Comments on NY State ERDA document- "Blueprint for Consideration of Advanced Nuclear Technologies"

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Overall, this is a well written, researched, and thoughtful document. My comments are as follows and are restricted to nuclear technology:

Technological maturity is key as well as standardization. The "standard" PWR and BWR technologies went through tremendous learning curves including Billions of dollars in various forms of environmental degradation of both structural and fuel systems. These are problems I am most familiar with. I am sure there were many other challenges as well. There are tremendous implications related to new technologies, including supply chains, training of everyone from construction to operation, safety analyses, licensing, etc. etc.- the list is very long. One that especially concerns me related to materials (in addition to "unknown unknowns") is radiation damage for fast reactors where neutron energies, and therefore radiation damage is much higher than in water moderated reactors. See link to Financial Times article on costs and standardization below, as well as the old Rickover quote which, in my opinion, has considerable applicability today.

Don't it go alone- Because of the long list mentioned above, it will be important to team up with other states to spread costs and experience among as many of the same reactor types as practical. I was a resident of southeastern Connecticut where Millstone Point reactors were located. As I recall, there were three different reactors- A GE BWR, a Westinghouse PWR, and a Combustion Engineering PWR. From what I heard, the low bidders for construction may have appeared to save money, but operations, supply chains, safety analyses, etc. were a costly and time-consuming nightmare, and this is for "standard" reactors.

Consider nuclear as a backup for renewables. Nuclear is generally not considered as a backup because of the days commercial reactors need to start up and shut down. However, if they are used to generate hydrogen via the use of electricity and waste heat, a reactor could be kept at full power and then some or all of the electricity could be used to support the grid in a very timely manner. In addition, the waste heat could be used on site most of the time, obviating the need to co locate with another industrial or other user. There are many uses for hydrogen including as fuel cells for long haul trucks. Again, if many reactors did this across the country, the "hydrogen economy" could be enabled.

Small, modular reactors. These certainly can be made in a factory or factories. I have done manufacturing certifications on about 40 of them. However, small reactors have many of the same overhead costs such as security, safety, etc. as big ones, so make sure these overhead burdens are considered.

Consider Gen IV for 20-30+ years out- There are benefits to Gen IV technologies such as reduced waste, etc. and there has been considerable thought given to them, but I wouldn't count on any of them for the next two decades due to the long lists above.

Don't consider Fusion unless a miracle happens. There certainly have big successes in fusion technology, especially recently, such as at the Livermore Laser Ignition Facility, but, in the big picture of a power reactor, they are tiny, in my opinion. The quote I often hear is that "Fusion power is 30 years away and always will be." Having a structural materials background, my understanding is that radiation damage in materials will be orders of magnitude higher than in other nuclear technologies, including fast reactors, although my "knowledge" is extremely limited in this regard.

Nuclear waste. I understand the desirability of putting waste in a mountain and forgetting about it. An alternative to me is to put it in shipping containers, put them in a remote, dry location and monitor them. Shipping containers are extremely rugged and can be monitored for corrosion or other degradation and repaired over centuries. They could even be moved to another location. The only argument I have heard about this had to do with their vulnerability in a nuclear war. If there is nuclear war, I think there will be bigger problems.

Act with urgency. It seems obvious that more nuclear should be part of the solution. The earth is warming now and existing nuclear technologies are ready. Don't spend time studying advanced technologies.

For information: I worked at KAPL and MAO for 41 + years in a wide variety of materials, manufacturing and scientific assignments, including being the manager of medium and small component support at MAO (pumps, valves, control drive mechanisms, instrumentation and control equipment, etc.) At KAPL, I worked initially in advanced fuel manufacturing engineering, then transitioned to actual manufacturing where I was the cognizant engineer for developing and manufacturing the fuel elements for the Ohio. I spent two stints at a core vendor in eastern Connecticut. At KAPL I was Manager of the Reactor Material Activity group and was manager of Structural Materials Engineering. Later I became and Advisory Engineer, working on advancing fuel systems and introducing the emerging disciplines of computational materials and computational chemistry. Throughout my career, I had extensive experience with a wide variety of vendors in our supply chain, which can be very complicated. For example, as manager of structural materials, I was responsible for maintaining supply chains for over one hundred materials, many of which has heat treatments options as well. Vendors change processes, go out of business, etc. Constant vigilance and effort is required. I retired in 2010 and joined the board of a scientific software company for about 6 years.

An Admiral Rickover Quote from 1953

"An academic reactor or reactor plant almost always has the following basic characteristics: (1) It is simple. (2) It is small. (3) It is cheap (4) It is light. (5) It can be built very quickly. (6) It is very flexible in purpose ('omnibus reactor'). (7) Very little development is required. It will use mostly off-the-shelf components. (8) The reactor is in the study phase. It is not being built now.

"On the other hand, a practical reactor plant can be distinguished by the following characteristics: (1) It is being built now. (2) It is behind schedule. (3) It is requiring an immense amount of development on apparently trivial items. Corrosion, in particular, is a problem. (4) It is very expensive. (5) It takes a long time to build because of the engineering development problems. (6) It is large. (7) It is heavy. (8) It is complicated.

"The tools of the academic-reactor designer are a piece of paper and a pencil with an eraser. If a mistake is made, it can always be erased and changed. If the practical-reactor designer errs, he wears the mistake around his neck; it cannot be erased. Everyone can see it.

“The academic-reactor designer is a dilettante. He has not had to assume any real responsibility in connection with his projects. He is free to luxuriate in elegant ideas, the practical shortcomings of which can be relegated to the category of ‘mere technical details.’ The practical-reactor designer must live with these same technical details. Although recalcitrant and awkard, they must be solved and cannot be put off until tomorrow. Their solutions require manpower, time and money.

“Unfortunately for those who must make far-reaching decisions without the benefit of an intimate knowledge of reactor technology and unfortunately for the interested public, it is much easier to get the academic side of an issue than the practical side. For a large part those involved with the academic reactors have more inclination and time to present their ideas in reports and orally to those who will listen. Since they are innocently unaware of the real but hidden difficulties of their plans, they speak with great facility and confidence. Those involved with practical reactors, humbled by their experience, speak less and worry more.”

Financial Times article on reactor costs.

https://www.ft.com/content/c06524b8-4a0e-4deb-b283-ccab951b04e4