

**Nuclear Energy – Fueling our Future**  
**Jerry Grandey,**  
**Mineral Economics and Management Society**  
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First let me say, it's good to be back in Colorado, my home for some twenty years.

As you heard in my introduction, I graduated from the Colorado School of Mines in 1968. I must say things have changed in the nearly 40 years since I was a student here.

Back then; we were a year away from putting a man on the moon. We were still involved in the Vietnam War. The irreverent Laugh-In was the hip new show and Olympic gold medalist Peggy Fleming was America's darling.

Now we're reaching out to Mars and beyond. We're involved in the War on Terror. Reality television is the big thing and Peggy Fleming is still around – hosting Skating with the Stars.

So in some ways, the more things change, the more they remain the same.

But thankfully, that's not true for everything or everyone.

Take me, for example. After graduation from the School of Mines, you see, I went on to law school. Ultimately, I found myself – long hair and beard – opposing the licensing of some of my best customers’ nuclear plants situated around the Great Lakes.

Clearly things have changed.

As a consequence of my youthful anti-nuclear activism, I learned more about the industry.

I discovered the risks were overstated and shrouded in mythology.

I found out about the industry’s outstanding safety and environmental record, the solid science, the promise of the technology, and the benefits it holds for all of us.

As a result, my thinking evolved, my beliefs changed and I have enjoyed a 30-year career in the nuclear industry.

Today, I believe the world is going through a similar evolution. The nuclear industry is undergoing a rebirth, as governments grapple with how to provide safe, cost effective, environmentally friendly and secure sources of energy to a power hungry world.

But, this is not the first time the world has become enamored with the promise of energy from the atom.

When I returned to Denver in the early-1970s, we were on the verge of a second wave of uranium exploration and production. The first wave occurred in the 1950s and centered on the military applications of the metal.

The second wave, this time for the generation of electricity, saw annual US production increase to 43 million pounds  $U_3O_8$ .

By 1979, prices for uranium hit in excess of \$40 per pound on “perceived”, rather than actual, scarcity. Many, including my boss and mentor, Bob Adams of Energy Fuels, predicted it was headed to \$100 or more.

Early in the 1980s, this second wave crashed on the disappointment of Three Mile Island, sagging electricity demand growth, and reduced expectations for the industry.

The large inventories of uranium, amassed in anticipation of 1,000 or more nuclear plants, were liquidated and prices declined for the next two decades hitting a low of about \$7 per pound.

The US all but shut down its industry, decommissioning and reclaiming 22 of 26 mills and some 300 mines. This pattern was repeated world wide – in Canada, Australia, Africa and the former Soviet Union.

We are now in the third wave, with exploration expenditures and newly formed junior mining companies increasing at an almost exponential rate.

Once again, as you heard in the market session earlier today, prices are rising. Once again, production is increasing worldwide. Once again, expectations are high.

So what makes us believe that we are seeing an expanding, long-term commitment to nuclear technology as a sustainable energy source? What makes us think this is not just another spike in the market?

Put simply, the world is a different place today. The demand for nuclear technology is being driven, not by OPEC induced shortages, but by real energy demand and, underlying this, by basic human desires – for quality of life, security, a clean environment and affordable electricity.

The preferred form of energy delivery has become electricity. Look around. We depend upon it:

- to run the lights in this room,
- to run our systems for defence, transportation, and computers,
- to run our hospitals, our financial markets and our economy.

Electricity is crucial to our way of life – and it is crucial to emerging economies – just to power basic infrastructure such as sanitation and clean water systems.

It is this insatiable demand for energy in the form of electricity that is driving governments and opinion leaders to rediscover the security, cost and environmental benefits that nuclear energy has delivered and promises to deliver to mankind.

For evidence, one need simply look at the international news stories from the last few months:

- In March, US President George W. Bush and Indian Prime Minister Manmohan Singh announced what has been called an “historic” nuclear pact that will help India satisfy its enormous energy needs while reducing its impact on the environment.

Under the agreement, which must be approved by the US Congress and others, the decades-long moratorium on sales of nuclear fuel and reactor components will be ended.

In return, India will separate its civilian and military nuclear programs and open its civilian facilities to international inspections. India currently has over 3,300 megawatts of nuclear generating capacity and has announced plans to increase this six-fold by 2020.

- At the World Nuclear Fuel Cycle conference held in Hong Kong earlier this month, representatives of the China National Nuclear Corp. noted that China plans to add thirty 1000 MWe reactors over the next 15 years. The nine currently operating nuclear reactors in China represent only 1.3% of China's total electricity generation.

- In March, Russia's atomic agency announced it was drafting its own ambitious program to build two nuclear reactors a year to make nuclear power account for a quarter of the nation's electricity by 2030. This came on the heels of a warning that Russia's uranium stockpiles were strained and could be depleted by 2020. The Russians called for mine expansion and a vastly increased exploration budget.
- Meanwhile, US President Bush is pushing a \$1.1 billion dollar program to promote the construction of new nuclear power plants, something the United States has not done since the 1970s. Upon signing of the "Energy Policy Act of 2005" – the first comprehensive US energy legislation in over a decade, Bush predicted: the US would "start building nuclear power plants again by the end of this decade."

- Indeed, ten companies are now engaged in site licensing, and the reactor technology for half of the chosen sites has been selected. A number of US utility executives believe the first new plant order will be placed within the next two years.
- And in late March, an overwhelming majority of leaders at a European Union summit gave strong backing to a revival of nuclear power as means to combat climate change and to reduce a growing dependence on imported energy supplies. The EU passed a resolution which recognizes the role that nuclear energy currently plays in maintaining the security of electricity supply and for avoiding CO<sub>2</sub> emissions.

Clearly, public and political attitudes about nuclear energy are changing globally, and this has translated into significant growth for our industry.

Today, countries representing half the world's population are constructing new nuclear power plants and many countries without nuclear power have begun to plan for it.

In the short term, which for this industry is a ten-year horizon, the number of reactors in operation by 2016 is forecast, by many experts, to increase to more than 500 from the current 440. If you add capacity gained through uprates, life extensions and refurbishments, conservatively speaking, nuclear power is certain to experience solid, albeit, modest growth in the coming decade.

However, accelerated growth for this industry is becoming much more likely. In Asia, for example, there are some 90 reactors under construction, on order, or planned over the next twenty years, primarily in China and India.

Other Asian countries with large populations and burgeoning economies are expected to follow, including Vietnam, Indonesia and Pakistan.

But the last plant ordered in the US was in 1973, and outside of Asia, there have been only a few plants built anywhere in the world, since that time.

If nuclear energy is to achieve the accelerated growth scenario, if we are going to start building a meaningful number of plants again, then nuclear must be competitive.

So how does it compare with other forms of electricity production in terms of affordability, environmental impact, and security of supply?

I would submit – very favourably.

Less than a month ago, on March 24, the World Nuclear Association published a paper, citing various independent studies, on the comparative life cycle analysis of electricity generated from nuclear, coal, natural gas, solar and wind.

Put simply, the studies analyzed –cradle to grave - how much energy it took to generate electricity from the various sources and expressed that as a percentage of the lifetime energy produced.

The paper concluded that among the sources of baseload electricity, nuclear power, using centrifuge enrichment technology, fares very well with only hydro closely comparable. “Baseload energy”, for those who might not know, comes from sources capable of providing the constant flow of electricity required to fuel major industries and provide minimum needs for our daily lives.

To give you some numbers, the life cycle percentage of input vs. output for hydro ranged from 0.5% to 2.3%.

Nuclear with centrifuge enrichment ranged from 1.7% to 2.1%. Coal ranged from a low of 2.9% to 14% and natural gas from 16.7% to 20%.

Our critics point out that for nuclear power, enrichment is clearly the key energy input. Although most of the world is switching to centrifuge technology, some enrichers still use older diffusion technology. When nuclear is compared using diffusion technology, the life cycle percentage of energy input vs. output rises and ranges from 4.8% to 9.5% – which is still competitive, but not as impressive.

But the WNA paper doesn't end with a simple energy cost comparison.

Another principle concern for life cycle analysis of energy systems is their likely contribution to global warming. This is a major external cost and one that is being increasingly considered.

The WNA paper cites a 1995 European Union funded comprehensive study – “Externalities of Energy” – and its follow up report in 2001. This study, which involves some 20 research projects over 10 years, quantifies the life cycle external costs of electricity generation in relation to health and environment. These are costs borne not by those within the industry, but society at large. They include effects of air pollution on human health, crop yields and buildings, as well as occupational disease, accidents, and the impact of carbon emissions.

When these costs are calculated, the EU study concluded nuclear energy is strongly favoured over both coal and gas. In fact, nuclear averages just 0.4 euro cents per KW hour for external costs, much the same as hydro. Gas is at least three times that amount and coal, 10 times as much.

The conclusion of these numerous studies is that nuclear is a clean and economic source of baseload power.

And if the world is serious about reducing greenhouse gases, nuclear energy could also be considered as a source of heat for large industrial applications. These could include non-conventional oil production in tar sands or shale deposits and the production of hydrogen, for use in transportation.

But is nuclear energy sustainable? Is there enough uranium in the world to power the ambitious plans for reactors for the decades and centuries to come?

To understand the answer to this question, it's important to review a little of the information about supply and demand, discussed earlier. Today, reactors are supplied by primary production from currently operating uranium mines and from secondary sources, like inventories and uranium derived from dismantled nuclear weapons.

Uranium demand at about 175 million pounds annually, has outstripped mine production by wide margins for the past two decades. We know that finite inventories will not last beyond a few more years. In response to these supply/demand fundamentals, the price for uranium has been on a steady rise, more than doubling in the last 24 months.

What this means is that new uranium deposits must be discovered and developed in time to meet the needs of an expanding industry.

Our critics point to the price increase as evidence of uranium scarcity and argue the technology is unsustainable.

But uranium is an abundant element – 40 times more abundant than silver; so there is great potential for many more discoveries with the current third wave of global uranium exploration. We should remember that during that second wave of exploration mentioned previously, sufficient uranium was discovered in a five-year period to supply the industry for 30 years.

Thus, there is no shortage of uranium in the world, only a shortage of known economic deposits due to the absence of meaningful exploration for 25 years. It is this new, third exploration cycle that, over the next decade, will find the orebodies required to power the world's growing reactor fleet.

When, at some point in the future, uranium does become scarce, used fuel can be recycled. Used fuel contains large quantities of unused energy – indeed, about 95% of the initial amount – and while a handful of countries already reprocess some of their used fuel – the current process is expensive.

But there are signs that might change. After discussion with the UK, France, Russia, Japan and China, the US government has announced a Global Nuclear Energy Partnership through which it has committed to "work with other nations possessing advanced nuclear technologies to develop new recycling technologies in order to produce more energy, reduce waste, and minimize proliferation concerns."

This strategy supports comprehensive development of an advanced fuel cycle which would include reprocessing, recycling and the use of advanced reactors to reduce the amount, heat load and toxicity of waste.

If the world ultimately goes in this direction and if the next generation of reactors comes on line smoothly, supply will not be an issue. Recycled fuel could provide an almost inexhaustible supply of energy.

So, the supply of nuclear energy is secure. The technology is affordable, and it is clean.

When we look at life cycle comparisons to other baseload energy providers, it's a winner on both economic and environmental grounds.

And the attitude towards the technology is changing and evolving – much as my beliefs did decades ago.

This is happening not only in the political and commercial arena, but among those who traditionally oppose our industry.

High profile environmentalists who changed their mind on the subject of nuclear include:

- British atmospheric scientist James Lovelock,
- Stewart Brand, founder of the Whole Earth Catalog,
- the late British Bishop Hugh Montefiore – founder and director of Friends of the Earth, and
- Patrick Moore, a founding member of Greenpeace.

I had the pleasure of meeting Patrick Moore earlier this year and found we had a lot in common.

A few decades back, Moore was one of the **most** rabid anti-nuclear activists. But his thinking, like mine, evolved, and he is now one of nuclear energy's most stalwart supporters.

Just this past weekend, Moore penned an opinion piece for the Washington Post called “Going Nuclear: A Green Makes the Case”. This concise and very readable article makes a compelling environmental case for the growth of nuclear power. I’ve brought copies of this article with me today, and I would encourage anyone who is interested to read the piece in its entirety.

Moore supports the idea of nuclear as an important part of an energy mix that reduces CO<sub>2</sub> emissions. He said, and I quote:

“My views have changed, and the rest of the environmental movement needs to update its views too, because nuclear power may just be the energy source that can save our planet from another possible disaster; catastrophic climate change.”

He closed by encouraging readers to imagine if 60 percent of our electricity was generated from nuclear.

“This would go a long way,” he said, “toward cleaning the air and reducing greenhouse gas emissions. Every

responsible environmentalist should support a move in that direction.”

Times have changed.

And I believe nuclear power will continue to grow in the decades and centuries to come and, in doing so, improve the quality of life for all of mankind.

Thank you for your kind attention.