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This is the second Museletter containing an excerpt from my upcoming book which has the working title 'The End of Growth'. The book is set for publication in July 2011.

The second piece in the Museletter was inspired by my recent visit to Alaska.

The End of Growth

Introduction: The New Normal

The central assertion of this book is both simple and startling: *Economic growth as we have known it is over and done with.*

The "growth" we are talking about consists of the expansion of the overall size of the economy (with more people being served and more money changing hands) and of the quantities of energy and material goods flowing through it.

The economic crisis that began in 2007-2008 was both foreseeable and inevitable, and it marks a *permanent, fundamental* break from past decades—a period during which most economists adopted the unrealistic view that perpetual economic growth is necessary and also possible to achieve. There are now fundamental barriers to ongoing economic expansion, and the world is colliding with those barriers.

This is not to say the U.S. or the world as a whole will never see another quarter or year of growth relative to the previous quarter or year. However, when the bumps are averaged out, the general trend-line of the economy (measured in terms of production and consumption of real goods) will be level or downward rather than upward from now on.

Nor will it be impossible for any region, nation, or business to continue growing for a while. Some will. In the final analysis, however, this growth will have been achieved at the expense of other regions, nations, or businesses. From now on, only *relative growth* is possible: the global economy is playing a zero-sum game, with an ever-shrinking pot to be divided among the winners.

Why Is Growth Ending?

Many financial pundits point to profound problems internal to the economy—including overwhelming, un-repayable levels of public and private debt, and the bursting of the real estate bubble—as immediate threats to the resumption of economic growth. The assumption generally is that eventually, once these problems are dealt with, growth can and will pick up again. But the pundits generally miss factors *external* to the financial economy that make a resumption of conventional economic growth a near-impossibility. *This is not a temporary condition; it is essentially permanent.*

Altogether, as we will see in the following chapters, there are three primary factors that stand firmly in the way of further economic growth:

- The *depletion* of important resources including fossil fuels and minerals;
- The proliferation of *environmental impacts* arising from both the extraction and use of resources (including the burning of fossil fuels)—leading to snowballing costs from both these impacts themselves and from efforts to avert them and clean them up; and
- *Financial disruptions* due to the inability of our existing monetary, banking, and investment systems to adjust to both resource scarcity and soaring environmental costs—and their inability (in the context of a shrinking economy) to service the enormous piles of government and private debt that have been generated over the past couple of decades.

Despite the tendency of financial commentators to focus only on the last of these factors, it is possible to point to literally thousands of events in recent years that illustrate how all three are interacting, and are hitting home with ever more force.

Consider just one: the Deepwater Horizon oil catastrophe of 2010 in the U.S. Gulf of Mexico.

The fact that BP was drilling for oil in deep water in the Gulf of Mexico illustrates a global trend: while the world is not in danger of *running out* of oil anytime soon, there is very little new oil to be found in onshore areas where drilling is cheap. Those areas have already been explored and their rich pools of hydrocarbons are being depleted. According to the International Energy Agency, by 2020 almost 40 percent of world oil production will come from deepwater regions. So even though it's hard, dangerous, and expensive to operate a drilling rig in a mile or two of ocean water, that's what the oil industry must do if it is to continue supplying its product. That means more expensive oil.

Obviously, the environmental costs of the Deepwater Horizon blowout and spill were ruinous. Neither the U.S. nor the oil industry can afford another accident of that magnitude. So, in 2010 the Obama administration instituted a deepwater drilling moratorium in the Gulf of Mexico while preparing new drilling regulations. Other nations began revising their own deepwater oil exploration guidelines. These will no doubt make future blowout disasters less likely, but they add to the cost of doing business and therefore to the already high cost

of oil.

The Deepwater Horizon incident also illustrates to some degree the knock-on effects of depletion and environmental damage upon financial institutions. Insurance companies have been forced to raise premiums on deepwater drilling operations, and impacts to regional fisheries have hit the Gulf Coast economy hard. While economic costs to the Gulf region were partly made up for by payments from BP, those payments forced the company to reorganize and resulted in lower stock values and returns to investors. BP's financial woes in turn impacted British pension funds that were invested in the company.

This is just one event—admittedly a spectacular one. If it were an isolated problem, the economy could recover and move on. But we are, and will be, seeing a cavalcade of environmental and economic disasters, not obviously related to one another, that will stymie economic growth in more and more ways. These will include but are not limited to:

- Climate change leading to regional droughts, floods, and even famines;
- Shortages of water and energy; and
- Waves of bank failures, company bankruptcies, and house foreclosures.

Each will be typically treated as a special case, a problem to be solved so that we can get "back to normal." But in the final analysis, they are all related, in that they are consequences of growing human population striving for higher per-capita consumption of limited resources (including non-renewable, climate-altering fossil fuels), all on a finite and fragile planet.

Meanwhile, the unwinding of decades of buildup in debt has created the conditions for a once-in-a-century financial crash—which is unfolding around us, and which on its own has the potential to generate substantial political unrest and human misery.

The result: we are seeing a perfect storm of converging crises that together represent a watershed moment in the history of our species. We are witnesses to, and participants in, the transition from decades of economic growth to decades of economic contraction.

Why Is Growth So Important?

During the last couple of centuries, growth became virtually the sole index of economic well-being. When an economy grew, jobs appeared and investments yielded high returns. When the economy stopped growing temporarily, as it did during the Great Depression, financial bloodletting ensued.

Throughout this period, world population increased—from fewer than two billion humans on planet Earth in 1900 to nearly seven billion today; we are adding about 70 million new "consumers" each year. That makes further growth even more crucial: if the economy

stagnates, there will be fewer goods and services *per capita* to go around.

We have relied on economic growth for the "development" of the world's poorest economies; without growth, we must seriously entertain the possibility that hundreds of millions—perhaps billions—of people will never achieve even a rudimentary version of the consumer lifestyle enjoyed by people in the world's industrialized nations.

Finally, we have created monetary and financial systems that *require* growth. As long as the economy is growing, that means more money and credit are available, expectations are high, people buy more goods, businesses take out more loans, and interest on existing loans can easily be repaid. But if more new money *isn't* entering the system, the interest on existing loans cannot be paid; as a result, defaults snowball, jobs are lost, incomes fall, and consumer spending contracts—which leads businesses to take out fewer loans, causing still less new money to enter the economy. This is a self-reinforcing destructive feedback loop that is very difficult to stop once it gets going.

In other words, the economy has no "stable" or "neutral" setting: there is only growth or contraction. And "contraction" is just a nicer name for Depression—a long period of cascading job losses, foreclosures, defaults, and bankruptcies.

We have become so accustomed to growth that it's hard to remember that it is actually is a fairly recent phenomenon.

During the past few millennia, as empires rose and fell, local economies advanced and retreated—but world economic activity expanded only slowly, and with periodic reversals. However, with the fossil fuel revolution of the past two centuries, we have seen growth at a speed and scale unprecedented in all of human history. We harnessed the energies of coal, oil, and natural gas to build and operate cars, trucks, highways, airports, airplanes, and electric grids —all the essential features of modern industrial society. Through the one-time-only process of extracting and burning hundreds of millions of years' worth of chemically stored sunlight, we built what appeared (for a brief, shining moment) to be a perpetual-growth machine. We learned to take what was in fact an extraordinary situation for granted. It became *normal.*

But as the era of cheap, abundant fossil fuels comes to an end, our assumptions about continued expansion are being be shaken to their core.

The end of growth is a very big deal indeed. It means the end of an era, and of our current ways of organizing economies, politics, and daily life. Without growth, we will have to virtually reinvent human life on Earth.

It is essential that we *recognize and understand the significance of this historic moment*: if we have in fact reached the end of the era of fossil-fueled economic expansion, then efforts by policy makers to continue pursuing elusive growth really amount to a flight from

reality. World leaders, if they are deluded about our actual situation, are likely to delay putting in place the support services that can make life in a non-growing economy survivable, and they will almost certainly fail to make needed, fundamental changes to monetary, financial, food, and transport systems.

As a result, what could have been a painful but endurable process of adaptation could become history's greatest tragedy. We can survive the end of growth, but only if we recognize it for what it is and act accordingly.

But Isn't Growth Normal?

Economies are systems, and as such they (to a certain extent at least) follow rules analogous to those that govern biological systems. Plants and animals tend to grow quickly when they are young, but then they reach a more or less stable mature size. In organisms, growth rates are largely controlled by genes, but also by availability of food.

In economies, growth seems tied to economic planning, and also to the availability of resources—chiefly energy resources ("food" for the industrial system), as well as credit ("oxygen" for the economy).

During the 19th and 20th centuries, expanding access to cheap and abundant fossil fuels enabled rapid economic expansion; economic planners began to take this situation for granted. Financial systems internalized the expectation of growth as a promise of returns on investments.

But just as organisms cease growing, economies must do so too. Even if planners (society's equivalent of regulatory DNA) dictate more growth, at some point increasing amounts of "food" and "oxygen" may cease to be available. It is also possible for industrial wastes to accumulate to the point that the biological systems that underpin economic activity (such as forests, crops, and human bodies) are smothered and poisoned.

But many economists don't see things this way. That's probably because current economic theories were formulated during the anomalous historical period of sustained growth that is now ending. Economists are merely generalizing from their experience: they can point to decades of steady growth in the recent past, and they simply project that experience into the future. Moreover, they have ways to explain why modern market economies are immune to the kinds of limits that constrain natural systems: the two main ones have to do with *substitution* and *efficiency*.

If a useful resource becomes scarce, its price will rise, and this creates an incentive for users of the resource to find a substitute. For example, if oil gets expensive enough, energy companies might start making liquid fuels from coal. Or they might develop other energy sources undreamed of today. Many economists theorize that this process of substitution can go on forever. It's part of the magic of the free market.

Increasing efficiency means doing more with less. In the U.S., the number of inflation-adjusted dollars generated in the economy for every unit of energy consumed has increased steadily over recent decades (the amount of energy, in British Thermal Units, required to produce a dollar of GDP dropped from close to 20,000 BTU per dollar in 1949 to 8,500 BTU in 2008). Part of this increasing efficiency has come about as a result of the outsourcing of manufacturing to other nations—which burn the coal, oil, or natural gas to make our goods (if we were making our own running shoes and LCD TVs, we'd be burning that energy domestically). Economists also point to another, related form of efficiency that has less to do with energy (in a direct way, at least): the process of identifying the cheapest sources of materials, and the places where workers will be most productive and work for the lowest wages. As we increase efficiency, we use less—of energy, resources, labor, or money—to do more. That enables more growth.

Finding substitutes for depleting resources and upping efficiency are undeniably effective adaptive strategies of market economies. Nevertheless, the question remains as to how long these strategies can continue to work in the real world—which is governed less by economic theories than by the laws of physics. In the real world, some things don't have substitutes, or the substitutes are too expensive, or don't work as well, or can't be produced fast enough. And efficiency follows a law of diminishing returns: the first gains in efficiency are usually cheap, but every further incremental gain tends to cost more, until further gains become prohibitively expensive.

In the end, we can't outsource more than 100 percent of manufacturing, we can't transport goods with zero energy, and we can't enlist the efforts of workers and count on their buying our products while paying them nothing.

Unlike most economists, most physical scientists recognize that growth within any functioning, bounded system has to stop sometime.

The Simple Math of Compounded Growth

In principle, the argument for an eventual end to growth is a slam-dunk. If any quantity grows steadily by a certain fixed percentage per year, this implies that it will double in size every so-many years; the higher the percentage growth rate, the quicker the doubling. A rough method of figuring doubling times is known as the rule of 70: dividing the percentage growth rate into 70 gives the approximate time required for the initial quantity to double. If a quantity is growing at 1 percent per year, it will double in 70 years; at 2 percent per year growth, it will double in 35 years; at 5 percent growth, it will double in only 14 years, and so on. If you want to be more precise, you can use the Y^x button on a scientific calculator, but the rule of 70 works fine for most purposes.

Here's a real-world example: Over the past two centuries, human population has grown at rates ranging from less than one percent to more than two percent per year. In 1800, world population stood at

about one billion; by 1930 it had doubled to two billion. Only 30 years later (in 1960) it had doubled again to four billion; currently we are on track to achieve a third doubling, to eight billion humans, around 2025. No one seriously expects human population to continue growing for centuries into the future. But imagine if it did—at just 1.3 percent per year (its growth rate in the year 2000). By the year 2780 there would be 148 trillion humans on Earth—one person for each square meter of land on the planet's surface.

It won't happen, of course.

In nature, growth always slams up against non-negotiable constraints sooner or later. If a species finds that its food source has expanded, its numbers will increase to take advantage of those surplus calories —but then its food source will become depleted as more mouths consume it, and its predators will likewise become more numerous (more tasty meals for them!). Population "blooms" (or periods of rapid growth) are always followed by crashes and die-offs. Always.

Here's another real-world example. In recent years China's economy has been growing at eight percent or more per year; that means it is more than doubling in size every ten years. Indeed, China consumes more than twice as much coal as it did a decade ago—the same with iron ore and oil. The nation now has four times as many highways as it did, and almost five times as many cars. How long can this go on? How many more doublings can occur before China has used up its key resources—or has simply decided that enough is enough and has stopped growing? The question is hard to answer with a specific date, but it must be asked.

This discussion has very real implications, because the economy is not just an abstract concept; it is what determines whether we live in luxury or poverty, whether we eat or starve. If economic growth ends, everyone will be impacted, and it will take society years to adapt to this new condition. Therefore it is important to know whether that moment is close at hand or distant in time.

The End of Growth Should Come as No Surprise

The idea that growth will stall out at some point this century is hardly new. In 1972, a book titled *Limits to Growth* made headlines and went on to become the best-selling environmental book of all time.

That book, which reported on the first attempts to use computers to model the likely interactions between trends in resources, consumption, and population, was also the first major scientific study to question the assumption that economic growth can and will continue more or less uninterrupted into the foreseeable future.

The idea was heretical at the time—and still is. The notion that growth *cannot* and *will not* continue beyond a certain point proved profoundly upsetting in some quarters, and soon *Limits to Growth* was prominently "debunked" by pro-growth business interests. In reality, this "debunking" merely amounted to taking a few numbers in the book completely out of context, citing them as "predictions" (which they explicitly were not), and then claiming that these

predictions had failed. The ruse was quickly exposed, but rebuttals often don't gain nearly as much publicity as accusations, and so today millions of people mistakenly believe that the book was long ago discredited. In fact, the original *Limits to Growth* scenarios have held up quite well. (A recent study by Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) concluded, "[Our] analysis shows that 30 years of historical data compares favorably with key features of [the *Limits to Growth*] business-as-usual scenario...").

The authors fed in data for world population growth, consumption trends, and the abundance of various important resources, ran their computer program, and concluded that the end of growth would probably arrive between 2010 and 2050. Industrial output and food production would then fall, leading to a decline in population.

The *Limits to Growth* scenario study has been re-run repeatedly in the years since the original publication, using more sophisticated software and updated input data. The results have been similar each time. (See *Limits to Growth: The 30-Year Update.*)

The Peak Oil Scenario

As mentioned, this book will argue that growth is over because of a convergence of three factors—resource depletion, environmental impacts, and systemic financial and monetary failures. However, a single factor may be playing a key role in bringing the age of expansion to a close. That factor is oil.

Petroleum has a pivotal place in the modern world—in transportation, agriculture, and the chemicals and materials industries. The Industrial Revolution was really the Fossil Fuel Revolution, and the entire phenomenon of continuous economic growth—including the development of the financial institutions that facilitate growth, such as fractional reserve banking—is ultimately based on ever-increasing supplies of cheap energy. Growth requires more manufacturing, more trade, and more transport, and those all in turn require more energy. This means that if energy supplies can't expand and energy therefore becomes significantly more expensive, economic growth will falter and financial systems built on expectations of perpetual growth will fail.

As early as 1998, petroleum geologists Colin Campbell and Jean Laherrère were discussing a Peak Oil impact scenario that went like this. Sometime around the year 2010, they theorized, stagnant or falling oil supplies would lead to soaring and more volatile petroleum prices, which would precipitate a global economic crash. This rapid economic contraction would in turn lead to sharply curtailed energy demand, so oil prices would then fall; but as soon as the economy regained strength, demand for oil would recover, prices would again soar, and as a result of that the economy would relapse. This cycle would continue, with each recovery phase being shorter and weaker, and each crash deeper and harder, until the economy was in ruins. Financial systems based on the assumption of continued growth would implode, causing more social havoc than the oil price spikes would themselves generate.

Meanwhile, volatile oil prices would frustrate investments in energy alternatives: one year, oil would be so expensive that almost any other energy source would look cheap by comparison; the next year, the price of oil would have fallen far enough that energy users would be flocking back to it, with investments in other energy sources looking foolish. But low oil prices would discourage exploration for more petroleum, leading to even worse fuel shortages later on. Investment capital would be in short supply in any case because the banks would be insolvent due to the crash, and governments would be broke due to declining tax revenues. Meanwhile, international competition for dwindling oil supplies might lead to wars between petroleum importing nations, between importers and exporters, and between rival factions within exporting nations.

In the years following Campbell and Laherrère's initial publication, many pundits claimed that new technologies for crude oil extraction would increase the amount of oil that can be obtained from each well drilled, and that enormous reserves of alternative hydrocarbon resources (principally tar sands and oil shale) would be developed to seamlessly replace conventional oil, thus delaying the inevitable peak for decades. There were also those who said that Peak Oil wouldn't be much of a problem even if it happened soon, because the market would find other energy sources or transport options as quickly as needed—whether electric cars, hydrogen, or liquid fuel made from coal.

In succeeding years, events appeared to be supporting the Peak Oil thesis and undercutting the views of the oil optimists. Oil prices trended steeply upward—and for entirely foreseeable reasons: discoveries of new oilfields were continuing to dwindle, with most new fields being much more difficult and expensive to develop than ones found in previous years. More oil-producing countries were seeing their extraction rates peaking and beginning to decline despite efforts to maintain production growth using high-tech, expensive secondary and tertiary extraction methods like the injection of water, nitrogen, or CO2 to force more oil out of the ground. Production decline rates in the world's old, super-giant oilfields, which are responsible for the lion's share of the global petroleum supply, were accelerating. Production of liquid fuels from tar sands was expanding only slowly, while the development of oil shale remained a hollow promise for the distant future.

From Scary Theory to Scarier Reality

Then in 2008, the Peak Oil scenario became all too real. Global oil production had been stagnant since 2005 and petroleum prices had been soaring upward. In July 2008, the per-barrel price shot up nearly to $150—half again higher (in inflation-adjusted terms) than the price spikes of the 1970s that had triggered the worst recession since World War II. By summer 2008, the auto industry, the trucking industry, international shipping, agriculture, and the airlines were all reeling.

But what happened next riveted the world's attention to such a degree that the oil price spike was all but forgotten: in September

2008, the global financial system nearly collapsed. The reasons for this sudden, gripping crisis apparently had to do with housing bubbles, lack of proper regulation of the banking industry, and the over-use of bizarre financial products that almost nobody understood. However, the oil price spike had played a critical (if largely overlooked) role in initiating the economic meltdown (see Temporary Recession or the End of Growth?).

In the immediate aftermath of that global financial near-death experience, both the Peak Oil impact scenario proposed a decade earlier and the *Limits to Growth* standard-run scenario of 1972 seemed to be confirmed with uncanny and frightening accuracy. Global trade was falling. The world's largest auto companies were on life support. The U.S. airline industry had shrunk by almost a quarter. Food riots were erupting in poor nations around the world. Lingering wars in Iraq (the nation with the world's second-largest crude oil reserves) and Afghanistan (the site of disputed oil and gas pipeline projects) continued to bleed the coffers of the world's foremost oil-importing nation.

Meanwhile, the debate about what to do to rein in global climate change exemplified the political inertia that had kept the world on track for calamity since the early '70s. It had by now become obvious to nearly every person of modest education and intellect that the world has two urgent, incontrovertible reasons to rapidly end its reliance on fossil fuels: the twin threats of climate catastrophe and impending constraints to fuel supplies. Yet at the Copenhagen climate conference in December, 2009, the priorities of the most fuel-dependent nations were clear: carbon emissions should be cut, and fossil fuel dependency reduced, *but only if doing so does not threaten economic growth*.

The Financial Component of Economic Contraction

If limits on resources and environmental sinks were closing the spigots on growth, the palpable pain that ordinary citizens were directly experiencing seemed to be coming mostly from another direction entirely: loss of jobs and collapsing real estate prices.

As we will see in Chapters 1 and 2, expectations of continuing growth had in the previous decades been translated into enormous amounts of consumer and government debt. Americans were no longer getting rich by inventing new technologies and making consumer goods, but merely by buying and selling houses, or by moving money around from one investment to another, or by charging transaction fees as others did so.

As a new century dawned, the world economy lurched from one bubble to the next: the emerging-Asian-economies bubble, the dot-com bubble, the real estate bubble. Everyone knew that these would eventually burst, as bubbles always do, but "smart" investors aimed to get in early and get out quickly enough to profit big and avoid the ensuing mayhem.

In the manic days of 2002 to 2006, millions of Americans came to rely on soaring real estate values as a source of income, turning their

houses into ATMs (to use once more the phrase heard so often then). As long as prices kept going up, homeowners felt justified in borrowing to remodel a kitchen or bathroom, and banks felt fine making new loans. Meanwhile, the wizards of Wall Street were finding ways of slicing and dicing sub-prime mortgages into tasty collateralized debt obligations that could be sold at a premium to investors—with little or no risk! After all, real estate values were destined to just keep going up. *God's not making any more land*, went the truism.

Credit and debt expanded in the euphoria of easy money. All this giddy optimism led to a growth of jobs in construction and real estate, masking the underlying ongoing job losses in manufacturing.

A few dour financial pundits used terms like "house of cards," "tinderbox," and "stick of dynamite" to describe the situation. All that was needed was a metaphoric breeze or rogue spark to produce a catastrophic outcome. Arguably, the oil price spike of mid-2008 was more than enough to do the trick.

But the housing bubble was itself merely a larger fuse: in reality, the entire economic system had foolishly come to depend on impossible-to-realize expectations of perpetual growth and was set to detonate. Money was tied to credit, and credit was tied to assumptions about growth. Once growth went sour in 2008, the chain reaction of defaults and bankruptcy began; we were in a slow-motion explosion.

The effort of governments since then has been directed toward getting growth started again. But, to very limited degree that this effort temporarily succeeded in late 2009 and early 2010, it merely masked the underlying contradiction at the heart of our entire economic system—the assumption that we can have unending growth in a finite world.

What Comes After Growth?

The realization that we have reached the point where growth cannot continue is undeniably depressing. But once we have passed that psychological hurdle, there is some moderately good news.

Not all economists have fallen for the notion that growth will go on forever. There are schools of economic thought that recognize nature's limits and, while these schools have been largely marginalized in policy circles, they have developed potentially useful plans that could help society adapt.

The basic factors that will inevitably shape whatever replaces the growth economy are knowable.To survive and thrive for long, societies have to operate within the planet's budget of sustainably extractable resources. This means that even if we don't know in detail what a desirable post-growth economy and lifestyle will look like, we know enough to begin working toward them.

We must convince ourselves that life in a non-growing economy can be fulfilling, interesting, and secure. The absence of growth does not necessarily imply a lack of change or improvement. Within a non-

growing or equilibrium economy there can still be continuous development of practical skills, artistic expression, and certain kinds of technology. In fact, some historians and social scientists argue that life in an equilibrium economy can be superior to life in a fast-growing economy: while growth creates opportunities for some, it also typically intensifies competition—there are big winners and big losers, and (as in most boom towns) the quality of relations within the community can suffer as a result. Within a non-growing economy it is possible to maximize benefits and reduce factors leading to decay, but doing so will require pursuing appropriate goals: instead of *more*, we must strive for *better*; rather than promoting increased economic activity for its own sake, we must emphasize whatever increases quality of life without stoking consumption. One way to do this is to reinvent and redefine growth itself.

The transition to a no-growth economy (or one in which growth is defined in a fundamentally different way) is inevitable, but it will go much better if we plan for it rather than simply watching in dismay as institutions we have come to rely upon fail, and then try to improvise a survival strategy in their absence.

In effect, we have to create a desirable "new normal" that fits the constraints imposed by depleting natural resources. *Maintaining the "old normal" is not an option*; if we do not find new goals for ourselves and plan our transition from a growth-based economy to a healthy equilibrium economy, we will by default create a much less desirable "new normal" whose emergence we are already beginning to see in the forms of persistent high unemployment, a widening gap between rich and poor, and ever more frequent and worsening financial and environmental crises—all of which translate to profound distress for individuals, families, and communities.

Alaska and Energy

During my recent visit to Anchorage, Alaska to speak at that city's Bioneers satellite conference, the friendly locals seemed eager to educate me about their local energy issues. Some of what I learned struck me as important to share with a wider audience. Alaska is, of course, a huge energy exporter. Crude from the North Slope saved America's energy bacon back in the '80s, helping to lower world oil prices and bankrupt the evil Soviet empire. Production there has declined from a peak of over two million barrels per day to only 600,000 or so today. Once the flow drops below 500,000 barrels, there will be problems with icing in the Trans-Alaska Pipeline system. Not good.

The state's economy is based almost entirely on resource extraction. Everyone gets a check annually from the Alaska Permanent Fund, set up in 1976 primarily by the efforts of then Governor Jay Hammond. High oil prices mean big dividends: in 2008-2009 extra-large payouts made Governor Palin look good to her constituents, though she was in no way responsible.

Alaska has enormous opportunities for renewables—wind,

microhydro, geothermal, tidal, even solar. But these are far from being adequately developed, and progress in that direction will take time and lots of investment—a dramatically higher pace of investment than is currently evident.

Anchorage (by far the largest city in the state) faces a particular challenge with natural gas: currently nearly all houses are heated with gas, but supplies from Cook Inlet will run low in two years, even sooner with an abnormally cold winter. Most options to replace current sources (more drilling, LNG, alternative energy) will take longer than two years to develop. There is no serious planning for what to do about this.

Then there is the situation of the native villages. On one hand, the indigenous peoples of the north might seem well placed to weather the changes ahead as industrial society succumbs to peak oil, peak coal, and peak gas: they have cultural traditions of self-sufficiency, small populations relative to land area, and access to lots of wild protein on the hoof (moose, caribou). However, as James van Lanen of Alaska Department of Fish and Game wrote to me in an email just the other day:

"Alaska Native villages are in a very precarious situation. These remote villages are only accessible by motorized travel via air or watercraft. They are entirely dependent upon fossil-fuel systems for goods and services: food, heat, health care. They have no contact with the outside world without fossil fuels.

"Some villages obtain more of their food resources from wild sources than others. It would be safe to say that on average 80% of the protein consumption in a village is from wild sources. Berries and Plants supplement some part of the overall diet but this is small. The two important things to consider are (1) much of the food consumed comes from industrial sources and is shipped in via small aircraft and (2) wild food harvests are currently almost entirely fossil-fuel dependent (there is a well-embedded 'machine culture' in native villages; I believe that there is no extant ability to obtain significant amounts of wild foods without the use of machines)..."

"Peak Energy will hit Alaska villages sooner and more intensely than many other places. Fuel is already up to $9 per gallon in some places. As it becomes uneconomical for current supply operations to continue the industrial resources these villages rely on will fizzle out."

"Most village people are aware of their complete dependence upon fossil fuels. Many elders foresee a future collapse due to increasing costs and modern dependence. However, there is no general awareness of the phenomenon of Peak Energy in these communities. There is no awareness that the entire system may break down. Alaska villages desperately need to become educated in what we are facing."

I came away from my too-brief sojourn in Anchorage with both a deep appreciation for this land of great natural beauty, contrasts, and extremes, and an equally deep concern for how Alaskans will deal with their enormous energy challenges. Some of those challenges are going to present themselves forcibly in the very near future.