

THE CORPORATE EXAMINER

Vol. 37, No. 4-5, March 16, 2010

Losing Faith in Economics



INTERFAITH CENTER ON CORPORATE RESPONSIBILITY

Inspired by Faith, Committed to Action

CONTRIBUTORS

John Gowdy is Professor of Economics and Rittenhouse Chair of the Department of Economics at Rensselaer Polytechnic Institute in Troy, New York. He is President-Elect of the International Society for Ecological Economics and served as past President of the United States Society for Ecological Economics. He received his PhD from West Virginia University and has published extensively on economics and ecological economics.

Andrew Groat is a Financial Consultant in Syracuse, New York. He received an MBA from Syracuse University and was a vice president of institutional sales at a major Wall Street firm covering global derivative markets for macro hedge funds.

Nate Hagens received an MBA with Honors from the University of Chicago and worked for Salomon Brothers and Lehman Brothers before managing a private hedge fund. He is completing his doctorate in Natural Resources at the University of Vermont and is Editor of The Oil Drum, an online energy discussion portal (www.theoil drum.com).

Charles A.S. Hall is Professor of Environmental Science at the State University of New York, College of Environmental Science, in Syracuse. His fields are systems ecology, energetics and biophysical economics. He received his PhD from the University of North Carolina at Chapel Hill under Dr. H.T. Odum. Dr. Hall is author of several books and numerous articles.

Lisi Krall is a Professor of Economics at the State University of New York Cortland with expertise in political economy and environmental and ecological Economics. A Fulbright Scholar, she also serves on the executive board of the Center for the Advancement of Steady State Economy. Her new book, *Proving Up: Domesticating Land in U.S. History*, uses evolutionary economics to explore the interconnections of economy, culture, and land in U.S. history.

Leslie Lowe is the Director of ICCR's Energy and Environment Program. She is an environmental attorney who received her J.D. from Harvard Law School and did graduate research in economic and social history at the University of Paris, Center for African Studies.

Kenneth Mulder is Farm Manager and Research Associate at Green Mountain College in Poultney, VT. His research interests include the efficiency of human and animal powered agricultural systems.

THE CORPORATE EXAMINER

Vol. 37, No. 4-5, 2010

Edited by: Julie Wokaty

Yearly rates: Single Subscription \$50

© 2010 Interfaith Center on Corporate Responsibility

www.iccr.org

The Corporate Examiner is published by the Interfaith Center on Corporate Responsibility for organizations and individuals concerned about the social impact of corporations and the application of social criteria to investments.

INTERFAITH CENTER ON CORPORATE RESPONSIBILITY
475 Riverside Drive, Room 1842, New York, New York 10115
212-870-2295

Photo credits & copyright: Cover, and pages 3 & 7 by Acilo Photography/iStockphoto; page 15, by SPRESSO/iStockphoto.

Losing Faith in Economics

CONTENTS

- Introduction 1
- The End of Faith-Based Economics 5
- Energy and Water:
The Real Blue Chips 13
- Energy Price Increases and the
2008 Financial Crash: Is it a Practice
Run for What's To Come? 19
- Capital and Sustainability 27

Energy and Water – The Real Blue Chips

By Nate Hagens and Kenneth Mulder

“The economy is a wholly owned subsidiary of the environment, not the reverse.”

Herman Daly, *Steady-State Economics*

Modern economic theory has inculcated in financial professionals a nearly unassailable belief that technology and human ingenuity will synergistically create higher and higher stock market wealth over time. Evangelized by the financial industry, the belief that equity indices will rise 10% per annum on average over the long run has become so widespread it is viewed as a natural law in American investing culture and beyond.

But ecology, biology, and systems theory suggest a reality that is quite different. Dollars (and all financial capital for that matter) are just markers for real capital, which is comprised of not only natural capital (resources) but also of built, social and human capital. Primary goods (water, energy, materials) are finite and as they are needed to make secondary goods (refrigerators, wind turbines, cars, etc.), these, too, are finite. However, tertiary goods (mortgage derivatives, collateralized debt obligations, natural gas futures contracts, etc.) have been limited only by the demand for them.

Due to its reliance on fiat currencies as a metric, standard economic analysis does not accurately account for the physical depletion of a resource, just as it does not distinguish between wants, needs or happiness on the demand side. The unfolding international credit crisis highlights the dangers of relying on strictly monetary measures for biophysical planning – credit and debt can be created with no underlying physical foundation. Energy and scarce natural resources, not dollars, are thus what must first be evaluated and ultimately budgeted to spend.

In a fiat system in which currencies are based on the full faith and credit of governments rather than gold and silver reserves, dollars only (temporarily) represent who controls these resources. Once it is understood that the difference between 1 trillion dollars and 100 trillion

dollars is merely paper, ink, and some unquantifiable deterioration in trust, a logical and important question to ask is: how much does it cost to procure and process the resources we want and need denominated in the resources themselves? This question lies at the core of biophysical economics, which attempts to look beyond short term market-based distortions using resource linked analysis.

With origins in biology's optimal foraging theory – which posits that organisms which maximize their flow rate of energy (food) minus their own energy (caloric) expenditures have had adaptive advantages – the concept of spending energy in order to obtain energy translates to the human sphere via the field of net energy analysis. Various named energy profit ratio, energy gain, energy surplus, and EROI (energy return on energy invested), net energy analysis looks beyond the short term pricing signals of the market and attempts to evaluate longer term trends in resource quantity, quality and availability.

If it takes more than a barrel of (equivalent quality) energy to find, extract and refine the marginal barrel of oil, it doesn't much matter if oil is \$100 or \$100,000 per barrel – because more dollars can't get us more gas. More dollars cannot create energy – they only allow us to free up existing fossil stocks and harness renewable flows faster – using finite energy and other depleting resources as inputs. The price of a product (e.g. oil) accepted for the current period is one that equilibrates supply and demand at the last, or marginal, unit of supply. In theory, a long series of these short term marginal prices will indicate scarcity or surplus for the long term.

Marginal unit pricing, however, does not reflect true scarcity in a world of non-perfect substitutes. Oil this year is at roughly the same inflation adjusted price of 35 years ago, yet the world has consumed almost 900 billion barrels in the interim, while oil-based transport has become the foundation of global trade. Therefore, basing energy and economic policy on dollar-based signals alone may lead to serious long term dislocations. Instead, calculating our costs in terms of critical natural capital may be a more fundamentally sound investment paradigm.

The two most important natural resources on a planet nearing seven billion people are water and energy. In most cases, each is required to procure the other. First, we use water directly through hydroelectric power generation at major dams, indirectly as a coolant for thermoelectric power plants, and to help produce biofuels. By sector, the two largest consumers of water in the United States are agriculture and electrical power plants, both prominent players in our future energy landscape. If we count only freshwater, fully 81% of U.S. use is for crop irrigation. For American corn production, an average of 2,100 gallons of irrigation water is required per bushel which yields 2.7 gallons of corn-based ethanol (Hill et al. 2006). This equates to 206 gallons of water needed per gallon of gasoline substitute, ethanol, before refining.

Internationally, several assessments suggest that up to two-thirds of the global population could experience water scarcity by 2050. This will be driven by the agricultural demand for water, which is currently responsible for up to 90% of global freshwater consumption. Water

shortages could become much more acute if there is widespread adoption of energy production technologies that require significant amounts of water, such as biofuels. In a resource-limited context, water could be diverted from current uses to be invested in energy production, especially if the market dictates this as society's priority. This would have significant impacts upon food production and human welfare.

Our media and science historically have not often considered water limitations in assessing scalability of bioenergy nor have policy assessments of future water needs typically incorporated increased irrigation demands related to biofuels production. However, Senator Jeff Bingaman, Democrat of New Mexico, recently introduced legislation that would require energy producers to account for the impact of energy development and production on the water resources of the United States. Another telling signal on the interconnectedness of water and energy came during Secretary of Energy Steven Chu's first press interview, when he stated that in a worst case scenario, up to 90% of the Sierra snowpack could disappear, all but eliminating a natural storage system for water vital to agriculture. Though the focus was climate change, water is emerging as a major variable interrelated with energy.

This resource interdependency goes both ways. In California for example, where water is moved hundreds of miles across two mountain ranges, water delivery is responsible for approximately 15% of the state's total electricity consumption. Cities without nearby reservoirs require energy to pump water from below ground to their citizens. Irrigated crops also require energy, including those crops used for alternative energy production, like corn. Dryland farming produces significantly lower and more volatile crop yields. For example, from 1947-2006, irrigated corn acreage in Nebraska had a 43% higher yield than dryland corn.

There are discrete costs in energy and water terms whenever we harness these valuable resources. As the cheapest, most accessible fossil fuel supplies are depleted, the biophysical ratio of energy output to energy input (EROI) tends to offset technological improvements, gradually yielding less surplus energy for the productive economy. In the 1930s in the United States, one unit of energy input used to return over 100 times the energy output in oil and gas. This ratio of 100:1 fell to 30:1 in the 1970s and to a range of 10-17:1 by the year 2000 (Cleveland, C. 2005). Anecdotal evidence based on physical costs suggests it is much less than this today. Essentially, we are in a race between technology, consumption and depletion – so far depletion is winning. In fact, much of the oil and particularly natural gas remaining in the US is uneconomic to drill at current prices.

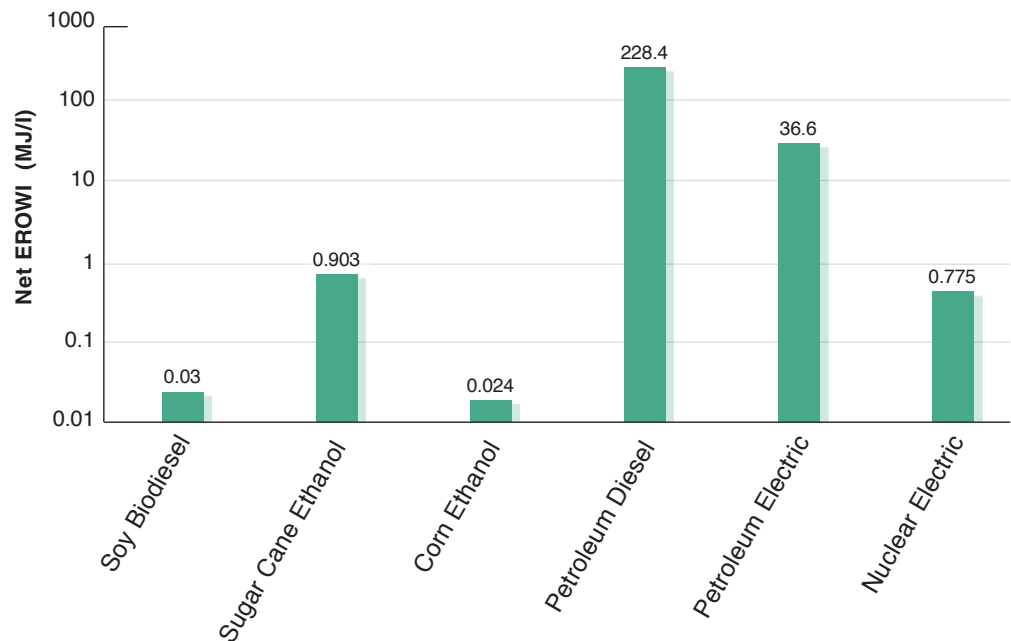
Figure 1.
(Service, R.F. 2009)

Water Requirements For Energy Production (Liters per megawatt hour)	
Petroleum extraction	10-40
Oil refining	80-150
Oil shale surface retort	170-681
NGCC* power plant, closed loop cooling	230-30,300
Coal integrated gasification combined cycle	~900
Nuclear power plant, closed loop cooling	~950
Geothermal power plant, closed loop tower	1,900-4,200
Enhanced oil recovery	~7,600
NGCC*, open loop cooling	28,400-75,700
Nuclear power plant, open loop cooling	94,600-227,100
Corn ethanol irrigation	2,270,000-8,670,000
Soybearn biodiesel irrigation	13,900,000-27,900,000

*Natural Gas Combined Cycle

A similar “biophysical analysis” can be undertaken treating water as the investment input. Unlike energy, human use of water, in theory, can be largely recycled. While this does not imply unlimited water withdrawals, it does suggest that water that is withdrawn is not necessarily rendered unusable. For example, cooling water withdrawn for use by a nuclear power plant may be returned and withdrawn again farther downstream to irrigate biofuels crops. However, some water does get consumed, either by being lost as steam or by being contaminated. Figure 1 above indicates water requirements for a variety of energy production technologies, expressed in liters per megawatt hour.

Figure 2.
Net EROWI (Energy
Return on Water Invested)
for Selected Fuels
(Mulder, K. et al.)



Although the primary perceived advantage of fossil energy resources has been their large energy return, our recent analysis combining statistics on the energy return (EROI) with the water invested per unit of energy using various technologies, suggests that fossil fuels also have a strong advantage in terms of their return on water invested (EROWI). With the energy return data, and the water requirement data, one can estimate a composite return statistic of these two natural resource inputs – a “net EROWI.” The calculations we performed suggested that the most water-efficient fossil electricity source examined yielded almost 600 times the energy per unit of water invested as did the most water efficient biomass source of electricity reviewed (Mulder, K. et al.). So, not only would the development of bio-energy on a scale sufficient to be a significant source of energy likely have a strong, negative impact upon the availability of fresh water, but it would require energy inputs far in excess of what we have traditionally allocated to the fossil energy sector.

Water limitations on energy may also make some seemingly benign environmental choices have unexpected drawbacks. The current move towards electric vehicles in response to higher oil prices, without a major change in the sources of electricity, would create major new water demand. If hybrid-electric cars fully replace gasoline vehicles, approximately 3 times more water will be consumed and 17 times more water will be withdrawn, primarily due to increased cooling of thermoelectric generation facilities (King, C. and Webber, M. 2008). This would exacerbate existing limits to the water/energy nexus. The 2009 heat wave in Europe raised river water temperatures so high that France could not reduce the heat of reactor casings for 14 of its nuclear plants, forcing reactor shutdowns. Although natural gas has been touted as the “cleanest fossil fuel,” water used in hydro-fracturing and other concerns about contamination are limiting drilling in the Marcellus Shale in New York and Pennsylvania.

Energy derived from finite and renewable resources is a function of multiple inputs including land, labor, and raw materials – any of which may become a limiting factor for energy production. A technology might have a high EROI and yet require sufficient levels of scarce, non-energy inputs as to be extremely restricted in potential scale. For example, the amount of land required for biofuels is between 100 and 1,000 times more than the land area required for conventional fossil fuels. In addition to non-energy inputs, energy technologies vary in their waste outputs and impact on environment. Within the biofuels class itself, there is a large disparity of pesticide and fertilizer requirements. For example, per unit of energy gained, soybean biodiesel requires just 2% of the nitrogen, 8% of the phosphorous, and 10% of the pesticides that are needed for corn ethanol, inputs that impact groundwater quality and stream runoff (Hill et al. 2006). As such, future refinements to an energy and water framework will likely have to extend beyond those two vital commodities.

When considering issues related to biophysical economics it is important to note that although alternatives to fossil fuels are many, these alternatives may not provide equivalent energy quality or quantity. Quality refers to a complex mix of physical, chemical, technical, economic, environmental and social attributes that are unique to each form of energy. These attributes include gravimetric (how much energy per unit weight) and volumetric energy density (how much energy per unit mass), power density (how much energy per unit of land/area), emissions, cost and efficiency of conversion, amenability to storage, risk to human

health, spatial distribution, intermittency, and ease of transport. It is also important to note that the amount of energy resources is unrelated to their quality, their flow rates, or their costs, measured in energy, environmental or financial terms. Essentially, large resource-in-the-ground estimates do not tell us anything about how much is extractable at any given point in time, nor to the costs in energy or financial terms.

The mainstream vision of our financial system has been based on numerous assumptions developed during a period when the planet was still relatively empty of humans, our civilization and our technologies. With so much unpopulated and undeveloped wilderness, there was little concern about seemingly small environmental and social “externalities.” It made more sense to focus on the growth of the market economy, as measured by GDP, profits and the stock market indices, as the primary indicators of human progress. (Costanza, R. 2009) But a long series of these short term settings has morphed into resource overshoot. Due to the depletion of the easiest and cheapest resources and increases in both population and consumption per capita, the two capital components of water and energy loom large from a social needs perspective.

In a world constrained by energy and increasing environmental limitations, but with growing human population, adherence to accounting frameworks based on natural capital will be essential for policymakers to assess energy, water and other limiting factors. Such a framework will help us discard energy dead-ends that are wasteful uses of our remaining high quality fossil sources and perhaps equally as important, of our time and effort. Ultimately, we should strive to have a renewable portfolio aggregating the highest returns on our most limiting inputs. Analysis that examines our energy and environmental balance sheets may highlight finite limits to human growth aspirations, and thus will be best matched with a similar framework in the social sciences. Our modern world is in great need of science and policy that both quantifies our available means, and reassesses the appropriate ends. Perhaps the market as we know it, will function better as an arbiter of “wants” while our “needs” budget is tied more tightly to our renewable ecosystem service balance sheet, of which debt and leverage are not a part.

References

-
- Cleveland, C. (2005). Net Energy from the Extraction of Oil and Gas in the United States. *Energy*, 30: 769-782.
- Costanza, R. (2009). Towards a New Sustainable Economy. *Real-World Economics Review*, 49: 20-21.
- Hill, J., Nelson, E., Tilman, D., Polasky, S., and Tiffany, D. (2006). Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels. *Proceedings of the National Academy of Sciences of the USA*, 103: 11206-11210.
- King, C., and Webber, M. (2008). The Water Intensity of the Plugged-In Automotive Economy. *Environmental Science & Technology*, 42(15): 4305-4311.
- Mulder, K., Hagens, N., Fisher, B. (accepted for publication 2010) Burning Water: Energy Return on Water Invested. *AMBIO – Journal of Human Environment*.
- Service, R. (2009). Another Biofuels Drawback: The Demand for Irrigation. *Science*, 326: 516-517.

Why Join ICCR?

WHO IS ICCR?

The Interfaith Center on Corporate Responsibility (www.iccr.org) is a membership organization which seeks a global community built on justice and sustainability through transformation of the corporate world.

Founded in 1971, at a time when the power of several social and religious movements converged, ICCR members first gained international attention for their efforts to end apartheid in South Africa. Today ICCR members are at the center of the Corporate Social Responsibility movement they began nearly forty years ago. Faith guides and shapes our priorities and we seek members and partners who embrace collaboration within this context. By promoting the transformation of corporate policies and practices, our members are certain that they are building a more just and sustainable world.

WHY BECOME A MEMBER OF ICCR?

ICCR members have a long tradition of work in areas of human rights, environmental stewardship and corporate governance. ICCR provides members with the research, resources and tools necessary to promote real changes in corporate practice and behavior. Members have the opportunity to be well-informed about cutting-edge issues in corporate social responsibility.

Working with ICCR, members sponsor shareholder resolutions, engage in dialogues with corporate management, participate in public hearings, partner with community organizations and raise awareness of issues through broad-based, outreach campaigns to key decision makers.

As we look towards the future, our growing coalition seeks new members who bring with them new visions and fresh ideas. The Interfaith Center on Corporate Responsibility is committed to broadening our membership by actively reaching out to all communities of faith who share our goals.

In short, ICCR members are inspired by faith and committed to action, as we work together to bridge the divide between morality and markets.

Please join us.

For more information or to become a member of ICCR please contact ICCR's Member Relations Associate Allison Lander at alander@iccr.org or 212-870-2984.

www.iccr.org



475 Riverside Drive, Suite 1842, New York, New York 10115