Industrial Decarbonization through Concentrating Solar Thermal

DATE: September 13, 2021
SUBJECT: Request for Information (RFI)

Description

This request for information (RFI) is intended to inform the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) on pathways to use solar energy to decarbonize industries that produce key building blocks of our national economy, including high-priority products like iron, steel, cement, and ammonia. Hydrogen is also of interest—as a fuel in its own right and as an important feed chemical for synthesis of liquid fuels and other products. Currently all these building blocks are primarily produced with high-temperature heat derived from carbon dioxide (CO_2)-emitting processes. Concentrating solar-thermal energy (CST) is a source of emission-free high-temperature heat. CST uses a field of mirrors that track the sun to focus its rays onto a receiver, where a heat-transfer medium is heated to a high temperature, which can be used for a variety of industrial processes or power generation. By incorporating thermal energy storage, CST has the potential to offer dispatchable renewable heat, at a wide range of temperatures, for difficult-to-decarbonize industries. This RFI seeks to gain information on the specific research, development, and demonstration opportunities to enable cost-effective integration of CST in these high-priority, difficult-to-decarbonize industries.

Background

To build a clean and equitable energy economy and address the climate crisis, SETO invests in innovative research, development, and demonstration projects that work to drive down costs of solar technologies and develop next-generation products ready for commercialization. This RFI seeks information to help advance the goals of achieving carbon pollution-free electricity by 2035 and to "deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050."[1] The Department of Energy is committed to pushing the frontiers of science and engineering, catalyzing clean energy jobs through research, development, demonstration, and deployment, and ensuring environmental justice and inclusion of underserved communities.

Achieving a net-zero carbon economy by 2050 will require the adoption of clean energy technologies in sectors beyond electricity generation. Technologies are needed that that can eliminate the need to burn fossil fuels for heat-driven processes that produce essential commodities, refined products, and other goods. The industrial sector is responsible for 28% of

[1] Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," January 27, 2021.

the nation's CO_2 emissions.[2] [3] Industrial processes that rely on electricity will reduce emissions as the electric sector decarbonizes, but only 12% of industrial energy consumption is in the form of electricity.[4] Even with more renewable electricity available, many industrial processes will be difficult to electrify because they require high temperatures or have other unique process characteristics.

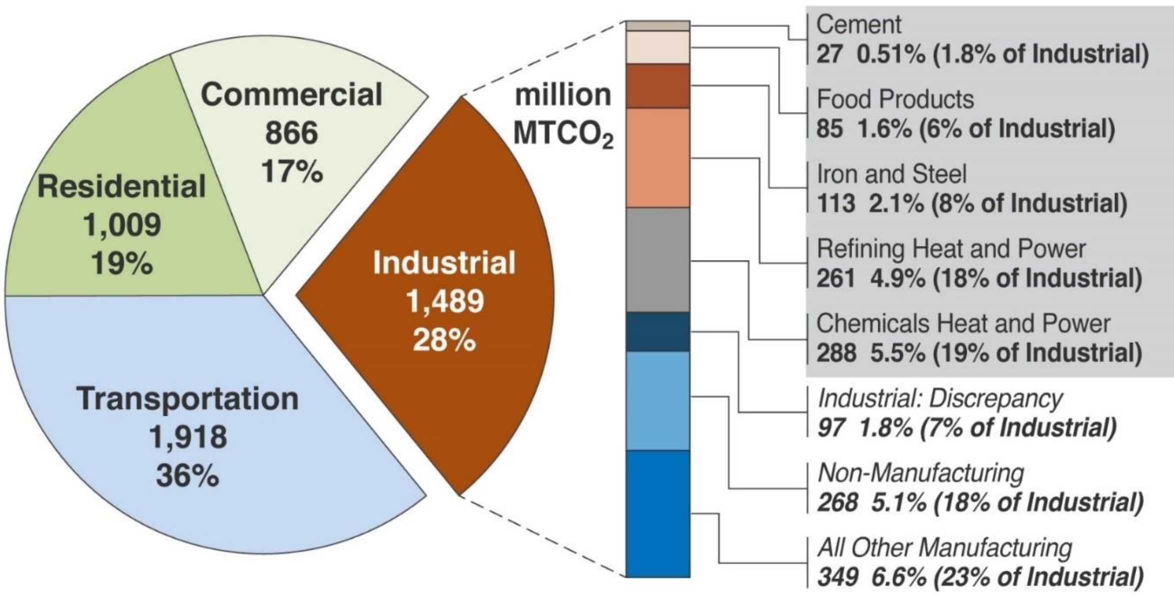

Figure 1: CO_2 emissions by industry. Source: DOE Advanced Manufacturing Office

CST technologies can directly produce steam or high-temperature fluids by concentrating sunlight. This solar-generated heat can then be directly integrated with thermally driven industrial processes. Solar-thermal processes could also generate energy-dense chemicals or fuels that could deliver stored solar energy throughout the country and the world. Developing pathways for solar-derived chemicals or fuels can help reduce the carbon intensities of numerous industries. However, significant technological challenges remain, including the design and equipment for integrated solar-thermal processes that can address the variability challenges inherent in using sunlight as fuel.

[2] Data source: EIA 2020, United States Energy Information Administration, Annual Energy Outlook 2020 with Projections to 2050. https://www.eia.gov/outlooks/aeo/

[3] EPA Greenhouse Gas Emissions: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#industry.

[4] Energy Flow Chart, Lawrence Livermore National Laboratory. https://flowcharts.llnl.gov/content/assets/images/energy/us/Energy_US_2019.png.

Currently, CST is primarily commercially deployed to produce electricity, in the form of concentrating solar-thermal power (CSP) plants. There are nearly 100 CSP plants producing electricity in commercial operation worldwide, representing almost 7 GW of capacity. Many CSP plants in operation today utilize thermal energy storage (TES) systems, which store solar energy as heat for use when it is needed. Longer-term storage can help alleviate the impact of longer periods of cloudy weather, for example, or even seasonal variations of solar energy production. Existing CSP plants have already demonstrated long durations of daily storage, up to 17 hours, which increases their value to the grid. With integrated TES, CSP plants can produce consistent amounts of electricity or heat on demand, regardless of the time of day or amount of cloud cover.

To achieve higher efficiency, and therefore lower cost, CSP systems, SETO R&D efforts have primarily focused on increasing the operating temperature and stability of heat transfer media and components, including receivers. This effort is primarily realized through the Gen3 CSP funding program,[5] which aims to develop a fully integrated thermal transport system, including a receiver and TES, able to deliver heat to an advanced power cycle based on supercritical CO_2 (sCO_2) at approximately 720°C. The Gen3 CSP program identified several heat transfer media (HTM) that showed promise in meeting SETO's goals, organized by phase of matter – gas, liquid, or solid. Recently, SETO announced the down-selection[6] of just a single pathway, based on solid particle HTM[7] to develop an integrated, MW-scale Gen3 CSP test facility, led by Sandia National Laboratories.[8] Unlike the other pathways, ceramic, sand-like particles can readily withstand temperatures greater than 800 °C, making them promising for both electricity production as well as high-temperature industrial applications. This pathway also matches well with processes where solid media are an essential component, like refining iron ore for steel production or cement production from limestone. It is also worth noting that temperatures in Gen3 CSP are consistent with those needed for thermal neutral operations of solid oxide electrolysis cells (SOECs).[9] These systems are known to have relatively high electrical efficiency producing hydrogen, relative to other electrolysis technologies.[10]

[5] U.S. Department of Energy Solar Energy Technologies Office. FOA: https://www.energy.gov/eere/solar/funding-opportunity-announcement-generation-3-concentrating-solar-power-systems-gen3csp. Selections: https://www.energy.gov/eere/solar/generation-3-concentrating-solar-power-systems-gen3-csp.

[6] https://www.energy.gov/eere/solar/generation-3-concentrating-solar-power-systems-gen3-csp-phase-3-project-selection

[7] Ho, Clifford, Albrecht, Kevin, Yue, Lindsey, Mills, Brantley, Sment, Jeremy Niko Iversen, Christian, Joshua Mark, and Carlson, Matthew David. "Overview and Design Basis for the Gen 3 Particle Pilot Plant (G3P3) (paper).". United States. https://www.osti.gov/servlets/purl/1642710.

[8] Sment, Jeremy Niko Iversen, and Ho, Clifford K. Fri . "G3P3 Phase 3 Project Execution Plan.". United States. https://www.osti.gov/servlets/purl/1761300

Consider cross referencing the H2insteel 101 White Paper Authored for HFTO.

[10] See Table 2 on page 6 of DOE Hydrogen and Fuel Cells Program Record #20006 (2020) Accessed August 2021. Note the 98% Stack Conversion Efficiency (% Lower Heating Value H2) under Stack Electrical Usage (kWh/kg).

This RFI is focused on the application of solar thermal heat, together with thermal energy storage, for both replacement of fossil fuel use and for reduction/elimination of CO_2 emissions in three priority industries: bulk chemicals, steel, and cement, as well as how hydrogen can be synergistically generated and used as part of solar-thermal-driven versions of these processes.

These three industries are being focused due to their size and contributions to greenhouse gas emissions. In the U.S., they consume 4,533 trillion British thermal units (TBTUs) of fossil fuel, representing 15% of the total fossil consumption by the industrial sector and 5% of total fossil fuel consumed; and they emit 428 million tons of CO_2, representing nearly 10% of total CO_2 emitted.[2]

A significant difficulty in decarbonizing the industrial sector is the variety of different kinds of processes, facilities, and products. This disparity leads to significant variation in required process heating characteristics, including temperature, degree of thermal cycling, daily and seasonal variability, among many others.

CST, with thermal energy storage can be used both for heating reactants to process temperatures, providing heat to isothermally drive reactions, and absorbing heat from products and exothermic reactions. However, beyond the thermal energy requirements, additional reductants (e.g., hydrogen) and oxidants (e.g. oxygen) may be needed for the reaction. In the case that solar thermal, hydrogen and oxygen is not sufficient to sustain the reaction, additional fossil fuel may be required for chemical reaction at full capacity.

To limit the scope of the RFI, questions have been focused on the following industries: iron and steel, cement and chemical production—with ammonia being of particular interest—as representative of high fuel consumption, high emission industries. Additionally, this RFI is interested in the production of hydrogen and other fuels that can be generated using concentrating solar thermal energy, as the use of carbon-free fuels may be necessary to fully decarbonize many applications that require 24-hour operation. The following gives a summary of the current state of technology of each of these processes

- *Hydrogen (and fuel reforming processes)*
    - Although most hydrogen is currently produced by steam methane reforming, using natural gas as a feedstock, interest is currently high in electrolytic methods. Clean hydrogen can by produced by electrolysis using high or low

---

See also Table 2 on page 5 of Hydrogen Production Cost From PEM Electrolysis Program Record # 19009 (2019) Accesses August 2021. Note the <70% Stack Conversion Efficiency (% Lower Heating Value H2) under Stack Electrical Usage (kWh/kg).

This is a Request for Information (RFI) only. EERE will not pay for information provided under this RFI and no project will be supported as a result of this RFI. This RFI is not accepting applications for financial assistance or financial incentives. EERE may or may not issue a Funding Opportunity Announcement (FOA) based on consideration of the input received from this RFI.

temperature electrolyzers, utilizing electricity from renewable sources. A combination of heat from CSP, supplied to highly-efficient solid-oxide electrolyzers may be an attractive pathway towards carbon-free hydrogen production.

- *Iron and steel production*
  - Present generation steel mills use blast furnace/basic oxygen furnace (BF/BOF) processes that start with iron ore, or electric arc furnaces (EAF) using principally scrap metal or direct reduced iron (DRI) as the two primary technologies to produce steel. In either of these two primary pathways to produce steel, there may be opportunities to minimize carbon emissions via solar heating of incoming reactants and/or utilization of high-temperature electrolysis for hydrogen production (e.g., clean hydrogen used for DRI).
- *Cement production*
  - Present generation cement plants use a combination of preheater cyclone towers to heat limestone meal to calcination temperatures (870-900°C); a pre-calciner to convert most of the limestone to lime; and finally, a rotary kiln to complete calcination and sinter the finished clinker at ~1,400°C. Heat is recovered from the exiting clinker and used in preheating and calcination. Fuel is used in rotary kiln and calciners. Although CST cannot mitigate the CO_2 produced intrinsically as part of the chemical process, the pre-calciner and kiln may be able to be redesigned to utilize carbon-free solar heat as their primary energy source.
- *Ammonia*
  - Ammonia is chosen as an example of chemical processes. Present generation ammonia plants have evolved over 100 years and use a combination of natural gas reforming, the water gas shift reaction, methanation and ammonia conversion, a process with significant CO_2 emissions. Aside from renewable pathways towards producing the necessary hydrogen precursor for clean ammonia production, CST may be an attractive choice to provide heat for driving the endothermic ammonia synthesis reaction. A large number of other chemical processes exist that can make use of CST integration for process heat, hydrogen generation and substitution of fossil fuels
- *Other industrial sectors*
  - Although the focus of this RFI is on the above, responses that describe opportunities for significant greenhouse gas emissions reduction in other industrial sectors is also welcome.

SETO aims to use the responses of this RFI to help develop promising pathways to incorporate CST into the energy consumption of these processes to accelerate decarbonization of the industrial sector, complementing existing efforts from DOE's Advanced Manufacturing Office, and in collaboration with the Hydrogen Energy Earthshot[11] recently announced by DOE in concert with its Hydrogen and Fuel Cell Technologies Office. Specifically, SETO is interested in the use of CST as both heat and electricity inputs to promote the displacement of fossil fuels, reducing carbon emissions for heavy industry, with the aim of full decarbonization by 2050.

Purpose

This RFI solicits feedback from industry, academia, research laboratories, government agencies, and other stakeholders on issues related to solar thermal decarbonization of difficult to decarbonize industries. EERE is specifically interested in information on the research, planning, and execution challenges that must be overcome to deploy concentrating solar thermal heat energy (with or without electrification) into iron ore reduction and steel manufacture, cement production and chemicals production, including ammonia and hydrogen. Beyond explicit focus on these three high-priority industries, opportunities for deployment of high-temperature solar heat in other process industries (examples: manufacturing of metals, ceramics, glass, fertilizers, fuels, etc.) are all welcome as the selected three industries are only a subset of fossil energy consumers in process industry. Input is sought on required research and development for solar thermal technologies with a trajectory for rapid graduation to industrial-scale demonstration(s). Due to the regional nature of the solar resource this RFI also solicits input on the strategic importance and the economics of developing new industrial infrastructure (and the associated economics of transport) versus appending to or expanding upon existing industrial chemical facilities.

This RFI is focused on solar heat at temperatures above 400°C and excludes industrial process steam at lower temperatures. Lower temperature processes are being explored in other DOE initiatives, like the American Made Challenge: Solar Desalination Prize.[12]

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

[11] https://www.energy.gov/eere/fuelcells/hydrogen-shot
[12] https://americanmadechallenges.org/solardesalination/

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.

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.

Confidential Business Information

Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery two well-marked copies: one copy of the document marked “confidential” including all the information believed to be confidential, and one copy of the document marked “non-confidential” with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

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, 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

DOE SETO is requesting information on the following categories:

Category 1: General solar thermal/thermochemical use cases

1. What are the most promising opportunities to integrate solar thermal energy into commercial production? As discussed above, high-temperature processes are of particular interest and please do include discussion of integration opportunities that are not yet currently cost-effective, but may be in the future.

2. What opportunities, if any, exist for solar thermal-driven industrial processes to realize higher techno-economic value for manufacturers than conventional industrial processes? For example, does solar-thermal integration into a specific industrial process uniquely enable any of these strategies:
   a. Process intensification – simplification of an industrial process wherein a single piece of equipment is used to perform a function that conventional is done in multiple linear steps.
   b. Vertical integration – careful design of integrated facilities to incorporate multiple, sequential processes, and thereby produce multiple marketable products. For example, this may be achieved by using waste heat from one process as an input into another.
   c. Value addition – design of a process such that it generates product in a form (i.e. purity, form factor, etc) that has higher value on the market than conventional forms.

Category 2: Solar thermal receivers, receiver-reactors, and heat exchangers

Solar thermal energy can be introduced into industrial processes either directly or indirectly, via a receiver – or multiple receivers operating in concert – which absorb concentrated solar light and convert into heat which is transferred to a medium. That medium may directly be an input into the industrial process, being heated before being introduced to the reactor. Or a chemical reaction may be performed directly in a receiver-reactor, in which case the thermodynamics and kinetics of a chemical reaction must be evaluated and co-optimized with the instantaneous input of solar energy.[13] Operations may be supplemented with heating from electricity, hydrogen, or other fuels to enable on-sun reactions.

Solar heat can also be introduced to a process indirectly, using receivers designed for inert heat transfer media that are looped between the receiver and a heat exchanger that transfers the heat into an industrial reactor. While this strategy may be simpler and enable less modification to industrial processes, it may lower both energetic and exergetic efficiency and increase capital

[13] Rosa, Luís Guerra. "Solar heat for materials processing: A review on recent achievements and a prospect on future trends." *ChemEngineering* 3, no. 4 (2019): 83.

costs relative to direct receivers[14]. In this RFI, SETO is interested in all of these potential pathways for solar thermal integration.

Direct Receivers and Receiver-Reactors

3. What strategies are available to design a direct receiver-reactor to operate both on-sun and off-sun, so that production can continue during times when the sun does not shine, either using stored thermal energy or alternative energy inputs?

4. What strategies and opportunities exist to optimize the controls and operation of a direct solar thermochemical receiver-reactor, taking into account the variability of the solar resource and the need to potentially control multiple inputs into the reactor, including solid or liquid reactant(s) and inert or reactive gases?

5. What are the limitations and availability of existing materials for use in high-temperature direct receiver-reactors? Please be sure to consider thermal, mechanical, and chemical (corrosion) concerns, as well as cost, to the extent that it is known, and be specific with regard to the relevant environmental conditions and process characteristics for any materials discussed.

6. What opportunities exist, if any, to adopt existing equipment or operational strategies in reactor design, with minimal changes, for use as a direct receiver-reactor – as opposed to dramatic redesign of reactors for solar thermal input?

7. A challenge for solar direct heating of solid media (like iron ore or calcium carbonate) is uneven heating, which can cause some particles to sinter. Fluidized bed receivers and reactors have been proposed to assist with homogenous heat transfer. What design improvements are feasible and what challenges are expected in fluidized bed on-sun receiver-reactors and fluidized bed reactors heated by TES systems?

Indirect (de-coupled) Solar Receivers and Reactors

8. For indirect systems, what changes to reactor design would be required in your industry to accommodate input from an inert heat transfer media from a solar receiver and/or thermal energy storage? Please specify any existing industrial experience with indirect heating of reactors. Specifically:

[14] Due to the fewer process steps that direct heating may enable.

   a. Is there a particular advantage or disadvantage in heat input originating from a solid, liquid, or a gas heat transfer media? Why?
   b. What research would be required in the future to ensure catalyst regeneration, recycle, and reactivation?
   c. How would reactor operations such as recycle, process heating and cooling be affected, if at all, by operating in an indirect solar thermal reactor?

9. In these systems, there is necessarily a separate heat exchange step between the media moving through the receiver and the media that is ultimately transformed into the product. Industry has specific designs for reactors and heat exchangers (for extracting and supplying energy, reboilers, condensers), developed for use with fossil fuels. By switching the heat input to indirect solar heat, what will be the specific challenges in designing and operating heat exchange equipment of similar cost and similar performance?

10. In many industrial processes, the heat of reaction – whether exothermic or endothermic – is substantially larger than the heat required to bring material up to the required temperature. In existing reactors, use of fossil-fuel combustion enables supply of large quantity of heat per unit volume to supply reaction heat for endothermic processes. Little is known about how to sustain these using sun or TES. It is possible that there may be a large disparity between the volume of heat transfer media needed and the reactor volume. What reactor design strategies are available to cost-effectively transfer heat from large volumes of sensibly heated heat transfer media to small reactor volumes?

11. Aside from equipment discussed above, what other components need to be developed (e.g. valves, sensors, pumps, separators, etc.) to enable cost-effective integration of solar thermal energy with high-temperature industrial processes? Please list the component and describe the research and development needed as specifically as possible.

Category 3: Thermal energy storage for solar-driven industrial processes

The variability inherent in solar energy – on seasonal, diurnal, and shorter timescales – is at odds with the 24-hour operations typically required for commodity production facilities. However, oversizing the solar input relative to the processing capacity of the facility may create opportunities in which: (a) reservoir(s) of solar thermal heat may be stored to ensure continuous, reliable operations; and/or (b) a transient inventory of thermally processed product may be built up, allowing for continuous down-stream operations. In an extreme case, a very large inventory of processed chemical may be produced and stored cost-effectively to either a) enable seasonal thermal/thermochemical energy storage and/or (b) allow sale of the chemical produced in response to seasonal market demand.

12. What specific opportunities or strategies exist to use materials process streams in high-temperature industrial processes as inherent thermal energy storage, to buffer solar thermal availability, as described above?

13. What specific opportunities exist to use an industrial process' chemical inventory to store thermal energy? What are the costs and benefits of using that inventory as thermal energy storage?

14. What other novel opportunities exist to store solar thermal energy, at appropriate temperature, for use in high-temperature industrial processes? Are there different opportunities for thermal energy storage to manage solar transient operation versus multi-hour operation overnight, or to address seasonal variability of the solar resource?

15. In steel production, it may be attractive to use direct reduced iron (DRI) to store solar thermal energy. DRI is often quite porous, it is metallic and of high thermal conductivity. How might these materials-level benefits, combined with a heat transfer media passing through, be integrated with existing iron processing? That is, are there attractive strategies to use DRI inventory as a solar-thermal energy storage media?

Category 4: Integration of solar thermal energy with industrial processes

This category requests input on the spectrum of processes and resultant technoeconomics of solar thermal operational strategies for high-temperature industrial processes, particularly the production of steel, cement, and ammonia. These questions are process focused and are interested in technoeconomic strategies for commercial operation. These strategies may range from inclusion of solar energy in minimally disruptive ways, perhaps through minor changes to existing processes, to the other extreme of complete revision and redesign of the process to optimize the efficiency of solar thermal input into the process. Responses to this category are encouraged to present a cost-benefit analyses, to the extent that they are available.

16. A concentrating solar-thermal facility may be able to choose how the heat it generates and stores is utilized; whether to produce electricity – via a turbine-generator – or delivered to one, or multiple industrial processes. What models and strategies are

available to co-optimize distribution of heat to these various options, to maximize economic value?

17. It has been estimated that more than 90% reduction in CO_2 emissions may be able to be achieved in iron ore reduction when renewable hydrogen is used as the chemical reductant.[15] Should concentrating solar focus on producing hydrogen via high temperature solid oxide electrolysis instead of pre-heating the iron pellets? Should it do both? Why?

18. The existing capital stock invested in the process industry, and the typical low risk-appetite in commodity industries, implies that the nearest term opportunities may be in opportunities that do not necessitate significant changes to process layout. For example, the ammonia industry is likely to be reluctant to take on significant changes to the usual process steps of reforming followed by Haber-Bosch; and would likely prefer to identify renewable pathways for hydrogen and nitrogen production, while keeping existing Haber-Bosch reactors intact. What other specific opportunities exist for initial entry of solar thermal heat above 400 °C heat input, to enable reuse of existing capital investment while reducing fossil energy use and reducing CO_2 generation? What barriers exist, technical or otherwise, to realize those opportunities?

19. Processes that currently take place in furnaces and fired heaters are specific examples where it may be difficult to add solar heat input, without complete redesign of equipment and processes. What research opportunities exist that would enable solar thermal input into large heat sources such as furnaces and fired heaters as replacement, complement, or supplement to fossil energy? This may be complemented by the use of hydrogen and reduced usage of natural gas.

20. What are the key figures of merit or metrics that should be used to evaluate the viability of integrating concentrating solar-thermal energy into high-priority industrial processes?

21. Some industrial applications require extremely high temperature, for example 1,100-1,500 °C for production of many metals. Both direct and indirect solar applications are limited by the ability of materials to absorb very high solar flux and the need for transporting heat via pipes and ducts into kilns and calciners. What research and development needs exist to enable ultra-high temperature process heat applications?

[15] Patisson, Fabrice, and Olivier Mirgaux. "Hydrogen Ironmaking: How it Works." *Metals* 10, no. 7 (2020): 922.

22. Please describe any industrially relevant chemical reactions or processes that would benefit from direct interaction with solar flux, beyond the simple thermal benefit. For example, are there industrially relevant chemical reactions and processes where direct photoelectrochemical excitations promote reaction rates or selectivity? Please describe how these photoelectrochemical excitations could be differentiated from the thermoelectrochemical processes known to occur at higher temperatures. Please attempt to describe the energetic benefit versus a purely thermal process.

Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to SETO.RFI.CSP@ee.doe.gov no later than 5:00pm (ET) on October 13, 2021. Responses must be provided as attachments to an email. It is recommended that attachments with file sizes exceeding 25MB be compressed (i.e., zipped) to ensure message delivery. Responses must be provided as a Microsoft Word (.docx) attachment to the email. Only electronic responses will be accepted.

Please identify your answers by responding to a specific question or topic if applicable. 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.