

Minutes of the Meeting of the Fusion Energy Sciences Advisory Committee

July 17, 2015
Teleconference, 3:00 – 5:00 PM

Mark Koepke opened the meeting at 3:01 PM

Committee Members Present:

Don Rej (Acting Chair) — *Los Alamos National Laboratory*
Amitava Bhattacharjee — *Princeton Plasma Physics Laboratory*
Troy Carter — *University of California, Los Angeles*
Arati Dasgupta — *Naval Research Laboratory*
John E. Foster — *University of Michigan, Ann Arbor*
Charles Greenfield – *General Atomics*
Richard J. Groebner — *General Atomics*
Chris Hegna — *University of Wisconsin, Madison*
Valerie Izzo — *University of California, San Diego*
Jin-Soo Kim – *FAR-TECH, Inc.*
Mark Koepke – *West Virginia University*
George H. Neilson — *Princeton Plasma Physics Laboratory*
Gertrude Patello — *Pacific Northwest National Laboratory*
Juergen Rapp – *Oak Ridge National Laboratory*

Ex-Officio Member Present:

Arnold Lumsdaine – *American Nuclear Society (Fusion Energy Division)*

Mark Koepke declared a quorum at 3:06 PM with 14 of 16 members present.

1. Welcome Remarks

Mark Koepke explained that he was an active participant in the work of the subcommittee. Therefore, Don Rej will serve as Acting Chair of today's meeting. Dr. Koepke announced that all questions for the public comment session should be emailed in advance to Sam Barish. Dr. Koepke will chair the teleconference after FESAC votes on the subcommittee report and the NFA report business is completed.

Don Rej took over as Acting Chair at 3:12 PM and introduced the members of the subcommittee on non-fusion applications (NFA), giving Amy Wendt, Subcommittee Chair, the floor.

2. NFA Report Presentation – Amy Wendt

Amy Wendt presented a series of slides. At 3:30PM and at 3:50PM, she was reminded that she had exceeded the allotted presentation time. She finished at 3:55PM. The following are some highlights concerning her presentation:

- The subcommittee members represent a broad cross section of research directly and indirectly related to FES.
- Charge to FESAC: This report is a response to a congressional request and covers technological areas as well as scientific areas.
- The subcommittee used Google Survey to solicit input from the community, and more than 100 responses were received.
- A brief discussion of economic impact is in the second appendix.
- There is a top-ten list of topical themes for applications.
- Anti-matter rocket research is still under-developed.
- Economic impact: This is not a comprehensive list, but a sample to get a sense of the magnitude of the impact.

3. Questions and Comments

At 3:58 PM, Don Rej announced that there will be two rounds of comments from the FESAC members. The first round will be for clarifying questions only. The second round will be for comments. He reminded the group to be concise and to focus on questions pertaining to the questioner's criteria for approval of the report.

Round 1: Questions

- *Amitava Bhattacharjee*: (1) Pat Dehmer's letter says that the report should consider contributions to scientific discovery and technological applications, but the report has little about scientific discovery and connections to other fields. I refer to discoveries in the early years of plasma science and fusion about solitons and chaos theory, which have had widespread impact in other areas. Curtis Callen, a high-energy scientist at Princeton University, when he talked with us about HEP benefits, mentioned solitons. Also, dusty plasmas have had impact on condensed matter physics.
- *Amy Wendt*: I take that as a comment rather than a question.
- *Amitava Bhattacharjee*: My question is why was this excluded?
- *Amy Wendt*: It was omission, not exclusion. Mark Koepke directed us to focus on current and recent research.
- *Mark Koepke*: There was a focus on recent work rather than on the distant past.
- *Amitava Bhattacharjee*: (2) In the Executive Summary about specific findings, you mention that economic impacts have not been assessed. I concur with this statement. It would be good if this report also said that we have not communicated all the good things that plasma science has contributed to so they can be taken advantage of by other fields.
- *Don Rej*: I would like to move on. Amitava and others will have an opportunity to provide comments during the second round.
- *Troy Carter*: You sent out a survey, but I did not get a request to respond. LAPD got comments in, but did you get a breadth of responses?
- *Amy Wendt*: If we missed people, we did it inadvertently and equally across categories. Surveying was done on a short time frame, and we did our best.

- *Charles Greenfield:* (1) First comment: I was surprised not to see APS-DPP and UFA mailing lists being used. Some areas are missing from the report. You did a good job trying to get input. Question: In the report you make it clear that economic impact is based on some older and outdated and, in some cases, questionable data. It is better to leave this out and show no data than to show questionable data.
- *Amy Wendt:* We considered the data not to be questionable, but that the numbers were adjusted for the time period measured. I don't consider any of these numbers unreliable, so I am comfortable including this in the report. The Subcommittee did discuss that the economic impact is considerable and whether this should be communicated.
- *Charles Greenfield:* I agree with the point and with making it, but the way it is worded in the report sheds some doubt on the numbers. (2) Second comment: Did the subcommittee consider the potential for spinoffs from future planned devices, such as ITER?
- *Amy Wendt:* We were advised not to speculate about future applications.
- *Arati Dasgupta (joined the call at 4:10 PM):* I was also surprised not to receive the survey.
- *Jin-Soo Kim:* I also did not get a survey request, nor did anyone else at my company. We could add some items to the fundamental science area.
- *Hutch Neilson:* The subcommittee did a great job.
- *Richard Groebner:* No questions.
- *Chris Hegna:* All my questions have been addressed.
- *Valerie Izzo:* No questions.
- *Gertrude Patello:* The charge didn't ask for economic data. Why was this included?
- *Amy Wendt:* The suggestion to include economic data came out of the Subcommittee's discussion. I forget who on the subcommittee suggested including this economic impact.
- *Philip Efthimion:* It was included so that Congress could get an appreciation for the impact of all this work.
- *Gertrude Patello:* What do the numbers represent?
- *Philip Efthimion:* The level of economic activity and the impact to the country and to national security. Congress wants to know that they are getting a return on their investment, even while they wait for fusion energy.
- *Gertrude Patello:* I am still confused about the numbers and what they mean specifically.
- *Philip Efthimion:* The numbers all come from a National Academy report.
- *Juergen Rapp:* No comments.
- *Arnold Lunsdaine:* No specific questions.
- *Don Rej:* No questions

Round 2: Comments

At 4:15 PM, Don Rej opened the second round of comments and asked the committee members to be succinct in stating his/her criteria for acceptability of the report.

- *Troy Carter:* (1) I am not a fan of Page 8, slide 2 because this list is not comprehensive. I suggest changing the wording to “processes are wide-ranging” and include specific examples. (2) The report cites four examples of specific applications, but these are not necessarily the key areas. (3) Focus the report more on technological and societal impact, rather than on other fields of study. I agreed with the space and astro section, but it is too focused on space weather. Was this done intentionally to resonate with the core audience? But there is another target audience (such as DOE leadership), who should know, for example, about gyrokinetics used to simulate momentum transfer in accretion disks and also about collisionless shocks. The report is too focused on technological and societal impact.
- *Arati Dasgupta:* (1) The report mentions computational work for fusion development work, but there is no mention of code development and validation for other areas. (2) There is no mention of atomic physics, which has been useful. The 2009 ReNeW report talked a lot about codes that have been developed, e.g., for high-Z atomic physics.
- *Amy Wendt:* The subject of computational tools is not my area of expertise.
- *Christopher Keane:* In the HEDLP part, I included a short paragraph about computational tools. It is on the WARP code. This could be moved elsewhere in the text to better emphasize this point.
- *Charles Greenfield:* Question for Mark Koepke: I have some minor wording change suggestions and typos. Could those be considered?
- *Mark Koepke:* Yes.
- *Charles Greenfield:* The discussion about economic impact has made me more concerned. It is fine to make this point. But the numbers come from different sources, and the sources need to be cited specifically.
- *Richard Groebner:* It was refreshing to read this report, to see that the work we are doing indeed has spin-off in different directions. I caught some typos. About economic impact: I found this impressive. It was not called for in the charge. Congress will be happy to see this. The question is whether inflated claims are being made. The report needs to back this up. Put in the original sources. How much can FES take credit for? Can we say that FES programs have funded themselves?
- *Chris Hegna:* No comments.
- *Valerie Izzo:* My comments are mostly minor wording things. In the beginning of the Executive Summary, the word “unparalleled” is used—is this justified? I think it is questionable.
- *Jin-Soo Kim:* We can highlight that fusion is a necessary part of these other fields. The report says that it “contributed,” but I would like to note the necessity of plasma science in these contributions to other fields. The data are from 2004—can that be improved? The Table of Contents says

applications are by category; the list on page 2 and page 3 is confusing. Use a table. The table on page 30 should be from that category, but it actually contains a mixture of categories.

- *Hutch Neilson*: Very good report. I am not sure why it was requested or who will use it. If its purpose is to document that FES research has near-term impact and that Congress is getting something for their investment, it is a good report. If its purpose is to document the richness of plasma science, then it does that as well. Things could be added, but I think this more than meets the good-enough test. I support the report as written. If you want to eliminate the economic impact statement, I could agree.
- *Gertrude Patello*: I can answer Jin-Soo Kim's question. I have already sent editorial questions to Mark Koepke last week. The problem with the word "categories" is that they are first called "areas," then they are called "categories." Then there are also "categories" of applications. This is confusing.
- *Jin-Soo Kim*: Exactly my point!
- *Gertrude Patello*: I am not in favor of including the economic impact data, but it would not prevent me from approving the report. I have no idea whether these numbers are considered by others, e.g., Congress, as large or small. I have doubts and would not include them, but I would not hold up approval of the report for that reason.
- *Juergen Rapp*: Overall, this is a good report. It was interesting for me to read it. No comments.
- *Arnold Lumsdaine*: I second what Hutch had to say.
- *Amitava Bhattacharjee*: Will the report have a recommendation section? Technological applications have been covered very well. My reservations about science were already mentioned. Are we communicating things well enough? Recommendations would be helpful and are not excluded by the charge.
- *Amy Wendt*: The charge did not call for recommendations. We discussed whether to include them, e.g., calling for a study of the economic impact. We decided it was beyond the charge.
- *Amitava Bhattacharjee*: If the charge does not forbid including recommendations, why not take the opportunity? To explore recommendations for interdisciplinary connections would be attractive to young scientists. Such recommendations would prompt DOE to promote this and make management decisions.
- *Christopher Keane*: We did discuss this, but we thought recommendations were beyond our scope.
- *Don Rej*: The report has a lot of information. If parts of the community were excluded from the initial survey, it does not seem to have affected the content. Troy Carter's comment about a wording change is appropriate. Maybe the report should highlight the example given by Christopher Keane. This report is different from the HEP one-pagers because this report is more than societal benefit, as mentioned by Amitava Bhattacharjee (and the HEP

example by Christopher Keane) -- high-gradient accelerators, astrophysics, positron spectroscopy, semiconductor etching. It is important to add references to substantiate assertions. We need to be very careful in attributions—how to denote credit if plasma scientists funded by FES have contributed significantly. The chemical engineers did a fantastic job with using plasma physics to improve processing before plasma physicists inspired by DOE funding started helping out. In the semiconductor industry, the development of high-density, low frequency RF stable plasmas was critical to getting high throughput for 40-cm wafer yield. But be careful to recognize the wider community to which the activities in our portfolio have contributed. Another thing is to highlight workforce development—for discovery science, medicine, and semiconductors. Appendix B is very complicated (the statement about “disentangling FES share” brings it out very clearly—put that statement right up front and make it clear so our critics do not do so); or get more quantitative data, but that is a big job and I agree with Hutch Neilson that the report is good enough. The introductory material that describes the FES portfolio helps, but scale it back significantly. The audience is Congress, and they want to see the impacts. My challenge to the subcommittee is that you have the content. I like the top ten list on slide 7, but what is the home-run example where there has been a success, in societal benefit and contributions to other fields, like astro and heliophysics? Find the big home-run examples. Also in materials: Quantum-dot work is quite nice (U. Minnesota, EFRC—supported by BES, but does beautiful work in high efficiency solar cells). Take the template that Mark Koepke showed us at the beginning of this meeting and reproduce it for societal benefit and contributions to other fields. I noticed in the survey--more so than in the report--that there are many future-looking things, rather than what we did: I noticed the abundance of language like “could,” “being developed,” etc. But what crossed home plate? The accomplishments in Section 3.7 are very good. I am okay with future-looking material, but make sure it can be accomplished on the timescale of Congress. Be careful that the portrayal of technological elements do not come out as hype. I vote for eliminating economic impact for the reasons already stated—it is okay to refer to a National Academy study, but don’t include the table of Appendix B. It could be used against the good things in the report. On page 18, there are comments about low-temperature plasma research having fragmented support and being a victim of its interdisciplinary nature. I would leave this out because the charge does not ask for root causes, so we should focus on the evidence of impact instead.

Summary of comments:

Don Rej: I suggest we get to a point of approval with editing. My synopsis of the comments is as follows:

- Include the time period for accomplishments.
- Scale back on the program description.
- Remove the last paragraph on page 18.

- Remove economic impact.
- Yes, there were omissions. But is what is there enough? There were many responses.
- Make sure impacts on other scientific disciplines are clear, especially computation.
- Avoid hype.
- Add the table that Mark Koepke gave us from HEP for a list of “home runs”, linked to the top-ten list.
- Make sure we recognize up-front contributions from non-FES programs, which were enhanced and enriched by FES scientists.

Discussion and Vote on the Report of the SNFA:

- *Amitava Bhattacharjee*: I vote to approve with edits. A specific suggestion is that it would be good to include a timeline. Please also include the two specific discoveries of solitons and transition to chaos. This is where plasma physics made an indelible impact on physics. These led to numerous prizes. The decision of the subcommittee to focus on more recent things is great, but please include just a couple of sentences to put this in context. It is important to do this.
- *Don Rej*: So something like a front piece about the FES storied history dating back to solitons and chaos transition.
- *Mark Koepke*: I can help Amitava Bhattacharjee write that.
- *Troy Carter*: I approve with edits. Your summary was adequate.
- *Arati Dasgupta*: I approve with edits. Also, please include the Christopher Keane comment about computations.
- *Chuck Greenfield*: I approve with the edits you proposed. However, I am reluctant to vote on a report that will be substantially changed.
- *Sam Barish*: You can provide your individual comments to the subcommittee, but we cannot have another FESAC group vote because that would require another official meeting.
- *Chuck Greenfield*: I approve as long as the Don Rej edits are incorporated.
- *Richard Greobner*: Ditto.
- *Chris Hegna*: Ditto.
- *Valerie Izzo*: Ditto.
- *Jin-Soo Kim*: Ditto. There is inconsistency in table presentation and labeling. This would change the presentation.
- *Mark Koepke*: I have Gert Patello’s edits and we can incorporate them in the final report.
- *Jin-Soo Kim*: Fine.
- *John Foster*: I approve with edits.
- *Hutch Neilson*: Ditto. I would be happier with a shorter list of edits and eliminating the economic impact. The “fragmented support” comment should also be eliminated. Those are my two main concerns. I am fine with the other edits.

- *Gertrude Patello*: I approve with edits.
- *Mark Koepke*: Ditto.
- *Juergen Rapp*: Ditto.
- *Don Rej*: Ditto.
- *Sam Barish*: I suggest eliminating the economic impact, but what about the reference on Page 4, Number 8? Should we omit it or revise it?
- *Mark Koepke*: We will eliminate the table, but keep the references.
- *Sam Barish*: Without the table, Appendix B has no content.
- *Mark Koepke*: We want to make the point.
- *Greenfield*: Without the table, the rest of Appendix B is okay.
- *Don Rej*: Due to the caveats and complexity, why not just put this in the introduction? It is fine to refer to the 2010 NAS decadal review there.
- *Mark Koepke*: We will get rid of numbers, and therefore the entire appendix. The gist of Number 8 still can be moved up earlier in the text.

4. The vote to conditionally approve with edits was unanimous (14-0).

Discussion on mechanics of doing the edits:

Don Rej: I am looking to Amy Wendt for how to parse out the areas. Also, Christopher Keane had some excellent comments on astrophysics and timelines and computations.

- *Amy Wendt*: I would offer to work with the subcommittee members to implement the changes, but would you please send us a list of the requested changes? The list should be as explicit as possible. I and other subcommittee members are willing to make the edits.
- *Mark Koepke*: As with how we handled the Strategic Planning Report last year, may I suggest that you, Don Rej, might work with the subcommittee chair and negotiate the edits. I could fill in if necessary, for perspective. That worked out well with the Strategic Planning report.
- *Don Rej*: That is fine.
- *Amy Wendt*: Fine.
- *Sam Barish*: The vote to approve with edits was unanimous (14-0). Secondly, FES has been thinking of making the report more uniform, polished, and understandable to laymen by using a professional editor. We did that with the FESAC 2014 report. This might make it more suitable for Congress. How would FESAC like to proceed?
- *Mark Koepke*: I echo Hutch Neilson's comment that this is more than good enough. Light editing of English is good enough. The professional editor was helpful on the Strategic Planning Report last year.
- *Hutch Neilson*: Another way to go is to let FESAC wrap up and submit to SC-1, who requested this report, and then let SC-1 produce its own report to Congress.

- *Edmund Synakowski:* Hutch Neilson captured what I would say. SC has the obligation to report to Congress. It is not a FESAC obligation to burden itself with this. Hutch was on the right track.
- *Don Rej:* As for the timeline, I need to provide a written version of the editorial requests to Amy Wendt. Then the subcommittee will do some heavy editing. When does FES need it?
- *Sam Barish:* We would like to have it by the end of July and get it out of DOE by the end of August.
- *Edmund Synakowski:* With summer schedules, it is unrealistic for the subcommittee to get it to FES by the end of July and FES finish it by end of August. Sometime in August is fine for the Subcommittee getting it to FES.
- *Don Rej:* So we hear August. Given day jobs, family, and summer, is August a realistic date?
- *Amy Wendt:* It depends on how explicit our instructions are. If you send us off to do additional work, that would be tough. Provide us with what to add to the report, and we should be able to make August.
- *Don Rej:* I see it as mostly repackaging, apart from the front piece about early work. So no new content. You may even wish to eliminate content. If too much hype, tone it down.
- *Sam Barish:* Don Rej will send Amy Wendt a list of suggested revisions. Amy Wendt and the subcommittee will make revisions and send it to Don Rej for review. Then FESAC members can send individual comments to Don Rej who will finalize for submission to SC. That way, FESAC members can participate without violating FACA rules.
- *Don Rej:* That is what Mark Koepke did with Christopher Keane for the Strategic Planning Report last year.

5. Public Comment

Leland Cogliani spoke about his writing the congressional language that led to the charge to FESAC. The objective was to identify current examples of applications to other disciplines or to technologies and development. Leland Cogliani's recommendation: listing ten or so best examples of each category is better than a lengthy list of all examples.

6. Other Business

None

7. Adjourn

The meeting was adjourned at 5:22 PM.