DOWNLOAD PDF HOW ENERGY AFFECTS THE ECONOMY

Chapter 1 : Energy Economy - Alternative Energy

Many people expect energy shortages to lead to high prices. This is based on their view of what "running out" of oil might do to the economy. In this post, I look at historical data surrounding inadequate energy supply. I also consider some of the physics associated with the situation. I see a.

What are the benefits of renewable energiesâ€"and how do they improve our health, environment, and economy? These gases act like a blanket, trapping heat. In the United States, about 29 percent of global warming emissions come from our electricity sector. Carbon dioxide CO2 is the most prevalent greenhouse gas, but other air pollutantsâ€"such as methaneâ€"also cause global warming. Different energy sources produce different amounts of these pollutants. To make comparisons easier, we use a carbon dioxide equivalent, or CO2eâ€"the amount of carbon dioxide required to produce an equivalent amount of warming. In contrast, most renewable energy sources produce little to no global warming emissions. The comparison becomes clear when you look at the numbers. Burning natural gas for electricity releases between 0. Different sources of energy produce different amounts of heat-trapping gases. As shown in this chart, renewable energies tend to have much lower emissions than other sources, such as natural gas or coal. Increasing the supply of renewable energy would allow us to replace carbon-intensive energy sources and significantly reduce US global warming emissions. For example, a UCS analysis found that a 25 percent by national renewable electricity standard would lower power plant CO2 emissions million metric tons annually by â€"the equivalent of the annual output from 70 typical MW new coal plants [4]. Improved public health The air and water pollution emitted by coal and natural gas plants is linked with breathing problems, neurological damage, heart attacks, cancer, premature death, and a host of other serious problems. The pollution affects everyone: Wind, solar, and hydroelectric systems generate electricity with no associated air pollution emissions. In addition, wind and solar energy require essentially no water to operate and thus do not pollute water resources or strain supplies by competing with agriculture, drinking water, or other important water needs. Biomass and geothermal power plants, like coal- and natural gas-fired power plants, may require water for cooling. Hydroelectric power plants can disrupt river ecosystems both upstream and downstream from the dam. A relatively small fraction of US electricity currently comes from these sources, but that could change: In fact, a major government-sponsored study found that clean energy could contribute somewhere between three and 80 times its levels, depending on assumptions [8]. And the previously mentioned NREL study found that renewable energy could comfortably provide up to 80 percent of US electricity by Jobs and other economic benefits Two energy workers installing solar panels. Solar panels need humans to install them; wind farms need technicians for maintenance. This means that, on average, more jobs are created for each unit of electricity generated from renewable sources than from fossil fuels. Renewable energy already supports thousands of jobs in the United States. In , the wind energy industry directly employed over , full-time-equivalent employees in a variety of capacities, including manufacturing, project development, construction and turbine installation, operations and maintenance, transportation and logistics, and financial, legal, and consulting services [10]. Other renewable energy technologies employ even more workers. The hydroelectric power industry employed approximately 66, people in [13]; the geothermal industry employed 5, people [14]. Increased support for renewable energy could create even more jobs. The Union of Concerned Scientists study of a percent-by renewable energy standard found that such a policy would create more than three times as many jobs more than , as producing an equivalent amount of electricity from fossil fuels [15]. In contrast, the entire coal industry employed , people in [26]. For example, industries in the renewable energy supply chain will benefit, and unrelated local businesses will benefit from increased household and business incomes [16]. Local governments also benefit from clean energy, most often in the form of property and income taxes and other payments from renewable energy project owners. Farmers and rural landowners can generate new sources of supplemental income by producing feedstocks for biomass power facilities. Stable energy prices Renewable energy is providing affordable electricity across the country right now, and can help stabilize energy prices in the future. As a result, renewable energy prices can be very stable over time. Moreover, the costs of renewable energy technologies have declined steadily, and are projected to drop even more. The cost of generating electricity from wind dropped 66 percent between and [21]. Costs will likely decline even further as markets mature and companies increasingly take advantage of economies of scale. In contrast, fossil fuel prices can vary dramatically and are prone to substantial price swings. For example, there was a rapid increase in US coal prices due to rising global demand before , then a rapid fall after when global demands declined [23]. Likewise, natural gas prices have fluctuated greatly since [25]. Coal news and markets report. Using more renewable energy can lower the prices of and demand for natural gas and coal by increasing competition and diversifying our energy supplies. And an increased reliance on renewable energy can help protect consumers when fossil fuel prices spike. Reliability and resilience Wind and solar are less prone to large-scale failure because they are distributed and modular. Distributed systems are spread out over a large geographical area, so a severe weather event in one location will not cut off power to an entire region. Modular systems are composed of numerous individual wind turbines or solar arrays. Even if some of the equipment in the system is damaged, the rest can typically continue to operate. For example, Hurricane Sandy damaged fossil fuel-dominated electric generation and distribution systems in New York and New Jersey and left millions of people without power. In contrast, renewable energy projects in the Northeast weathered Hurricane Sandy with minimal damage or disruption [25]. Water scarcity is another risk for non-renewable power plants. Coal, nuclear, and many natural gas plants depend on having sufficient water for cooling, which means that severe droughts and heat waves can put electricity generation at risk. Wind and solar photovoltaic systems do not require water to generate electricity and can operate reliably in conditions that may otherwise require closing a fossil fuel-powered plant. The risk of disruptive events will also increase in the future as droughts, heat waves, more intense storms, and increasingly severe wildfires become more frequent due to global warmingâ€”increasing the need for resilient, clean technologies.

Chapter 2 : The Positive Economic Effect of Solar Energy

Crops would fail, prices would rise, and the problem of low solar energy would affect both the natural world, and the economy consisting of businesses, governments, consumers, and financial.

Posted on August 27, by Gail Tverberg Many people expect energy shortages to lead to high prices. In this post, I look at historical data surrounding inadequate energy supply. I also consider some of the physics associated with the situation. I see a strange coincidence between when coal production peaked hit its maximum production before declining in the United Kingdom and when World War I broke out. There was an equally strange coincidence between when the highest quality coal peaked in Germany and when World War II broke out. Some of my previous analysis has shown that if we view energy in terms of average energy supply per person, the world as a whole may be again entering into a period of inadequate energy supply. My energy analysis considers the combined energy supply available per person from fossil fuels, nuclear, and renewables. It is not simply an oil-based analysis. If successful, the outcome might be analogous to the collapse of the central government of the Soviet Union in , after oil prices had been low for several years. The rest of the world benefitted from lower oil prices resulting from lower total demand. It also benefitted from the oil that remained in the ground and consequently was available for extraction in recent years, when we really needed it. The idea that oil prices can rise very high seems to be based on the oil price increases of the s and of the early s. While oil prices can temporarily rise very high, it is hard to make a case that they can remain high for an extended period. For one thing, high oil prices tend to cause recessions and lower employment. In such an environment, affordability of energy products is lower, and oil prices tend to fall. For another, it is easy for the Federal Reserve to get oil prices back down by raising interest rates. In fact, the Federal Reserve is raising interest rates right now. In my opinion, we should be more concerned about low oil prices than high because we live in a world economy with huge debt bubbles. Debt bubbles support employers that are close to the edge financially; they also support buyers who would not be able afford automobiles or college educations, if loans were to become more expensive because of higher interest rates. Employment in the affected industries would be cut back, leading to recession. Because of these issues, pricking the debt bubble is likely to lead to a major recession and, indirectly, lower energy prices, as in late Figure If energy prices stay persistently low, the world is likely to see much lower oil supply, in part because oil exporters need the tax revenue that they obtain from high-priced oil to fund their programs. This energy shortfall is virtually never explained to the public. It is only apparent to the occasional researcher who realizes that this might be the issue. The amount of energy that a networked economy needs to operate depends on: The number of people alive at the time, The industry that has been put in place, and The promises, such as retirement promises, that have been made to citizens. Adequate energy supply is important for jobs and their pay levels. A rising supply of energy per capita tends to add jobs. The Asian countries shown in Figure 1 are some examples of countries where rising energy supply has given rise to more non-agricultural jobs. Energy consumption includes oil, natural gas, coal, and many smaller types of energy consumption, including wind and solar. The jobs added rarely pay high salaries compared to those in the developed world, but they have helped raise the standard of living of those who have obtained them. A falling supply of energy consumption per capita tends to make jobs that are high-paying more difficult to obtain. High energy jobs such as building new schools and resurfacing roads tend to disappear, while jobs requiring little energy consumption, such as waitress and bartender, are added. Figure 2 gives some examples of European countries that have seen declines in energy consumption per capita in recent years. When jobs that pay well become more difficult to find, a significant share of the population starts believing that there is no room for additional immigrants, regardless of how needy they may be. This seems to be part of the dynamic many countries have been encountering recently. If growth in energy supply is inadequate, other physics-related issues also arise: He finds that when there is inadequate total energy supply, this shortage is reflected in growing wage and wealth disparity. Thus, the goods and services made possible by energy supplies are disproportionately allocated to a small proportion of individuals at the top of the economic hierarchy, while those at the bottom receive a falling share. Using this approach, some portion of the economy can be maintained in a period of temporary energy scarcity, even if the most vulnerable parts are lost. First published in New Scientist, 17 January The UK problem in the time-period was a coal problem. The coal whose delivered cost was lowest had been produced first. It was near the surface and geographically close to where it was ultimately to be used. Many types of costs rose as the easy-to-extract and deliver coal was exhausted. For example, more worker-hours were needed per ton of coal extracted. If the costs of extracting and delivering coal rose, a person might think that these higher costs would be passed on to consumers as higher prices. This is the hypothesis behind the ever-rising oil price theory. Thus, a person might expect that coal prices would rise because coal companies needed more revenue to handle what was becoming an increasingly inefficient mining and delivery process. Mining companies sort of solved their wage problem by paying miners an increasingly inadequate wage. Probably not coincidentally, World War I started in , just after UK coal production hit its peak in The war provided jobs for miners and others who could not otherwise find jobs that paid a living wage. Workers leaving for the war effort left fewer for mining. The fact that it was on the winning side allowed the UK to remain the dominant world power until , despite its declining coal production. This status made it easier for the UK to borrow, allowing it to import coal, even when it otherwise lacked funds to pay for it. Second Low-Energy Consumption Period: Also, Germany, which was the other major European coal producer besides the UK, was reaching a peak in its predominant type of coal production, hard coal Figure 4. Because of the these issues, European demand for imported goods from the US dropped dramatically. In particular, the US had been a big supplier of food to Europe during World War I, but this source of demand disappeared after , when soldiers returned to their fields. Hard coal production in Germany to With respect to US demand for coal, the big issue besides low demand from Europe was internal US demand. Mechanization was starting to replace unskilled workers , both on farms and in factories. Mechanization of farming created a double problem: The winners were those with the new mechanization who could produce food cheaply; the losers were those who still used processes that required much more manual labor. Available food prices fell far below the non-mechanized cost of food production. City dwellers were also winners thanks to the lower food prices. Wage disparity became an increasingly serious problem in the s Figure 5. Workers with low wages could not afford to buy many goods and services. Thus, physics requires that energy products be used in the manufacturing and delivery of goods and services. Following this logic through, the low wages of workers displaced by mechanization further acted to reduce demand for US energy supplies, over and above European coal problems. Debt levels grew in the Roaring 20s, partly driven by the apparent advantages of the new mechanization. In , the debt bubble began to collapse, showing the underlying weakness of the economy. The problems of the late s to bore a striking resemblance to those of today. Wage disparity had become a major issue because of displacement of many workers mechanization and immigration. In response, tariffs were added: Limits were also set on the number of immigrants , in the hope that reduced competition from immigration would help raise the wages of unskilled workers. Eventually, the low-demand-for-energy problem was solved with World War II. The extra demand of World War II added many women to the work force for the first time. US energy consumption grew thanks to the war effort. The large wage increase about this time Figure 6 primarily reflects the addition of many more workers to the labor force. Three-year average growth in wages and in average personal income, based on data of the Bureau of Economic Analysis. Disposable personal income includes transfer payments such as Social Security and Unemployment Insurance. It also is net of taxes. The denominator in this calculation is total US population, so the changes reflect the effect of adding a larger share of the population to the workforce. In addition, the US dollar took over as the reserve currency from the British pound in This gave the United States the power to import more goods and services including oil than it would have been able to if it had been more limited in its ability to borrow. If we analyze US coal production, we see the interplay between geological limits and demand really, what is affordable by consumers. With respect to geological limits, US anthracite coal hit an apparently geologically limited production peak in US coal production by type, in Wikipedia exhibit by contributor Plazak. The US production of the second-highest quality coal, bituminous coal, rose rapidly between and , when its production path suddenly changed to a jagged plateau, which lasted until about Coal production then dropped precipitously, as the economy sank, and did not rise again until the time of World

War II. The wage disparity of the s seems to have led to flattening production, with a steep drop with the problems of the s. Looking out at on Figure 7, bituminous coal may have hit a geological production peak. Energy prices are this time were low Figure 10 , again pointing to low prices being associated with peaks in the production of a type of energy supply, not high prices. Production of the two lowest qualities of coal sub-bituminous and lignite coal did not begin until The rapid ramp-up of coal supplies helped cushion the peak in oil production in the United States, which occurred coincidentally or not the same year, We see a shift toward ever-lower quality of energy resources, but we do not see a pattern of spiking of prices associated with peak demand. Instead, low prices seem to be associated with peaks in production. Third Low Energy Consumption Period:

Chapter 3 : Can Alternative Energy Save the Economy and the Climate? - Scientific American

The Physics of Energy and the Economy Posted on February 8, by Gail Tverberg I approach the subject of the physics of energy and the economy with some trepidation.

How Oil Prices Impact the U. Oil exploration and production is again an important industry in the United States. In this article, we will look at how oil prices impact the U. A Reversal of Fortune In the s and early s, the United States was struggling under declining domestic oil production and the resulting need to import more oil. Wells in Texas and other regions were still producing, but falling far short of meeting growing energy demands. In the latter half of the s, however, new technology allowed companies to economically draw oil and gas from shale deposits that were once considered depleted because the cost of extraction would be impractical. Higher prices per barrel of oil also helped to justify the cost of a hydraulically fractured well. The United States is once again one of the top producers of oil and gas. Greater domestic oil production is a net positive for the United States. Oil and the Cost of Doing Business The price of oil influences the costs of other production and manufacturing across the United States. For example, there is the direct correlation between the cost of gasoline or airplane fuel to the price of transporting goods and people. A drop in fuel prices means lower transport costs and cheaper airline tickets. As many industrial chemicals are refined from oil, lower oil prices benefit the manufacturing sector. Before the resurgence in U. This reduction of costs could be passed on to the consumer. Greater discretionary income for consumer spending can further stimulate the economy. However now that the United States has increased oil production, low oil prices can hurt U. Conversely, high oil prices add to the costs of doing business. And these costs are area also ultimately passed on to customers and businesses. Whether it is higher cab fares, more expensive airline tickets, the cost of apples shipped from California, or new furniture shipped from China, high oil prices can result in higher prices for seemingly unrelated products and services. The hydraulically fractured wells tend to have a shorter production life, so there is always new drilling activity to find the next deposit. All this activity requires labor including drilling crews, loader operators, truck drivers, diesel mechanics, and so on. The people working in these areas then support surrounding businesses like hotels, restaurants, and car dealerships. Less activity can lead to layoffs which can hurt the local businesses that catered to these workers. Therefore, the negative impact will be felt keenly in the shale regions even as some of the positive impacts of lower oil prices start to show in other regions of the United States. This is regionally painful for the country and effects show in state-level unemployment statistics. However, these losses may not have a noticeable impact on national unemployment numbers. The other groups that tend to suffer when U. There are a lot of different companies drilling and servicing wells on the shale deposits, and many of these companies finance their operations by raising capital and taking on debt. This means that investors and banks both have money to lose if the price of oil drops to where new wells are no longer profitable and the companies dependent on drilling and service then go out of business. Of course, investors and bankers are well-versed in risks and rewards, but the losses still destroy capital when they happen. Between the job losses and the capital losses , a dip in oil prices can trim the growth of the U. The Benefits of Diversity Even with the loss of growth, the U. Although oil and gas production has been one driver of recent growth, it is far from the most important sector of the economy. It is, of course, connected to other sectors and losing growth in one can weaken others, but sectors like manufacturing gain more than they lose. In short, the U. This means it takes more than just low oil to shake the U. Bottom Line Oil prices do have an impact on the U. High oil prices can drive job creation and investment as it becomes economically viable for oil companies to exploit higher-cost shale oil deposits. However, high oil prices also hit business and consumers with higher transportation and manufacturing costs. Lower oil prices hurt the unconventional oil activity, but benefits manufacturing and other sectors where fuel costs are a primary concern. Trading Center Want to learn how to invest? Get a free 10 week email series that will teach you how to start investing. Delivered twice a week, straight to your inbox.

Chapter 4 : What Are the Effects of Overusing Energy? | Home Guides | SF Gate

In addition to the jobs directly created in the renewable energy industry, growth in clean energy can create positive economic "ripple" effects. For example, industries in the renewable energy supply chain will benefit, and unrelated local businesses will benefit from increased household and business incomes [16].

He created businesses large and small, consumers, governments with their regulation, and financial institutions of all types. And the Master Economist declared that the economy should grow. And it did grow, but only for a while. Then He declared that stimulus of various types should fix it, and it did, for a while. I think if we dig deeper, we discover that energy plays an all-powerful role, just as it does in the natural world in general. If population keeps growing, it helps the economy grow, because more consumers mean more demand. Can human population keep growing? Population growth became much more rapid after fossil fuels began adding to food supply, in the s. Coal enabled much greater use of metal and glass, allowing changes which permitted horses to do more work on farms, and innovations such as electric light bulbs. The answer seems to be no. Here we find that researchers have found an extremely important role for energy. The relationship they have found relates to any species, not just to Homo sapiens. Ecologists often talk about the existence of a natural cycle between predators and prey. The predators eat the prey that is available, but in time, the predators drop in number, as less food becomes available. When the population of predators drops, the prey is able to expand its population. In fact, Lotka and Volterra created a model that has been used to model a number of predator-prey relationships, including the wolf and moose population on Isle Royal National Park Lotka Volterra Jost. Wikipedia Humans are now the dominant predator species on earth. Our numbers have grown from a relative handful in our earliest days to over 7 billion in Other species have had to contract in relationship to the advances man has made. The United Nations is now forecasting a world population of over 9 billion in , and over 10 billion in United Nations. If this happens, the populations of other species will need to be pushed down to offset the growth in the human species. Eventually, this situation will reach a limit, since we need to eat other species, both plants and animals. The situation is more complicated than Figure 2 suggests, because there are many species involved, and there are many other changes taking placeâ€”temperature of the sun is gradually changing, its orbit around the sun varies, etc. Also, external energy, including fossil fuels and nuclear, is adding to total energy available to man. But the point remains: Odum has written extensively on this subject. Let me explain his view. The Role of Energy in the Population of Species Energy plays a major role in the balance between predators and prey. Natural systems, such as groups of plants and animals, arrange themselves to get the best possible use of energy resources available. All of us know that if there is a bare spot on our lawn, and enough sunlight and water, it is not long before some kinds of plants come along to fill the gap. Sunlight and water are food for plants, and if more are available, more plants will grow. This tends to work with animals as well. From the point of view of a wolf, a moose is a form of stored energy, since eating it provides calories that provide energy to the wolf. If at some point more moose become available to eat, then more offspring of wolves will be able to survive to adulthood, under survival of the fittest, so the wolf population will increase. As a result, the wolves get as much use as possible of the energy available to them. Howard Odum, in A Prosperous Way Down, credits Lotka with discovering the fundamental energy law that underlies ecological systems, which Odum calls the Maximum Power Concept and rephrases as follows: In the self-organization process, systems develop those parts, processes, and relationships that capture the most energy and use it with the best efficiency possible without reducing power. Energy Use by Humans Energy plays an important role for each of us as humans, just as it does for other species in ecosystems. The most obvious use for energy is in the food that we eat. Some of the energy we use is embedded energyâ€”that is energy from the past that has been used to make something that we use today. The stored energy can be human energy, as in the energy it would take to shear wool from a sheep, make it into yarn, and knit a sweater from it. Stored energy can also be from other sources. For example, it takes a great deal of energy to extract and refine metals. One type of stored energy comes in the form of education Odum. Education requires that teachers attend school themselves for many years, meaning that teachers must somehow be supported by the energy of the rest of society both during their own education and while they are teaching students. Education also involves the concentration of knowledge in the form of books and on the Internet. All of this requires energy. Books require energy to support the people taking time to write the books, to physically make the books, and to transport them to the location where they are read. The Internet requires electrical energy. Even thinking requires energy. The people with the highest education tend to receive higher salaries than others, indicating that this form of embedded energy is highly valued by society. The Role of Energy in Numbers and Types of Businesses and Governments Businesses, governments, and consumers form another self-organizing system, not unlike ecological systems Odum. This system has gradually arisen over many years, and adapts itself as conditions change. The financial system is the part of the self-organizing system that keeps track of the energy costs of the system as well as other costs , and pushes the whole system toward the lowest cost approach to creating goods and services. Businesses tend to succeed or fail in ways that make the most productive use of energy resources, according to the rules set out by the system. An entrepreneur decides to plant a field of turnips. In this case, part of the energy for the business comes from the sun, and part of the energy comes from the labor of the entrepreneur. The calories the entrepreneur eats provide energy for his labor. If the entrepreneur buys fertilizer, it is an energy input as well, since energy was required to make and transport the fertilizer to the location where it is used. Part of the energy used by the entrepreneur may come from mechanical equipment that was made in the past using heat energy, and part from fuels that power that equipment. If purchased energy is scarce, and because of this, high-priced, the entrepreneur will have to charge a higher price for turnips he sells in order to cover his costs. So it is the price of goods, which is tied to energy costs, that helps determine both which goods are sold and which businesses will succeed. High energy cost tend to lead to business failures. Governments, too, use energy, and fit in with the same self-organizing system as businesses. The type of government requiring the least amount of energy is one run by a single person, perhaps a king or dictator. It is also helpful if there is excess energy generated by society to provide clothing, a home, heat for the home, and the many other things that the king or dictator expects to own. More complicated governments require more energy. A government of elected officials requires not only the excess energy from society to feed and clothe the elected officials, it also requires the energy to build the buildings where polling takes place, and the energy for officials to travel to the location of the government offices. The offices themselves also require energy, both for their construction and their maintenance. If energy supply is constricted, the price of energy is likely to be higher, and thus the cost of government will be higher. Taxes will need to be raised. If there is a sufficient energy surplus elsewhere to afford these higher taxes, these higher taxes may be acceptable to taxpayers. If not, some government officials may need to be laid off, to balance the energy budget. What Happens When Energy is Deficient? A deficiency in solar energy would likely cause the world to get colder. Crops would fail, prices would rise, and the problem of low solar energy would affect both the natural world, and the economy consisting of businesses, governments, consumers, and financial institutions. The last time this was a major issue was during the Little Ice Age. The biggest impact seems to have been during the s. What happens when energy supply such as wood, coal, oil or natural gas is constrained? Unfortunately, we are getting a chance to find out. There is considerable evidence that oil, our largest and most flexible source of energy, is now encountering supply issues. Oil price in is more than three times the price it was ten years ago, in inflation-adjusted prices. It is during the time that prices have been high indicating short supply that the world has been suffering from recession. This is precisely the impact one would expect, if energy is closely tied to the economy. Adequate supply would be reflected in low price. When it is not, the economy of countries, especially of oil importers, tends to go into recession. We will discuss this more in future posts. Figure 3 shows that there was a previous time, in the s and early s, when oil prices were very high in inflation adjusted terms. This was the time shortly after the United States discovered that its own oil supply was decreasing rapidly Figure 4. After United States oil production began decreasing in , a huge amount of effort was put into finding more oil supplies, increasing efficiency, and converting oil use to other types of energy use. There was considerable success in these areas. Oil uses that could be easily switched to another fuel were switched away. For example, where oil had been used to create electricity, new generation using nuclear or coal was built. In the case of oil for home heating, the switch was often made to natural gas. Cars became smaller and more energy-efficient during this period. It might be noted that the period of high oil prices in the mid s and early s was also a time of recession. He has also shown that there appears be a direct connection between the price run-up of , cutbacks in consumer consumption and spending on purchases of domestic automobiles, and the economic slowdown of â€" Hamilton, The run-up in oil prices in the past few years seems to be related to a combination of a world oil supply that is not growing very rapidly, and b increasing demand from developing economies, such as China and India, and c higher production costs for oil, because much of the inexpensive to extract oil has already been extracted. There is a great deal more that could be said about these issues, but I will save this information for later.

Chapter 5 : The Physics of Energy and the Economy | Our Finite World

Specifically, we need to gauge our success in curbing CO2 emissions alongside the broader effects on the U.S. economy, particularly on employment opportunities, economic growth and people's incomes.

The world has been reeling from the financial crisis with reverberations being felt throughout the real economy on production, consumption, jobs and well-being. At times like these, we are all reminded of just how intertwined our future prospects have become and forced to reflect on how history has led us to our current circumstances. The economic progress of past decades has seen hundreds of millions of people enjoy major improvements in their material well-being, and these changes have been particularly noteworthy in the emerging economies. We all understand how globalization and market liberalization have underpinned these developments, but we must not lose sight of the crucial enabling role played by the energy sector. Without heat, light and power you cannot build or run the factories and cities that provide goods, jobs and homes, nor enjoy the amenities that make life more comfortable and enjoyable. In times of economic turbulence, the focus quite rightly falls on jobs. The energy industry is known for being highly capital intensive, but its impact on employment is often forgotten. Beyond its direct contributions to the economy, energy is also deeply linked to other sectors in ways that are not immediately obvious. For example, each calorie of food we consume requires an average input of five calories of fossil fuel, and for high-end products like beef this rises to an average of 80 calories. The energy industry significantly influences the vibrancy and sustainability of the entire economy â€” from job creation to resource efficiency and the environment. The key factors in maintaining the health of this nexus of resources energy, food and water are sustained investment, increased efficiency, new technology, system-level integration e. Looking towards the decades ahead, this nexus will come under huge stress as global growth in population and prosperity propel underlying demand at a pace that will outstrip the normal capacity to expand supply. To face this strain, some combination of extraordinary moderation in demand growth and extraordinary acceleration in production will need to take place. New and healthy forms of collaboration that cross traditional boundaries, including national, public-private, cross-industry and business-civic, will be required to address these challenges. Frameworks that encourage collaboration while also being respectful of the different roles of different sectors of society will need to be developed rapidly. While easy to say, this could prove difficult to achieve. These types of economic stressors could lead to turbulence as well as political volatility. If the impacts of these stressors are distributed unevenly across society, suspicion, blame and a deeply felt sense of injustice among many people could follow. From this, hostility and opposition could arise even to investments that would ultimately help relieve the strain on resources. So we must achieve a renewal of the deep social contract between industry and the rest of society as a fundamental and mutually respectful backdrop for individual developments, investments and services. It is up to industry to take the lead in this endeavour. Nobody will do it for us. Business can only thrive in a healthy society. Whether in industry or politics, powerful actors need to make the role of the energy sector and the benefits of our work clear, while demonstrating that we can be trusted to work together across boundaries to face the challenges ahead. In return, society at large will grant a license to operate that is too often missing today. Executive Summary As the world struggles to emerge from a global recession and financial crisis, countries are looking for solutions to improve domestic economic performance and put people back to work. Global energy demand and prices have been resilient during the recession, leading policy-makers in countries with the potential to produce energy to look to that sector as a potential engine for economic growth. The energy sector constitutes a relatively modest share of GDP in most countries, except for those in which oil and gas income loom large. Most importantly, energy is an input to nearly every good and service in the economy. For this reason, stable and reasonable energy prices are beneficial to reigniting, sustaining and expanding economic growth. At the same time, the ability of a country to capitalize on supplier networks and the multiplier effect depends on the capacities of the local labour and industrial markets. Many resource-rich countries strive to maximize the economic benefits of their resource endowments by encouraging the growth of related industries. For all of these reasons, the energy sector can make an important contribution to the recovery from the global downturn. For example, the oil and gas industry in the United States is an important bright spot in an economy still struggling to find its footing. The US oil and gas extraction sector grew at a rate of 4. Technological advances in oil and gas extraction have led to remarkable increases in employment in the United States. Likewise, renewable energy innovations in the power sector have contributed to employment gains, although the multipliers in that sector are highly sensitive to the nature of domestic supplier networks. However, balancing energy prices, energy security and the environment requires trade-offs between job creation and overall productivity in the energy sector. Although the record of managing natural resource wealth to promote economic development is mixed, several countries have done so with great success. Areas with fewer natural resources are also focusing on the energy sector as a potential driver of economic growth. Steady and reliable energy supplies are crucial to growth in developing and emerging economies. South Korea, China and India are fostering entrepreneurship and technological innovation in non-traditional energy sectors as another avenue to promote the development of their rapidly growing economies. Many developed economies are also seeking to expand their renewable energy capacity to be at the forefront of this growing sector and to achieve sustainability goals. Energy can undoubtedly be a driver of economic growth, but how can governments enact policies that encourage it? Governments generally focus on prices, security of supply and environmental protection when considering energy policy. The added goals of job creation and economic growth can be challenging. The industry contributes to economic growth and job creation, in some countries to a very great extent. But in most countries, its position as the lifeblood of the modern economy dwarfs the direct effects. Introduction Energy is the lifeblood of the global economy â€” a crucial input to nearly all of the goods and services of the modern world. Stable, reasonably priced energy supplies are central to maintaining and improving the living standards of billions of people. As Peter Voser explains in his opening message to this report, Energy: Many parts of the developed world still face sluggish economic growth and risks from financial crises. Financial institutions lowered their forecasts for world economic growth, impacting an energy sector tied to capital markets. Therefore, oil prices remain volatile, and the global economy is still looking gloomy. And as private and consumer earnings have declined, those nations are facing shrinking tax bases, compounding issues with sovereign debt. The impact is felt around the world, including in what have been the more vibrant emerging markets. Despite the economic turmoil, energy demand has been resilient throughout the recession, driven primarily by rapidly growing consumption in the developing world. But how does the energy industry contribute to economic growth and employment, apart from its vital products? Given the risks and challenges in the overall global economy how can the energy industry play a role in economic recovery and job creation? This report seeks to provide a framework for understanding the larger economic role of the energy industry at a time when issues of employment and investment are so critical in a troubled global economy. This report is organized into five chapters: Chapter 1 describes the overall role that energy can play in the economy of a nation and how this sector may serve as an engine of economic growth. Chapter 2 compares and illuminates the job creation potential of different types of energy extraction and generation based on a case study of the United States. Chapter 3 discusses how countries endowed with traditional energy resources can maximize the benefit of resource extraction for their economies. Chapter 4 examines how countries are developing non- traditional energy industries and the economic impact of such efforts. Chapter 5 offers conclusions. First, energy is an important sector of the economy that creates jobs and value by extracting, transforming and distributing energy goods and services throughout the economy. In some countries that are heavily dependent on energy exports the share is even higher: Second, energy underpins the rest of the economy. Energy is an input for nearly all goods and services. In many countries, the flow of energy is usually taken for granted. But price shocks and supply interruptions can shake whole economies. For countries that face chronic electricity shortages like India, continuing disruptions take a heavy, ongoing toll. This role is particularly important when economic growth and job creation are such high priorities around the world. Labour and Employment The energy sector directly employs fewer people than might be expected given its share of GDP, especially when compared to other industries. Figure 2 shows the share of energy sector employment compared to other sectors in several OECD countries. More than eight times as many Norwegians work in healthcare as in energy extraction. Nonetheless, recent research in the United States demonstrates that the energy industry supports many more jobs than it generates directly, owing to its long supply chains and spending by employees and suppliers. As Senator Hoeven explains in his contribution, North Dakota: Thus, many more jobs are created â€” a multiple of those in the oil industry itself. Energy-related industries do not have a large need for labour, but the workers they hire are relatively highly skilled and highly paid. For example, compensation per worker in energy-related industries is about twice the average in Germany, Norway, the United Kingdom and the United States and four times the average in Mexico and South Korea. As a result of their high salaries, employees of the energy industry contribute more absolute spending per capita to the economy than the average worker. High wages in the sector reflect the fact that energy industry workers are much more productive than average, contributing a larger share of GDP per worker than most other workers in the economy. Investment requirements per worker in the energy industry are also very high. These supplier networks are crucial to understanding the potential economic impact of the energy industry. Countries with a comparative advantage in energy-related skills and capabilities tend to retain more of these benefits domestically. The impact will be smaller in countries that cannot supply materials and expertise locally. Competition from governments and businesses including the energy industry creates scarcity and drives up the cost of capital. However, capital costs are currently extremely low because of the depressed state of the global financial system. Now is a good time to consider investment in capital-intensive industries. First, lower energy prices reduce expenses for consumers and businesses, increasing disposable income that can be spent in other ways. Second, lower energy prices reduce input costs for nearly all goods and services in the economy, thus making them more affordable. The converse is also true: Global oil prices entered a long upward swing in , and the trend accelerated sharply in This price rise contributed to the deep recession in the developed world that began in late Rising energy prices took purchasing power away from consumers, particularly from lower-income groups. In the United States, technological innovations have spurred the development of natural gas production from shale formations. Increasing shale gas production has significantly reduced US gas and electricity prices.

Chapter 6 : How does coal affect our economy? | Socratic

Currently, the world depends heavily on coal, oil, and natural gas to meet its energy needs. However, the utilization of these energy sources has a drastic impact on our environment, which is well documented.

Bill Ritter touts as a "new energy economy. Of those, a majority are energy-related industries," said Raymond Gonzales, president of the Brighton Economic Development Corporation. The race to perfect the batteries that will power the next generation of automobiles and buses has manufacturers in Europe, the United States and China scurrying to build plants and research centers. They have to respond one way or another. Private-sector investments and regional and local government efforts to boost "green" technology are good, they say. For instance, some 29 states have imposed renewable fuel portfolio standards - requirements that utilities generate a minimum percentage of their electricity from renewable fuels such as wind, solar or geothermal. Renewable fuels standards are inconsistent. Tax and pricing policies are fickle. And that needs either comprehensive domestic energy and climate legislation now before the Senate or a worldwide climate treaty. A way to capture some of the carbon dioxide it sends skyward from all that coal. Bolted to the plant is a labyrinth of pipes, valves and catwalks surrounding two modest cooling towers. Diverted flue gas is cooled and filtered through ammonia in one column, then pumped to the other, where steam from the plant reheats it and strips off the carbon. It is simply a test. It can capture 90 percent of the carbon dioxide from the exhaust, although We Energies is diverting less than 1 percent of its flue through the CO_2 scrubber. But the test is a success - the first industrial-scale example of carbon capture in the United States. It is step No. The second part of this experiment went online last month: The third test, expected to start in , will scale the process up to a semi-commercial production - a megawatt coal plant in Oklahoma. AEP, We Energies and 37 other partners involved with these tests are working feverishly to show that baseload coal can be part of a low-carbon energy future, said Henry Courtright , senior vice president of EPRI, which is helping coordinate the project. A new carbon framework will emerge, Courtright said. They fear their competitors - or a different industry, or an as-yet unseen technology, or even another country - will emerge victorious in the race to decarbonize various industrial and economic sectors. In general, economists see two ways to drive new technologies and shift cultural paradigms: Policy makers can push the technology into the market by targeting investing at specific research. Or they can pull it by setting a bar or standard and offering incentives to clear the mark. Economists disagree wildly on the effectiveness of various strategies. So far federal and state governments have mostly pushed efforts to decarbonize the economy, offering grants and tax incentives for specific projects. But so long as carbon is free, those efforts push against prevailing economic forces, said Adam Jaffe , dean of College of Arts and Sciences and professor of economics at Brandeis University. For climate this is particularly crucial, he said, given the problem is global, the consequences dire, the remedies unknown and almost uncountable. Jaffe as analogy compares a price on carbon to the economic incentives that have sent generations of miners off to the hills in search of glory and riches: Instead of searching for gold, these new carbon prospectors will be looking for ways to cut emissions. Failure at Copenhagen means technical change continues, albeit in fits and starts. It will remain confined mostly in the developed world, continuing the global technological divide. But soon it will be the taste of money, or so city leaders hope. Vestas is bringing 2, jobs to the region , and Brighton civic leaders anticipate the creation of another 4, as the plant draws ancillary suppliers. He remembers when Brighton was a farm town with nothing but a K-Mart distribution center on its outskirts. The old Armory re-opened last month as an arts center, the first time Brighton has had such a center since the opera house burned on July 25, Federal and international policies will eventually follow.

DOWNLOAD PDF HOW ENERGY AFFECTS THE ECONOMY

Chapter 7 : How Energy Availability Affects Economies and Societies | racedaydvl.com

The world energy economy has the largest influence on the decisions that people and governments make. Current global consumption rates are depleting the planets ability to sustain our way of life. Increased demand means increased prices in every sector of the world economy.

The Organisation for Economic Co-operation and Development OECD warns that, given the current trends, energy-related emissions will increase by 70 percent by This can accelerate the negative consequences of climate change, including higher temperatures and a rise in the frequency of extreme weather events See References 1. Increased Carbon Footprint The primary environmental effect of energy overuse is an increase in your carbon footprint, but there are simple changes you can make at home to avoid this. Leaving your laptop plugged in all the time will use nearly kilowatt hours kWh of electricity each year, and a desktop computer left to idle will use more than kW of electricity annually. Even leaving your fully charged cellphone attached to its charger can waste almost 20 kWh a year, explains the Lawrence Berkeley National Laboratory. References 2 and 3 Increased Risk of Climate Change Coal and natural gas supplied more than two-thirds of the energy in the U. Each energy form contributes to total greenhouse gas emissions. According to the U. This figure is a 10 percent increase from In addition, methane emissions from natural gas increased during the same period by 17 percent. Part of this increase is due to the careless use of electricity. Reduction in Supply In areas with heavy population densities, the price you pay for home electricity is determined by supply and demand. Some power plants charge consumers more during peak hours. Your overuse will contribute to a scarcity in this energy supply and thus an increase in overall electricity costs. Over the long term, the rise in demand may place additional burdens on threatened environmental areas -- such as coastal areas or wildlife refuges -- to ensure adequate resources. Drilling for natural gas or mining for coal to meet excessive energy demands will negatively impact the environment See References 6. Higher Energy Costs A natural consequence of overusing energy is increased costs for you. This can come in the form of fuel and energy bills; you will be paying more without an appreciable return on your investment. You may also risk lowering the expected lifespan of appliances and other electronics. When you have to replace spent devices, you further impact the environment by generating waste and purchasing replacement equipment. Your wise use of electricity, therefore, can translate into long-term savings in energy bills and also reduce the need for other purchases See References 7.

Chapter 8 : Learn about Energy and its Impact on the Environment | Energy and the Environment | US EPA

According to a meta-analysis from of the Renewable and Appropriate Energy Laboratory (RAEL) at the University of California, Berkeley, which examined 13 studies on the economic benefits of renewable energy, approximately , jobs could be created and maintained if the country passed a 20 percent by RPS.

By questioning the how, why and what of energy use, says Rebecca Willis, new possibilities - of living, travelling, eating, working and buying - can open. There are no pavements in downtown Bahrain. Visiting a few years ago for a family wedding, I wanted to pop to the shops to pick up some nappies. I could see a chemist from our hotel window, but the receptionist looked horrified when I asked her how to get there and insisted on calling a cab for me. But why walk, when petrol costs a few pence a litre? Access to abundant energy has shaped Bahrain, from the lack of pavements to the extravagant construction projects, artificial beaches and ultra-air-conditioned buildings. Japan is richer than Bahrain, but it has no indigenous oil or gas. It uses a quarter of the amount of oil per person, and a third of the carbon dioxide. Its society and economy have developed in a very different way. Profiting from lean manufacturing and fuel-efficient cars, the Japanese have made a virtue out of a necessity. The contrast between Japan and Bahrain shows how economies and societies are shaped by energy, and how the demand for energy can vary hugely, between countries and over time. Our cities, our history, even our food has been shaped by access to energy. Today, in industrialised societies, we use fifteen times the amount of energy per person than we did before the industrial revolution. But we have become so accustomed to it that we have no conception of its importance in political and social life. Progress in education, social mobility, science and technology are celebrated; the role of abundant energy in making them happen is largely ignored. Modern dairy cows can produce up to sixty litres of milk a day, five times more than a calf needs. This is seen as a triumph of agricultural science and technique. The American ecologist Howard T Odum points out that the reason a dairy cow does so well is because she relies on a steady stream of oil. She produces lots of milk because she eats lots of food - not just grass, but feed grown with oil-based fertilisers. Once you start looking in terms of energy inputs and outputs, the modern dairy cow no longer seems such a good deal. The rangy cattle of subsistence farmers, whose only inputs are grass and water, actually provide better value in converting energy into human food. An urban revolution Our cities, too, have been shaped by energy. Thomas Cromwell and his cronies relied on the River Thames, and a brace of strong oarsmen, to get around the city. Before fossil-fuels, London was a long, thin city, spread out either side of the river. Few people lived more than half a mile from a boat. As power sources changed, so did the shape of the city. The arrival of steam-power and trains made development spread along railway routes like spokes on a wheel, with railway suburbs developing around stations. Oil and the internal-combustion engine changes this yet again, spreading development into the spaces between and beyond the spokes. Our cities have been shaped by energy, from the muscle-power of rowers and horses, onwards. In the United States, where planning laws are far less restrictive than in Britain, the car has allowed cities to sprawl in all directions. Atlanta is miles wide. Since the recession, it is these same suburbs that have suffered worst, thanks to a toxic combination of crashing house prices and rising fuel prices. Yet it is an astonishing blind spot to most politicians. Insofar as it appears on their radar, they understand it as a technical question about energy supply. Where should we get our energy from - nuclear or renewables? What happens if Russia switches off its gas supplies? How do we "keep the lights on" if power sources fail? Very little thought is given to the underlying question of why we need so much energy in the first place. As we work to meet carbon targets, and as fossil-fuels become more difficult, expensive and environmentally harmful to extract, we will no longer be able to take for granted the role of energy in shaping society. We need to move the thinking from being narrow, technical and supply-dominated to a broad, political question that concerns everyone. Understanding the role that energy plays in shaping society will help us to find solutions. But politicians are doing us a disservice by pretending that we can have as much energy as we need. If you think from the demand side, new solutions appear. Urban thinkers in the US, sick of blighted suburbs and six-lane freeways, have formed the "smart growth" movement. They advocate compact towns and walkable neighbourhoods, based around "hubs" of retail and employment sites, close to transport interchanges. In other words, and with considerable irony, they are arguing to recreate the concept of the High Street. Yet in the UK, the current planning reforms are taking us in the opposite direction, toward greater sprawl. An issue for everyone Thinking about the energy and carbon used to make the products we buy, many of which are made overseas, would lead to much more efficient use of resources. If we understood the energy implications of food, we could reward farmers for careful land management, and encourage local, seasonal food and drink. This would help rural economies as well as cutting emissions. We need to develop a "public-health" approach to energy. Rather than defining it as a technical question to be solved by experts, we need to see it as an issue for everyone. For two hundred years, economic growth has been enabled by access to cheap, abundant fossil-fuels. Change this variable, and the economy itself changes, and society with it. Outcomes may not be worse, but they will be different. As power politics move centre-stage, the role of energy as a driver of social and economic progress will be better understood, and greater understanding may well lead to better decisions about how to shape our society.

Chapter 9 : Why Energy is Vital to Economic Growth | racedaydvl.com

Nuclear power is clean, efficient, and cheap. It works by splitting uranium atoms to create heat. The resultant steam turns generators to create electricity. But there are two rate, but huge, disadvantages. If something goes wrong, it can create a nuclear meltdown. The resultant radioactivity is.

Posted on February 8, by Gail Tverberg I approach the subject of the physics of energy and the economy with some trepidation. An economy seems to be a dissipative system , but what does this really mean? There are not many people who understand dissipative systems, and very few who understand how an economy operates. The combination leads to an awfully lot of false beliefs about the energy needs of an economy. The primary issue at hand is that, as a dissipative system, every economy has its own energy needs, just as every forest has its own energy needs in terms of sunlight and every plant and animal has its own energy needs, in one form or another. A hurricane is another dissipative system. It needs the energy it gets from warm ocean water. If it moves across land, it will soon weaken and die. There is a fairly narrow range of acceptable energy levelsâ€”an animal without enough food weakens and is more likely to be eaten by a predator or to succumb to a disease. A plant without enough sunlight is likely to weaken and die. In fact, the effects of not having enough energy flows may spread more widely than the individual plant or animal that weakens and dies. If the reason a plant dies is because the plant is part of a forest that over time has grown so dense that the plants in the understory cannot get enough light, then there may be a bigger problem. The dying plant material may accumulate to the point of encouraging forest fires. Such a forest fire may burn a fairly wide area of the forest. Thus, the indirect result may be to put to an end a portion of the forest ecosystem itself. How should we expect an economy to behave over time? The pattern of energy dissipated over the life cycle of a dissipative system will vary, depending on the particular system. The Standard Wrong Belief about the Physics of Energy and the Economy There is a standard wrong belief about the physics of energy and the economy; it is the belief we can somehow train the economy to get along without much energy. In this wrong view, the only physics that is truly relevant is the thermodynamics of oil fields and other types of energy deposits. All of these fields deplete if exploited over time. Furthermore, we know that there are a finite number of these fields. Thus, based on the Second Law of Thermodynamics, the amount of free energy we will have available in the future will tend to be less than today. According to this wrong view of energy and the economy, all we need to do is design an economy that uses less energy. We can supposedly do this by increasing efficiency, and by changing the nature of the economy to use a greater proportion of services. If we also add renewables even if they are expensive the economy should be able to get along fine with very much less energy. These wrong views are amazingly widespread. The Economy as a Dissipative System If an economy is a dissipative system, it needs sufficient energy flows. Otherwise, it will collapse in a way that is analogous to animals succumbing to a disease or forests succumbing to forest fires. The primary source of energy flows to the economy seems to come through the leveraging of human labor with supplemental energy products of various types, such as animal labor, fossil fuels, and electricity. For example, a man with a machine which is made using energy products and operates using energy products can make more widgets than a man without a machine. A woman operating a computer in a lighted room can make more calculations than a woman who inscribes numbers with a stick on a clay tablet and adds them up in her head, working outside as weather permits. As long as the quantity of supplemental energy supplies keeps rising rapidly enough, human labor can become increasingly productive. This increased productivity can feed through to higher wages. Because of these growing wages, tax payments can be higher. Consumers can also have ever more funds available to buy goods and services from businesses. Thus, an economy can continue to grow. Besides inadequate supplemental energy, the other downside risk to continued economic growth is the possibility that diminishing returns will start making the economy less efficient. These are some examples of how this can happen: Deeper wells or desalination are needed for water because aquifers deplete and population grows. More productivity is needed from each acre of arable land because of growing population and thus, falling arable land per person. Larger mines are required as ores of high mineral concentration are exhausted and we are forced to exploit less productive mines. Fossil fuels from cheap-to-extract locations are exhausted, so extraction must come from more difficult-to-extract locations. In theory, even these diminishing returns issues can be overcome, if the leveraging of human labor with supplemental energy is growing quickly enough. Theoretically, technology might also increase economic growth. The catch with technology is that it is very closely related to energy consumption. Without energy consumption, it is not possible to have metals. If technology makes a particular type of product cheaper to make, there is also a good chance that more products of that type will be sold. Thus, in the end, growth in technology tends to allow more energy to be consumed. Why Economic Collapses Occur Collapses of economies seem to come from a variety of causes. One of these is inadequate wages of low-ranking workers those who are not highly educated or of managerial rank. In some cases, not enough jobs are available; in others, wages are too low. Another area vulnerable to inadequate energy flows is the price level of commodities. If energy flows are inadequate, prices of commodities will tend to fall below the cost of producing these commodities. This can lead to a cutoff of commodity production. If this happens, debt related to commodity production will also tend to default. Defaulting debt can be a huge problem, because of the adverse impact on financial institutions. Another way that inadequate energy flows can manifest themselves is through the falling profitability of companies, such as the falling revenue that banks are now experiencing. Still another way that inadequate energy flows can manifest themselves is through falling tax revenue. Governments of commodity exporters are particularly vulnerable when commodity prices are low. Ultimately, these inadequate energy flows can lead to bankrupt companies and collapsing governments. The closest situation that the US has experienced to collapse is the Depression of the s. The Great Recession of would represent a slight case of inadequate energy flowsâ€”one that could be corrected by a large dose of Quantitative Easing QE leading to the lower cost of borrowing , plus debt stimulus by China. These helped bring oil prices back up again, after they fell in mid World Oil Supply production including biofuels, natural gas liquids and Brent monthly average spot prices, based on EIA data. Clearly, we are now again beginning to experience the effects of inadequate energy flows. This is worrying, because many economies have collapsed in the past when this situation occurred. How Energy Flows of an Economy are Regulated In an economy, the financial system is the regulator of the energy flows of the system. If the price of a product is low, it dictates that a small share of energy flows will be directed toward that product. If it is high, it indicates that a larger share of energy flows will be directed toward that product. Wages follow a similar pattern, with low wages indicating low flows of energy, and high wages indicating higher flows of energy. If the energy flows are inadequate using what we would think of as the natural flows of the system, debt is often used to increase energy flows. Debt has the effect of directing future energy flows in a particular direction, such as paying for a factory, a house, or a car. These flows will be available when the product is already part of the system, and thus are easier to accommodate in the system. Since factories, houses and cars are made using commodities, the use of an increasing amount of debt tends to raise commodity prices. With higher commodity prices, more of the resources of the economy are directed toward producing energy products. This allows for increasing energy consumption. This increased energy consumption tends to help flows of energy to many areas of the economy at the same time: The need for debt greatly increases when an economy begins using fossil fuels, because the use of fossil fuels allows a step-up in lifestyle. There is no way that this step-up in lifestyle can be paid for in advance, because the benefits of the new system are so much better than what was available without fossil fuels. For example, a farmer raising crops using only a hoe for a tool will never be able to save up sufficient funds energy flows needed to pay for a tractor. While it may seem bizarre that banks loan money into existence, this approach is in fact essential, if adequate energy flows are to be available to compensate for the better lifestyle that the use of fossil fuels makes possible. Debt needs are low when the cost really energy cost of producing energy products is low. Much more debt is needed when the cost of energy extraction is high. The reason more debt is needed is because fossil fuels and other types of energy products tend to leverage human labor, making human labor more productive, as mentioned previously. In order to maintain this leveraging, an adequate quantity of energy products measured in British Thermal Units or Barrels of Oil Equivalent or some similar unit is needed. As the required price for energy-products rises, it takes ever-more debt to finance a similar amount of energy product, plus the higher cost of homes, cars, factories, and roads using the higher-cost energy. In fact, with higher energy costs, capital goods of all kinds will tend to be more expensive. This is a major reason why the ratio of debt to GDP tends to rise as the cost of producing energy products rises. One measure of debt is all-inclusive; the other excludes Financial Business debt. Clearly one of the risk factors to an economy using fossil fuels is that debt levels will become unacceptably high. A second risk is that debt will stop rising fast enough to keep commodity prices at an acceptably high level. The recent slowdown in the growth of debt Figure 3 no doubt contributes to current low commodity prices. A third risk to the system is that the rate of economic growth will slow over time because even with the large amount of debt added to the system, the leveraging of human labor with supplemental energy will not be sufficient to maintain economic growth in the face of diminishing returns. In fact, it is clearly evident that US economic growth has trended downward over time Figure 4. A fourth risk is that the whole system will become unsustainable. When new debt is issued, there is no real matching with future energy flow. For example, will the wages of those taking on debt to pay for college be sufficiently high that the debtors can afford to have families and buy homes? If not, their lack of adequate income will be one of the factors that make it difficult for the prices of commodities to stay high enough to encourage extraction. These promises include shareholder dividends and payments under government programs such as Social Security and Medicare.