the ECTOS program in 2003.<sup>84</sup> The FCBs were well received by bus drivers and the general public, and are now a part of the Europe-wide CUTE program, which has FCB’s in nine cities across Europe.<sup>85</sup> Hydrogen FCB’s are also being deployed in Australia, Japan, and China. FCBs have also been highlighted as part of China’s “Green Olympics” program for the 2008 Summer Games in Beijing.<sup>86</sup>

**CHINA IS INCLUDING FUEL CELL BUSES AS PART OF OF ITS GREEN OLYMPICS PROGRAM FOR THE 2008 GAMES IN BEIJING**

Hydrogen is making major strides beyond road transportation. Icelandic New Energy, for example, began the H-Ship project starting in February 2004 to test the viability for fuel cells in the shipping industry. Hydrogen fuel for

ships is especially significant for Iceland, an island nation with a massive fishing industry, heavily reliant on ships to keep its economy afloat. Japan, already the world leader in solar PV production, is making significant advances in hydrogen as well, and expects to have a hybrid fuel cell train in operation by the end of 2007.<sup>87</sup> Hydrogen is also a viable fuel for air travel and the fuel of choice for space exploration – NASA has been using it to power its space shuttles, using the steam as drinking water for the crew.

Sustainable energy is also a better alternative to industrial biofuel, “clean” coal, and nuclear energy. Proponents of these sources argue that they can improve environmental conditions, increase energy supply, and slash the rising cost of energy. However, these energy sources are unsustainable, environmentally destructive, and a threat to human security. Resources invested in these technologies divert valuable and

finite resources that can be applied in the development and promotion of sustainable energies. This is especially true in light of the genuinely sustainable alternatives that are readily available.

## **BIOFUEL, COAL, AND NUCLEAR ENERGY: UNSUSTAINABLE DEAD ENDS**

### **Industrial Biofuel – Factory Farming for Energy**

Biofuel is defined as recently living matter that has been converted to fuel for uses such as cooking, heating, and transportation. Biofuels are a primary source of domestic energy for three billion people, often in rural regions in the developing world.<sup>88</sup> When burned indoors for heating and cooking, biofuels cause severe health problems. An estimated 80% of all global exposure to airborne particulates occurs indoors in developing countries, contributing to diseases such as cancer, acute respiratory infections, asthma, tuberculosis, cataracts, blindness, and low birth weight.<sup>89</sup>

In developed countries, biofuels are being promoted by politicians and the industrial agricultural sector for their potential to supplement gasoline and diesel with a lower environmental impact than fossil fuels. U.S. refiners, for example, anticipate doubling their use of corn-based ethanol to eight billion gallons a year by 2012.<sup>90</sup> The European Union is moving in a similar direction, and hopes to ultimately meet 20% of its fuel needs for road transportation using biomass.<sup>91</sup>

Unfortunately, unconstrained industrial biofuel production will produce dire consequences for the natural environment. One concern is that the limited availability of the world's arable land means that biofuel feedstock may take priority over food crops.<sup>92</sup> In addition, conventionally grown crops depend heavily on pesticides as well as petroleum-based fertilizers. Among other problems, the runoff from these additives contributes to the expansion of so-called "dead zones" – aquatic areas so polluted with nitrates and industrial waste that they cannot support life. Increasing industrialized agricultural processes for biofuel would only exacerbate this problem. Additionally, significant expansion of biofuel feedstock production may cause widespread deforestation in regions such as South East Asia. The Malaysian government, for example, intends to develop 3 million hectares of new oil palm plantations by 2011 to meet the increasing global demand for bio-fuel,<sup>93</sup> even though oil palm production is responsible for an estimated 87% of the deforestation in Malaysia from 1985 to 2000.<sup>94</sup> In addition to decreasing biodiversity, deforestation limits the planet's ability to absorb CO<sub>2</sub> from the atmosphere, undermining one of the main justifications for using biofuels in the first place.<sup>95</sup>

### **Coal – Carbon Will Always Pollute**

Coal's industry advocates have suggested that it can be made more environmentally friendly by increasing production efficiency as well as through carbon sequestering: capturing and storing coal's carbon emissions before they enter the atmosphere. They propose many ways for containing the carbon, including storage of the gas in large underground reservoirs or even in reservoirs under the ocean. If successful, proponents assert, geologic sequestration can mitigate coal's contribution to climate change. Yet, even supporters of carbon sequestration concede that underground storage may be dangerous because leaks in underground storage containers could lead to water displacement, groundwater contamination, or even human asphyxiation.<sup>96</sup> Furthermore, the tremendous amount of carbon involved means that this type of sequestration would require upwards of hundreds or even thousands of years before any carbon could be released.<sup>97</sup> The additional energy required for carbon sequestration could also accelerate coal consumption, hampering the reduction of carbon emissions through long-term sustainable solutions.

Besides carbon emissions, coal mining and burning causes other significant damages to land, groundwater, local ecosystems and human health. Coal mining, particularly mountain top removal, has proven to result in catastrophic environmental effects. In West Virginia, coal producers are blowing up hilltops to access coal seams, dumping the leftover rock and dirt into nearby valleys. With mountain top removal, hundreds of feet of dirt, plants, and rock above the coal seam are blasted off and dumped over the side of the mountain, smothering streams, polluting the air, and eroding the soils. One study by five government agencies calculated that mountain top removal in the Appalachian coalfields has resulted in 724 miles of streams buried and thousands of acres of destroyed forests.<sup>98</sup> Coal-fired electric power plants are the largest source of human-caused mercury air emissions in the U.S., accounting for about 40% mercury emissions in the country.<sup>99</sup> The EPA warns that neurological abnormalities from mercury exposure include deficiencies in memory, attention, language, movement and cerebral palsy.<sup>100</sup> A study by the Centers for Disease Control and Prevention found that 8% of women had mercury blood levels exceeding the level deemed safe for unborn children.<sup>101</sup>

## Nuclear – Never Far from a Disaster

Nuclear power is being promoted for its potential to decrease GHG's production. A leading industry group has even asserted that nuclear energy can produce electricity, "without polluting the environment."<sup>102</sup> However, nuclear power is not pollution nor emissions free. Every step of the nuclear fuel cycle – mining, development, production, transportation and disposal of waste – relies on fossil fuels and produces GHG emissions. A complete life-cycle analysis shows that generating electricity from nuclear power emits 20-40% of the carbon dioxide per kilowatt hour (kWh) of a gas-fired system when the whole system is taken into account.<sup>103</sup>

Nuclear power is the slowest and costliest way to reduce CO<sub>2</sub> emissions, as financing nuclear power diverts scarce resources from investments in renewable energy and energy efficiency. The enormous costs of nuclear power per unit of carbon emissions reduced would actually worsen our ability to abate climate change as we would be buying less carbon-free energy per dollar spent on nuclear power compared to the emissions we would save by investing those dollars in solar, wind or energy efficiency.<sup>104</sup> According to a Massachusetts Institute of Technology study on the future of nuclear power, 1500 new nuclear reactors would have to be constructed worldwide by mid-century for nuclear power to have a modest impact on the reduction of GHG's.<sup>105</sup> In addition, nuclear power's role in mitigating climate change (and in reducing oil dependence) is further constrained because its impact is limited to the production of electricity.

Nuclear power plants generate toxic radioactive waste that threatens both human life and the natural environment. To date, the United States alone has produced more than 80,000 tons of highly radioactive waste for which there is no suitable storage location.<sup>106</sup> This waste will remain lethal to human health and the environment for more than 250,000 years, and its continued production poses an unacceptable burden on present and future generations. Nuclear reactors also emit contaminated water and steam as part of daily routine operations. Numerous nuclear power plants have been leaking radioactive toxins into groundwater and soil.<sup>107</sup> Radiation has been proven to cause cancer, various immune deficiencies, infant mortality and chromosomal mutations. While the National Regulatory Commission (NRC) sanctions the radioactive content of these routine releases, the National Academy of Sciences concluded that there is no "safe" level of radiation exposure."<sup>108</sup>

The nuclear power industry has already demonstrated that it is unable to compete in a liberalized electricity market. Despite the tens of billions of dollars that the nuclear industry has received since its inception in 1948, it is still unable to operate without massive subsidies, tax breaks and incentives. In the U.S., the 2005 Energy Bill allocated over \$13 billion in direct and indirect subsidies for the nuclear industry, mostly geared towards research and development of new reactor technologies.<sup>109</sup> The U.S. nuclear industry is estimated to have received more than \$115 billion in direct subsidies from 1947 through 1999. Government subsidies for wind and solar energy for the same period totaled only \$5.49 billion.<sup>110</sup>

It is also important to note that nuclear power construction cost estimates have been notoriously inaccurate in the past. In fact, the estimated costs of some existing nuclear units in the U.S. were frequently wrong by factors of two or more. Data provided by the DOE reveals that the total estimated cost of 75 of today's existing nuclear units was \$45 billion (in 1990 dollars).<sup>111</sup> The actual costs turned out to be \$145 billion (also in 1990 dollars). The estimated cost of \$1,500 - \$2,000 per KW for the new generation of nuclear plants is extremely optimistic and unlikely to be achieved as evidenced by the prices of recently built nuclear power plants in Japan, which were much higher, ranging between \$1,796 and \$2,827 per KW (2003 US dollars).<sup>112</sup>

Nuclear power plants present unique security and safety threats. Nuclear storage facilities and power plants themselves are vulnerable to accidents or attacks, and there are similar hazards in transporting nuclear waste by truck, train or ship. A recent report estimates that the Chernobyl disaster may ultimately cause 270,000 cases of cancer, of which 93,000 could be fatal.<sup>113</sup> There is also concern regarding terrorist or wartime attacks for which there is little defense, as "mock attacks" carried out by the NRC against nuclear power plants from 2000-2001 were successful in nearly half of the tests performed.<sup>114</sup> A terrorist or military attack resulting in a core meltdown would carry a disastrous human toll, with estimates of upwards of 15,000 acute radiation deaths and up to one million deaths from cancer.<sup>115</sup> And in a much less hypothetical example, the Indian Point nuclear reactors, located some 30 miles from New York City, were listed as suggested targets in documents found from Al-Qaeda after the World Trade Center attacks.

In addition, the nuclear fuel cycle involves numerous byproducts and processes that can also be utilized for weapons purposes, literally making every nuclear power plant a potential nuclear bomb factory.<sup>116</sup>

Indeed, civilian nuclear programs in Israel, India, and Pakistan, enabled each of those countries to covertly develop nuclear weapons as a result of their “peaceful” nuclear energy programs. International Atomic Energy Agency (IAEA) Director Mohammed El-Baradei paints an even grimmer picture, saying, “We just cannot continue business as usual...we are really talking about 30, 40 countries sitting on the fence with a nuclear weapons capability that could be converted into a nuclear weapon in a matter of months.”<sup>117</sup> Currently, Iran’s assertion of its right under the Nuclear Non-Proliferation Treaty to uranium enrichment capabilities is raising international concerns as the same technologies used for the production of nuclear power can be used to produce nuclear weapons. The recent proposal to create a Global Nuclear Energy Partnership to reprocess the used nuclear fuel and create an international network of nuclear fuel and technology transfer would further increase current proliferation risks. Reprocessing nuclear spent fuel would be a dangerous shift in global nonproliferation policy and would increase the likelihood that fissile material could be stolen to build a nuclear bomb.

According to a recent report by the U.K. government’s advisory panel, the Sustainable Development Commission, the risks associated with nuclear power greatly outweigh its minimal contribution to reducing CO<sub>2</sub> emissions. The report identifies major disadvantages of nuclear power, including lack of a long-term solution to storage of radioactive waste, high cost uncertainties, unjustified subsidies and the burden placed on taxpayers to cover escalating costs, as well as international security and proliferation risks. The report further concludes that, because of these enormous disadvantages, nuclear power is not the answer to climate change.<sup>118</sup>

When compounded with its limited ability to reduce GHG’s compared to the reductions that could be achieved by using the same dollars for sustainable energy, the enormous proliferation and waste-related issues make nuclear energy an untenable and irrational energy choice.

## **SUSTAINABLE ENERGY: GOOD CHOICE FOR THE ECONOMY**

Consumers, politicians, workers, and business leaders are increasingly appreciating that the decision between economic growth and environmental sustainability is truly a false choice. Dollar for dollar, the economic rewards from sustainable energy investments continue to outpace those from conventional energy sources. A recent study conducted at the University of California at Berkeley confirmed that sustainable energy sources provide more jobs “per MW of power installed, per unit of energy produced, and per dollar investment than the fossil fuel-based energy sector.”<sup>119</sup> At the same time, sustainable energy is becoming more affordable to end-users and is attracting the attention of financial institutions and investors who are

incorporating sustainable energy projects into their portfolios.

**DOLLAR FOR DOLLAR, THE ECONOMIC REWARDS FROM SUSTAINABLE ENERGY INVESTMENTS OUTPACE THOSE FROM CONVENTIONAL ENERGY SOURCES**

Across the board, the sustainable energy sector is experiencing virtually unprecedented financial success. Currently a \$2.5 billion industry, solar PV is projected to grow an average of almost 20% a year through 2020.<sup>120</sup> Wind energy is also booming, with

a record-setting \$3 billion worth of new equipment installed in the U.S. alone last year.<sup>121</sup> Some forecasts anticipate that solar and wind energy will each constitute a \$40 billion to \$50 billion industry by 2014.<sup>122</sup> Already a \$1.5 billion industry in its own right, geothermal energy may grow by up to 15% annually in some sectors, and the DOE predicts that foreign governments will spend as much as \$40 billion from 2003 to 2023 to build geothermal energy plants.<sup>123</sup>

The sustainable energy sector promises to boost the American and international job market just as many manufacturers and energy providers are outsourcing or downsizing their workforces. The Union of Concerned Scientists estimates that 355,000 new jobs in American manufacturing, construction, operation, maintenance, and other industries can be created if the United States obtained 20% of its energy from sustainable sources by 2020.<sup>124</sup> Solar power alone is expected to provide more than 150,000 U.S. jobs by 2020.<sup>125</sup> The Breakthrough Technologies Institute estimates that the hydrogen fuel cell industry could create up to 189,000 jobs in direct and indirect employment by 2021.<sup>126</sup> Germany now employs 170,000 people in its sustainable energy sector, and substantial future growth is anticipated.<sup>127</sup> On a global scale, over 1.7 million people are already directly employed in sustainable energy manufacturing, technology, and maintenance, with indirect employment believed to be several times higher.<sup>128</sup>

Jobs in the sustainable energy sector are also more cost-efficient than their conventional counterparts. Wind energy, for example, can produce upwards of five times as many jobs and more than twice the energy of nuclear at an equal investment.<sup>129</sup> Meanwhile, the United States oil industry lost 40% of its refining jobs between 1980 and 1999, and the American coal industry, where employment dropped 66% during the same period, expects to lose an additional 36,000 jobs by 2020.<sup>130</sup>

**SUSTAINABLE ENERGY SOURCES PROVIDE MORE JOBS PER MW OF POWER INSTALLED, PER UNIT OF ENERGY PRODUCED, AND PER DOLLAR INVESTMENT THAN THE FOSSIL FUEL-BASED ENERGY SECTOR**

The United States will have to reinvigorate its financial commitment to sustainable energy technologies in order to stay competitive in the global marketplace. In recent years, the U.S. has fallen behind in industries such as solar PV manufacturing, where many new solar-related jobs are being created. Although some international PV companies have manufacturing plants in the U.S., only one of the world's top ten PV manufacturers in 2002 was an American company, and in 2003 the United States produced less than half the number of PV modules as the world leader, Japan.<sup>131</sup> Indeed, a 2003 report on the U.S. photovoltaic industry warns that, "If we do not rise to the challenge of reestablishing a leadership position, then our domestic PV industry...will continue to lose technology leadership, market share, jobs, and revenues."<sup>132</sup>

Sustainable energy can provide major benefits to consumers. As the prices of oil and natural gas skyrocket, sustainable energy resources are becoming increasingly cost-competitive with conventional energy. It is true that many sustainable energy generators are capital-intensive to install. However, this is moderated by the fact that their "fuel" is abundant, free, and more environmentally friendly than conventional sources. In addition, technological advances, government incentives, and the development of economies of scale, are all contributing to falling costs for sustainable energy end-users. The cost of solar PV, for example, has gone down 90% since the 1970's, bringing solar energy increasingly closer to cost-competitiveness with conventional fuels.<sup>133</sup> This trend can be expected to continue, as it has been estimated that "for every doubling in cumulative production the cost has dropped to 80% of the previous cost."<sup>134</sup> In addition, recently developed technology means that thinner, cheaper PV cells with up to 16% efficiency rates may soon achieve the "breakthrough" cost that the Energy Foundation has cited as essential to establishing PV's widespread use.<sup>135</sup> Geothermal energy is becoming more affordable as well, with generating costs decreasing by 25% over the last 20 years.<sup>136</sup> Indeed, the use of geothermal energy in Iceland may have saved consumers \$3.5 billion from 1970 to 2000.<sup>137</sup> The cost of marine current energy could fall by 30% if deployed on a larger scale.<sup>138</sup> In some regions, wind energy is already cost-competitive with conventional sources and will become even more affordable, as the IEA predicts up to a 25% cost reduction for wind power from 2001 to 2020.<sup>139</sup> This is no doubt aided by the fact that, "the winds over possibly one quarter of the U.S. are strong enough to provide electric power at a direct cost equal to that of a new natural gas or coal power plant."<sup>140</sup> Indeed, for part of 2005, utility customers in Texas and Colorado paid more for conventionally produced electricity than for wind-generated electricity, partly due to long-term, fixed-rate contracts with utility providers.<sup>141</sup>

**WIND ENERGY CAN PRODUCE UPWARDS OF FIVE TIMES AS MANY JOBS AND MORE THAN TWICE THE ENERGY OF NUCLEAR AT AN EQUAL INVESTMENT**

Hydrogen fuel could also be introduced into the marketplace at prices that rival fossil fuels. High gasoline taxes, combined with hydrogen's greater efficiency, mean that, "hydrogen could already be competitive [in Europe] today."<sup>142</sup> A 2004 study by the Hawaii Natural Energy Institute concluded that hydrogen produced from geothermal energy

is competitive with gasoline, and that "hydrogen can be a competitive transportation fuel in Hawaii by the end of the decade."<sup>143</sup> Hydrogen will become even more affordable as the cost of electrolyzers decreases, and the cost of implementing a hydrogen fuel infrastructure is also believed to be lower than previously thought. According to the Linde Group study, the infrastructure for a Hydrogen Highway could make hydrogen available to a third of Europe's citizens by 2020 for as little as €3.5 billion (US \$4.2 billion).<sup>144</sup>

## **SOUND POLICIES TO FAST-TRACK SUSTAINABLE ENERGY**

In spite of numerous advances, sustainable energy still faces the challenge of becoming more cost-competitive with conventional sources. The “Catch 22 element at work,” according to Peter Fraenkel of Marine Current Turbines Ltd., is that marine and other sustainable energy sources become affordable “once they are perfected and then deployed on a large scale...but while costs and risks are high there is no incentive for large-scale deployment.”<sup>145</sup> Thus, governments must get “ahead of the curve” by enacting policies that more accurately reflect the true costs and benefits of both conventional and sustainable energy sources. Public leadership will provide a further incentive for the business sector, which might otherwise hesitate to embrace sustainable energy technologies.

One effective mechanism to spur the sustainable energy industry is the introduction of Renewable Portfolio Standards (RPS), which mandate that a certain percentage of a state or utility’s energy be derived from sustainable sources. The RPS’s and other purchase mandates that already affect 35% of the U.S. electricity load and 18 states (plus the District of Columbia), have been cited as a contributing factor to the introduction of approximately 2,000 MW of renewable energy, as well as 50% of the wind energy that was introduced in the U.S. between 2001 and 2005.<sup>146</sup> If implemented at the federal level, these standards could have an even greater impact. RPS’s, however, should include only energies derived from sustainable sources. Another successful incentive in this regard has been net metering, which offers small-scale energy producers a significant savings by allowing them to sell their surplus energy back to the grid. As of January 2006, some form of net metering was being offered in most of the fifty United States.<sup>147</sup> Indeed, net metering in conjunction with other incentives has already helped make solar electricity competitive with some utility-delivered power in California.<sup>148</sup>

Measures such as technology procurement, tradable certificate programs, increased funding of sustainable energy production, development of codes and standards, and simplification of the permitting process are important measures to remove the roadblocks that currently impede the faster development of sustainable energies.

Importantly, promoting a more efficient use of energy is one of the cheapest and fastest ways to move towards a sustainable energy future. According to the DOE, improving building energy efficiency by 30% could reduce consumer costs in the U.S. by \$38 billion over a 15 year period.<sup>149</sup> Such measures would greatly reduce GHG emissions and cut down fossil fuel imports. Energy efficiency measures (including building energy designs and technologies, energy use regulations, fuel economy standards, appliance efficiency standards, and efficiency performance targets) should therefore be at the forefront of sound policy for sustainable energy.

## **OBSTACLES TO A SUSTAINABLE ENERGY ECONOMY**

### **Subsidies and Incentives**

Although some business and governmental initiatives have met with great success in promoting sustainable energy practices, the dominant political culture still favors outdated 20<sup>th</sup> century means of energy production. A leading petrochemical industry organization recently asserted that the most effective way to ensure a reliable, affordable supply of gasoline is to encourage “continued reliance on market mechanisms, not price regulation or other actions that interfere with and distort the market realities that both refiners and consumers must face.”<sup>150</sup> Yet market distortions - such as subsidies and the failure to account for the true societal cost of conventional energy - have unjustly benefited the nuclear and fossil fuel industries for decades. Worldwide, conventional energy sources received approximately \$250 billion in 2003 in government subsidies,<sup>151</sup> for example, while combined U.S. and European government support for renewable energy totaled just \$10 billion the following year.<sup>152</sup> Even the World Bank, which has gone to great lengths in recent years to recast itself as a “green” financial institution, allotted just 9% of its energy financing last year to sustainable projects.<sup>153</sup> According to the United Nations Development Program, the unfair advantages afforded to unsustainable energy, “discourage new entrants into the market and undermine the pursuit of energy efficiency.”<sup>154</sup>

Subsidies, incentives, and other forms of assistance are the economic lifeblood of the nuclear industry. Indeed, nuclear power receives 61% of the European Union’s energy-related research and development funding even though it contributes only 13% of the region’s energy.<sup>155</sup> In addition, the unacceptably high

cost of insurance, waste removal and storage, and decommissioning would make nuclear energy completely untenable in a truly equalized marketplace. Yet the American nuclear industry has been shielded from this reality by measures such as the Price-Anderson Act of 1957, which protects it from full liability in the case of an accident. Under Price-Anderson, each commercial nuclear reactor is required to carry only \$200 million in primary insurance, with the industry's total liability coming in at about \$10 billion while shifting the remaining financial obligation to the taxpayer.<sup>156</sup> In the event of a core meltdown, however, the economic damage could total trillions of dollars.<sup>157</sup> Also not considered are costs of nuclear power plant decommissioning, expected to reach well over \$50 billion, for which the industry had secured less than half of the necessary funding as of 2000.<sup>158</sup> These subsidies remained in place despite the fact that the nuclear power sector is now a mature industry.

**GLOBAL ANNUAL SUBSIDIES FOR CONVENTIONAL ENERGIES TOTAL SOME \$250 BILLION**

The fossil fuel industry has also thrived from disproportionate market incentives. One such example is a Clinton-era initiative that gave royalty relief to oil companies conducting deepwater oil and gas drilling on federal lands when gas prices were low. Yet with oil prices nearing record highs, the Deep Water Royalty Relief Act will allow oil and gas companies to avoid royalty payments on over \$65 billion worth of revenues for the next five years. This could cost taxpayers approximately \$9.5 billion over that period with losses to the treasury over 25 years at approximately \$20 billion.<sup>159</sup> The U.S. 2005 Energy Bill has also provided royalty relief, tax breaks and other incentives for the oil, gas, coal and nuclear industries, which have been estimated at \$27 billion.<sup>160</sup> The oil industry has responded in kind, having spent almost \$190 million in U.S. campaign contributions since 1989.<sup>161</sup> Fossil fuels receive indirect subsidies as well, often in the form of military support to maintain secure oil supply lines. Indeed, the United States spends more than \$50 billion a year maintaining troop readiness to intervene in the Persian Gulf during peacetime.<sup>162</sup> That sum alone does not account for the enormous costs of war often driven by a need to secure energy resources.

Even some policies that appear to promote sustainable energy ultimately undermine its progress. At a recent speech to the Renewable Fuels Association, President Bush asserted that, "energy companies need to reinvest [their] cash flows into...researching alternative energy sources, or developing new technologies, or expanding production in environmentally friendly ways."<sup>163</sup> Yet the President's own hydrogen fuel initiative, the \$1.2 billion Freedom Car program, is expected to derive 90% of its hydrogen from fossil fuels, with the remaining 10% coming from nuclear energy sources.<sup>164</sup> This approach severely undercuts any significant gains in energy independence and environmental protection that would come from using green hydrogen fuel.

## Unaccounted Costs: Externalities

In addition to the assistance they receive through subsidies, unsustainable energy sources are misleadingly under-priced because their market values do not account for the toll they take on human health and the environment. These costs are paid by society at large and include, but are not limited to, environmental costs associated with ecological disasters, air pollution, and climate change, and also health costs, productivity costs and social costs. Because these costs are not taken into account in the calculations of the price of energy, economists call them "externalities." The calculation of external costs is not a simple task because

**IF EXTERNALITIES WERE INCLUDED IN PETROLEUM-BASED ELECTRICITY PRICES, THEIR COST WOULD DOUBLE, IMMEDIATELY MAKING SUSTAINABLE ENERGY MORE COST-COMPETITIVE**

of the uncertainties and assumptions involved. But as noted elsewhere, "...not to incorporate externalities in prices is to implicitly assign a value of zero, a number that is demonstrably wrong."<sup>165</sup>

Even without quantifying the risks from radioactive waste or weapons proliferation, for example, nuclear energy produces up to \$2.7 billion a year in external costs in the EU-15 countries alone.<sup>166</sup> A recent study calculated that 75,000 American lives could be extended each year with a decrease in the soot and particulates that pollute our cities' air.<sup>167</sup> The rewards could be even greater for cities such as Bombay, India, where just breathing the air has been compared to smoking more than two packs of cigarettes a day.<sup>168</sup> In 1999, the real cost of gasoline was estimated to lie between \$5.60 and \$15.14 per gallon, when the price at the pump was barely more than a dollar per gallon.<sup>169</sup>

Similarly, consumers often pay higher prices for sustainable energy because the ecological benefits it provides are unaccounted for. The IEA considers these “unrewarded environmental characteristics” to be the principal barrier to increasing the market share for sustainable energy.<sup>170</sup> Though the immense advantages of sustainable energy are difficult to quantify, monetizing the costs and benefits of sustainable and unsustainable energies is indispensable to understanding their comparative prices. A study in the journal *Nature*, for example, puts the total value of the world’s ecosystem services at an average of \$36 trillion a year.<sup>171</sup> Another study concluded that if externalities were included in petroleum-based electricity prices, their cost would double, immediately making sustainable energy more cost-competitive.<sup>172</sup> The European Wind Energy Association estimates that when external costs are accounted for, electricity produced using gas and coal carries a total social cost up to twice that of wind.<sup>173</sup> Despite the difficulty of calculating the costs, it is clear that understanding the penalty society pays for unsustainable energies is an essential part of the rapid transition away from reliance on those sources.

## **CONCLUSION: DEMOCRACY AND STABILITY AT HOME AND ABROAD**

Though much work remains in the realm of energy policy, little action needs to be taken to convince the world’s citizens of sustainable energy’s power and promise. In a 2000 survey, 76% of respondents from 27 countries agreed with the statement that human beings should “coexist with nature” rather than “master nature.”<sup>174</sup> Europeans believe that sustainable energy more than any other energy source will be affordable, efficient, and environmentally sound in the next fifty years.<sup>175</sup> Americans agree, with more than 85% supporting greater funding for sustainable energy research and development, and only a third in favor of reducing foreign oil dependence through drilling in the Alaska National Wildlife Refuge (36%), building more coal-burning electric plants (33%), or constructing new nuclear power plants (36%).<sup>176</sup>

Switching to sustainable energy would have an added benefit of promoting democratic values and the international aspirations embodied in the United Nations. Most conventional energy sources are centrally controlled, produced, and distributed, leaving many consumers with few choices regarding where their energy comes from or how it is produced. Sustainable energy, however, can be decentralized to allow end-users greater freedom in deciding how their energy will be both produced and consumed. Governments can foster this dynamic by encouraging greater local control over energy-related decisions. In Denmark, for example, two-thirds of wind turbines are cooperatively owned. This has given local communities a direct stake in the projects’ success and increased their overall support.<sup>177</sup> Similarly, small-scale hydropower projects in Sri Lanka are often managed by Electricity Consumer Companies, where local decisions are made on issues ranging from setting tariffs, to end-uses, to resolving disputes between consumers.<sup>178</sup>

In addition to regional and national initiatives, the switch to sustainable energy must receive genuine support at the international level. Currently, there is no global institution to promote and implement a transition to a sustainable energy economy. For nearly fifty years, the International Atomic Energy Agency has promoted nuclear energy, while the International Energy Agency, established in 1974 during the OPEC oil crisis, is mandated to secure adequate supplies of fossil fuels. The establishment of an International Sustainable Energy Agency would address the critical need for a global commitment for a world-wide transformation to a 21<sup>st</sup> century safe, nuclear and carbon-free energy future.<sup>179</sup>

September 2000 bore witness to a rare moment of global unity when every member of the United Nations pledged to meet a set of eight Millennium Development Goals by the year 2015. Three of those goals bear repeating here:

- Eradicate extreme hunger and poverty
- Ensure environmental sustainability
- Develop a global partnership for development

Clearly, much work remains to be done. In the words of Secretary General Kofi Annan, “We will have time to reach the Millennium Development Goals...but only if we break with business as usual.”<sup>180</sup> The Millennium Goals are a demonstration of the possible, and they place a moral obligation in the hands of every citizen to demand environmentally responsible practices from their leaders and themselves. Politicians, businesspeople, diplomats, academics, workers, and activists, all share a common bond and a common responsibility to help realize these goals by supporting a rapid transition to plentiful sustainable energy. The barriers to this transition are not technological, but political. The failure to make this transformation would occur not from a want of possibility, but from a scarcity of democracy.

## Appendix

### INTERNATIONAL SUSTAINABLE ENERGY AGENCY PROPOSED MODEL STATUTE

#### SUMMARY OF PROPOSAL FOR AN INTERNATIONAL SUSTAINABLE ENERGY AGENCY (ISEA) SUBMITTED TO THE WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT

**OBJECTIVES:** The International Sustainable Energy Agency (ISEA) would seek to accelerate and enlarge the contribution worldwide of sustainable energy strategies, technologies, and applications for the purpose of achieving a sustainable quality of life for all, including

- equitable access to sustainable energy resources and development: to ensure equitable, decentralized availability and development of sustainable energy strategies and technologies, in order to drastically reduce and ultimately eliminate dependence on unsustainable forms of energy, such as costly and polluting imported fuels;
- poverty eradication: to provide sustainable energy resources to benefit development and the goal of poverty eradication in low-income areas in the world that currently lack adequate energy, especially in developing countries and countries with economies in transition;
- global security: to promote clean, safe, sustainable energies as a substitute for the world's precarious global reliance upon foreign sources of fossil and nuclear fuels and the costly protections they require, and to eliminate nuclear proliferation, which is inextricably linked to the process of nuclear power generation and waste production;
- climate protection: to significantly reduce emissions of greenhouse gases and to increase existing international commitments or targets for same;
- environmental and social protection: to significantly reduce non-greenhouse energy-related pollutants affecting air, water, and land, and concurrently, the health of affected peoples;
- technological innovation and dissemination: to promote the accelerated development and dissemination of sustainable energy industries and businesses for the 21st century.

**FUNCTIONS:** The United Nations General Assembly would authorize ISEA to:

1. assist member states in identifying, phasing out and ending all government production subsidies and all government consumption subsidies for unsustainable forms of energy, except for those targeted for low-income persons, and redirecting subsidies toward support of sustainable forms of energy, including 20% of such subsidies to support an International Sustainable Energy Agency;
2. assist member states in achieving the institutionalization of public participation by all major groups of civil society, as well as transparency, and information access, in all governmental energy policy decision-making and implementation;
3. assist intergovernmental entities in achieving the institutionalization of public participation by all major groups of civil society, as well as transparency and information access, in all intergovernmental energy policy decision-making and implementation;
4. assist member states and intergovernmental entities in identifying and utilizing national and international sustainable resources to promote energy conservation and diversification to sustainable forms of energy, for long-term energy security and social needs and economic development while protecting the environment locally, regionally, and globally; and specifically, to:
5. assist member states to meet targets for greenhouse gas reductions and energy conservation and efficiency goals in the Protocols to the Framework Convention on Climate Change and other international and regional agreements, as well those in national plans;
6. assist member states to conduct and stimulate research, development and deployment of sustainable energy strategies, technologies, and applications;
7. assist member states to integrate external costs, such as those of health, society and the environment, into energy policy and pricing decisions and regulations, and to compile and compare national energy policy and data among member states for energy policy and planning purposes;
8. assist member states to increase the commercial market penetration of sustainable energy technologies by integrating sustainable energy considerations into policy-making in major energy-consuming sectors of the economies of member states, such as transport, agriculture, industry, housing, etc.; and by addressing regulatory issues so as to allow markets to function in accordance with sustainable development objectives;
9. assist member states to facilitate the transfer of sustainable energy strategies, technologies and applications and increase capacity-building and the dissemination and exchange of information and expertise, by acting as a forum and clearinghouse for same;

10. assist member states to promote sustainable energy education and training at every level and in all sectors, and especially primary, secondary, university, adult, and consumer education programs; and create a pool of skilled sustainable energy managers and technologists through education and training programs in sustainable energy management;
11. assist member states to standardize norms for the manufacture of sustainable energy technologies and evaluate their efficiency and performance; and provide for the application of such norms to operations of the Agency as well as to member states under any bilateral or multi-lateral arrangements;
12. assist member states and intergovernmental entities to monitor sustainable energy projects and provide implementation reports based on the social, economic and environmental standards of sustainability; and serve as a repository for same; and
13. assist the further establishment of national and local Agenda 21s, including targets and timeframes, to serve as guiding documents in planning and implementing these functions;
14. create and administer a special ISEA sub-Agency comprising 50% of the income of ISEA, to support sustainable energy projects and incentives in low-income areas in developing countries and countries with economies in transition, and assist in identifying additional sources of public and private funding to attract investment to such areas; and
15. take additional actions to enhance regional and international cooperation in promotion of the objectives and functions described herein.

## NOTES

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