

Energy Efficient HPC Working Group General Membership Feedback

April 4, 2013

Overview

- Good feedback
 - 27% response rate
 - government, vendors, international and academic members
- High value for most existing activities (scale 1-10)
 - 9 out of 14 activities valued above 8
 - Next 3 valued above 7.5
- Strong interest in new activities
 - SW Team rated highest
 - ERE case study and Memory Workload also rated high
- Other suggested activities diverse and interesting

Good Feedback

Respondent Affiliation	Number
Government	30
International	25
Vendor	23
Academic	10
Total	88

27% Response Rate (88/331)

High Value for Most Existing Activities

Question	Average Value*
Power Measurement Methodology	8.86
Conferences and Workshops	8.74
Procurement Considerations	8.67
Website	8.37
Liquid Cooling Temperature	8.33
Total Usage Effectiveness (TUE)	8.3
Webinars	8.21
Dashboard Recommendations	8.18
Liquid Cooling Commissioning	8.05
General Membership Meetings	7.7
Demand Response	7.67
Energy Reuse Effectiveness (ERE)	7.57
Speaker's Bureau	7.04
Linked-in Group	6.13

9 > 8.0

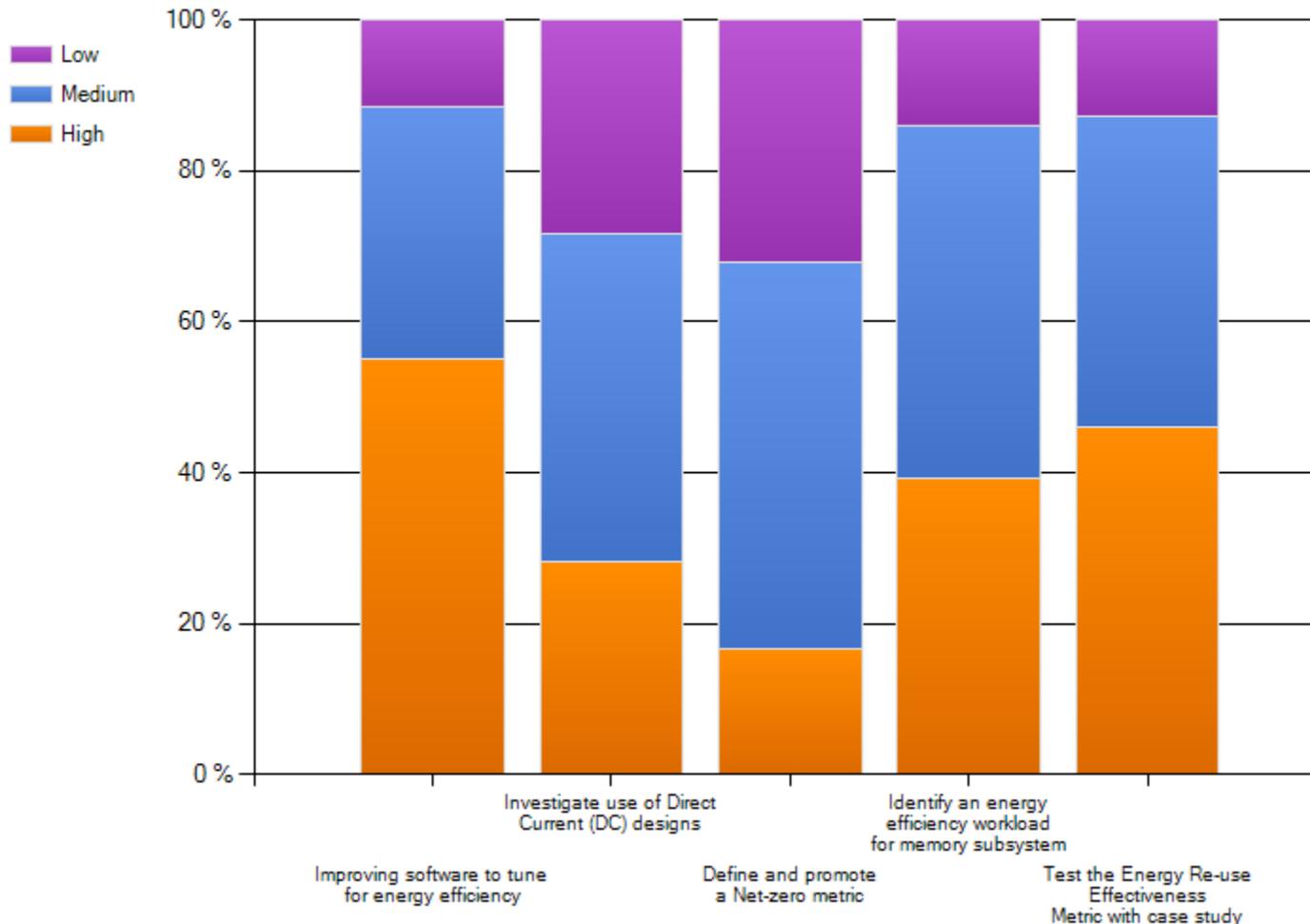
12 > 7.5

Re-assess

*Value on 1-10 scale, Ten = High Value

Strong interest in new activities

Are there additional or alternative activities that you think the EE HPC WG should take on? Some activities are suggested below. Please rate each activity with an estimate of high, medium or low value.



- Highest support for new SW Team
- Also interest in ERE Case study and EE workload for memory subsystem
- Less interest in DC designs and Net-zero metric

Suggestions Diverse and Interesting

- Explore storage system efficiency, metrics, etc.
- Investigate deployment of liquid immersion cooling
- Tabulate member PUE, ERE information
- Investigate HPC in the Cloud
- Invite large webhosting firms to present to the WG.
- Invite ASHRAE to present to the WG
- Collective voice of HPC customers to the vendors as to what they are missing/doing wrong
- Analysis of the relative efficiencies of various cooling methods
- Best practices for old facilities versus new
- Development of methods to collect real time data on energy use
- Migrate HPC cooling technology in the direction of energy recovery (electrical, heat, and cooling)
- Define a power quality envelope for HPC.
- Investigate homogeneous vs heterogeneous Energy Efficient architectures

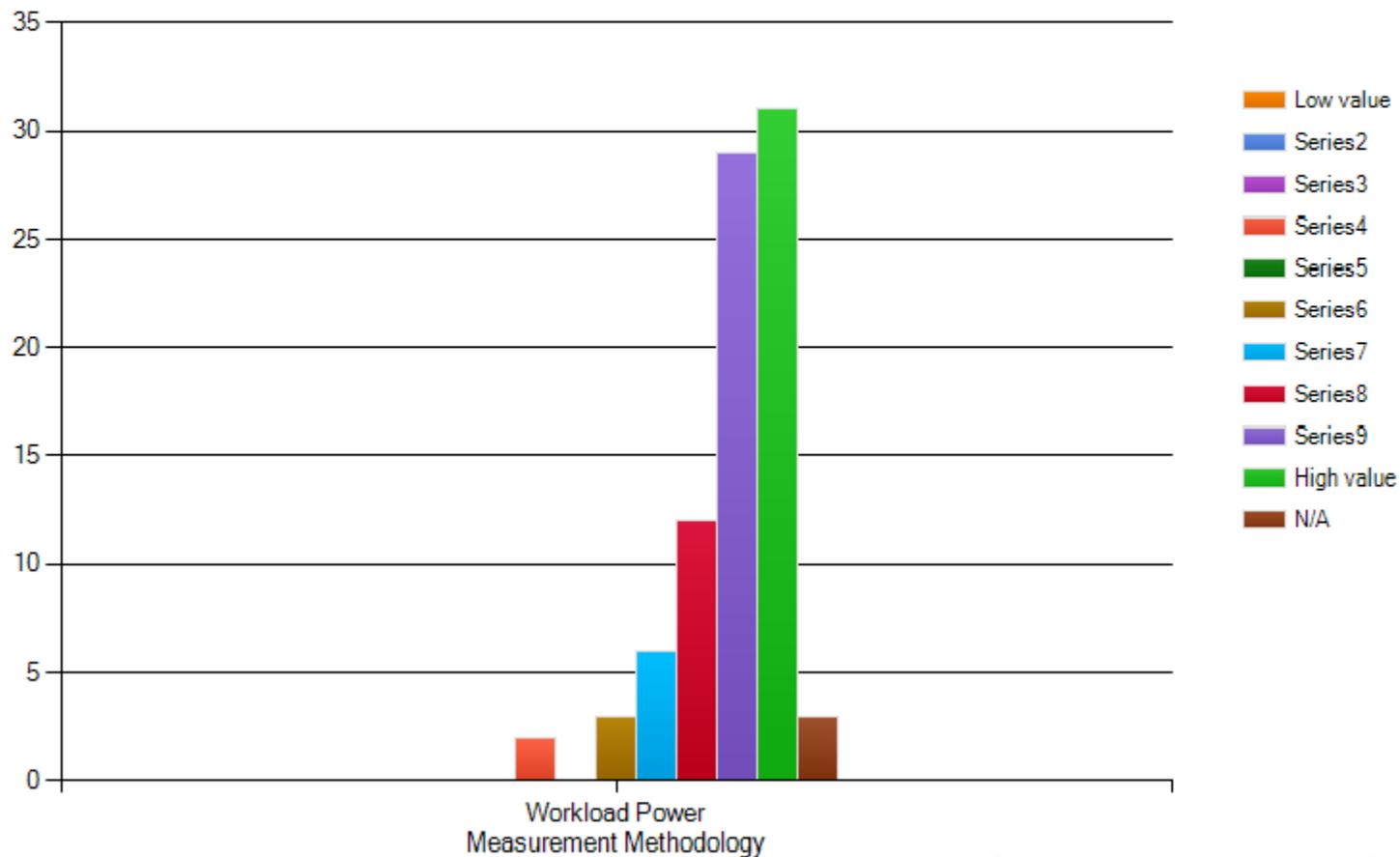
Next Steps

- Thank everyone who responded
- Post presentation on <http://eehpcwg.lbl.gov/>
- Sub-Teams to review/disposition detailed feedback
- Create EE SW Team
- Continue soliciting ERE case study participants
- Re-affirm creating Memory Workload Team
- Re-assess continuing Speakers Bureau and Linked-in Group
- Co-chairs to follow-up on funding suggestions

Detailed Feedback

Power Measurement Methodology

In early 2011, the EE HPC WG undertook a survey of power submissions to the Green500 and the Top500 lists. The survey demonstrated that there was a wide variation in the quality of the measurements used for reporting power. The EE HPC WG prompted a collaborative effort between the Top500, Green500 and The Green Grid to improve the methodology by which power and energy is measured while running a workload, such as High Performance Linpack (HPL). How would you rate the value of this power measurement methodology improvement activity?



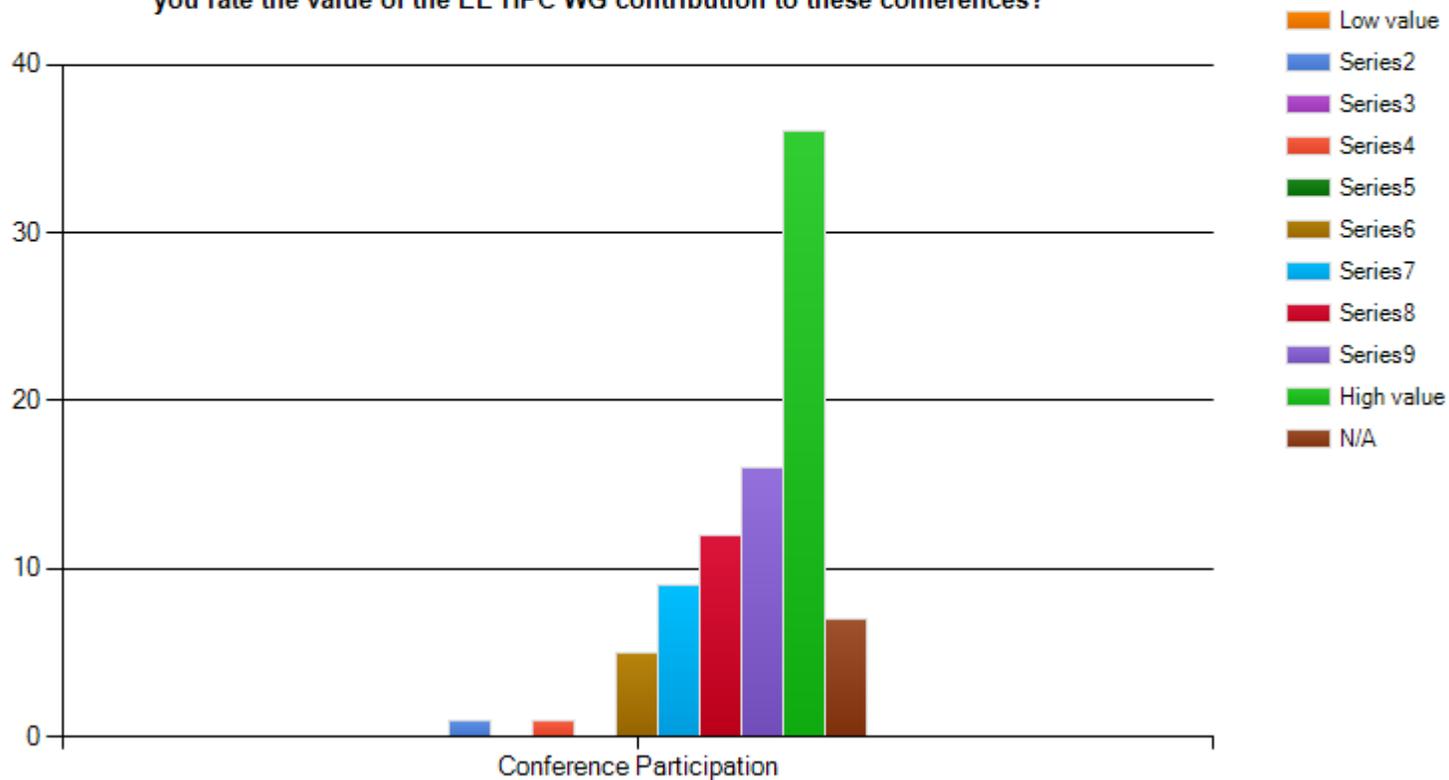
Average rating = 8.86

Power Measurement Methodology

- Indeed, it's very important to clarify the methodology if we want to be sure the ranking corresponds to the reality.
- This activity has not yet impacted our measurements, but we are tracking and contributing.
- I thought that the group put together some very good guidelines. I'm not familiar with the survey, so I cannot comment on how successfully it addressed the results of the survey.
- Standardized power measurements are the only way to be able to compare the performance of data centers across the country.
- High value if not restricted to HPL, which is not a good metric considering real application.
- I fully agree with this collaborative effort idea. Maybe the group should also drive a new application-oriented benchmark. Indeed, measuring energy consumption on HPL gives absolutely no real energy consumption on a production system.
- This work is receiving world wide attention
- We need to get to a point where the power measurement is fully standardized and mandatory for top500 entries. This requires approved power measurement devices supplied with systems, but this won't happen until people start asking for it so this survey was a very good first step.
- There are many good works coming out of Super Computer area, especially coming from all Node Monitoring tools and etc.
- A good power measurement includes at least typical server fan power, as it makes sense to off load air cooling onto more efficient larger fans.
- We need apples to apples comparison.
- Vital to be comparing apples to apples.

Conferences and Workshops

The EE HPC WG has actively participated in key conferences; including SC, ISC and other more targeted venues. The third annual EE HPC WG workshop was held at SC12. Participation in the workshop has grown every year and over 150 people attended at SC12. The agenda is unique in that it provides a forum to discuss both infrastructure and system architecture. In addition to this workshop, the EE HPC WG has held Birds of Feather sessions at ISC and SC every year since 2010. A State of the Practice paper was also presented at SC11 and additional papers are planned for future conferences. These conferences provide the only venue for members of the EE HPC WG to meet and network in a face-to-face venue. Conference participation allows for educating the HPC community, networking between peers as well as increasing membership. How would you rate the value of the EE HPC WG contribution to these conferences?



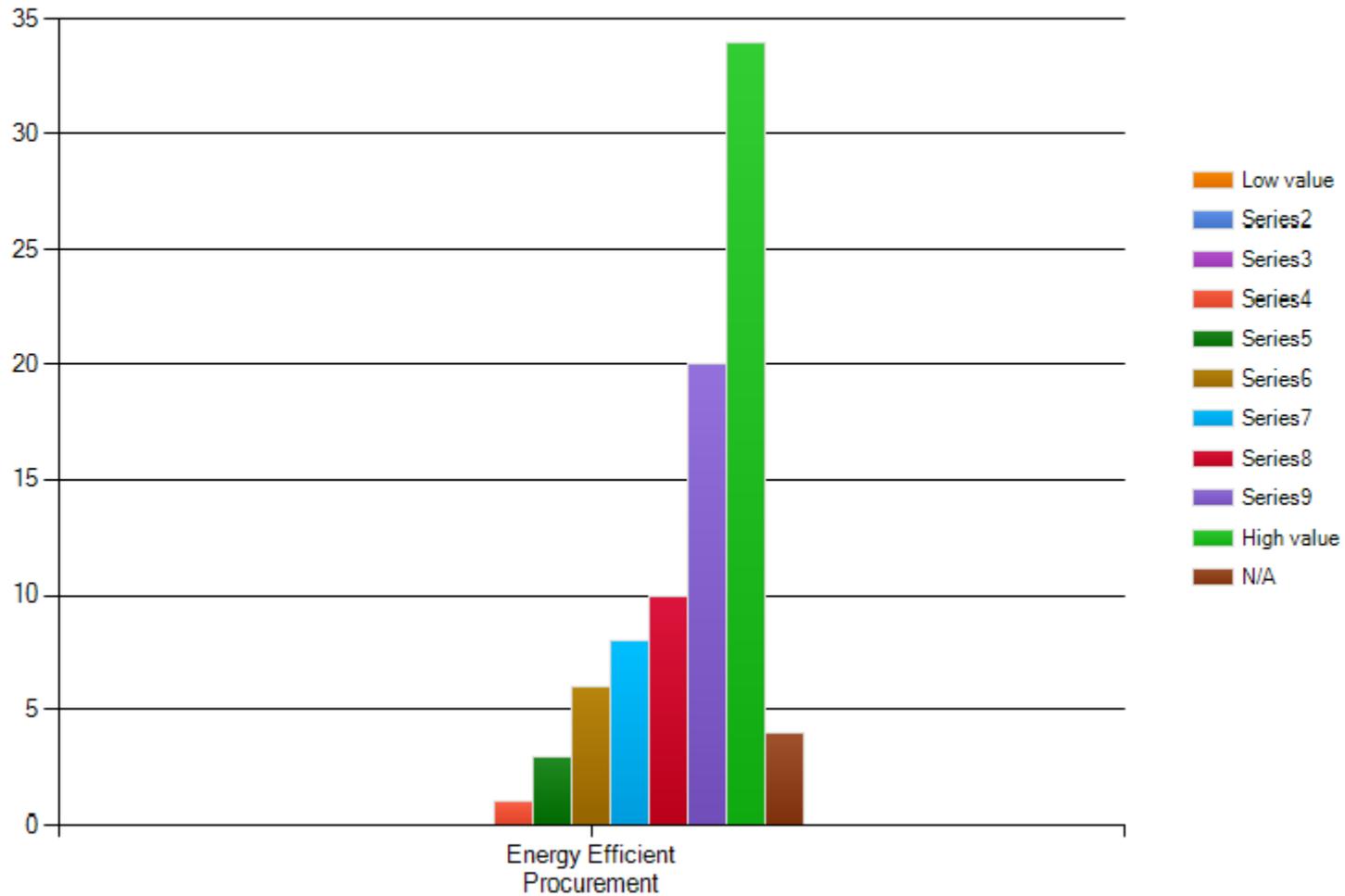
Average rating = 8.74

Conferences and Workshops

- This is a highly visible effort, and attendance growth demonstrates its value.
- Yes, these are the venues. At SC12 I was interested in other topics but would certainly participate in any SC13 activity.
- It's value to the conferences is high, however attendance, due to budget cuts, is dropping. There needs to be some method to video conference in participants that cannot travel to the conference to due to budget constraints.
- It is important to share what we have learned with the community
- Face to face interaction for the working group is very valuable to share information and new ideas
- Networking between people in this field is critical because it is such a new specialty.
- Not familiar with these conferences, but I am sure it is valuable. Maybe look at other conferences too. Other SCs and etc.
- I have not yet attended any of these conferences and feel it unfair to "rate" such contributions.
- This is a good way to get infrastructure related info. into the conversation.
- The workshop is very informative but overlaps with a lot of interesting tutorials/vendor events on Sunday at SC12. May be a few more people would be able to attend if it on Monday since it is closer to the start of conference.

Procurement Considerations

The EE HPC WG is writing a document that reflects 'best practices' for including energy efficiency as an important consideration when writing procurement documents for HPC system acquisitions. How would you rate the value of Energy Efficient Procurement Best Practices?



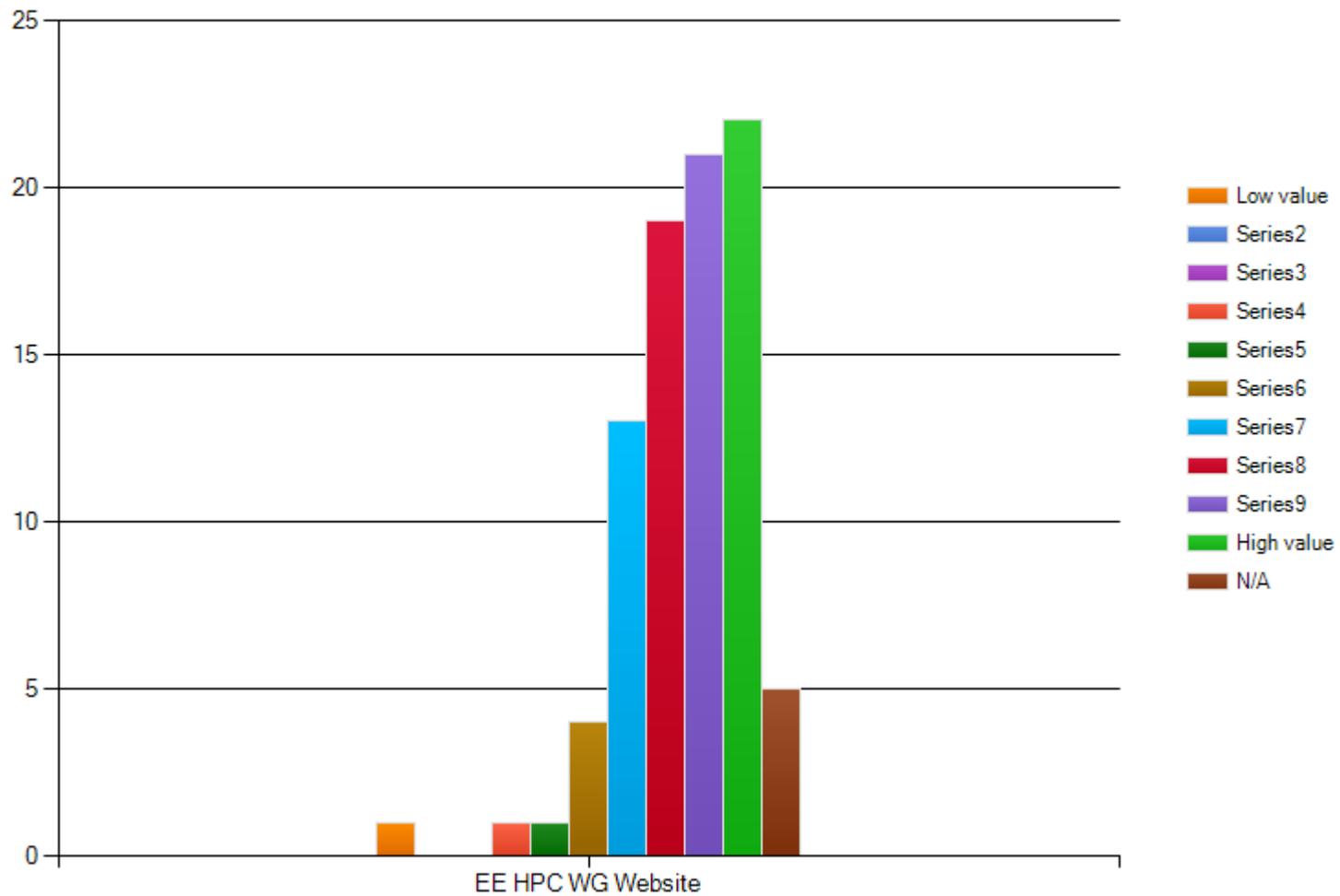
Average rating = 8.67

Procurement Considerations

- Idem. We cannot evaluate the document. But we will look at it now!
- We are already leveraging some ideas from this document relevant to our procurements, such as cooling specification.
- SO far progress is only in the formative stage, but from what I've heard and read so far, I think this is a valuable activity.
- The best practices document can be included in the acquisition package and provide vendors with "built to" specifications. This will save a lot of time for acquisition teams and provide incentives for vendors to meet those specifications if they have any hope of selling their equipment.
- beyond highhigh
- Sounds like a worthwhile effort. I have not been involved and don't know enough about it to rate
- The EE HPC WG has a large impact on the market and can help drive efficiency improvements
- It's a huge part of the operational costs of a system, and it's easier to change than staffing costs. This is really important. The best practices should provide guidance on how to resolve the public procurement challenges of buying system(s) and data center space at the same time. It can be hard to buy the right things when procurements are separated into different parts. Also see: [http://www.efficient-datacenter.eu/index.php?id=48&no_cache=1&tx_ttnews\[tt_news\]=87](http://www.efficient-datacenter.eu/index.php?id=48&no_cache=1&tx_ttnews[tt_news]=87)
- This is a tricky one. The Best Practice is for what and whom, and why. Often the best practice for the HPC are not necessary the best to others. But it should be looked at and worked on!!
- I think this could be very valuable if it is done well.
- Requirements associated with purchasing are the fastest way (only way ?) to get new technology deployed.

Website

The EE HPC WG hosts a website <http://eehpcwg.lbl.gov/> with information about the WG, documents, calendar, membership, links and events. How would you rate the value of the EE HPC WG website?



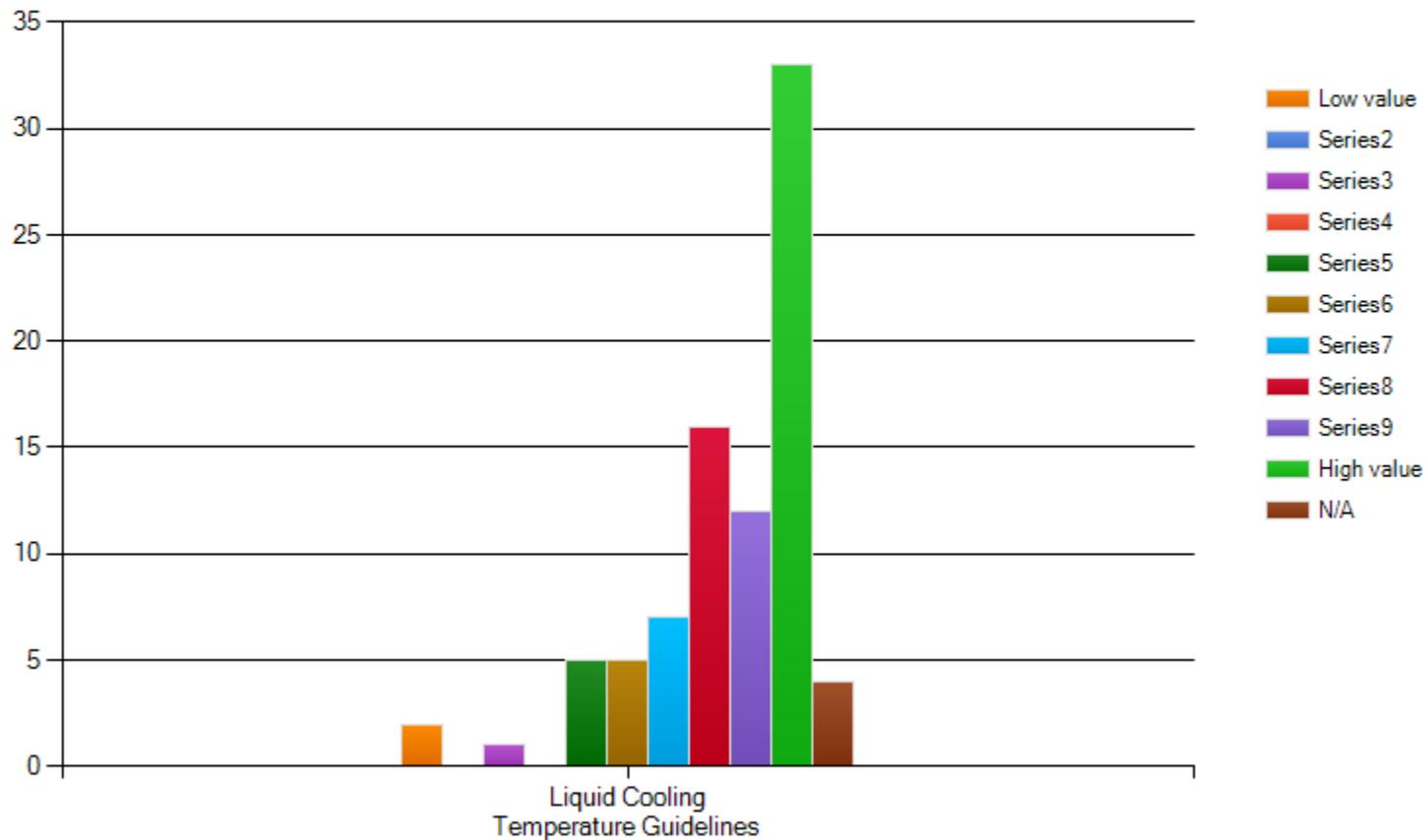
Average rating = 8.37

Website

- Very important resource, but very difficult to find. :-)
- I recently discover this website and I think it will be very valuable for some of our future decisions.
- I like the site but left the topmost bullet empty because there is always room for improvement!
- Could be higher with some work on the web site
- Since I am on Tokyo time zone, looking at the WEB is most important besides e-mails. So, it is very valuable to me.
- I didn't know we had a website.
- There is not much content there... As a new member I have a hard timing finding my way around these resources. Examples: - are there mailing lists? I do get seemingly irregular invitations to webinars, but that is all. Other than this, the eehpcwg remains completely silent to me. - I see in the calender that the is a meeting/call on "HPL Power/Energy Measurement Methodology" every Wednesday. Who is invited? What is the agenda? Are there meeting minutes available anywhere? - There seems to be a bit of content on the website, but when do these documents get updated? Is there an email reminder about new content available? I can't easily figure out if you just dump documents or if this stuff is actively developed and worth reading. - I received one mail with an "EE HPC WG Meeting Report" on Dec 19 2012. The next meeting was scheduled for Feb 12th. I haven't seen an agenda or minutes for that, at least not via email. The general idea is: you are too quiet!

Liquid Cooling Temperature

The transition from air to liquid-cooling is a technology inflection point that provides an opportunity to set guidelines for facilitating the energy and cost efficiency of liquid-cooled HPC systems. The EE HPC WG worked collaboratively with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to develop guidelines for warmer liquid-cooling temperatures to guide future HPC system procurements, and to facilitate the design of warmer temperature cooling systems. How would you rate the value of this liquid cooling temperature guideline activity?



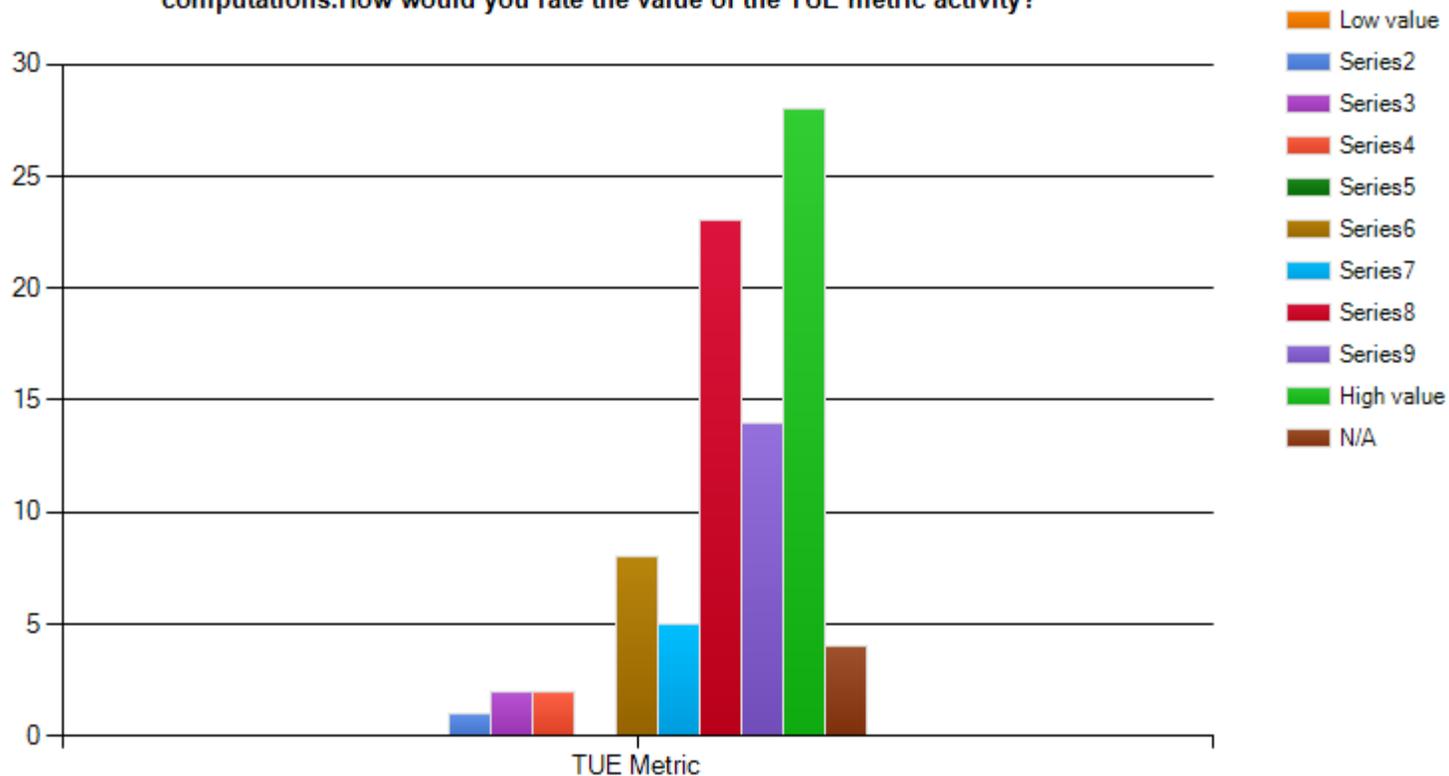
Average rating = 8.33

Liquid Cooling Temperature

- We are interested by this topic because we will probably use warmer liquid-cooling for our next systems. But, right now, we do not have the opportunity to read the result of this WG.
- Our facility is targeting class W3 cooling. The guideline allows up to 32C, but in our climate we can provide lower temperature (<24C) most of the time.
- I have not been involved in this. I did listen to Steve Hammond's presentation. I learned that liquid cooling actually used less water than air
- I believe this group has been instrumental in compelling vendors to develop solutions which utilize higher water temperatures for cooling.
- This is the future for HPC.
- It is more to understand industry trends than directly used in my job/work.
- Not sure. Need more details.
- This is very important to encourage development of liquid cooled systems that operate at higher temperatures.
- Was not available when we made our procurement, but this is very important.
- Liquid of all kinds? right?
- This effort needs more input from chip manufacturers. For example, if they decide to allow overclocking of their server chips, then warm water cooling is less attractive.
- Our industry needs guidelines like this
- Site issues such as legacy systems and shared environment have a large effect.
- The paper indicating the potential to use high temperature water for direct cooling appears to have been connected with the industry now moving very quickly in that direction. Examples: Asetek and CoolIT along with HPC suppliers.
- Data center density will continue to increase. This is good since the space required to house such facilities can be very expensive (>\$300/SF) and the infrastructure required to cool the loads is extensive. EE HPC WG is providing "ahead of the curve" thought to answering the questions that will soon be asked by a growing industry.

Total Usage Effectiveness (TUE)

Many data centers still have PUEs above 2.0, but advanced data centers are closing in on 1.0. Best practices for things like improving air flow in the data center have led to PUEs on the order of 1.5 and free cooling can result in a PUE even lower than 1.1. We can now focus on what is in the 1. Part of focusing on the 1 includes refining the PUE measurement methodology to account for cooling and power distribution losses inside the compute system. This is even more critical for HPC where the location of many components such as fans and power supplies shift between in and outside of the system, depending on the product architecture. The EE HPC WG has defined and is testing a new metric called TUE, that provides insight to all power delivery losses, cooling energy use, and miscellaneous power draws that do not directly provide useful computations. How would you rate the value of the TUE metric activity?



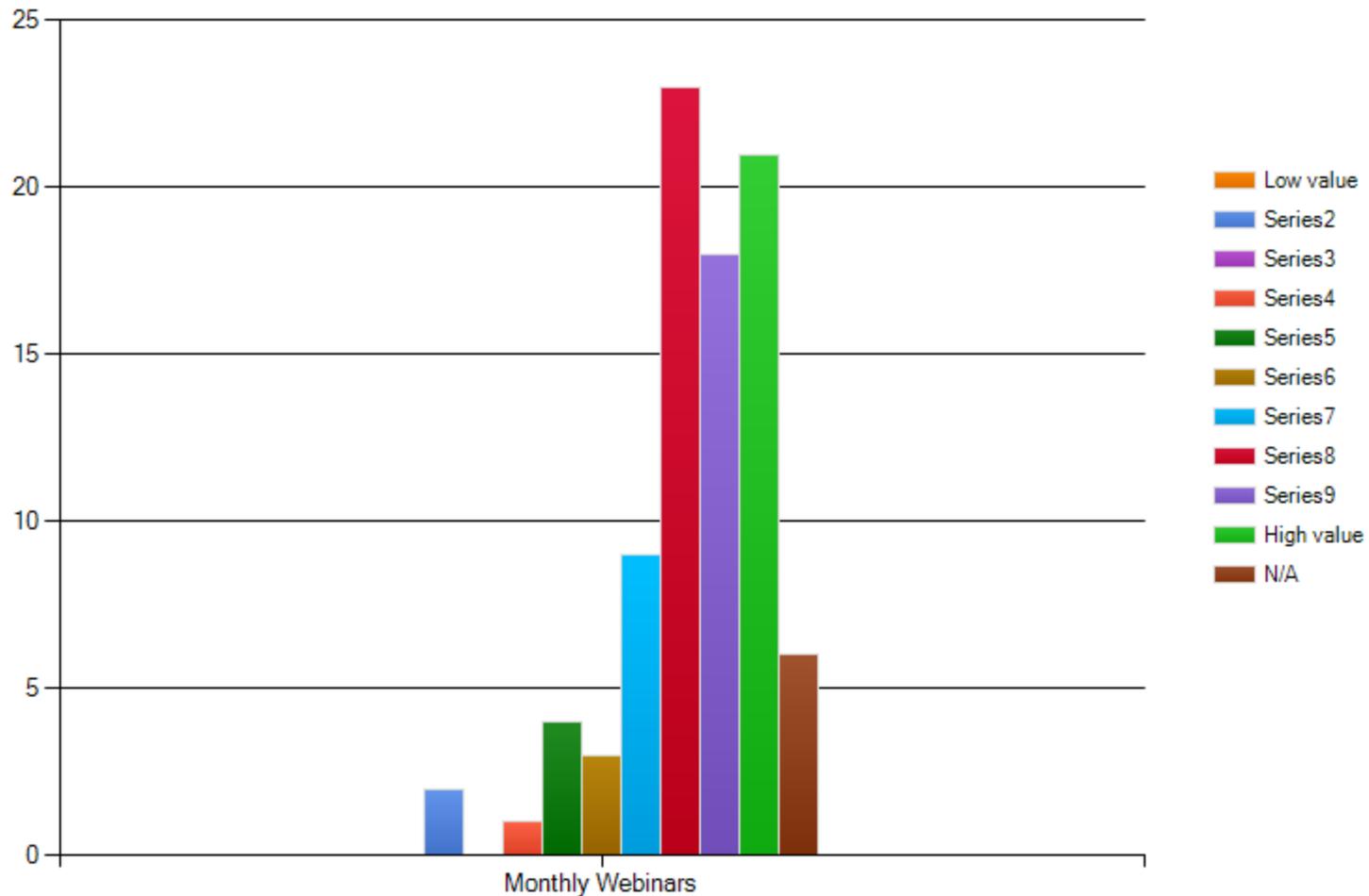
Average rating = 8.3

Liquid Cooling Temperature

- We think this metric is very useful because more precise than PUE as it takes into account elements that are not always negligible. But, once more, we didn't know this document before.
- Frankly, I see more value in the compute performance energy metric of item #2. I am concerned that the plethora of metrics will obscure the goal as much as having poorly defined ones.
- Another metric could be seen as additional burden to data center managers.
- This has the potential to drive further energy efficiency improvements within the platform. We are also looking to drive efficiency in power distribution, not just cooling.
- TUE is important. All aspects of power and cooling should be included to provide a "true" measurement. If items are left out of the measurement, you are gaining some idea of efficiency but not a true one.
- TUE is way of getting to the core of the measurement
- Must be done in cooperation with IT companies
- This will become more important in the future as manufacturers provide more visibility into their systems.
- I haven't studied this, but it's a critical part of improving efficiency. I'm aware that several other groups such as The Green Grid are doing similar things here. It's critical that these metrics produced by other standards groups are suitable for HPC systems so again this is important work.
- I am open for any good Metrics. I am at ISO/IEC JTC1 SC39 WG1 Ad-Hoc Group to look at many possible new ISO capable (becoming of) metrics now and screening a lot. So, like to learn more.
- It would help to have detailed schematics and recommended power metering systems, particularly when you can specify a number of vendors.
- I am very interested in developing a new metric that would supplement the PUE metric.
- Values like this are only valuable if there is a defined standard that allows everyone to measure the value the same. PUE is so broadly defined and deciding what gets factored in total load becomes a game of who can count the fewest actual items. TUE could be interesting if implemented as a very defined metric measurement process.
- It is now clear that the "back end of the dog" is fairly well understood but is still not being widely implemented. On the one hand Facebook has a PUE of 1.07 and a huge number of data centers are not installing blanking panels. From some accounts the "front-of-the-dog" long poles in the tent are utilization and possibly software algorithms

Webinars

The EE HPC WG hosts monthly webinars that provide a forum to allow members to learn from one another's expertise by encouraging presentations with an opportunity for feedback, questions and answers. Participation in these webinars is consistently ~25 people. How would you rate the value of these webinars?



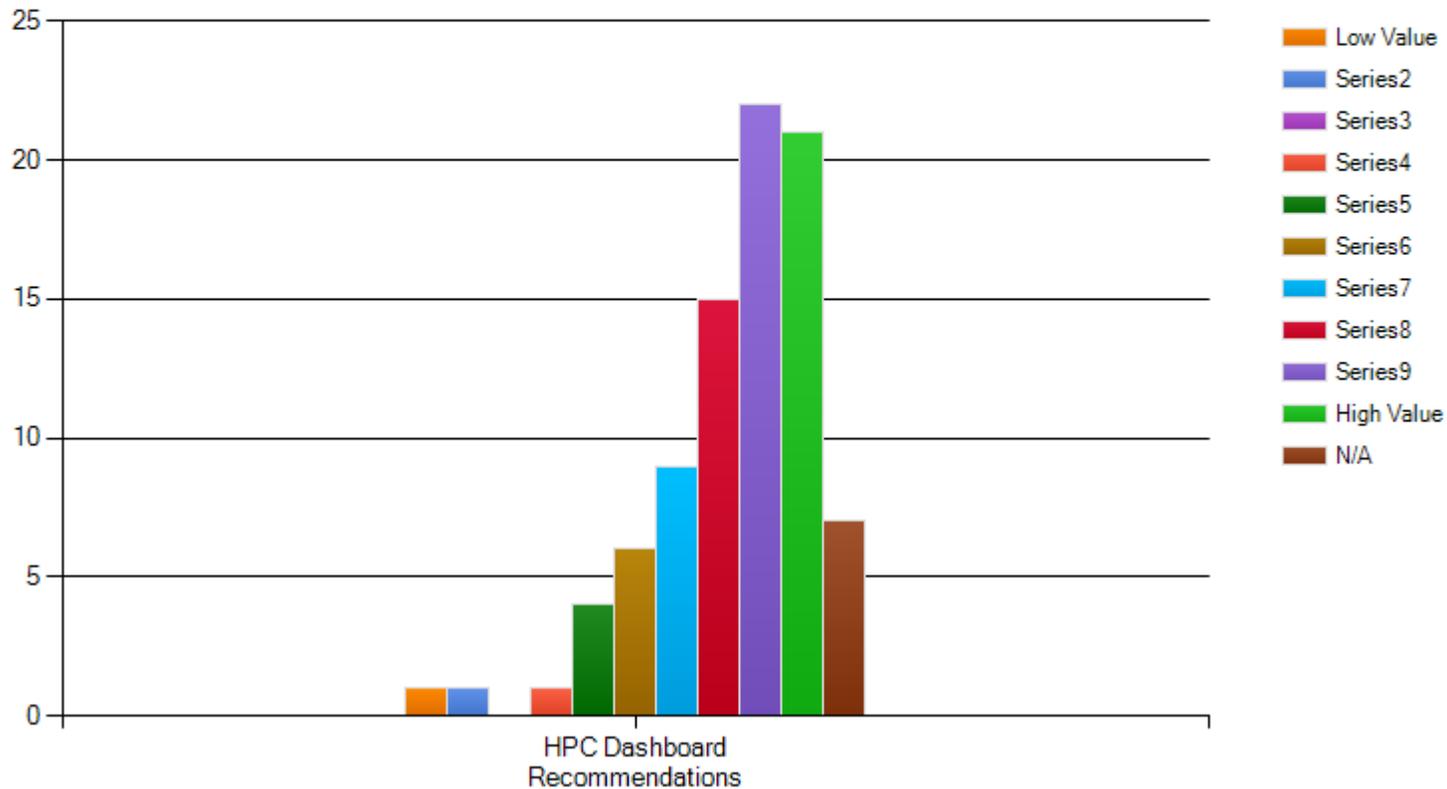
Average rating = 8.21

Webinars

- Since I am in Europe it is hard to attend due to time difference.
- I do have time zone issue, as I am in Japan.
- A suggested new focus area. I think Mike Patterson will also support this. There is much talk about "soft" metering. There is little standardization of IPMI data. If we could get HPC suppliers to follow an agreed standard then metering becomes very much easier. The sensors/data are there and we are not using them.
- They seem valuable, but unfortunately difficult time zones usually prevent me from attending these

Dashboard Recommendations

With increasing HPC energy consumption and the rising cost of energy, it has become important for stakeholders to be able to monitor and manage energy consumption. Dashboards will monitor and display energy consumption of various physical data center components. Most HPC data centers are just starting to gather and use dashboards for energy management. In order to accelerate the development and adoption of dashboards for energy management, the EE HPC WG created recommendations for HPC sites to help select or tailor the energy elements or parameters of an HPC data center infrastructure dashboard. How would you rate the value of the HPC dashboard recommendations?



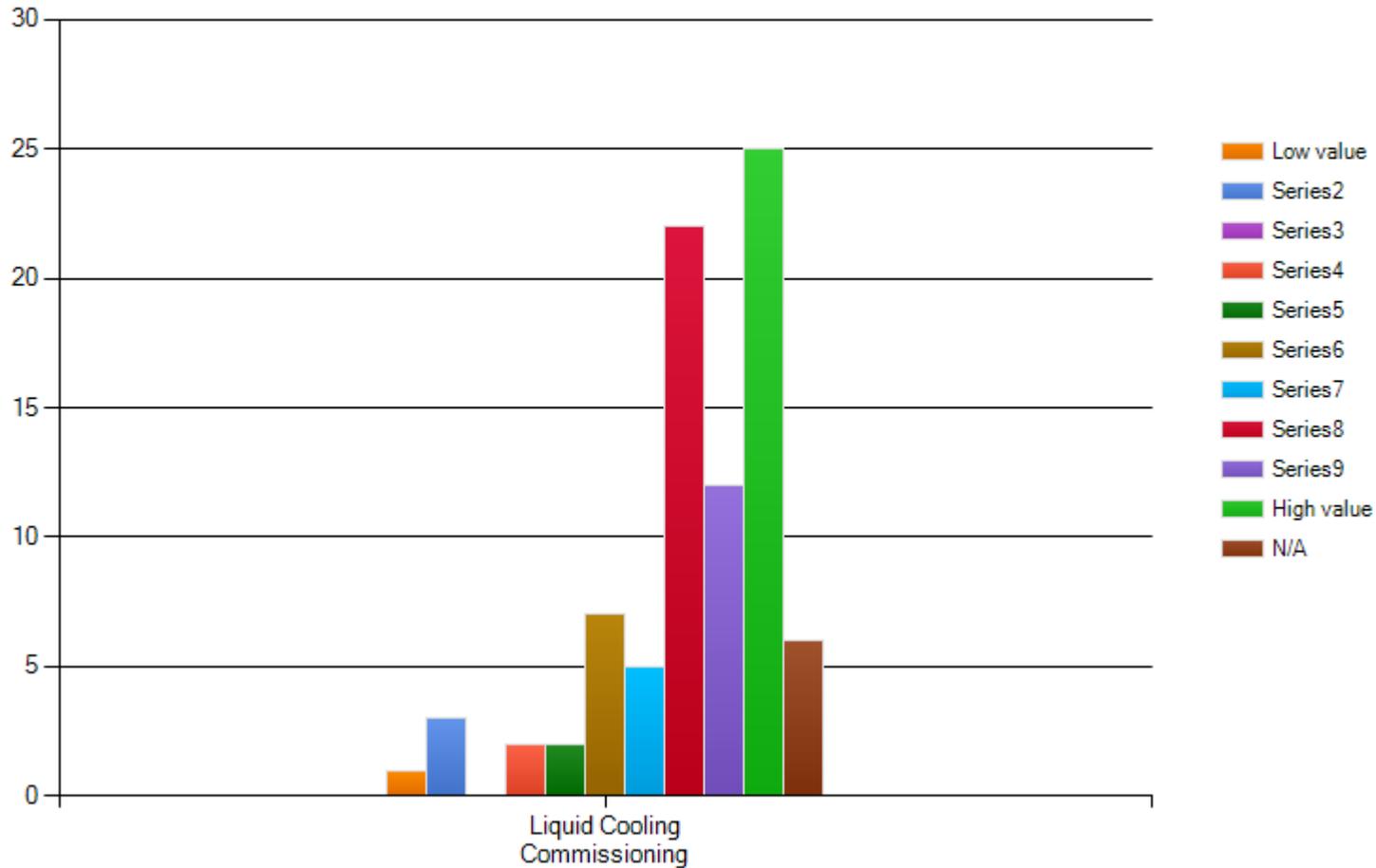
Average rating = 8.18

Dashboard Recommendations

- We cannot evaluate the HPC dashboard recommendations because we didn't use this document to select our dashboard. But we can do it now.
- We have real time energy monitoring, with features based on monitoring tool capabilities and tailored to our environment.
- I thought the dashboard paper was a fine paper, but it missed a good comparison with existing monitoring systems.
- EE HPC recommendation assist in justification of expenses to implement dashboards and other monitoring capabilities into the data center.
- Being able to visualize performance simply is important.
- I wasn't aware of this. I will go find it now!
- I have to look at it more and understand more, but good direction!!
- I find the dashboards to have value -- but recommendations only go so far. It's like when a salesman recommends something for your car, you may be skeptical of its value.
- Suggest we need to focus on getting good quality needed data collected and stored in a cost effective manner. For example, what are a few measurement point data that can be put in a database providing high value. In my opinion trying to guess what people want to see on a dashboard is very difficult. A better thing is to agree on levels of data collection. A tool that allows easy construction of a dashboard is likely a better idea. E.g. similar to LabView or Vee. and let users design the display.

Liquid Cooling Commissioning

The EE HPC WG has a newly formed team on Liquid Cooling Infrastructure Commissioning. There is a widespread availability of air cooled commissioning plans, but a lack of commissioning plans for facilities that require infrastructure for liquid cooling. This team will be developing a best practice document to address that gap. How would you rate the value of liquid cooling infrastructure commissioning activity?



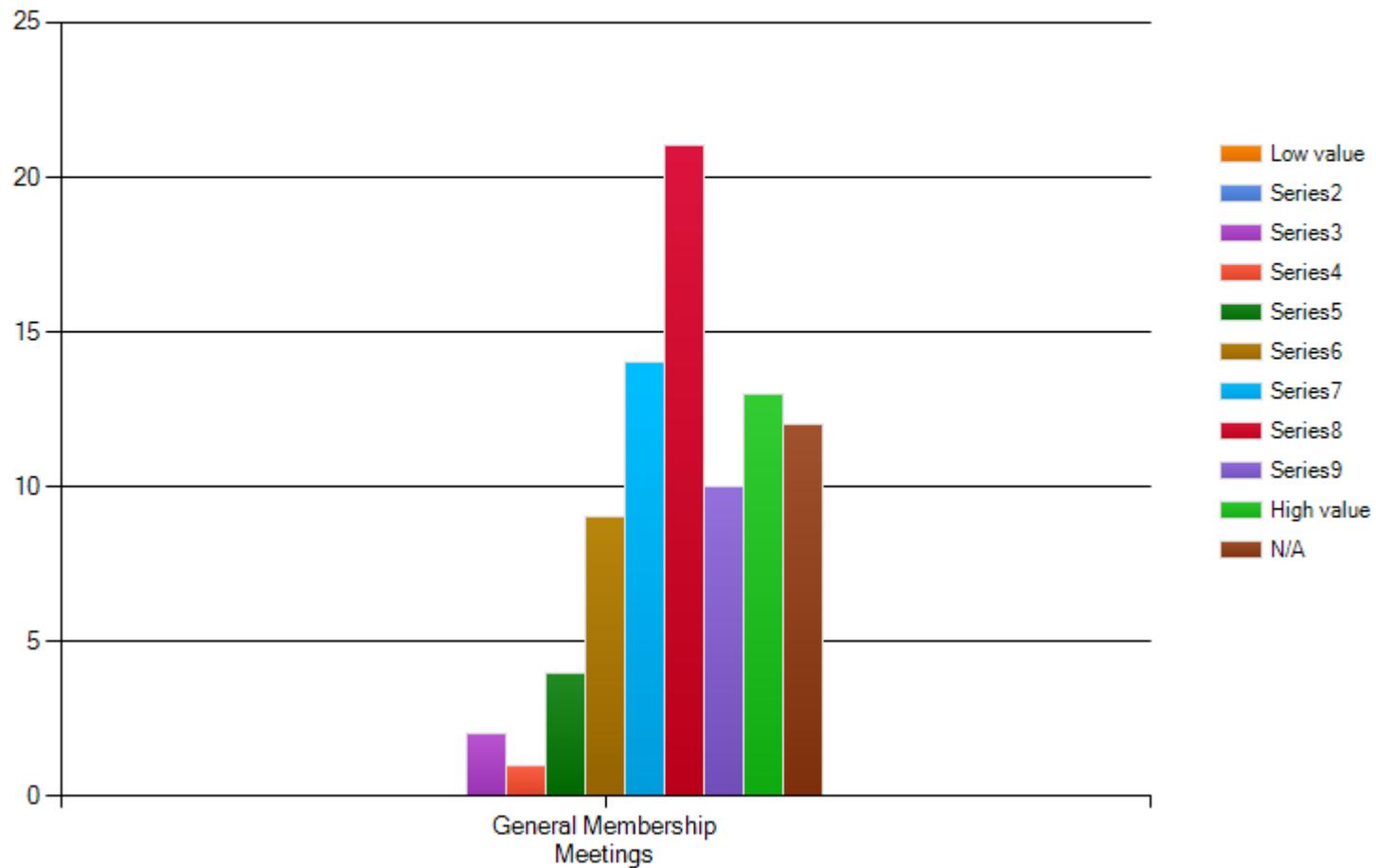
Average rating = 8.05

Liquid Cooling Commissioning

- Our staff has not yet fully engaged in this effort, but it is an important effort. We are particularly interested in liquid chemistry and other properties, materials in contact with liquids, straining, initial pressure testing, etc. This applies to multiple liquids involved, as provided by both facility and the platform.
- I don't know anything about the efforts of the working group in this regard. However, I found Steve Hammond's talk very illuminating.
- Liquid Cooling Infrastructure is the "norm" rather than the exception in HPC centers. A well developed set of commissioning guidelines would save managers a lot of time in their commissioning process.
- I grew up with IBM 3168 and up, and Water Cool has been in my life. Lately, there are many strange liquid cooling solutions out there, dipping a whole server into the bath? Using non-water liquid for Chillers and etc. So, this is very interesting area and like to follow up on you guys' work.
- But then I'm biased. This commissioning probably needs to be looked at in a couple of different ways. a) as connected to a conventional chiller or chiller plus economizer setup and b) connected to a cooling tower or dry/adiabatic cooler
- Every center is different and not sure how to do this.
- I assume this includes "new" topologies e.g. dry coolers. An area we don't hear much about is water quality and comparisons of water conditioning technologies. This affects all the heat transfer devices in an important but hidden manner.
- You need to address the specific differences between the American and the European ways of building cooling infrastructures. This has a strong impact on the best practices!

General Membership Meetings

The EE HPC WG hosts bi-monthly general membership meetings. The agenda for these meetings provides a status update on all of the technical team activities, as well as key conference participation and announcements. Comments and questions are encouraged and minutes are published. How would you rate the value of these bi-monthly general membership meetings?



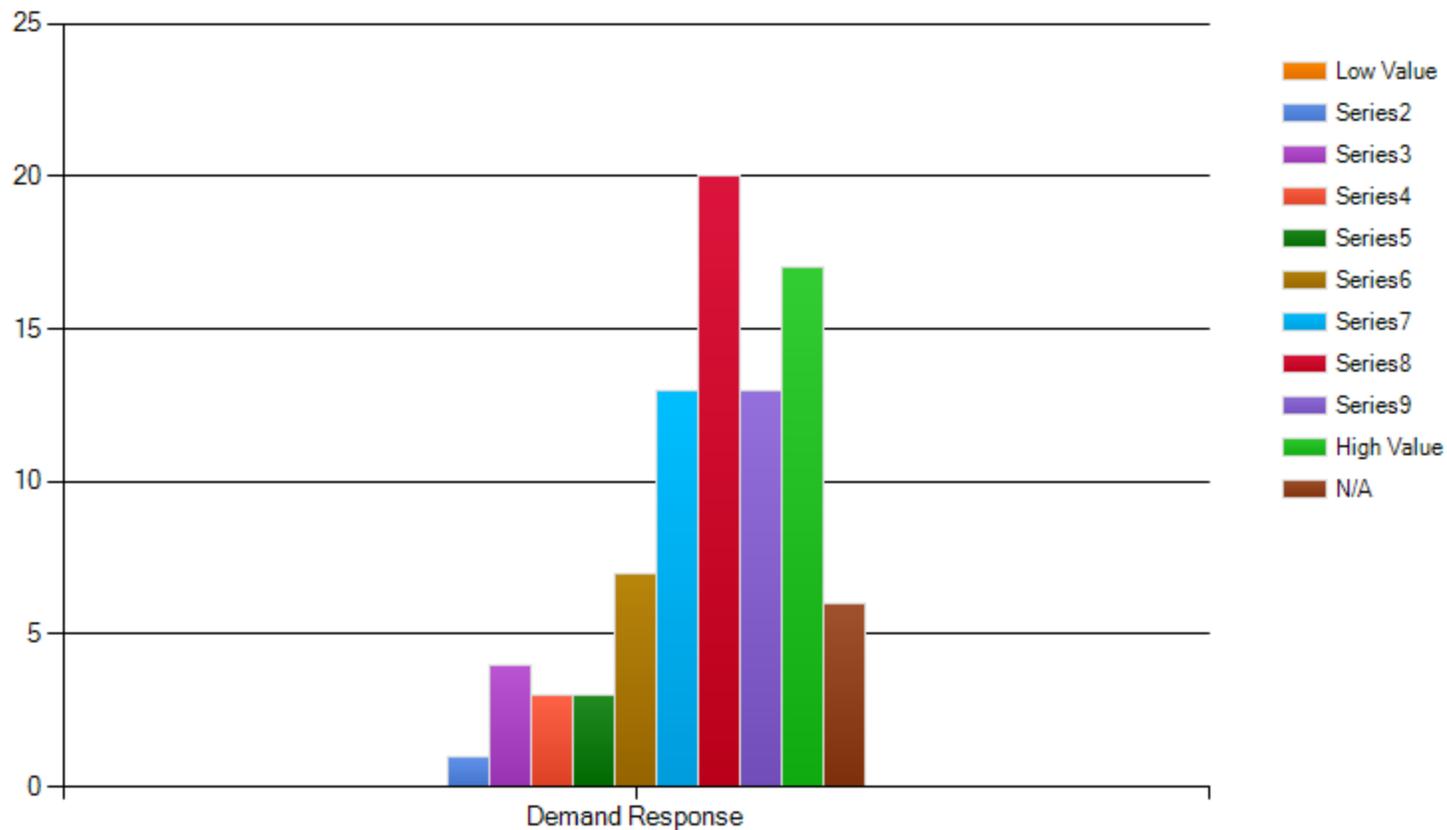
Average rating = 7.7

General Membership Meetings

- I haven't attended any of these.
- it is important to find out where other labs are at and what all is going on
- Once again, I am in Tokyo time zone, and can't always attend the teleconference.
- Is this a conference call? Where are these minutes? Hidden somewhere on the website? I'd like to get the agenda beforehand via email.
- I never attended one, but i believe they must be very important to discuss issues in presence

Demand Response

HPC centers with petascale systems are realizing the large impact they will be putting on their electricity service providers as they bring on (and perhaps turnoff or idle) megawatt scale (soon double digit) super computers. Further, utility rate structures and incentive programs are being introduced to encourage grid responsive demand. There is interest in discussing demand response and electric grid integration across a wide range of opportunities and issues. The EE HPC WG is investigating if there is benefit from the collective action of the EE HPC WG. How would you rate the value of this Demand Response activity?



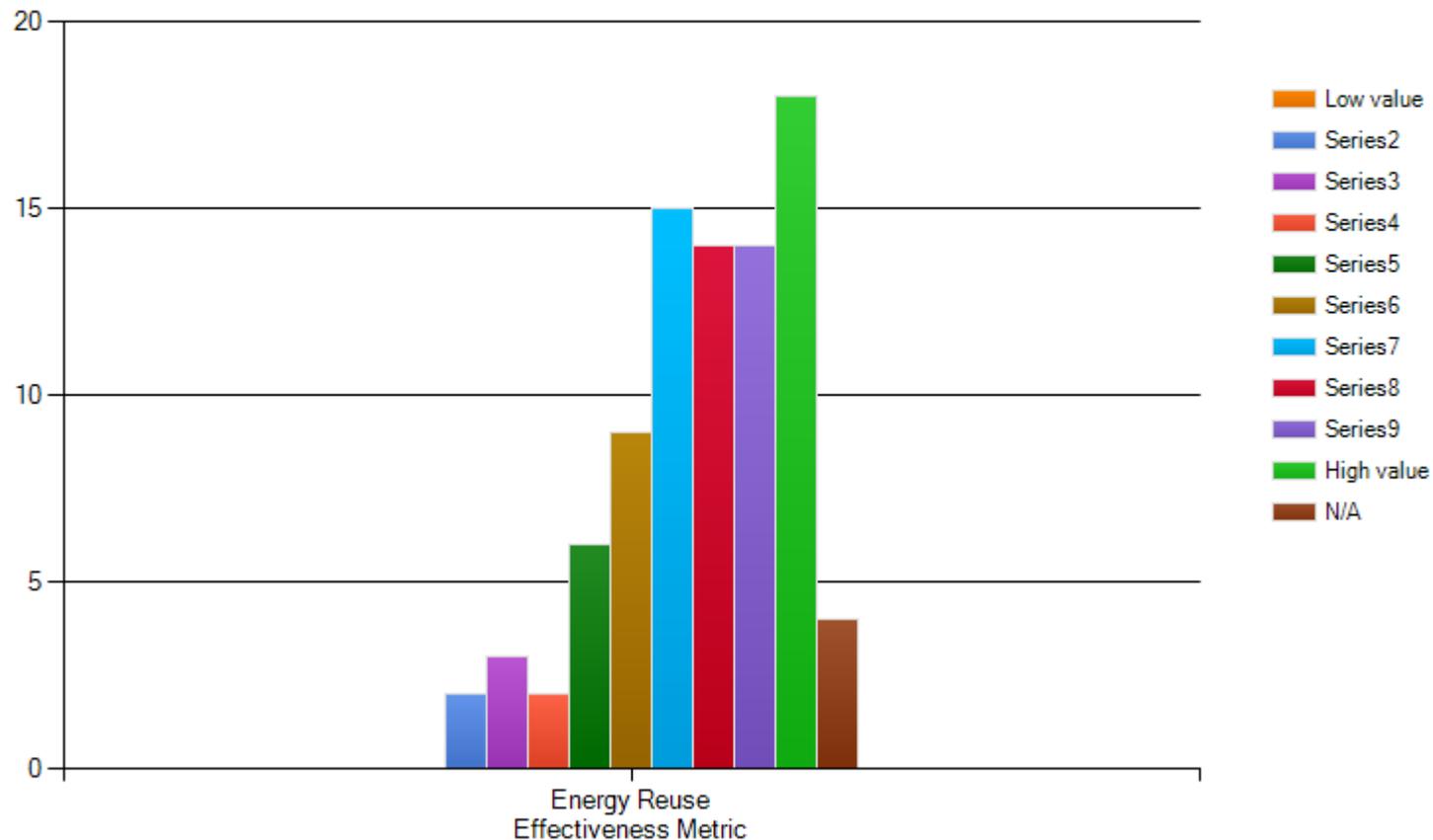
Average rating = 7.67

Demand Response

- This is something that they've implemented at Princeton University.
- In its current form, "demand response" mostly refers to computers responding to power grid events. We are interested in reversing this, i.e. power grid handling huge transients at HPC data centers. We anticipate the need for HPC-utility coordination as transients grow to 10-20 MW per AC cycle.
- Again, high value, but progress is only in formative stage. There is, however, some concern about whether some data centers have service level agreements that would benefit from demand response. I think they should have SLAs that let them benefit.
- HPC centers must coordinate with electricity service providers and explain the scope of the systems which they will be operating and the power which they will, or will not, use. Systems of notifications must be in place to notify service providers and prevent possible interruptions to the grid due to large swings in power demand.
- high as well it is really important when using this much energy in a community
- "soon double digit".... we are already there ;-)
- If we can come up with a good solution for the Demand Rseponse, then we can use it almost everywhere else in IT/ICT computings. No?
- Should not the utilities be involved in this? Possibly a sub-group within the working group.
- At petascale, it makes sense for the data center to have their own generator to avoid transmission losses.
- We need this with in the next 2 years.
- I find it interesting -- but I'm not sure it has high priority over getting through other things first.

Energy Reuse Effectiveness (ERE)

The Green Grid in collaboration with EE HPC WG created a metric, Energy Re-use Effectiveness (ERE). It is defined as the Total Energy minus Reused Energy divided by IT Energy. With no heat reuse, ERE is simply PUE. But, unlike PUE, less than one is possible and desirable. In any data center with energy reuse both PUE and ERE should be measured and trended and will help the owner towards improved energy efficiency as well as reduced overall energy consumption. How would you rate the value of the ERE metric activity?



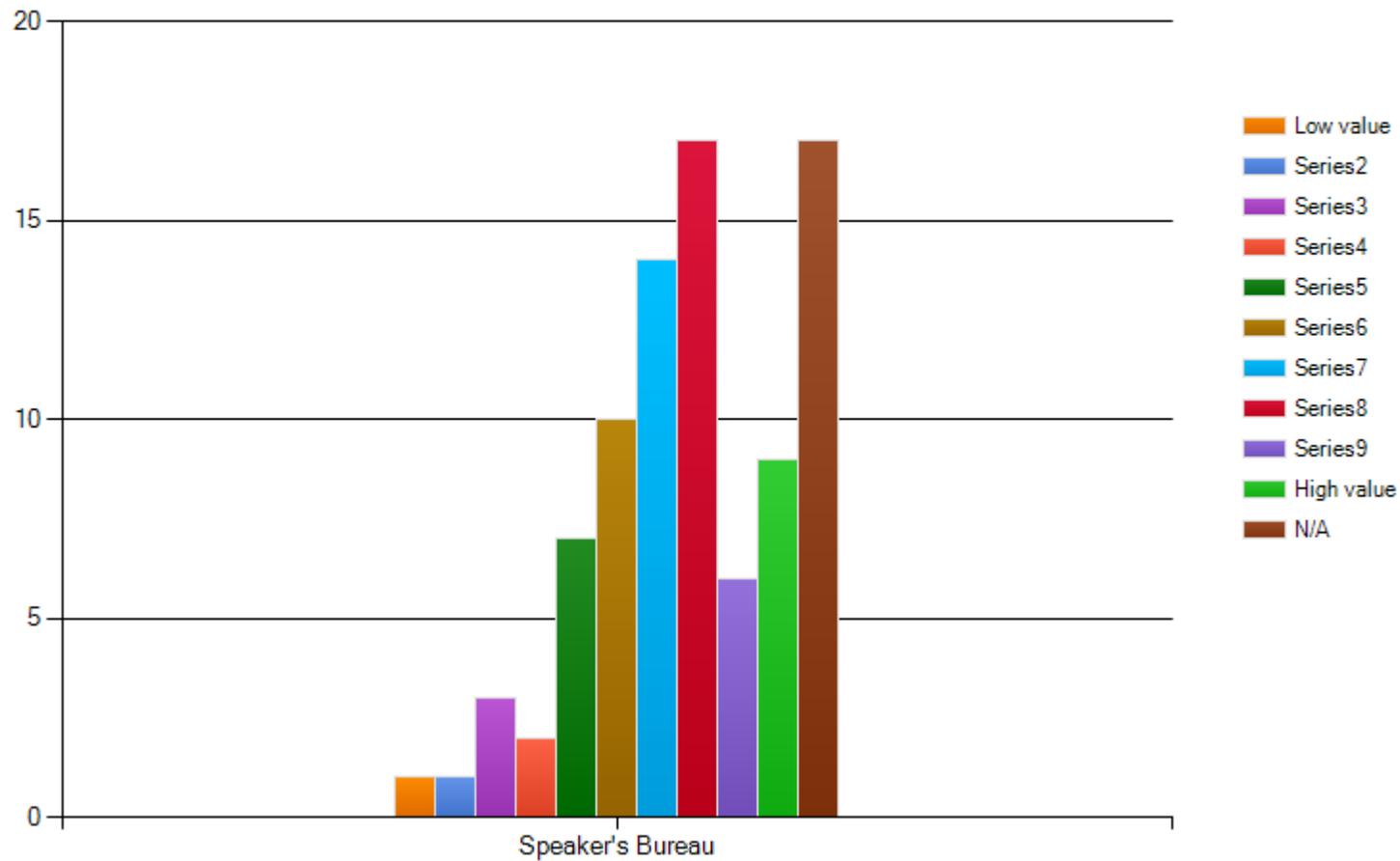
Average rating = 7.57

Energy Reuse Effectiveness (ERE)

- We do not have a customer who can cost effectively use more than 1% of the heat we generate, if any. In all of our prior analysis, costs of heat reuse were prohibitive, but we keep on looking for opportunities.
- I think ERE treats both heat and electricity as the same energy which would be wrong.
- Decreasing energy bills and making data centers more efficient is becoming more critical with shrinking budgets.
- High ERE is also in the future. Who would of thought of reusing waste energy off of a computer
- The quality of the waste heat will drive adoption of the heat re-use from data centers. This metric will help to encourage use of the waste heat.
- This is highly valuable work, but it will take many years before it is used widely. Right now simply having energy reuse is a big deal and the actual efficiency isn't the primary concern to decision makers. This is partly because the amount of reuse achievable is poor, which is in turn because the warm water cooled or high inlet air temperature cooled systems are not well established in the HPC area. Even with large reference sites such as the SuperMUC in Germany vendors and purchasers do not understand the total cost of ownership story around these systems. One area of improvement would be a TCO model for procurements rather than just a ERE value. ERE doesn't show how much extra you need to spend to get a system that is capable of outputting it's waste heat at a useable temperature.
- I have been doing this area of work at TGG's Global Harmonization Task Force, and as well feeding the info into the ISO/IEC JTC1 SC39 team. ERE is very important to me, and working on the concept for a while with these two activities.
- This is a two edged sword. A heat engine's efficiency is dependent on the temperature difference between input and output temperatures. To maximize the difference, some may be tempted to run the servers at maximum allowable temperature thus making them throttle or shorten lifespan
- ERE needs to include the quality of the energy. For the most part heat from data centers is only good for heating swimming pools.
- however it is about total cost of ownership so if one spends millions to try and reuse the heat and the investment can never be returned then it was money that could have been used better else where
- It sounds like a good idea on the surface -- but if there is no heat reuse what is the point of having PUE defined twice? Perhaps this encourages the reuse behavior, but it's not something to easily retrofit.
- ERE is more important in Europe. We might consider a demonstration showing some financial benefit. This will naturally come along with high temp. water cooling.
- It is almost impossible to account for reuse in any real way.

Speaker's Bureau

The EE HPC WG has a speaker's bureau. There are currently four speakers listed. The purpose of the speaker's bureau is to provide a forum to allow members to learn from one another's expertise by encouraging presentations with an opportunity for feedback, questions and answers. Another purpose is to maintain a list of potential speakers for use by other groups looking for same. How would you rate the value of the speaker's bureau?



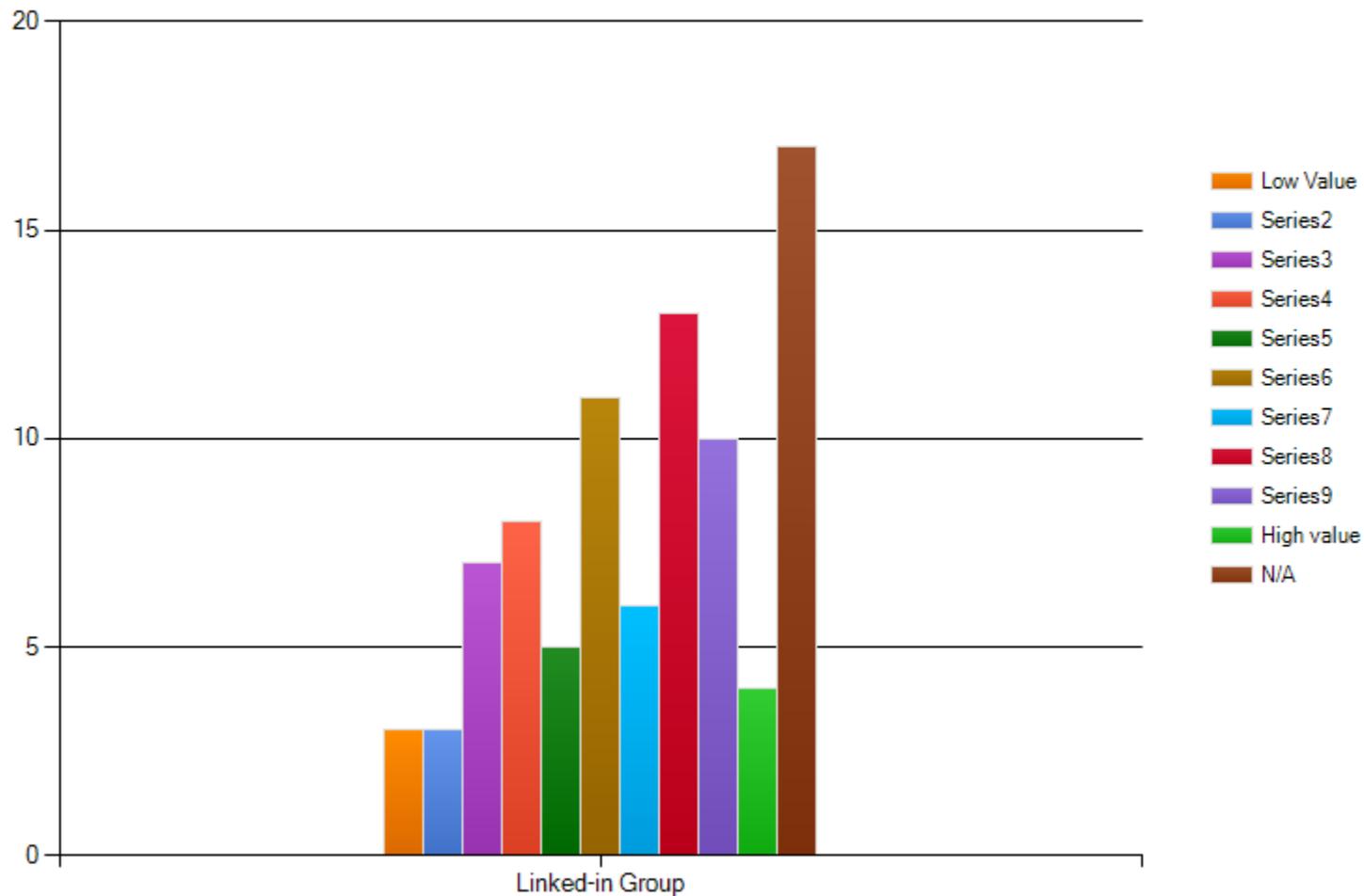
Average rating = 7.04

Speaker's Bureau

- Not well used or well understood.
- I wasn't aware of this.
- I'm not familiar with the speaker's bureau.
- high
- Not familiar with this bureau yet
- Good idea, but I wasn't aware it existed until now!
- Who's who is very important, so it is very valuable.
- did not know it existed
- Excellent WG - exactly the sort of action oriented knowledge generation and dissemination that is needed in this area. Truly appreciate it.
- This is news to me. I would like to know more.
- Typo -- Third phrase -- "...to provide a provide a forum..."
- This doesn't have to be anonymous. I'm Daniel from TU Dresden.

Linked-in Group

The EE HPC WG has a Linked-in Discussion Group called Energy Efficient HPC. There are 74 members. To date, almost all of the discussions have been event announcements. How would you rate the value of the Energy Efficient HPC Linked-in Group?



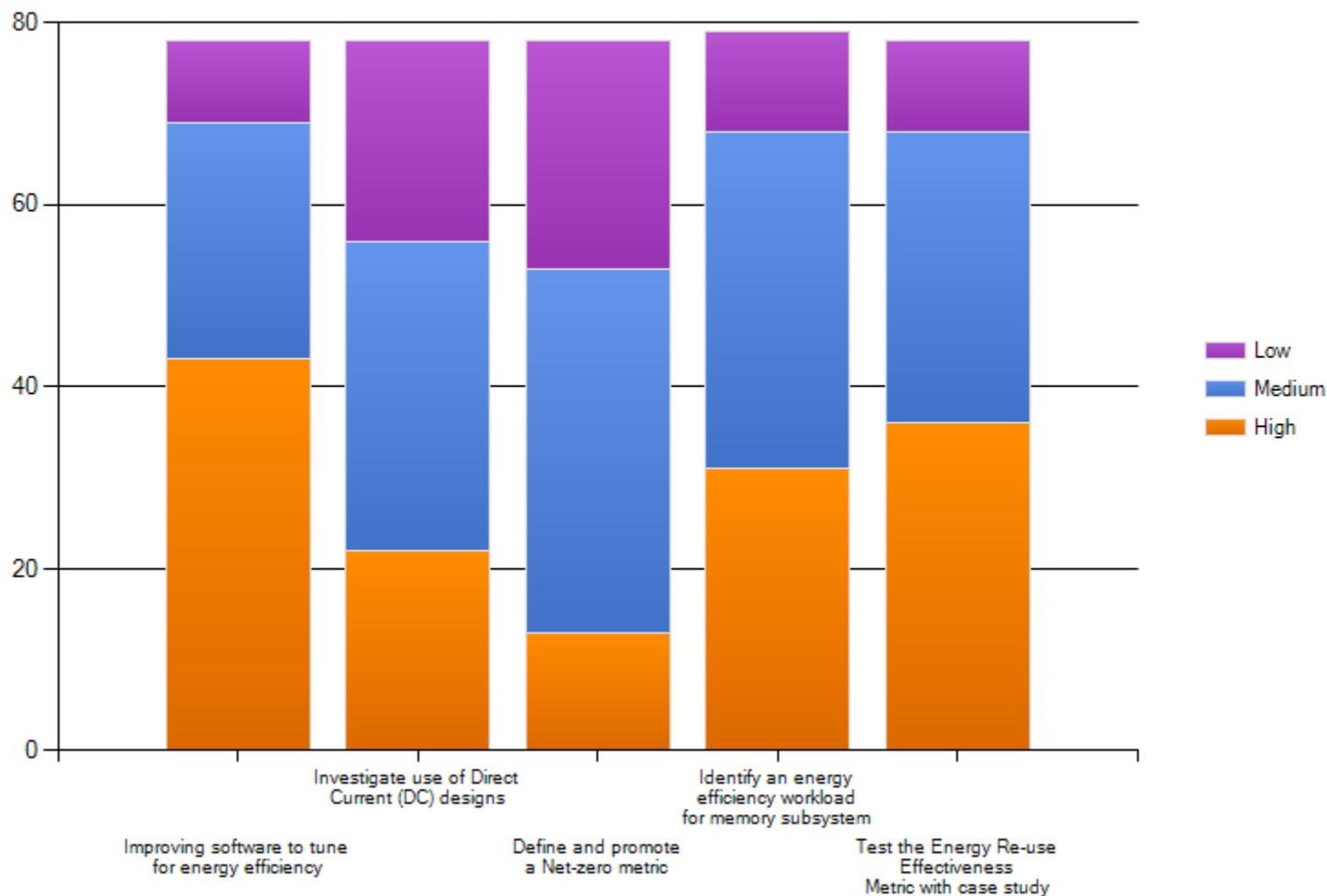
Average rating = 6.13

Linked-in Group

- Linked-in has never been central to my online activity. But I do monitor my Linked-in connections and groups.
- Keep doing it, because this activity will grow as LinkedIn use becomes more common among users, and as LinkedIn adds features to make it more effective.
- I just join it today (3/19/13)
- Not used it yet
- LinkedIn is very good. I stay away from Facebook and SNS stuff, but LinkedIn is very professional oriented and like it as the 1st choice on the Internet grouping.
- I applied for membership and was ignored
- Did not know it existed.
- I didn't know this existed.
- Never heard about it. If it is only announcements, then the value is low. I need announcements via email. If this is too much traffic, collect stuff and make it one mail per week.
- Too many notifications (eventually deactivated notifications, and haven't looked at the group since). I'm interested in efficient HPC, but the LinkedIn group is pretty meh

Survey Suggested Activities

Are there additional or alternative activities that you think the EE HPC WG should take on? Some activities are suggested below. Please rate each activity with an estimate of high, medium or low value.



Survey Suggested Activities: Comments

- I think sw to improve energy efficiency is very important, but I don't think it is in the charter of the group (as I understand it so far). DC power design. This is a pretty major shift from current systems. If the group does anything, I think it should start by investigating if it's worth the effort. The need should be to compare with newer high efficiency AC system. I don't know of any data centers with DC power systems that currently exist. Just even finding out where they exist is beneficial. Memory subsystem ... currently the only workload I see people talking about is HPC. Exercising a memory subsystem brings in a whole new set of workloads. It gives the group the opportunity to investigate non-compute-intensive applications. I'll always rate a case study as high. Data never hurt.
- These are all excellent ideas. Focus on what yields the broadest impact for the longest period of time. In my opinion, developing metrics, metrology, and best practice guidelines for energy efficiency will produce the greatest impact for the investment of time, energy, and funds into the EE HPC WG.
- 1) Software should be looked at. I was Systems Programmer. 2) DC is still questionable. It is not a bad thing, but AC as is OK too. Mixed feelings. 3) Net-zero is very difficult, I think and so even we have the metric? Could we really do it? Use it? 4) Memory Subsystem is a good area to expand this work into! 5) Energy Re-Use, I have been talking about it at TGG's Global Harmonization Taskforce as well as at ISO/IEC JTC1 SC39, so Yes ERE metrics should be developed, and I like to wait for it and I like to review it at SC39 WG1 Ad-Hoc group. Please come up with a good one for us!
- Obviously improving software is the best way to improve efficiency, but it requires a different skill set than thermodynamics and power conversion engineering, so it needs its own advocacy group.
- As mentioned above - start a project/group to define a IPMI standard. This is a way to obtain data streams at a very low cost. Then these can be used for dashboards.
- Developing new energy efficient systems can lead to tens of percents of improvement, optimizing the computational efficiency of the (real) applications by optimizing, new algorithms and methods can lead to orders of magnitude. My feeling is that the EEHPCWG focuses too much on hardware than on applications.

Respondent Suggested Activities

- Hope you'll consider reviewing the exploding storage area. At our maturity level, storage need is growing much faster than computing. Very little seems known about storage systems energy efficiency, metrics for them, or how to best optimize their use in a data center along with compute clusters. All issues of significant importance to me.
- Investigate deployment of liquid immersion cooling
- Investigate the use of ESPC or UESC contracts for efficiency measures in existing supercomputer centers
Tabulate member PUE, ERE information and post on the website. Update it every 6 months Investigate HPC in the Cloud and research in large scale data networks Invite large webhosting firms to present to the WG. Google, Facebook, Yahoo, Microsoft Encourage disruptive technologies - thinking of new approaches Invite ASHRAE to present to the WG
- I think what is missing is a collective voice of HPC customers to the vendors as to what they are missing/doing wrong. It's good to add things like warm water cooling requirements to tenders, but the feedback loop is very long (at least 5 years). In practice product groups in IT companies are optimising the costs of their systems to win bid and often allowing for energy reuse is an area that suffers. Cray Cascade is a classic example of that, chillers are still needed because the cooling water needs to be too cold. If the WG could produce a statement of requirements that major sites could sign up to this might shorten the feedback loop. A similar thing is happening in the cloud space around open compute where facebook are stating a form factor and various requirements ... in HPC every new system is often totally different yet still suffers from the same basic issues as a result of optimising for low up front costs.
- Provide an analysis of the relative efficiencies of various cooling methods. Possibly along the lines of the comparison testing of chill off 2 but taking into account the total energy draw rather than just the ratio of total energy to server (which is NOT IT) energy.
- Probably need to work more on best practices for old facilities versus new. What are the trade offs between between saving money and being environmentally friendly/responsible.

Respondent Suggested Activities, Continued

- Just getting people to better monitor their use would be a better start. Development of methods to collect real time data on energy use and other parameters provides both a realization factor to facilities as well as a trend to observe for "problems".
- Many data center owner/operators are struggling just to get computer systems deployed & operating . Cannot get out too far in front of the cost issues that drive these deployments.
- Migrate HPC cooling technology in the direction of energy recovery (electrical, heat, and cooling). Efforts are being made to make the software and hardware more efficient and to reduce PUE's to 1.0, but there are still MW of energy going up the cooling towers that should be recovered and reused. Investigate absorption and absorption cooling, heat pump water heaters, and other technology such as <http://texasiof.ces.utexas.edu/PDF/Presentations/May%2016%202012/11%20Low%20Temp%20Research%20INL.pdf> Define a power quality envelope for HPC. Right now CBEMA, SEMIF47, and IEC are typically pointed to in procurement specifications for HPC. Should HPCs have their own criteria? How do you verify that a machine meets a given criteria. What instrumentation can be used to identify a PQE and its severity? Effects of PQEs on different equipment (IT, mechanical, electrical). Addressing sudden power drops caused by a PQE (extreme changes can cause chillers to drop off even if they rode through the PQE. This conflicts a little with the past to get power consumption down during idle time lower energy cost. Investigate the problems that rapidly changing HPC loads have on cooling and electrical infrastructure. There is interest in the effect on the utility, but chilled water systems will probably be affected before the utility notices any problem (e.g. chillers can't reduce their cooling capacity fast enough to follow a sudden multiMW load drop and trip off on low temperature.
- Investigate homogeneous vs heterogeneous Energy Efficient architectures

Potential Funding Sources

- DOE
- In Europe one option could be to request an FP7 CSA grant from the European Commission.
- Alas, not my area of expertise. I think the industry is better served if the contributions from the group remain free and open. The IEEE charges for its specs and makes money true, but the result is that many people (like me) get the information secondhand. I cannot justify 100s of dollars for a few official pages of spec. You might consider hosting a conf. But I think charging a hefty registration is self-defeating. If the attendance hits a good demographic, you might charge for vendor tables. Customized presentation and consultation might work. A company wants to do Level 3 measurements or improve its Top500 ranking ... do you have experts that can help them to that?
- EE HPC WG needs funding either from federal agencies, or from private industry. For the federal side, perhaps we could develop a consortium that contributes core funding from multiple agencies who benefit from your work. Realistically, DOE, DOD, and NSA would need to contribute the most. Try to partner with NIST too for the metrology efforts. Write a column for a HPC related journal, which will generate more interest. If legally feasible, start a web site, and feature advertising from vendor sources who offer energy efficient data center and computing products. Link it to the LBL web site and vendor white papers.
- Look into federal funding and grants
- Member Dues
- The EU and PRACE has substantial funding for Petascale systems, could be worth looking at. Perhaps also it's worth talking to vendors with products with have the qualities we would like to see in general for example Fujitsu, IBM, SGI?
- Gee-wiz, that is a difficult one. I guess need to go up way above LBNL and PNNL level into much higher place (person) at DOE and the U.S. Gov. Also, talk to EU people both JRC and people up top in Brussels. Japana wise, can't think any good way. Politicians thinks No.2 in speed is OK for the Super Computers, and they think HPC is more of waste to develop in Japan. Sadly!
- We could consider DOE and local state agencies as long as the benefits are focused on the larger stakeholders.
- Anybody with skin in the game, server manufacturers, cooling infrastructure, power, utilities etc.
- Utilities who can reduce baseload
- Industry participation in the funding. Maybe acknowledgement would encourage corporate funding.
- Office of science should be able to help but I have no contacts.
- The HPC WG is very effective - I am puzzled as to why funding for it is not prioritized.
- The HPC industry should have a strong incentive for this.
- I'm afraid not, I'm based in the UK. Although might vendors be prepared to fund/sponsor EEHPC?

Other Comments

- This survey has shown us that many documents were available. Until now, for most of them, we were not aware of their existence. But, it 's sure that we will use them more in the future.
- I think the EE HPC WG is doing a great work and I would like to thank you all of you that make it possible.
- Technical committees was a great idea.
- Thanks for your efforts and good work. I'll try to contribute as I have time. Doug Hefele
- This group is doing work that is highly valuable! You need to publicize and communicate it better. Develop a "brand" and use that recognition to attract support.
- Excellent initiative!
- Please keep this work going, I think the momentum will continue to build up. I think it's worth exploring areas where the HPC community can work with the wider IT community, especially with the emerging 'cloud' segment which is 10x the size of HPC and have similar power and cooling challenges. Another nice thing to have would be a no nonsense CxO level summary of the situation around energy efficiency. The message about PUE has got through, but the rest is still a mystery. Vendors are throwing terms about without really understanding what they mean, and the vendors with poor products are still able to muddy the waters, or say one thing and bid another.
- I do enjoy reading the work EE HPC WG is doing, and also, at the TGG Forum, HPC presentation slots were well taken by many attendees!! Keep up the good work, and keep the fire going!! Very truly, Tom Misaki TGG / GIPC / SC39 Japan
- Keep up the good work ...
- It is/was a great idea to have this survey.
- Please keep up the great work, this is important stuff.
- While PUE and derivatives like ERE are useful, we ultimately seek to reduce the denominator of those ratios.