Sustainable Fossil Fuels

The Unusual Suspect in the Quest for Clean and Enduring Energy

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Synopsis

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More and more people believe we must quickly wean ourselves from fossil fuels to save the planet from environmental catastrophe, incessant oil conflicts and economic collapse. This view is epitomized by the claim in one of many recent anti-fossil fuel books that "Civilization as we know it will come to an end sometime in this century unless we can find a way to live without fossil fuels."[1]

This view is misguided. This book explains why.

Those who argue that the end of fossil fuels is nigh usually start with evidence that we consume conventional oil faster than we find it, and then link this to the latest energy price spike and geopolitical conflict. What they overlook is that a peak in the production of "conventional oil" is unlikely to be of great significance given the potential for substitution among the planet's enormous total resources of conventional and unconventional oil, conventional and unconventional natural gas, as well as coal. A refined petroleum product like gasoline can be produced from any of these other fossil fuels, and indeed it is today from unconventional oil in the form of oil sands (Canada), natural gas (Qatar) and coal (South Africa). The planet has perhaps 800 years of coal at today's use rate and an even longer horizon for natural gas if we exploit untapped resources like deep geopressurized gas and gas hydrates. While this substitution potential does not mean that energy supply markets will always operate smoothly – prices can oscillate, sometimes dramatically, from one year or decade to the next – it suggests that we should not misinterpret periods of high prices as indicating the imminent demise of our still plentiful fossil fuel resources.

When it comes to fossil fuels, those worried about resource exhaustion find common cause with those worried about environmental impacts. But we can use fossil fuels with lower impacts and less risk.

Fossil fuels are a high quality form of stored solar energy – the result of millions of years of photosynthesis that grew plants and the animals that fed upon them, both of whose decomposing remains were trapped in sediments and eventually transformed through subterranean pressures into natural gas, oil and coal. When humans are ignorant or uncaring about the impacts of using

[1] D. Goodstein, *Out of Gas: The End of the Age of Oil* (Norton, 2004), p.123.

this source of energy, they can create great harm to themselves and the environment. Open pit coalmines destroy mountains and valleys. Oil spills soil coastlines and harm wildlife. Uncontrolled burning pollutes the air in homes and cities, acidifies lakes and forests, and risks major climate disruption.

This litany of impacts and risks presents a black image for fossil fuels. However, the history of fossil fuel use is also one of humans detecting and then successfully addressing its environmental challenges. Industrialized countries are the most dependent on fossil fuels, and yet in these countries indoor air quality is excellent compared to all of human history since the discovery of fire (with a huge benefit for life expectancy), urban air quality is better in many cities than it was 100 years ago, and acid emissions have fallen in some regions by over 50% in the past 30 years.

The latest challenge is CO_2 emissions from fossil fuel combustion, the most significant of the human-produced greenhouse gases that threaten to raise global temperatures and disrupt weather patterns and ecosystems. But in the decade or so that researchers have grappled seriously with this challenge many promising solutions have appeared. Fossil fuels can be converted to clean forms of energy – electricity, hydrogen and cleaner-burning synthetic fuels like methanol and dimethyl ether – through gasification processes that enable the capture of carbon and its safe storage, most likely deep in the earth's sedimentary formations.

There are costs. Estimates from independent researchers suggest that zero-emission fossil fuel production of electricity would increase final electricity prices by 25–50% were this technology to become universally applied. Researchers also suggest that the cost of vehicle use would increase by about the same percentage as we shifted from gasoline and diesel to primarily hydrogen, electricity and some biofuels for personal mobility. This increase, which is less than recent price jumps of electricity, gasoline, heating oil and natural gas in many jurisdictions, implies that the cost of energy would climb over the next century from its current level of 6% to about 8% of a typical family's budget in an industrialized country – remaining much lower than what it was 100 years ago and than what it is today for a poor family in a developing country. Thus, to shift our use of fossil fuels to these zero-emission processes over the course of this century would result in real energy price increases of much less than 1% per year during the next three to five decades.

Even if we can use fossil fuels cleanly, however, we might prefer to switch to other options sooner in order to ensure that our energy system is not a house of cards that collapses when we deplete our lower cost fossil fuels. But this decision requires careful consideration of the difficulties and costs involved in forcing the switch quickly versus allowing it to occur gradually as the cost of fossil fuels trends upward in the distant future. We need to have a realistic view of the other options – the "usual suspects" of energy efficiency, nuclear power and renewable energy.

Energy efficiency has great potential according to physicists, engineers and environmentalists. There are, however, significant countervailing factors that will hinder efforts to make dramatic efficiency gains. First, efficiency gains lower the cost of energy services and therefore incite some greater use of existing technologies, and especially the innovation and commercialization

of related energy-using technologies, a feedback effect that has caused energy consumption in industrializing countries to grow almost as fast as economic activity over the past two centuries. Ambitious increases in energy efficiency require a dramatic rise in the cost of energy in order to prevent the widespread adoption of the myriad of energy-using innovations commercialized every year. But, as noted, the shift to zero-emission energy supplies, whether from renewables, nuclear or fossil fuels, is unlikely to increase final energy prices by more than 25–50% from current levels. Second, the energy system itself will consume increasing amounts of energy in the process of converting lower quality and less accessible primary energy sources (unconventional oil, unconventional gas, coal, and renewables) into higher quality and cleaner secondary energy (electricity, hydrogen and synthetic fuels). The net effect is to decrease the overall efficiency of the global energy system. Third, the more than 50% increase in the world's population over this century will happen mostly in poorer regions of the world, where energy use is minimal. Even a marginal increase in energy use by people in these countries to provide the most basic services has a profound implication for aggregate energy use at the global scale. Thus, while we should pursue energy efficiency, it is likely that the global energy system will still expand three- or four-fold over this century, especially as people in developing countries use their rising incomes to enjoy energy services that most people in wealthier countries take for granted.

Nuclear power is potentially inexhaustible, but it must overcome public fears about radiation leaks from operational accidents, waste storage and even terrorist attacks, as well as superpower concerns about nuclear weapons proliferation. To make significant advances, therefore, nuclear must be substantially cheaper than its competitors for providing zero-emission energy. Most cost estimates, however, suggest that it will be cost-competitive at best and perhaps more expensive when the full costs of facility decommissioning, waste disposal and insurance liability are accounted for. The use of nuclear will grow in some regions, but for the next 100 years its share of the global energy system is unlikely to expand much beyond its current 3%. In the more distant future, developments in fusion technology or other non-radiating nuclear alternatives may expand its opportunities.

Renewable energy is seemingly inexhaustible and environmentally benign, yet many of its manifestations are characterized by low energy density, variability of output and inconvenient location. This will often require dedicated facilities for energy concentration, storage, and transmission, and these can cause significant environmental and human impacts depending on their character and scale. The dams and reservoirs of large hydropower projects flood valuable valley bottoms and impede migratory fish and animals, windpower farms can conflict with scenic, wildlife and other values, and biomass energy plantations compete for fertile land with agriculture and forestry. As the contribution of renewables grows in scale, the associated energy concentration and storage costs will become more of an issue. Even when helped by strong policies, it takes time for renewables-using innovations to achieve the commercialization and expanded production that is necessary to lower costs. Starting from the negligible market share of renewables today, and in a growing global energy system, it will be an enormous and likely very expensive endeavor to force the wholesale replacement of fossil fuels with a renewables-dominated system in the course of just one century.

In anticipating the relative contribution of each of these energy options over this century, it is important not to confuse means and ends. The end is not an energy system dominated by renewables or nuclear or fossil fuels. The end is a low impact and low risk energy system that can meet expanded human energy needs indefinitely and do this as inexpensively as possible, without succumbing to cataclysmic forces at some future time. With this sustainable energy system as the goal, it is unjustifiable to rule out fossil fuels in advance of a holistic comparison that considers critical decision factors. These factors include cost, of course, but also the general human desire to minimize the risk of extreme events (like a major nuclear accident), to ensure adequate and reliable energy supplies free from geopolitical turmoil, and to sustain values, institutions and lifestyles.

Even though it will perhaps triple in size over this century, the global energy system should nonetheless reduce its environmental impacts and risks. If the costs are not too great – and they appear not to be – it can become in effect a zero-emission energy system with negligible impacts to land, air and water. And any residual, unavoidable hazards can be ones from which the system could recover within a reasonable time, either from natural processes alone or in concert with human remediation efforts.

This sustainability objective for the global energy system is achievable, and indeed we have several options. But when all of these options are compared without prejudice, fossil fuels – the "unusual suspect" – are likely to retain a significant role in the global energy system through this century and far beyond, and the transition toward renewables and perhaps eventually nuclear will be gradual. Deliberately diverting from this lowest cost path by prematurely forcing fossil fuels out of the energy supply mix may not mean as much for wealthy countries, but for the poorer people on this planet this arbitrary requirement would divert critical resources that could otherwise be devoted to essential investments in clean water, health care, disease prevention, education, basic infrastructure, security, improved governance and biodiversity preservation.

Ironically, however, clean energy – whether relying on fossil fuels or some other option – does not ensure a sustainable human presence on earth. Indeed, if the eventual, long-term costs of developing a clean energy system are as low as some of the evidence suggests, the challenges to sustainability may be even greater as humans use energy to satisfy their basic needs and seemingly inexhaustible desires for materials and living space.

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Advance Praise for Sustainable Fossil Fuels

"Professor Jaccard tackles the two key global energy problems, an apparent shortage of oil and a dangerous build up of CO_2 in the atmosphere, and presents an original perspective on how simultaneously to resolve them with such clarity that it appears obvious – after you have read the book! … The text provides a balanced mix of serious economics and science, presented in easy-to-understand language and with just the right addition of everyday examples and quiet humor."
—Dr. Jon Gibbins, Professor, Energy Technology for Sustainable Development Group, Mechanical Engineering Department, Imperial College

"Mark Jaccard skillfully makes the case that those who leave modifying the way we use fossil fuels out of any plan to achieve "sustainability" in our energy systems surely confuse means with ends. If our objectives are to improve energy security and protect the environment at reasonable cost, he makes clear that, with a little bit of ingenuity and resolve, our extensive fossil fuel resources could well be our best friend rather than our worst enemy."
—Dr. John Weyant, Professor, Department of Management Science and Engineering, Stanford University

"Jaccard's well-researched study injects a much-needed dose of reality into the discussion of a 'sustainable' energy system. It is the voice of the economist tempered by extensive practical experience in the field and an evident concern for the future of our environment."
—Dr. H. Jake Jacoby, Professor of Management and Co-Director of the MIT Joint Program on the Science and Policy of Global Change, Massachusetts Institute of Technology

"Discussions of energy options too often oversimplify the world into good guys and bad guys. In his latest book, Mark Jaccard has done us all a service. He has brought cool analysis and common sense to a complex area of public policy fraught with myth and image management. His objective is to consider what might constitute a more sustainable energy system and in this he considers not only the usual suspects (energy efficiency, nuclear and renewables) but the unusual – fossil fuels. In doing so, he moves beyond the simplistic rhetoric and offers us practical policy recommendations that deserve serious consideration."
—Milton Catelin, Chief Executive, World Coal Institute

"Does preventing global warming require an end to fossil fuels? Jaccard makes a strong case that significant fossil fuel use and climate protection can co-exist, without harming economic growth. Read the book and decide for yourself."
—David Hawkins, Director, Climate Center, Natural Resources Defense Council

"Jaccard's book offers an important perspective on the major challenges posed by conventional energy. CO_2 emissions from fossil fuel burning must be curbed and oil dependence must be reduced to address climate-change and oil-supply-insecurity concerns. Many understand that this implies making energy use more efficient and increasing renewable energy roles. But few realize that fossil energy technologies can be modified at relatively low incremental costs to help address these concerns with CO_2 capture and storage technologies. This book addresses this issue. It is a marvelous primer showing why this option must be taken seriously by policymakers and the general public."
—Dr. Robert Williams, Senior Research Scientist, Princeton Environmental Institute, Princeton University

“Mark Jaccard’s analysis of the potential contribution of fossil fuels provides a much-needed contrast to the more extreme views of imminent resource exhaustion.”
—Dr. G. Campbell Watkins, co-editor of The Energy Journal

“This is an optimistic book. It significantly broadens energy perspectives. In the general discourse, energy is often associated with serious challenges: security of supply, peace, climate change, many other environmental issues, and the unfilled needs of energy services for economic growth and poverty alleviation for a majority of the world's population. This book presents new technically and economically feasible options that promise to address these challenges. There is light in the tunnel, and it is now up to all stakeholders, and our political processes, to realize these options! I strongly recommend this book to all concerned about our common future!”
—Dr. Thomas Johansson, Professor and Director, International Institute for Industrial Environmental Economics, Lund University – formerly Director of the Energy and Atmosphere Programme of the Bureau for Development Policy in the United Nations Development Programme.

“Professor Jaccard's book provides a very important addition to the policy debate over future sources of energy in a climate constrained world that is trying to become environmentally sustainable. At the heart of his book is the idea that "Renewables and zero emission fossil fuels will compete for the dominant position in meeting the needs of a sustainable energy system over the coming century". He finds that zero (carbon) emissions fossil fuels are likely to have a cost advantage over renewables and in any event renewables, he argues, "would be hard pressed to overtake fossil fuels by the end of the century". Whilst a number of published scenarios challenge this view, particularly for the period beyond the 2050s, he has marshalled a lot of arguments that are worthy of serious debate and further research. Although I am not convinced, I would urge all involved in this debate to read this important book!
—Bill Hare, Visiting Scientist, Potsdam Institute for Climate Impact Research – formerly led the Greenpeace International work on the Kyoto Protocol.

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Paperback: **ISBN 0521679796** | Published December 2005 | CAD$28.95/USD$24.99
Hardback: **ISBN 0521861799** | Published December 2005 | CAD$82.95/USD$70.00

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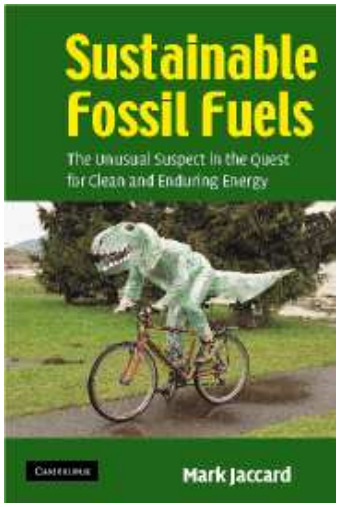

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