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Triple Bio: Bioagriculture, Bioenergy and Bioproducts

A vision to support an emerging bioeconomy in Washington State

Global Oil Depletion and
Implications for the Pacific Northwest
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". . . we may also have to confront the possibility that our innate energy optimism is itself obsolete, and that, in a future energy economy bounded by risks to supply, crushing energy privation, and a carbon ceiling, it will simply not be possible to continue producing energy in ever-increasing volumes. If that is the case, if there truly are limits to the size of our energy economy, then we will have to radically rethink not only the way we produce energy, but the way we use it." -- Paul Roberts, the End of Oil

"I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait 'til oil and coal run out before we tackle that." Thomas Edison

The Perfect Storm?: the converging crises of the 21st Century

Peaking global production of conventional oil (and natural gas) will place an incredible strain on global economies in general and on agricultural economies in particular. Tight petroleum and gas supplies, and consequently high prices for diesel fuel and nitrogen fertilizer, were expected to have a severe impact on US agriculture even before the devastation of Hurricane Katrina was fully realized. The USDA estimates that US farm income will fall more than 10% from 2004 to 2005 due to rising energy costs and expectations are that the near future could be even worse (Goldstein and Wilson, August 30, 2005). Increasing costs for production, processing and transportation will at least partially be passed on to consumers in the form of higher prices for food and other basic goods, squeezing consumer's budgets already stung by higher energy prices. Even retail giant Wal-Mart blamed rising fuel prices for the first quarter of sluggish profits the company has had in more than four years and suggested that struggling profits will continue if prices remain high and consumers have less money to spend on basic goods (Hall 2005). If the more pessimistic predictions for the peaking of global oil production prove accurate, the current US agricultural system *could* crack under the additional strain. Even if the optimistic predictions prove accurate, and oil production does not peak for at least 25 years, tight and volatile energy markets and higher costs will speed the erosion of an increasingly fragile sector of the economy.

Fossil hydrocarbons – specifically petroleum and natural gas – play a fundamental role in today's agricultural system. Diminished supply due to peaking – or increased costs for fossil hydrocarbons due to increased demand present a serious threat to the sustainability of US agriculture. However, the threat of peak oil and gas production is only one of the major crises facing agriculture early in the 21st century. Some of the other crises include the loss of genetic diversity and productive soil resources – which may prove to be even more devastating to the long-term future of civilization in a post-hydrocarbon world than a [temporary] liquid fuel shortage; the erosion of rural / farm economic vitality and subsequent loss of the remaining social and intellectual capital necessary for the production of food and fiber supplies to meet basic human needs; the potential for catastrophic contamination of the food supply by terrorists; and devastating impacts of severe climate change and variability such as increased drought, resource degradation, pests and disease. While most of the US economy has prospered greatly during the "hydrocarbon boom" of the past few decades, agriculture is in the midst of – and has been in – a constant state of crisis in spite of massive public subsidization and grand efforts to improve productivity and open foreign markets for agricultural products. Without immediate and creative intervention, peaking global oil and gas production could be the literal straw that breaks the camel's back.

Washington's farms and rural communities are in crisis – one that is generally overlooked by the majority of society. Most commodity prices are no better today than they were 30 years ago, while the cost of production has increased. Furthermore, incomes in rural agricultural communities have

not kept pace with national or state averages. In 1973 per capita income in non-metro Eastern Washington was equal to national and state average per capita income. In 2003, per capita income in non-metro Eastern Washington was only 75% of national average, while per capita income for the state was 106% of the national average (NIIP 2005). Average net income for Washington farmers in 2002 was $32,108. The average government payment (includes Conservation Reserve Program and Wetland Reserve Program as well as commodity payments and crop insurance) was $18,244 per farm – ***nearly 57% of net farm income***. Growing income inequality, and the consequent sense of limited opportunity, has drained the social capital and political influence of rural Washington as many people – especially young people – leave to find opportunity in the urban regions of the state.

Washington State has also ranked among the worst states in the percentage of children suffering from hunger and malnutrition for the past several years – much of which is in the rural reaches of the state (Nord, Andrews and Carlson 2003). The state of Washington lost more than 10% of it farms (more than 4,000) between 1997 and 2002 (NASS 2002) – most of these losses are from farms with sales of less than $500,000 – suggesting that small and midsized farms have been hit hardest. The average age of farmers in Washington has risen to 55.4 years old from 50.1 in 1982 – before the brunt of the farm crisis began. These are long-term trends, but have been exacerbated in recent years by rising production costs and depressed commodity prices related to consolidation and vertical integration in agricultural industry (Heffernan and Hendrickson 2002). The consequence of these trends is lost control over on-farm decision making by independent owner-operators, and more control by the few processors farmers can market to – leading to a situation in which only short-term financial considerations impact decision making.

Recent studies have raised awareness of the impacts that climate change will have on major industries, economies and regions, including the Pacific Northwest. In early 2004, the University of Washington Climate Impacts Group released studies indicating that under current trends the April 1st snowpack in the Cascade Mountain range could be reduced by 60% or more in the next 50 years and that we have already experienced a 30% reduction over the last 50 years (Service 2004). The Cascade snowpack is ***the*** primary water reservoir for the region and a critical resource to agriculture in the state. Irrigated agricultural production in Washington accounts for only 37% of the crop land, but 75% of the crop values. The Yakima Valley in Eastern Washington (approximately ½ million acres) is completely dependent on snowpack for irrigation and accounts for nearly $1 billion dollars in market value annually. Drought years in 1994 and 2001 accounted for an average of $140 million in lost value each year. Models predict 20 – 40% lower availability of water for irrigation by 2050 (Scott, M. et. al. 2004). In addition to water impacts, climate change is likely to cause greater problems with insect pests and diseases – while our capabilities to control pests and disease through petro-chemical inputs and genetic mechanisms may be severely diminished. If the energy produced from diminishing supplies of oil and gas is replaced by coal and heavy oils (oil sands and shale, etc.), the consequences for climate impacts are dramatically increased as the greenhouse gas emissions related with recovery and refining of these heavy oils are considerably higher than for conventional oil.

The consensus among energy experts is that the peaking of global oil and gas production presents a near-term, liquid fuel crisis which could have severe economic consequences – but one which we could likely recover from with desperate, crash-mitigating investment in the exploitation of remaining fossil hydrocarbon resources. The peaking of oil and gas, when considered in isolation from the other crises facing civilization, can be "mitigated" simply by finding a substitute source of liquid fuel – no matter what the external costs and consequences of that source might be. From a broader, long-term perspective, though, peaking oil and gas ought to be seen as the first substantive

cracks in the sustainability of the fossil hydrocarbon economy. ***A sustainable energy economy must fully account for impacts on global carbon budgets, human and natural capital, as well as the supply of energy.***

Shifting the Paradigm: living on current solar income

The sun is the primary ***source*** of energy on the earth (gravity and geothermal are others). Energy from the sun takes numerous forms: direct radiation in the form of heat and light, as well as the bio-geo-chemical forms of stored solar energy (biomass and wind). Wind energy is caused by the heating and cooling of air masses via solar radiation. Biomass energy is the chemical storage of solar radiation as hydrocarbon compounds via photosynthesis. Fossil fuels are merely biomass converted into super-condensed hydrocarbons under extreme temperature and pressure over geologic time. They represent, in the truest sense, a savings account of stored solar energy. Even hydropower – so critical to the Pacific Northwest's energy system – is ultimately solar energy because it is dependent on the solar-driven hydrological cycle (even though the energy source we capture is gravity).

A household budget provides a good analogy for describing a sustainable energy economy. A well-managed household budget is one that functions on current income, but also one that does not commit all current income to purchases but rather accounts for savings of some of that income for when it is needed later. Living beyond one's means, or using savings (or credit – which is income borrowed from the future) to supplement current income, is not sustainable, because it diminishes the stock of savings. Savings represents a stock of stored income – which can be used in an emergency, but which should not be considered income and should be replenished in better times. The hydrocarbon economy – which has enabled tremendous economic prosperity – is essentially the same as living on savings rather than current solar income. While there is a great deal of uncertainty about how large our remaining savings account is, it is obvious that we have "burned" through much of it with little regard for the fact that it is our savings – especially the most useful aspects of it – in a relatively brief period of human history. A wise financial counselor would *urgently* advise us to wean ourselves off of our savings and back onto current income rapidly, rather than suggesting that we continue to deplete our savings as business as usual until we "discover" another major "source" of savings. In order to wean us from our savings, the counselor would likely suggest that we look for ways to "pinch" our budgets by eliminating excess and getting better use out of our current resources and also to think about how we might increase our current income. Obviously, weaning off of savings and back onto current income is a painful process with a household budget, but those who make the transition are much more likely to be sustained. Much of the current discussion surrounding oil depletion is focused on extracting more of our savings – business as usual and thus digging ourselves in deeper – rather than making the hard transition to current solar income.

The bad news is that we've been living on our savings for so long that we are addicted in virtually every aspect of our civilization. The really bad news is that we now realize that we will soon not only exceed our current income, but that our demands will soon exceed even what our savings can supply (at least for the most liquid savings). The good news is that we have used both our savings and our current income very inefficiently and weaning ourselves from savings to current solar income may not necessarily require that we "go back to the stone age" as some pessimists have suggested.

Albert Einstein once wrote "today's problems cannot be solved by thinking the way we thought when we created them." Avoiding or mitigating the coming crises will require a shift from the current paradigm of dependence on supplying our insatiable demand for energy through fossil hydrocarbons

to the more sustainable paradigm of living on current solar income. Getting to that point may be painful (just like it is with a household budget) and will require systemic changes in the way that we value and utilize energy as well as major breakthroughs in research and development of new technologies that enable us to maximize the "harvest" and use of current solar income without causing unintended environmental and socio-economic consequences. Shifting to this new energy economy will require a multi-fronted strategy that includes such things as conserving energy and resources; dramatically increasing the amount of work or services provided by the same amount of energy and resources; eliminating wastes through reuse, recycling and converting into new products; expanding the deployment of renewable energy technologies; developing local and regional food and fiber systems; and developing new products from renewable hydrocarbons that can substitute for the fossil hydrocarbon products we now depend on. This final strategy, the development of power, fuels and products from renewable hydrocarbons – or biomass, is now commonly called developing the ***bioeconomy***.

Triple Bio: A vision to support the emerging bioeconomy

A bioeconomy is likely to be part of our future as a response to dwindling petroleum resources and the need to move to mitigate ecological damage associated with fossil hydrocarbon use. The particularly hazardous consequences of global climate change on many aspects of our state's economy create a compelling case for advancing carbon-neutral industries. The State of Washington can benefit from a targeted and immediate investment in developing a bioeconomy appropriate for our bioregion. The breadth of unique biophysical resources in the Pacific Northwest (PNW) provide a special opportunity for our state to produce biomass feedstocks, create products and develop an industry unlike any other region of the country. Triple Bio is a vision that will help launch a PNW bioeconomy in the agriculture, natural resources, waste management, and energy sectors of Washington State – and one that will complement many existing efforts to improve the sustainability of our food, fiber and energy systems.

Triple Bio involves three interwoven tracks – ***bioagriculture*** to produce food and feedstocks in an environmentally and energetically sustainable way; ***bioproducts*** research and development to process raw biological feedstocks into useful and higher value materials; and ***bioenergy*** to reduce our reliance on fossil fuels for transportation fuels, electricity and heat. Bioenergy refers to both power (electricity and heat) and liquid fuels derived from biomass. Bioproducts refer to refined, value-added materials derived from biomass, such as industrial, biological, medical and nutraceutical products. Bioagriculture – or BIOAg (Biologically Intensive and Organic Agriculture) is a suite of concepts, practices and technologies which capitalize on biological processes to maximize resource conservation and resource-use efficiency. Triple Bio will place the State of Washington in a strategic position as we enter the post-oil and carbon constrained age.

Bioenergy, especially liquid biofuels for transportation, represents a virtually unfillable demand given the productive land base available and existing transportation infrastructure, thus avoiding the typical scenario of large-scale commodity production saturating markets and depressing agricultural prices, leading to rural economic decline and the tendency to use extractive and resource-degrading farming systems. Bioenergy production will generate waste streams, such as glycerin from biodiesel, that hold potential as higher value bioproducts. Research and development on these "co-products" will rapidly make biofuels economically competitive with current fossil energy sources, hastening their adoption and expansion. Bioproducts research will reduce the environmental impacts of other waste streams from agriculture, resource management and bioprocessing, further protecting

ecosystem functions. Agricultural production of feedstocks for bioenergy based on ecological principles and strategies will enable long-term, sustainable production as demand for productive land resources increases to provide food, fiber and energy for a growing population. This trio of strategies can form the core of an emerging bioeconomy that relies increasingly on ”current solar income” as we wean our state from fossil hydrocarbon dependence and the environmental, economic, and geopolitical erosion we are currently experiencing.

While the consequences of peak oil and impacts of fossil fuel use will be particularly acute in the PNW (ie. we have no oil reserves in the region), we also have a significant potential to make a shift in the fundamental basis for our region’s economy from imported fossil fuels to our regionally abundant natural resources. The variability of climatic, geological and ecological conditions in the PNW makes it possible to produce more than 350 different agricultural products. In addition, the significant production of low-cost hydroelectric power (2/3 of Washington electricity) could provide the foundation for competitive industrial development in support of a regional bioeconomy. The development of a regional bioeconomy could relieve economic pressure in the region caused by the decline of traditionally important fossil hydrocarbon-dependent industries, such as aerospace and international trade, as well as reducing the loss of dollars from our state’s economy used to purchase petroleum (more than $20 million / day leaves our state to purchase transportation fuel. This amounts to a >$7billion potential market annually, more than Microsoft brings into our economy annually.)

Developing a bioeconomy supports the concept of shifting the fundamental basis of the economy from fossil hydrocarbons to renewable, biological resources – and thus living on current solar income. A bioeconomy incorporates many strategies, such as energy crops, waste utilization and biologically-based products, to displace the use of fossil fuels for the energy and products needed by society. In addition to our use of fossil fuels for electricity and liquid fuel, fossil fuels are the feedstock for many of the products we depend on today, such as plastics. A regionally appropriate bioeconomy is more than just the production of new products, though, it encompasses all three reference points of sustainability: ecological, social and economic. To meet this larger goal, a bioeconomy needs to include the recognition that local and regional needs may be different from place to place, and that a sustainable bioeconomy must be founded on the advantages and opportunities specific to the region.

Encouraging the emergence of a bioeconomy in the Pacific Northwest will require a significant and sustained investment, but it will be an investment that returns early dividends as well as improving the long-term sustainability of our economy. The state of Iowa has made a substantive investment in their bioeconomy initiative over the past decade, and it has paid off. Iowa is making an investment of more than $15 million per year in research and development of crops and bioenergy / bioproduct technologies at Iowa State University (and partnering research entities) and significantly more investment in new enterprises that commercialize these technologies. Iowa now boasts: (1) 7% jobs in the biosciences; (2) 40% of all US biodiesel production; (3) 24 built or soon to be built ethanol plants; (4) a top 3 position in bioscience patents; and (5) the fastest growing economy in the US – and second fastest growing average income (Vilsack 2004). Iowans are not resting on their laurels, though. They have set specific goals to develop at least ten regional biorefineries in Iowa by 2020 and start at least five new bio-businesses each year. Iowa is already ***exporting*** technology they have developed to other states and has become the “gold standard” example of how to create a bioeconomy. Iowa’s bioeconomy is not just about developing biofuels and products, but about creating employment, investment and ownership opportunities for Iowans and preserving the integrity of Iowa’s agricultural economy. Iowa’s success can be replicated in Washington, but it can’t be copied. A bioeconomy suited to our region will necessarily be different than the Iowan experience

because we have different geophysical and climatic conditions, biological resources and market opportunities.

Developing a bioeconomy in Washington State will require partnerships between farmers, natural resource managers, researchers, industry and the state. It will also require the development of a strategic vision for the future that can inform public policy, agriculture and natural resource management, industrial development, and emerging markets. A regional bioeconomy must be producer-driven . . . the idea that "if we build it they will come" is naïve. A bioeconomy is dependent on biological feedstocks – and production of those feedstocks must fit within existing agricultural and natural resource systems and must be profitable for the producers. We will need to recognize our comparative advantages, and invest in products and technologies that utilize our resources most efficiently and effectively. The bioeconomy must also be driven by the concept of sustainability – sacrificing the future by over-extraction of biological resources (ie. over-harvesting, degrading productive resources) is the same "type of thinking" that has created the problems we are facing today. The emergence of a bioeconomy will require considerable public ***and*** private investment. For example, WSU is in the midst of a 5 year, $3 million research and development initiative on anaerobic digestion of dairy manures. This research is leading to significant improvements in the technological and economic performance of this waste to energy technology. Commercialization of anaerobic digestion technologies by potential users in Washington will require an additional investment in the hundreds of millions of dollars over the next decade, but will generate significant economic impact, reduce greenhouse gas emissions and environmental impacts, provide renewable energy and other valuable bioproducts (including the potential for liquid fuel), improve farm income and protect the productive capacity of farms in Washington State.

Finally, developing a bioeconomy in Washington State will require political and economic will in the face of the converging crises of the 21st century. Increasing prices for energy, especially for liquid fuels in our region, will make investment more difficult as discretionary income, investments, and public revenues are squeezed. The potential for continued volatility in market prices for fossil hydrocarbon energy will send mixed signals to our economy, encouraging and discouraging innovation and fundamental change at the same time. Supporting the emergence of a bioeconomy will require steadfast investment in spite of volatility and political pressure, but will be an investment with clear dividends and one that will better prepare our local, state and regional economies to effectively deal with the crises we are facing. A suggestion for a good initial investment in a PNW bioeconomy is the development of a strategic roadmap for research, development and commercialization of agricultural and forestry practices and bioenergy and bioproduct technologies for the next 10 years. This will be a relatively inexpensive and rapid assessment that will identify the most effective way to leverage limited public and private resources into real, on the ground projects that will improve our regional economy and ultimately our preparedness to handle the coming crises.

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