Response to RFI: http://www.gpo.gov/fdsys/pkg/FR-2011-03-14/pdf/2011-5794.pdf

Responder:

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Disclaimer:

The opinions voiced in this response are the author's and do not necessarily reflect those of either Washington University or the Department of Energy.

Format:

Because the stance of the Government is presumed to be that largely technical issues should be decided on largely technical grounds, the style of this response to the RFI will be that of a review of a manuscript submitted for publication: a series of focussed comments which address specific points of the RFI and the Framing Document.

Comments on RFI:

Pg. 13607, column 3. The definition "By enable options, we mean that we do not pick winners and losers; the markets make those choices." is **NOT Appropriate**. The problem with this definition is that many enabling technologies (such as massive electricity storage), which will take generations to bring online and thereby empower a switch to sustainable renewable energy, can not presently offer a respectable rate of return over a credibly short period of time. When (in the future) they are needed, their huge time-to-completion may assure, while they are constructed, that an energy starved public must endure a generation or more of rolling blackouts and shivering cold winters: one does not build aircraft carriers only after one goes to war! Only government intervention can

resolve this Catch-22 Moreover, this definition may be antithetical to Mission [6] “drive adoption and deployment of a clean electricity supply”.

Pg. 13607, column 3. The appropriateness of Mission [5] “modernize the grid” depends crucially upon one’s views of modernization. And these in turn depend upon the economic models one adopts. For example, traditional economic modelling based upon constant dollars, arbitrary discount factors, and fondly imagined rates of return may yield quite different answers than would models based upon embodied energy and projected utility to unborn generations. In America, one is supposed to esteem the “patriot dream that sees beyond the years”.

Pg. 13608, column 1. The issue of “How close to commercial viability does a demonstration have to be?” will be very tricky. For example, if one is dealing with massive underground pumped hydro energy storage, the cost of a best technology 1-GW forward/backward conversion module would presumably be relatively independent of the size of the storage module. However, staging issues for construction of the first GWh of storage would make that first GWh very costly, while the cost of each additional GWh should decrease rapidly. My view is that once folks have agreed that a principle has been proven but the cost of building full-scale is uncertain, then one should go at once to whatever size facility once wishes to propagate across the United States. The history of technology is that scaling up, whatever the application, is often are more difficult than one might imagine.

Pg. 13608, column 1. The issue of “What, if any, role should the Department have in addressing these barriers?” will of course be contentious. I take my stance from Section 10 of the Constitution which says of laws regulating interstate commerce that “all such Laws shall be subject to the Revision and Control of Congress”. In this present world, energy is the commodity of commodities; and Congress should do whatever is constitutionally permissible to facilitate its flow throughout our nation. The log jam on energy transmission must be removed. Assuring the safety of that transmission is a realistic goal: as soon a transmitter learns that reasonably foreseeable disasters are punished by turning off its questionable lines until they are brought up to standard, their outraged stockholders (and the public) will force them to very high standards of maintenance and inspection. This works wonderfully for airlines!

Comments on Framing Document (http://www.energy.gov/qtr/documents/DOE/QTR_Framing.pdf):

Overall, this document addresses, from a more administrative than technical perspective, numerous meritorious goals. However, this responder's interests focus upon 'storage', and energy storage in particular. He is unable to see how it adequately addresses the issue of Massive Energy Storage, to which a significant fraction of our GDP must soon be devoted if we are to achieve a timely and robust solution to the Intermittency Challenge. Therefore, he must award the FD a grade of **Publish after Major Revision**.

Strategic Plan. The "Six Strategies" enumerated on page 21 of the Framing Document are wonderful. But, absent (i) known tactics by which they can be actualized, (ii) the requisite material resources to power those tactics, and (iii) unswerving dedication to the project administration-after-administration, they are just so much enchanting vaporware. First, for example, the term "clean energy" appears 31 times in the Framing Document, but each time without a rigorous definition that a supermajority of the Congress might buy into. Technological development flourishes best when its goals and constraints are well defined. Second, where will the money come from? Still startlingly apt after two millennia is Cicero's aphorism from the *Fifth Philippic* (43 bce): "*nervos belli pecuniam infinitam*", "the sinews of war, money in abundance". Third, our move to a clean and sustainable future simply must not, sixty years hence and after much backing and filling, collapse ignominiously like our quest to find ample safe repositories for our nuclear waste.

Storage. The term 'storage' appeared thirty-two times in the Framing Document: once in the context of nuclear waste, ten times in the context of CO_2, and twenty-one times in the context of energy.

Storage of Nuclear Waste. It is stated on pg. 13 of the Framing Document that "For example, highly radioactive and toxic used nuclear fuel is produced and stored at the current fleet of nuclear plants, and presents a future problem for centennial-scale storage.". This is not a "future" problem! The problem is a special case of the country's overall problem of radioactive waste disposal. That problem has been recognized, but not resolved, for more than sixty years. Therefore, the problem is now! And pushing it off into the future is contrary to the precepts of the International Atomic Energy Agency (IAEA, *Safety Principles and Technical Criteria for the Underground Disposal of High Level Radioactive Wastes*, 1989, p. 7) "*Principle No. 1: Burden on future generations* The burden on future generations shall

be minimized by safely disposing of high level radioactive wastes at an appropriate time, technical, social and economic factors being taken into account."

Capture of Carbon Dioxide. None of the ten mentions of CO_2 storage discusses the technological tactics of the capture and storage process, which may or may not come on line in time to meet the stated goal "By 2035, 80% of America's electricity will come from clean energy sources." However, on pg. 40, reference is made to a 2010 report of the Interagency Task Force on Carbon Capture and Storage (http://fossil.energy.gov/programs/sequestration/ccstf/CCSTaskForceReport2010.pdf). With respect to the few existing capture facilities, this report says: "Scaling up these existing processes represents a significant technical challenge and a potential barrier to widespread commercial deployment in the near term" and "it is unclear how transferable the experience with natural gas processing is to separation of power plant flue gases, given the significant differences in the chemical make-up of the two gas streams" (p. 28 of above URL). Also with respect to capture, on pp. 32-33 the above report are listed nine planned demonstration projects, each of which should capture over 100 kt of CO_2 per year, which is tiny compared to the need.

It should be recommended that the DOE be blatantly and repeatedly open, even pessimistic, about the cost burdens that carbon capture will place upon the public: and it should be so in the Framing Document report. This reviewer takes as a matter of indisputable fact and morality that the consumer of energy should pay the costs of its externalities as the energy is used. This is no time for the DOE to go wobbly.

Storage of carbon dioxide. The Framing Document likewise does not address how the captured CO_2 is to be permanently stored. A cornerstone of the Framing Document report should be urgent recommendation of massive storage research. The URL given in the preceding topic also discusses storage. Presumably injection into underground formations will be relatively less costly than the initial capture. But the thousand year lifetime of storage mentioned on pg. 42 of the above URL is less than the estimated half life of excess CO_2 in the atmosphere. The Framing Document should champion extensive additional permanence research.

Storage of energy. Of the twenty-one mentions of energy storage in the draft Framing Document, only 6 were so specific as to mention the nature of the storage.

On pg. 25, it is stated that "DOE's goal is to drive reduction in the cost of battery storage to $300 per kilowatt hour (kWh) by 2014, roughly half of current costs.". But this can not be the

whole story because fork lift batteries are already available off the shelf at under $225 per kWh (http://www.solar-electric.com/crinba12.html). The batteries DOE has in mind must be special in some way.

On pg. 38 there are 5 mentions to thermal storage (2 implicit). First, the details of the thermal storage are not specified, although the public has a need to know that heat exchangers of adequate megawattage won't be cheap and that that their effectiveness may not be as high as desirable. Second, "long-term storage is defined as between 4 and 16 hours, which may be setting the bar a bit low because (in a 100% renewable future) on the order of 4 days of average consumer demand should be held in reserve to buffer the consumer against prolonged spells of overcast with calm winds.

The remaining 15 mentions do not point to specific means of attaining the storage needed. But they should because merely envisioning suitable storage is no guarantee that it can be provided. However, the Framing Document (pg. 35) did provide links to four DOE reports, only three of which have appeared since 2005. The first of these (2008) was of a general policy nature and seemed not to treat the hard technical issues in detail. The remaining two will be discussed in more detail.

The second of the three (December 2010) discusses grid-scale storage from a policy orientation, although their Fig.7 is a hugely interesting Ragone-type plot, which shows (as of April 2010) output power (ordinate) vs. stored energy (abscissa) for installed and planned energy (electricity?) storage systems: none exceed 100 MW or 1 GWh . In addition, their announced targets for system lifetime and system storage capacity do not seem compatible with society's needs for robust long-lived storage at gigawattday and above levels. It does not even mention the Intermittency Challenge which stands between us and massive diurnal and trans-seasonal load shifting.

The third (also December 2010) is focussed primarily upon batteries. Batteries, though hugely useful, are seldom mentioned as a solution for GWd energy storage.

In short, the *Framing Document does not squarely confront the Intermittency Challenge* which must be resolved if humanity is to transition smoothly to a green and sustainable future.