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The Honorable Kristina M. Johnson
Under Secretary for Energy
United States Department of Energy
1000 Independence Avenue SW
Washington, DC 20585

Dear Ms. Johnson:

Thank you again for taking time out of your busy schedule to meet with me on July 22. I was delighted to hear about your progress at DOE and about the new programs that you're developing. I particularly enjoyed our discussion about the program for energy education, Regaining our Energy Science and Engineering Edge (RE-ENERGYSE), and I have taken seriously your request for my comments and ideas on its various components. I also would like to share with you some information on ongoing MIT initiatives that you may find applicable to the RE-ENERGYSE program. I'd welcome a chance for further discussion, if that would be useful to you.

Overall, I believe the RE-ENERGYSE program will be essential for developing the nation's education system to prepare the workforce to meet the energy challenges ahead. Perhaps most important, it will highlight an essential fact: an energy education that meets the country's critical need for "energy preparedness" must necessarily be multidisciplinary.

For consideration as you move forward, I offer the following ideas for the program components that you asked me to review:

1. *Energy Fellowships.* I recommend *expanding the scope of these fellowships* to include the energy science, engineering, technology, architecture and urban planning, management, economic, and social science domains that are so critical to understanding the complexities of changing our energy systems. Supporting development of energy-oriented study in all of these related areas will permit us to address the critical supply, demand, infrastructure, investment, and policy aspects of our energy challenges.

   At MIT, we have had great successes in energy research, policy evaluation, and curriculum development, in large part because of our sustained commitment to the multidisciplinary aspects of energy challenges. While I remain a believer in the importance of a strong disciplinary base for high-quality undergraduate education, the addition of cross-disciplinary perspectives enhances the probability of meeting our goal of high-impact, real-world energy solutions.

I also recommend extending the length of the fellowships to four years, the more common fellowship length.

2. *Graduate Training Program in Integrative Energy Systems.* I strongly recommend that this program be *expanded beyond master's programs to include doctoral programs.* In fact, I would advise doctoral programs over master's programs at the outset, to establish the essential base of an energy curriculum. A robust cross-disciplinary education (essential for the preparation of our next generation of energy scientists, technologists, economists, and investors) is important for research careers as well as for manufacturing, operations, and practice.

   At the doctoral level, as we discussed briefly, I would recommend modeling this program on the National Institutes of Health (NIH) Training Grant Program. The NIH Training Grants create "communities of education and research," bringing together faculty dedicated to a shared educational goal and supporting graduate student fellowships, seminars, and course development. Eligible institutions would request five-year awards to support predoctoral and postdoctoral trainees enrolled in integrated curricula and research in energy. Institutions would then recruit qualified students who are committed to careers in energy research and provide them with mentoring and career development. This approach would enable coherent graduate curricula for energy to develop at universities as opposed to an approach focused on fellowships for individual students. While this individual focus supports students engaged in energy research, it does not foster the development of integrated energy curricula. Through training grants, curricula would develop that could be widely circulated among other universities' graduate programs.

   Training grant-supported programs can encourage collaboration among departments and provide opportunities to teach new graduate courses at the interface between disciplines. A DOE-sponsored training grant program would contribute to the development of a diverse and highly trained workforce available to assume leadership roles in addressing the nation's complex energy research and training needs. The NIH Training Grants have provided powerful and effective incentives for recruiting a diverse community of graduate students.

   I believe the DOE should also consider complementary *undergraduate curricula.* As I mentioned briefly in our meeting, MIT recently launched a cross-disciplinary undergraduate Energy Studies Minor, which will begin registering students in September of 2009. Developing this curriculum required an extensive interdepartmental effort over the course of two years. The energy minor builds on the strengths of the Institute by integrating course offerings (and requirements) from all of MIT's five schools. The program includes relevant existing courses from 15 departments and a dozen new and substantially revised classes. A core goal of the minor is to ensure that students develop a strong foundation in the science and engineering of energy and also a fluency in the social sciences, design, and business of energy, all of which are critical to working across boundaries in the energy arena. Rather than funding undergraduate scholarships, DOE could have an enormous impact by supporting the development and dissemination of undergraduate course material and curricula. MIT would gladly cooperate with DOE on such a project, and I'm sure other institutions considering this approach would, as well.

3. *Energy Postdoctoral Fellowships.* Similar to the Energy Graduate Fellowships, I recommend *expanding the scope* to include the energy science, engineering, technology, architecture and

urban planning, management, economic, and social science domains. I also recommend *extending the postdoctoral fellowships to two years*, which would have far greater likelihood of real research progress (as recognized by being the standard for most postdoc awards).

4. *EUREKA.* I applaud this initiative. As you know, MIT places a large emphasis on creating research opportunities at the undergraduate and graduate levels. I recommend expanding this program to include master's students, particularly those studying at non-research-intensive institutions. I also recommend that DOE develop a robust matching program to ensure positive, productive matches between students and mentors.

   I am concerned that $5,000 grants will not be sufficient to fully support an undergraduate for the summer. If recipients are responsible for all expenses, including living and travel, I suggest increasing the assistantship to $7,500 to minimize the students' out-of-pocket costs.

5. *Technical Education.* This is a critical initiative; however, it will be stymied by the matching requirement, especially at the community college level. I also recommend focusing on *certificates for teachers* versus technicians to maximize the program's leverage by "training the trainers." MIT has found in our education programs for developing nations that this "training-the-trainers" approach has a much greater multiplier effect than focusing only on reaching individual students.

6. *Education and Outreach.* While I certainly agree that more outreach is needed to engage the public in addressing the nation's energy challenges, I wonder whether expanding the fellowship and EUREKA programs would be a more effective strategy.

   Concerning these energy education and outreach efforts more generally, as we discussed during our recent meeting, MIT has developed breakthrough educational technologies that could easily be deployed to expand energy education nationwide (or worldwide!). For example, MIT's OpenCourseWare (OCW) is a web-based publication of virtually all MIT course content and has been widely used by secondary school teachers and students. OCW content is free and open to the public, and the site averages more than one million visitors to content each month. Educators and students across the nation and the world use OCW to enhance their knowledge base and expand their learning experience. Energy course materials that we are now developing could be posted on OCW in a special energy portal, including videos of courses and could serve as a model for other universities and community colleges interested in developing energy curricula. This online course approach, potentially available on iPods, cell phones, and Kindles as well as on desktops and laptops, could dramatically increase the impact of DOE's new energy education programs, reaching millions, not just hundreds or thousands of students and teachers.

   Another online MIT resource, iLab, provides internet access to state-of-the-art laboratories. iLab's scalable, open-source infrastructure provides a unifying software framework that supports access to a wide variety of laboratories. Students and teachers anywhere in the world can carry out experiments at any time, which has proven particularly valuable for students whose schools cannot afford first-rate laboratory equipment.

   Researchers at MIT and other institutions have studied the application of on-line games to science education at all levels. The National Academy's Board on Science Education is now

conducting a major study of this potentially promising educational tool, and a growing body of academic literature addresses it. DOE might want to consider encouraging educational games, particularly for grades 6 to 12, which could take advantage of the current models of energy technology and climate change. An educational gaming approach could significantly scale up DOE's impact.

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I applaud your commitment to expand the Nation's energy awareness and education at all levels through RE-ENERGYSE. Thank you for asking for my feedback on the program ideas. My colleagues and I would welcome an opportunity to discuss any of these ideas further. I very much hope you or your staff might visit MIT to see firsthand the application of our initiatives to RE-ENERGYSE.

Please do not hesitate to contact me if I can be of further assistance.

Sincerely, All best,

Susan

Susan Hockfield

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