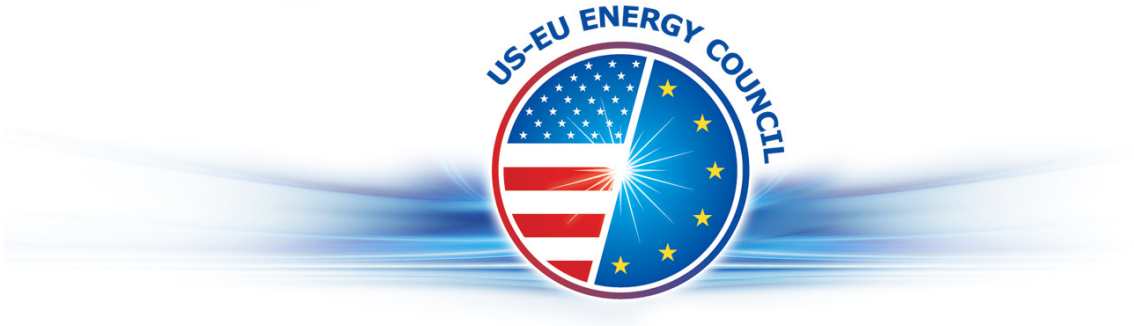


Trans-Atlantic Workshop on Rare Earth Elements and Other Critical Materials for a Clean Energy Future

Hosted by the MIT Energy Initiative
Massachusetts Institute of Technology
400 Main Street, Building E19-307,
Cambridge, Massachusetts
December 3, 2010

Workshop Background

Rare earth elements and other critical raw materials are essential to our industrial production, particularly for clean energy options like wind turbines, solar cells, electric vehicles, and energy-efficient lighting. Wind turbines are the most rapidly growing source of electricity generation in both Europe and the United States. Solar photovoltaic cells are steadily declining in cost, and their widespread, cost-effective use on power grids is anticipated within the coming decade. Electric vehicles, meanwhile, offer a means to move away from imported oil for transport towards a mix of coals, gas, wind, solar and nuclear energy with much lower net carbon dioxide emissions. Compact fluorescent and LED lighting offer an avenue to greatly reduce electricity consumption.

Yet these vital clean energy options will use a large share of available rare earths and other less common materials. Production of some of these materials is concentrated in a very small portion of the globe, so that supplies may become tight and costs prohibitive as markets grow. To cope with this dilemma, there are a few main effective strategies. First, we can try to find new or enhanced recycling technologies to increase available supplies. Second, we can try to find substitute materials or alternate device designs that perform as well or nearly as well at comparable cost. Third, we can look for technology and process design changes to limit the amounts of scarce materials that are required.

Objectives

The workshop will gather experts from the US and the EU to exchange views on emerging challenges emerging form scarce availability of rare earths and other critical elements.

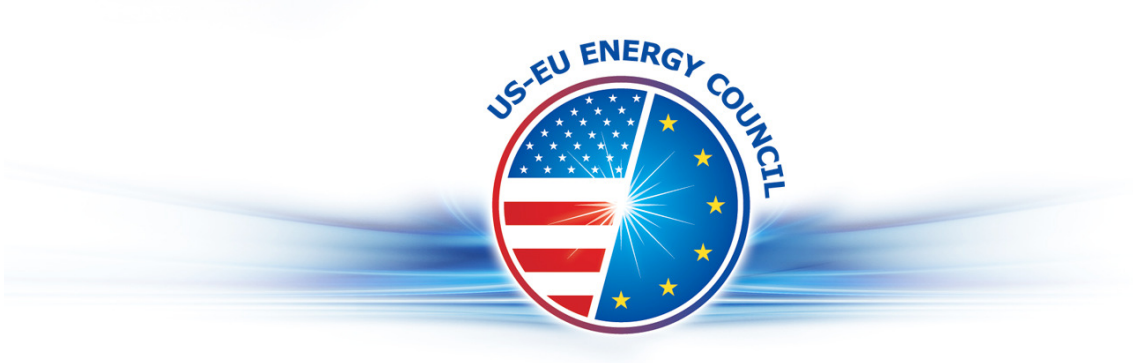
What are the most important materials for continued expansion of clean energy markets? Which of these materials are likely to experience supply constraints over the next two decades? Which are the priorities for research, particularly for the substitution of the use of critical elements? To what extent can we alleviate tight supplies through enhanced exploration and development? How might wind turbines and electric vehicles be redesigned so they do not rely on scarce materials? What kinds of advanced materials can substitute for the materials now in use? What new technology pathways should we follow to find the substitutes we need? What are the opportunities for Trans-Atlantic cooperation to accelerate our progress along those pathways and leverage the substantial resources that are being devoted to them?

These are the types of questions that will be addressed by the participating top scientists, engineers, officials, and utility executives with expertise in advanced materials, materials recycling, electric vehicle drives, wind turbine design, and photovoltaic power systems to discuss these issues, define the most promising technology options, and assess the long term research and development opportunities. Interactions should help examining the practical potential to achieve clean energy functionality with prudent use of critical materials, through substitutes, alternate technologies and more efficient use.

Workshop Venue and Organization

The workshop will be hosted by the U.S. Department of Energy (DOE) and the Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts on December 3, 2010 and is organized in cooperation with the European Commission Directorate General for Research and Innovation, Unit "Materials", under the auspices of the EU-US Energy Council, its Working Group on Energy Technology, and its expert subgroup on advanced materials. This initiative also contributes to the work developed within the Innovation Action Partnership under the EU-US Transatlantic Economic Council.

The workshop will be limited in size, and all participants are expected to engage actively in discussion. Officials of the European Commission and DOE, invited selected high level scientists and experts to participate.



A Keynotes: Setting the Scene - Critical Materials for a Clean Energy Future

(8:30 - 10:30 am)

Keynote addresses will be invited from leading energy policy makers, scientists and executives to highlight findings of the EU Report on Critical Materials, the DOE Critical Material Strategy, and the MIT report on Critical Elements in Energy Technology, all recently released or about to be released. A Japanese keynote speaker is invited.

Chairs/Animateurs: **Jeff Skeer**, DOE Office of Policy and International Affairs and **Renzo Tomellini**, EC Directorate General for Research and Innovation

Rapporteurs: **Tom Lograsso,** Ames Laboratory and **Nick Morley**, Oakdene Hollins.

Each Speaker will have 15 minutes

Diana Bauer, Office of Policy and International Affairs, U.S. Department of Energy*, Highlights of the DOE Critical Materials Strategy*

Antje Wittenberg, Directorate General for Enterprise and Industry, *The EU Raw Materials Initiative and the Report of the Ad-hoc Group (tbc)*

Tom Lograsso, Ames Laboratory (Iowa State University)*, Future Directions in Rare Earth Research: Critical Materials for 21st Century Industry*

Derk Bol, Materials Innovation Institute M2i (Netherlands) M2i, *Material Scarcity Report and Industrial Perspectives*

Bob Jaffe, Massachusetts Institute of Technology, *Insights from the Energy Critical Elements Policy Study by the American Physical Society and Material Research Society*

Renzo Tomellini, EC Directorate General for Research and innovation, *Preliminary Findings on the Role of Rare Metals as Supply Chain Bottlenecks for Priority Energy Technologies*

Kazuhiro Hono, Magnetic Materials Center Managing Director, NIMS, *Research Trends on Rare Earth Materials in Japan*

Edward Jones, Lawrence Livermore National Laboratory, *Outcomes of U.S.-Japan Roundtable on Rare Earth Elements R&D for Clean Energy Technologies (18-19 November 2010)*

QUESTIONS AND ANSWERS TIME AND DISCUSSION

Coffee Break (10:30 – 11:00 am)

B Strategies and Research for Finding Critical Material Substitutes

(11:00 am - 12:30 pm)

This session will highlight ways to substitute for critical materials that are used in clean energy devices like EV motors, LED lighting and solar cells. How can science find materials that substitute for those used in clean energy devices today and perform just as well? How can R&D efforts help us design devices that perform the same function with relatively inexpensive and easily available materials?

Chairs/Animateur: Linda Horton, DOE Office of Basic Energy Sciences

Rapporteurs: **Tom Lograsso,** Ames Laboratory and **Nick Morley**, Oakdene Hollins

Each Speaker will have 10 minutes

George Hadjipanayis, Chairman, Department of Physics and Astronomy, University of Delaware, *Moving Beyond Neodymium-Iron Permanent Magnets for EV Motors*

Bertrand Fillon, Commissariat à l'Energie Atomique et aux Energies Alternatives, *Challenges for the Future Sustainable Energy Generation, Distribution and Use*

John Hsu, Oak Ridge National Laboratory, *Flux Coupling Machines and Switched Reluctance Motors to Replace Permanent Magnets in Electric Vehicles*

Spomenka Kobe, Jozef Stefan Institut, *Rare Earth Magnets in Europe*

Madhav Manjrekar and Elena Arvanitis, Siemens Corporate Research, *Research Priorities for Critical Material Substitutes from a European Corporate Perspective*

Anne de Guibert, SAFT, *Critical Materials and Alternatives for Storage Batteries*

QUESTIONS AND ANSWERS TIME AND DISCUSSION (30 minutes)

Lunch (12:30 – 1:30 pm)

Hosted by the Delegation of the European Union to the United States of America

C Strategies and Research for Using Critical Materials More Effectively

(1:30 - 3:00 pm)

This session will highlight strategies for reducing critical material needs over multiple device lifecycles. These include innovations to *reduce waste* in manufacturing, *enhance recycling* of critical materials used, and *design molecular structure* so that less critical material is required.

Chairs/Animateur: **Pilar Aguar**, EC Directorate General for Research and Innovation

Rapporteurs: **Tom Lograsso,** Ames Laboratory and **Nick Morley**, Oakdene Hollins

Each Speaker will have 10 minutes

Iver Anderson, Division of Materials Sciences and Engineering, The Ames Laboratory, *Current and Future Direction in Processing Rare Earth Alloys for Clean Energy Applications*

Michael Heine, SGL Group - The Carbon Company, *Carbon Fibers in Lightweight Systems for Wind Energy and Automotive Applications: Availability and Challenges for the Future*

Steve Duclos, Chief Scientist, GE Global Research*, Research Priorities for More Efficient Use of Critical Materials from a U.S. Corporate Perspective*

Mark Caffarey, UMICORE, "*Opportunities and Limits to Recycling of Critical Materials for Clean Energies*

Peter Dent, Electron Energy Corporation*, Strategies for More Effective Critical Materials Use*

Daniel Beat Müller, Norwegian University of Science and Technology, *Material Flow Analysis*

QUESTIONS AND ANSWERS TIME AND DISCUSSION (30 minutes)

Refreshment Break (3:00 – 3:30 pm)

D Opportunities for EU-US Cooperation on Critical Energy Materials

(3:30 - 4:30 pm)

This session will identify synergies between U.S. and EU efforts to find substitutes for critical materials and reduce the needs for such materials in clean energy technologies. These synergies will form the core of a Trans-Atlantic Strategic Vision for Critical Materials Research.

Chairs/Animateurs: **Jeff Skeer**, DOE Office of Policy and International Affairs and **Renzo Tomellini**, EC Directorate General for Research and Innovation

Rapporteurs: **Tom Lograsso,** Ames Laboratory and **Nick Morley**, Oakdene Hollins

E. Wrap Up Session

(4:30 – 5:00 pm)

This session will identify next steps and actions in pursuing a collaborative research agenda.

Chairs/Animateurs: **Jeff Skeer**, DOE Office of Policy and International Affairs and **Renzo Tomellini**, EC Directorate General for Research and Innovation

Rapporteurs: **Tom Lograsso,** Ames Laboratory and **Nick Morley**, Oakdene Hollins

Close (5:00 pm)