

**Please note, the RFI submission deadline has been extended to December 5, 2014.**

**DATE:** 14 October 2014

**SUBJECT:** Request for Information (RFI)

**DESCRIPTION:** This RFI is intended to inform DOE on the possible areas of technical research that would improve photovoltaic module recycling efficiency.

## **BACKGROUND**

Installed capacity of solar energy in the US has been quickly increasing in the past few years with 4.5GW installed in 2013 compared to 3.3GW in 2012 and 1.9GW in 2011. Conservative projections for US solar energy installation of 3GW per year have already been surpassed and will likely keep increasing. By 2050, it is projected that up to 700 total GW of solar will have been installed in the US. As the amount of photovoltaic systems increases, the mass of PV module waste once modules reach their end of life will increase as well, adding a new waste source to the existing waste stream. While the time period that defines end-of-life for modules may vary due to various conditions, the overall rate of PV coming off-line due to being at end-of-life will echo the rate of installation.

PV modules are discarded once the power output has degraded to the point that the power output is no longer valuable as an electricity source. Failed modules have a variety of different components that could be recycled using already established recycling processes. By mass, 85% of a Si PV module is composed of the cover glass and Al frame, both of which can be recycled through general recycling plants once they have been separated from the rest of the module. Other components, such as contacts which contain valuable metals like Ag, could also be recovered and provide the benefit of offsetting mining production. The absorber materials of PV modules vary but are currently mostly composed of Si, CdTe and CIGS. For Si modules, there is a toxicity concern in the lead solder used for interconnects. In CdTe, the toxicity of Cd is of concern. CdTe and CIGS modules contain rare elements Te, In, Ga and Se which may pose a concern due to their abundance and future availability.

For these reasons, the development of efficient and cost-beneficial recycling processes to aid in creating a future PV recycling economy is of interest. Recycling of modules at end of life could provide energy savings compared to the production of new materials, as well as provide another source of raw materials that is not dependent on production from mining. This would divert a large amount of waste from the landfill. The large majority of the materials in standard modules are the glass and aluminum frames which can be recycled using existing recycling technologies if they can be separated easily. Other components of the module, such as the absorber material and metal contacts/interconnects may require further development of both the recycling and separation technologies.

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In some regions, policies have been established to address and direct the recycling of photovoltaic modules. In Europe, the European Union has passed legislation which establishes targets for the collection, processing and recycling of waste from electrical and electronic equipment (WEEE). The WEEE Directive also covers the collection and recovery of photovoltaic modules. Individual members of the EU are currently in the process of transcribing this directive into their own policies in order to begin implementation.

On an international level, the International Energy Agency Photovoltaic Power Systems Programme (IEA-PVPS) works on the issue of PV module recycling through Task 12 of their program. This task includes research projects aimed at analyzing the environmental impact of photovoltaic modules, identifying the environmental safety and health issues related to photovoltaic modules and publishing the results. Specific research topics that have been undertaken include research in Cd recovery for CdTe modules, life cycle assessments and economic feasibility studies. The IEA PVPS effort has catalyzed the establishment of PV Cycle to organize PV module recycling efforts with targets of collecting 65% of PV module waste and recovering 85% of collected materials as per the 2009 revised WEEE targets.

Additionally, on the industrial side, a handful of PV manufacturing companies have built recycling programs for modules. Globally in academia, groups have research projects that look at increasing the efficiency of recycling processes for module components and developing improved characterization methods to test the quality of components for recyclability potential.

As the installed capacity of PV modules expands rapidly in the US, it may be important to begin building the technical framework for efficient recycling of PV modules, with possible cost benefits, in order to acknowledge and support the full life cycle of a large amount of materials that will contribute to the waste stream through the PV industry.

**PURPOSE:** The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on issues related to PV module recycling technology. EERE is specifically interested in information on the role of government in aiding PV module recycling and impactful areas of research in developing recycling technology. This is solely a request for information and not a Funding Opportunity Announcement (FOA). EERE is not accepting applications.

**DISCLAIMER AND IMPORTANT NOTES:** This RFI is not a Funding Opportunity Announcement (FOA); therefore, EERE is not accepting applications at this time. EERE may issue a FOA in the future based on or related to the content and responses to this RFI; however, EERE may also elect not to issue a FOA. There is no guarantee that a FOA will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if EERE chooses to issue a FOA regarding the subject matter. Final details, including the anticipated award size, quantity, and timing of EERE funded awards, will be subject to Congressional appropriations and direction.

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Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development; this RFI does not constitute a formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. EERE will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. EERE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that EERE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind EERE to any further actions related to this topic.

**PROPRIETARY INFORMATION:** Because information received in response to this RFI may be used to structure future programs and FOAs and/or otherwise be made available to the public, **respondents are strongly advised to NOT include any information in their responses that might be considered business sensitive, proprietary, or otherwise confidential.** If, however, a respondent chooses to submit business sensitive, proprietary, or otherwise confidential information, it must be clearly and conspicuously marked as such in the response.

Responses containing confidential, proprietary, or privileged information must be conspicuously marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Federal Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

If your response contains confidential, proprietary, or privileged information, you must include a cover sheet marked as follows identifying the specific pages containing confidential, proprietary, or privileged information:

**Notice of Restriction on Disclosure and Use of Data:**

Pages [list applicable pages] of this response may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for the purposes described in this RFI DE-FOA-0001218. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.

In addition, (1) the header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: “Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure” and (2) every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

**EVALUATION AND ADMINISTRATION BY FEDERAL AND NON-FEDERAL**

**PERSONNEL:** Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The Government may seek the advice of qualified non-Federal personnel. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response,

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consent to EERE providing their response to non-Federal parties. Non-Federal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

## **REQUEST FOR INFORMATION CATEGORIES AND QUESTIONS:**

1. Is PV recycling an important problem? Why or why not?
  - a. What defines 'end of life' for a PV module. What are the expected volumes of PV modules that are at end of life (rather than at end of warranty) in 15 years? 30 years?
  - b. There are many issues within the field of PV recycling that would benefit from improvement such as establishing policy, growing the infrastructure and developing technical solutions. In the current US environment, what is the largest problem in the field of PV recycling?
2. The Federal government, the industry and academia can all contribute to the development of a PV module recycling infrastructure but perhaps by addressing issues at different points of the supply chain.
  - a. What current US policies, if any, are related to the development of PV recycling?
  - b. What is the most impactful action the Department of Energy could take in terms of PV module recycling?
  - c. What is the most impactful action that industries related to PV module recycling could take? (such as module manufacturers, distributors, developers, waste management, recycling industry)
3. A large and well-established recycling infrastructure already exists for materials that make up the bulk of common PV modules such as glass and aluminum.
  - a. How easily and efficiently can current PV modules be fed into the current recycling infrastructure?
  - b. What are the three most important technical hurdles in recycling processes that need to be overcome in order to efficiently recycle PV modules? What is needed for PV recycling to be economically profitable?
  - c. What industries are uniquely suited to solve PV recycling issues that are not traditional recycling or PV industries?
4. List the top three areas of module design that can be improved to increase recovery rates at end-of-life without sacrificing performance or reliability.
5. List the top three areas in applied science research and development that would contribute the most impact to a better understanding of PV module recycling.

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**REQUEST FOR INFORMATION RESPONSE GUIDELINES:** Responses to this RFI must be submitted electronically to [pv-recycling-rfi@ee.doe.gov](mailto:pv-recycling-rfi@ee.doe.gov) no later than 5:00pm (ET) on **December 5, 2014**. Responses must be provided as a Microsoft Word attachment to the email, of no more than 3 pages in length, 12 point font, 1 inch margins. Only electronic responses will be accepted.

Please identify your answers by responding to a specific question or topic if possible. Respondents may answer as many or as few questions as they wish.

EERE will not respond to individual submissions or publish publicly a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name;
- Company / institution contact;
- Contact's address, phone number, and e-mail address.

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