Nuclear and the New American President

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Abstract
The American election is over, and just before this event there was a great deal of talk about energy independence. The Democratic candidate, for example, called for a "transformation" of the US economy in order to make his country independent of imported energy – particularly from the Middle East – and this transformation would feature a recourse to renewables that, supposedly, would enable the creation of 500,000 new employment opportunities. There might also eventually be a more widespread tolerance of nuclear energy and the offshore drilling for oil. In conjunction with my previous publications, and in particular my energy economics textbooks, I feel that nuclear energy should be recognized as the natural basis of a new American energy economy. At the same time I can respect the argument for a large and diverse portfolio of renewables.

Let me start by repeating what I said in an article in the journal Energy and Environment (2004), We do not know if global warming is the real deal, or just part of a cycle, but we have discovered that gas and oil can become extremely expensive in a very short time. In these circumstances the optimal behaviour is to get friendlier with the friendly atom, and do what former Prime Minister Blair and the founder of Greenpeace suggest, which is to increase the use of nuclear energy.

What does nuclear energy have to do with the depletion of oil and gas? As emphasized in my new energy economics textbook (2007), it has almost everything to do with it, because nuclear may well be the most flexible of all energy expedients, in that it can supply the 'extra energy' required to e.g. obtain the large quantities of motor fuels that voters in the energy importing countries have no intention of doing without, regardless of what they say or believe or hope. As Len Gould noted in the important forum EnergyPulse (www.energypulse.net), those voters intend to maintain their transportation activities at close to the present level – which in many cases is mandatory if they are to maintain the standard of living of themselves and their families – even if they must go to war to ensure this outcome.

Germany is a country that, together with Sweden, has expressed a desire to abandon its nuclear ambitions. After the widespread distribution of my short paper 'Some Friendly Economics for the Nuclear Energy Booster Club', I received mails from several persons in that country (and elsewhere) requesting their names to be removed from the list of persons directly receiving my papers. I was especially surprised by the origin of several of these 'Dear Johns', however…

'Wir Werden Wiedermal Marschieren' (=We Will March Again), was the title of a book that gained considerable attention in Germany when I was in that country with the U.S. Army. It became a best seller, and was about the retaking by the German military of places like the Sudetenland (in Czechoslovakia) in the coming Third World War, which the author of that book and many of his readers saw as inevitable as well as essential for their peace of mind.

Early in my 'tour', the armies of Nato countries participated in perhaps the largest peacetime military manoeuvre ever held in 'West' Germany, which was called 'Apple

Harvest'. Toward the conclusion of that exercise, the referees ruled that the Red Army had broken through the Fulda Gap and had almost reached Nuremberg, and it was judged that the only way that they could be stopped was with nuclear weapons. I had the opportunity to review the calculations for one of the simulated nuclear projectiles fired from a large cannon at the advancing Red Army. Had it been real instead of simulated, a portion of the eastern suburbs of Nuremberg would have been removed from the face of the earth. After that rather disturbing result came to be known, German officers, journalists, book-club members, and various decision makers lost their appetite for marching. The same kind of reversion will likely happen when the German public comes to realize that abandoning nuclear energy could wreak havoc on their personal agendas! Among other things it could mean that virtually every factory in Germany becomes a candidate for transfer to regions with an adequate and reliable supply of energy.

This is why I make a point of suggesting in my lectures that a more realistic attitude toward nuclear energy might be wise. The key issue of course is not the calculations that I make from time to time concerning the economic optimality of nuclear generating equipment, but my pension! It is also the key issue for many of academics and energy professionals in this country (Sweden) and probably elsewhere, although they have been convinced by know-nothing members of the anti-nuclear booster club and their favourite politicians that they would be doing themselves a disservice by understanding the easily understandable.

Perhaps the clearest argument for nuclear power has been presented by Rhodes and Beller (2000), which is similar to the basic contention of this contribution. They say that "Because diversity and redundancy are important for safety and security, renewable energy sources ought to retain a place in the energy economy of the century to come." The meaning here is clear, especially if you add that we probably will never possess what is known in intermediate economic theory as the optimal amount of nuclear power. But they do state that "nuclear power should be central….Nuclear power is environmentally safe, practical and affordable. It is not the problem – it is one of the solutions." Actually, it is an indispensable component of any rational energy program.

An American President's Dilemma

During the just concluded presidential campaign in the United States (U.S.), President-Elect Obama did not express a great deal of confidence in nuclear energy. Instead he suggested that a larger involvement with renewables should be undertaken in order to create 500,000 new jobs, and remove the U.S. from the clutches of foreign sellers of energy. This sounds as if there is some kind of choice as to what kind of energy structure and strategy should be embraced in order to restore the economic health of the Republic and ensure its energy future.

Actually there is no meaningful choice at all if nuclear is excluded or reduced in scope. As is well known, nuclear energy is not popular with everybody. It certainly was not a favourite energy preference with many of the young people who voted for the new president, to include those who came under the influence of second-rate teachers of energy economics. As for France, mentioned by Presidential candidate John McCain as an energy roll-model, there are many persons who hope that someday the 80 percent of the electricity supply that originates with nuclear can be replaced by another energy source. Frankly, that yearning seems unrealistic. In countries like France and Japan, where energy independence is paramount, nuclear energy is not there to be questioned but to be exploited. 'No oil, no gas, no coal, no choice' is the way the French put it, and although the energy prospects of many other countries may appear rosier at the present time, they could find themselves in the same predicament some fine day. The French also prefer the standardize nuclear equipment, which is something that the US should consider.

Even in Russia, which would be one of the richest countries in the world if its industrial and agricultural potential were fully developed, plans are being made to greatly increase its nuclear inventory in order to provide a competitive advantage with its trading partners, and to develop the Russian economy at a maximum rate.

This does not mean however that it makes economic or political sense for any country to ignore conservation and renewables, and/or other non-conventional energy sources. The ugly fact of the matter is that the world would probably be in a very bad way if these things do not become prevalent in a few decades, or perhaps even sooner, because they might have to accommodate a very large part of the energy burden in all except a few lucky countries. But one way to make sure that they will not be available is for naive voters and decision-makers to accept the twisted hypothesis that it is already economical to accelerate the introduction of these items, in concert with nuclear stagnation or a nuclear retreat.

Statistical analysis and a simple algebraic demonstration makes it clear that in terms of reliability and cost, the Swedish nuclear sector was the most efficient in the world before the curse of (electric) deregulation arrived. It is due to an intensified concern for the economic future that the irrational nuclear 'downsizing' in this country (Sweden) has been at least temporarily halted. The key departure was upgrading the ten remaining reactors so that they could produce the same electric energy (in kilowatt-hours = kWh) as the original twelve reactors, which amounts to nearly 47 percent of the total generated energy. (Approximately the same amount is accounted for by hydro.) The logic here is straightforward, and cannot be altered by the resolute ignoring or downgrading of mainstream economic history: *a high electric intensity for firms, combined with a high rate of industrial investment and the technological skill created by a modern educational system, will lead to a high productivity for large and small businesses. This in turn results in a steady increase in employment, real incomes, and the most important ingredients of social security (such as pensions and comprehensive health care).*

The question for Sweden or the U.S. or anywhere else then becomes whether welfare aspirations of the kind promised by the new U.S. president can be realized if the most efficient electric generating facilities in the world are scrapped or allowed to deteriorate because they did not make the 'cut' in a half-baked popularity contest. For instance, in order to recruit voters with anti-nuclear tendencies, the former Swedish prime minister informed those members of the population who prefer opinion and feelings to evidence and logic that nuclear power was "obsolete".

Behind this crank conjecture was the allusion that the impressive prosperity of an industrial country like Sweden could be maintained even if the country's nuclear assets were liquidated. What was not mentioned was that few countries have made as great an effort to include renewables in the energy mainstream as Sweden, but even so the result in terms of energy generated is insignificant. It is true that while (technically) renewables can be substituted for nuclear, the benefit-cost ratio is economically unacceptable. The decision makers in many other countries know this too, and better today than ever, because as pointed out in a recent issue of an American news periodical, energy policy has become a part of security policy.

One more point. I have gotten in the habit of claiming that it is possible to build a nuclear installation in four years (from 'ground break' to grid power). A gentleman recently pointed out however that I was rendering a disservice to readers with this contention, stating that in the US there are many factors which prohibit such a rapid process. Maybe so, but when the price of oil begins to escalate again, and pundits start talking about an oil price of 200 dollars a barrel, whatever these factors are they will be brushed aside. How do I know this? It is because greater political and engineering obstacles were surmounted during the second World War.

A Technical Consideration

As far as I can tell, wind energy is often pictured as a prominent alternative to nuclear energy where the generation is of electricity is concerned. In the United States the billionaire investor T. Boone Pickens has proposed a 'wind corridor' through the middle of the country, from the Rio Grande in the south to the Canadian border in the north, filled with wind installations generating electricity that would be inserted into new or old grids and transmitted both east and west. The aesthetics of this arrangement are not clear to this humble teacher of economics and finance, but I still remember enjoying the charm of the occasional windmill as I proceeded by train down the magnificent west coast of Sweden last summer.

The key term in the above paragraph is "occasional", because in this country, where engineering science has always received the highest respect, nobody in their right mind believes that an all-out commitment to wind energy makes the slightest engineering or economic or scientific sense, regardless of what they may say in a disco or student club, or when the television cameras are turned in their direction. I have a long survey of nuclear energy that I am revising (2008), however it contains one simple technical aspect of this topic that everyone should ponder, because it requires only a minimum of secondary school algebra. It turns on the expression *Capacity Factor* (CF), which has to do with the amount of energy that is actually produced over a given period as compared to the amount that could be produced if the facility had operated at maximum (or rated) output one-hundred percent of the time. This can be written CF = Actual Energy Output over a given period *divided* by Rated or *Maximum* Output. *When you hear about the beauty of wind energy, make sure that you ask about the Capacity Factor.*

Consider a wind turbine with a *power* rating of 100 kilowatts. In a month of 30 days its maximum *energy* output is 100 x 30 x 24 = 7,200 kilowatt-hours. However its *measured output* during that period would likely be lower, and perhaps much lower. Suppose it was 3,600 kilowatt hours. Then we would have CF = 3600/7200 = 0.50 = 50%. For wind a capacity factor of 15-35% appears average; and the important energy observer and commentator Jeffrey Michel confirms a stable 0.17 average for Germany before 2007, although it might have reached 0.2 in 2007. As for nuclear, 30 years ago capacity factors in the U.S. were about 55% due to the 'down-time' caused by unscheduled outages and scheduled maintenance, but now outages have decreased and average values are above 85%. Also, if capacity factors are calculated net of scheduled outages, then from time to time they have reached about 95%. which apparently applies to plants managed by e.g. Exelon.

By way of extending this theme , we can consider some information about the capacity factors of wind installations that was presented in EnergyPulse by Len Gould (2008) and Kenneth Kok (2008). Unfortunately I cannot say whether these are extreme or typical cases, but they have one thing in common that all readers of this and other papers on energy economics should observe and remember: the actual output from wind installations is often not just lower than the rated (or 'nameplate') output, but very much lower. Gould cites an operation by an independent North American wind power company in which the actual capacity factor for 2007 was somewhere between 8.67% and 17.35%. This might be characterized as a revolution in energy technology in reverse. Even so, it was superior to a performance noted by Kok, in which a TVA facility on Buffalo Mountain (near Oliver Springs, Tennessee) registered a capacity factor considerably under the above figures. In these circumstances it should be easy to understand why it was impossible to convince the voters and decision makers in Finland to choose renewables in order to obtain the increase in electric energy that might be necessary to maintain or

augment the standard of living, despite the considerable dislike of nuclear energy. Put another way, nuclear installations with very high capacity factors turned out to be preferable to windmills that did not rotate over very long periods. As I like to insist, with nuclear energy you generally have an excellent idea of what you are getting. With e.g. wind (or even solar), you often are unpleasantly surprised.

A Conclusion

"Economics is an easy subject that is difficult"
-John Maynard Keynes

I never tire of mentioning the bizarre fairy tale that was confected by two well known energy experts, Amory Lovins and Joseph Romm, and published in *Foreign Affairs* (1992-93), which is the prestigious journal of the (United States) Council on Foreign Relations. It goes like this:

> "For example, the Swedish State Power Board found that doubling electric efficiency, switching generators to natural gas and biomass fuels and relying upon the cleanest power plants would support a 54 per cent increase in real GNP from l987 to 2010 – while phasing out all nuclear power. Additionally, the heat and power sector's carbon dioxide output would fall by one-third, and the costs of electrical services by nearly $1 billion per year. Sweden is already among the world's most energy-efficient countries, even though it is cold, cloudy and heavily industrialized. Other countries should be able to do better."

I called that statement completely wrong the first time I saw it, while in my new textbook (2007) I suggest that it and similar contributions are misleading bunkum. For example, there are a number of questions that must be answered in detail before biomass can unambiguously be classified a large- scale fuel-of-choice for the near future. (See e.g. Grunwald (2008),) As for renewables such as solar and wind, and probably hydrogen, they will undoubtedly increase in quality and quantity, but hopefully it will not be at the expense of nuclear.

On one occasion when I published the above, I was invited to participate in a telephone conference that featured Dr Lovins. A telephone conference no less. Better a telephone conference than fisticuffs or a cursing competition next to the latrine at Camp Gifu (Japan), but fortunately I managed to propose a suitable alternative. He can put in an appearance in my class in energy economics the next time I teach at the Asian Institute of Technology (Bangkok), or for that matter any other institution of higher learning, where he can attempt to turn into reality some of the dreams of my students in which I am made a fool of or seriously humiliated.

As David Schlageter pointed out in EnergyPulse (2008), "Renewable energy sources only supplement the electric grid with intermittent power that rarely matches the daily electrical demand." He continues by saying that "In order for an electric system to remain stable, it needs large generators running 24/7 to create voltage stability. Wind and solar generation are not on-line when needed to meet energy demand, and therefore to help decrease system losses." In the promised land of wind energy, Denmark, voltage stability is attained by drawing on the energy resources of Sweden and Germany (and perhaps Norway). The Danes pay for the imported electricity, but not for the stability – which they would do in the great world of economic theory. Of course, for the reason suggested above by Lord Keynes, economic theory does not have much to say about even crucial energy issues. It can be suggested though that the Danes may be unable to afford more than basics where electricity is concerned. According to NUS Consulting (of South Africa), the price of

electricity in Denmark was the highest in the world in 2006 and the next highest in 2005. It can hardly be lower today. In 2005 Sweden had the next lowest price, and in 2006 the fourth lowest. Something must be drastically wrong in the Kingdom of Sweden for voters and politicians to remain passive in the face of this deterioration, particularly when NUS statistics indicate that the rise in the Swedish price is one of the most rapid in the world, and is almost certainly due to two things: a preposterous electric deregulation, and the closing of two nuclear reactors. The thing that should never be forgotten here is that for geographical and industrial reasons, Sweden is one of the most energy intensive countries in the world. As a result, a high energy consumption should be considered by the decision makers a necessity rather than a luxury, and treated accordingly.

But what about nuclear waste, which is repeatedly portrayed as a malicious and unavoidable cost of nuclear based electricity because, ostensibly, it will have to be locked up for hundreds of thousands of years? It is sometimes maintained however that the cost of disposing of nuclear waste is balanced by the *benefit* of no carbon-dioxide (CO2) emissions from reactors. For instance, the International Energy Agency (IEA) has calculated that for France – the country with the largest production of nuclear energy (as a fraction of the total output of electric power) – the average person is responsible for 6.3 tonnes of carbon dioxide (per year), which e.g. is one-third of the U.S. average. The cost-benefit *trade-off* mentioned above is worth remembering, however I prefer for students to know (and be able to explain) why France intends to treat 'waste' as a potential fuel. (A similar strategy has been proposed by the UK's energy minister.) A law now exists in France stipulating that toxic waste is to be stored in such a way that it can be comparatively easily accessed and recycled if, at some point in the future, "new" technologies appear which will allow it to be classified a preferable input in the nuclear fuel cycle. This option was also referred to, indirectly, by presidential candidate John McCain, however it appears that such thinking is not acceptable to an American audience…yet.

On many occasions I have been told that my own thoughts on nuclear matters are mistaken because of the subsidies received by the nuclear industries. Everything is relative in this old world of ours however, and so I continue to insist that nuclear is essentially subsidy-free. Furthermore, with reference to the second paragraph in this contribution, I like to cite an observation in the *Financial Times* (October 6, 2006). Nuclear power has provided "an abundance of cheaply-produced electricity, made the country (France) a leader in nuclear technology worldwide and reduced its vulnerability to the fluctuations of the turbulent oil and gas markets."