

FESAC-SP - A Ticket to Valley of Death ?

Charles Skinner , Princeton, NJ

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To: Mark.Koepke, zinklesj, keane1, chris.keane, heidbrin, drej, knowlton, reyessuarez1, kbowers, kothe, jsteadman, tcarter, milorasl, karl.van.bibber, dcorrell, denewman, woottona, Arati.Dasgupta, hegna, gert.patello, minami.yoda
Cc: Ed.Synakowski, dmeade

I thank the FESAC SP panel for their service and offer the following comments that I hope can be taken into consideration in the final report. I begin with an imagined conversation with a concerned citizen and then ask whether the path laid out can honestly claim to meet the goals expressed in the preface. The views expressed are my own and do not necessarily reflect the views of any other entity.

- Prologue
- Unique Leadership ?
- Bait and Switch ?
- Valley of Death ?

PROLOGUE:

'Abundant Energy - immense benefit to the U.S. and to the world !' [1] came the cry one sunny morning at the Energy Fair. Joe Everyman perked up his ears. He was there with his family to learn what was in store in their energy future, especially for his two young toddlers. He went over to talk to the grey-haired scientist at the FESAC display.

'Hey, I remember you' said Joe, *'Weren't you part of the team that generated 10 MW of fusion power on TFTR 20 years ago. That was great ! - how much fusion power are you up to now ?'*

'Er...' the scientist said *'well, actually we haven't generated any fusion power since then. But we have been studying fusion science'*

'OK' said Joe *'What is happening with that ?'*

'Well' the scientist said *'We have a new strategic plan that will make important contributions in informing options for a Fusion Nuclear Science Facility and providing strategies for a DEMO reactor'* [ibid p.20].

'Really !' said Joe *'How much fusion power will that generate and what's the price tag ?'*

'The plan budgets 3-4 \$billion over 10 years; but to actually generate fusion electricity we will still have to design and build and operate an FNSF and then design and build and operate a demo reactor'

'So how long to generate fusion power ?' Joe repeated.

'Well, if all goes well, and the future US fusion budgets increase by an order of magnitude, each stage could take a decade, - so maybe fusion power in 2080 if we are lucky. On the other hand the US balked at building previous machines such as CIT[2], BPX[3], TPX[4], FIRE[5], and stopped building NCSX[6], so I'm not going to hold my breath.'

'But I thought that we only had a couple of decades to switch to low carbon energy to avoid catastrophic climate change. Shouldn't we spend the money developing energy technologies that can do something sooner ?'

The scientist looked embarrassed. *'Actually I became a fusion scientist when I saw how important it was to develop safe and environmentally friendly energy sources'* he said. *'But frankly, for the past two decades fusion has been funded at a level where we can identify problems, without having the resources to actually solve them.'*

'Hmmm' said Joe loosing interest. He was looking at the next tent on the Los Angeles \$8B green energy initiative[7] that would bring large amounts of clean electricity to the Los Angeles area by 2023. *'Let's check this one out kids...'*

UNIQUE LEADERSHIP ?

The FESAC-SP draft placed the highest importance on *'ensuring that the U.S. is in a position to exert long-term leadership roles within the fusion energy mission'* mentioning 'leadership' 36 times in 44 pages. So who are the followers ? EFDA says a *'demonstration fusion power plant (DEMO), producing net electricity for the grid at the level of a few hundred Megawatts is foreseen to start operation in the early 2040s [8]*. It doesn't think it needs a FNSF. The Chinese are also not following a US FNSF: *"To promote the development of the fusion energy for ultimate use in China, design activities of the Chinese Fusion Engineering Test Reactor (CFETR) have commenced. CFETR will be an important facility to bridge from ITER to DEMO, which is a necessary step toward the fusion power plant. The main objectives of CFETR are steady-state operation, full cycle of fusion power and T fuel."* [Li et al., Phys. Scr. T159 (2014) 014001]

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Note they say they have started on a real design, not on '*contributions in informing options...*'

Twenty years ago the US was really leading the world by being the first nation to generate 10 MW of fusion power. But looking forward, can the US really claim leadership if there aren't any followers ? Self proclaimed '*leadership*' bespeaks of an insecurity in the role of the US in the world fusion effort.

BAIT AND SWITCH ?

The FESAC-SP Preface speaks glowingly of the promise of "*Fusion energy (that) could therefore fulfill one of the basic needs of modern civilization: abundant energy with excellent safety features and modest environmental impact that is available to all nations.*" However the \$3-4 billion plan for the next 10 years is for "*.. important contributions in informing options for FNSF and providing strategies for DEMO.*"

The next 20 years will crucial for the switch to low or no carbon energy sources to avoid catastrophic climate change. But it seems fusion has nothing to offer ! In the next decade the US will not plan to '*fulfill one of the basic needs of modern civilization:*' - it won't even begin on the design for FNSF.

VALLEY OF DEATH ?

N. Lopez Cardozo compared investment in fusion research to other energy technology developments in a presentation at ITER, citing for example, the total investment in renewables of **\$257 billion** in 2011 [(attached), an early version of this talk is available at [9]]. He finds "*a reasonable budget is order 10 Beuro/year (12 \$billion/year) in the ITER Era, i.e. from 2020 or so. Don't pretend we can do it with steady budget.*" He also cautions about the "*valley of death*"; a term for the gap between federally funded research and a new commercialized technology.

It seems to me to be intellectually dishonest to preface the FESAC strategic plan with the promise of '*abundant energy*' and '*US leadership*' when the proposed funding falls far, far short of what is required.

References:

- [1] Fusion Energy Sciences Advisory Committee Report on Strategic Planning: Priorities Assessment and Budget Scenarios September 21, 2014 p.iii
- [2] Compact Ignition Tokamak 1989 <http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=102433>
- [3] Burning Plasma Experiment 1992 <http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=218767>
- [4] Tokamak Physics Experiment 1993 <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=518451>
- [5] FIRE <http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=1027699>
- [6] 2008 NCSX http://en.wikipedia.org/wiki/National_Compact_Stellarator_Experiment
- [7] http://www.fierceenergy.com/story/las-8b-green-energy-initiative/2014-09-24?utm_campaign=+SocialMedia
- [8] EFDA 'Fusion Electricity A roadmap to the realisation of fusion energy' (November 2012)
- [9] N. Lopez Cardozo
http://advprojects.pppl.gov/ROADMAPPING/presentations/Wednesday_pm/LOPESCARDOZO_Fusion_Spectrum.pdf