Comments of the American Council for an Energy-Efficient Economy (ACEEE) on

DE-FOA-0002564: Request for Information on Establishing a New Manufacturing Institute

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About ACEEE

The American Council for an Energy-Efficient Economy (ACEEE), a nonprofit research organization, develops transformative policies to reduce energy waste and combat climate change. With our independent analysis, we aim to build a vibrant and equitable economy – one that uses energy more productively, reduces costs, protects the environment, and promotes the health, safety, and well-being of everyone.

ACEEE has been a leader for four decades in industrial energy policy, programs and technologies and has been actively engaged in the development promotion of smart manufacturing and strategic energy management (SEM).

Introductory remarks

For industry to get on track for next zero GHG emissions by 2050 radical changes are needed in multiple areas, including transformation in the way that energy is sourced and used. Currently the use of electrical energy in heavy industry is relatively low (less than 5% of energy use) and it's principally used for motor drives, whereas hydrocarbons are the dominant source of energy use. Process heating needs are largely met through the combustion of hydrocarbon fuels, either directly or indirectly through steam systems.

As the share of low-carbon electricity on the grid grows rapidly in the next decade and options increase for direct use of renewables, industry can transition to more electric power, pursuing a major pillar or pathway to decarbonization—electrification. However, this transformation won't be simple or inexpensive, and will not be a plug and play solution where low-carbon technology can simply replace an incumbent technology as there are often integration issues since equipment is often tailored to meet the unique needs of manufacturing facility with numerous control systems to interface with. Yet, there may be some common solutions that will be applicable across many industries such as replacement of low-temperature steam.

To achieve this transition substantial RD&D, integration, scaling, and resolution of numerous issues will be needed. As a result, we suggest a new institute focus on electrification opportunities that exist across multiple industries to accelerate adoption of these technologies. The institute should focus on the host of electric technologies have been developed over the past decades. Adoption has been relatively modest because of the relatively high cost of electricity versus incumbent hydrocarbon fuels, opportunities to replace equipment are few and far in between because of the long-life of incumbent technologies, and there is a lack of information/awareness of energy saving and nonenergy benefits of electric technologies as noted in a recent ACEEE report on Beneficial Electrification.[1]

Collecting this information and developing communication products on the performance and application characteristics for these electric technologies is needed to enable engineers and process managers to specify and develop investment justifications for equipment replacement. Pilots and demonstrations are needed to provide application guidance for technology options and to identify parameters required to integrate these technologies into existing industrial facilities.

The institute should pursue integration studies for upstream and downstream equipment and control systems across multiple applications. It should provide support for the rapid scaling of technologies and applications. The process of significantly electrifying a wide range of industrial processes will require an understanding and resolution of challenges some of which are known but many of which will be uncovered during the scaling efforts. Hence, it's important for an electrification institute to receive input from industry to ensure that the perspective of continuous improvement guides the institute's directions and activities.

For electrification to succeed, the electric resources will require equivalent availability, reliability, and resilience to existing energy resources to keep industry running efficiently 24/7. As a result, the institute should study and develop new tools and strategies required for orchestrating the increased use of variable/intermittent electric sources into industrial facility operations. These approaches may include storage (i.e., electrical, thermal, and chemical) and load flexibility. However, industry may also be able to make use of curtailed

[1] E. Rightor, A. Whitlock, R.N. Elliott. 2020. *Beneficial Electrification*. Washington, D.C.: ACEEE. https://www.aceee.org/research-report/ie2002

electricity through storage or flexible process operation to improve grid operations. Developing and documenting these strategies should be an important role for the new institute.

The current RFI highlights metals as a focus for the new institute. While that should be certainly one area for focus, it would be a mistake for the institute to focus on this industry alone. Opportunities exist in other industries and there are additional cross-cutting applications such as low-temperature process heat, electricity assisted separations, and integration of variable electricity into plan operations that should be considered as well for maximum impact. The United States steel and aluminum industries have already been leaders in adopting transformative technologies including electrification, enabled by past federal government funded collaborative RD&D. Other industries within the sector also deserve the opportunity to benefit from the activities of this new institute

Responses to questions

CATEGORY 1: INSTITUTE SCOPE

Electrification represents a major decarbonization pillar that can be leveraged across all industries. Cross-cutting opportunities exist for replacement of incumbent technologies such as those that provide process heat with electricity that could benefit from common solutions and a rapid, agile approach to knowledge development and application support. The institute should focus on electrification RD&D in industry building upon a rapidly decarbonizing electricity grid and affordable distributed renewable electricity. The title "Clean Energy Manufacturing Institute" does not reflect a focus on the decarbonization of the United States' industrial sector and could lead to confusion as to whether the institute focuses on producing products to support a clean energy industry or on transforming how industries products all products. Other titles to consider could include "Industrial Electrification Institute," "Low-Carbon Electrification Industrial Institute," or "Industrial Decarbonization Institute."

Numerous electric technologies could accelerate Beneficial Electrification that are currently commercial, emerging technologies with expanding capabilities, and transformative technologies in need of a boost in RD&D. These technologies could benefit from a boost in applied RD&D to document the energy and nonenergy benefits of the currently commercial technologies, particularly the GHG reduction potential, and to clarify the required parameters and specifications, and to accelerate the adoption of these technologies by industrial plants. For emerging technologies, RD&D should support rapid piloting and demonstrations at increasing scale for common applications such as process heat or electricity assisted separations.

Around 60% of the GHGs associated the energy use in industry are associated with process heating. Several electric technologies could provide process heat below 300ºC, which accounts for two-thirds of the process heat.[2] The range below 200ºC is of particular interest since applications in this range could be served with electric technologies such as industrial heat pumps or electric boilers.

Increased use of low-carbon electricity in process technologies is also an area for RD&D, including the use of electricity for electrochemistry in chemical reactions and separations, electricity assisted reactions, or use of electricity to generate the high-temperature applications such as an electric ethylene cracker. Early-stage industrial R&D for electric crackers is underway, but additional integration RD&D will be required to supply electricity at exceptionally high loads and understand the more efficient heat transfer that will be needed at scale.

Greatly increased proportions of low-carbon electricity on the grid from intermittent or variable sources (e.g., from wind or solar) will decrease the carbon intensity, but it brings new challenges and opportunities for orchestrating that variability and translating it into a reliable, constant energy source. Industry can take advantage of this resource, initially for processes where precursor materials can be made when the power is available and at advantaged rates (e.g., clinker in cement manufacture, or generation of hydrogen), but science and technology need to be advanced to broaden the range of practical applications while making variable electricity usable by industrial consumers. RD&D is needed on how most effectively to integrate storage—electrical, mechanical, thermal, and chemical—into industrial facilities and provide the systems that would allow opportunities for flexible load control.

Several barriers exist to industrial electrification for decarbonization including incumbent technology and practices and the associated risk from operational change, high costs for many emerging low-carbon technology, relatively high cost of electricity compared to

[2] C. McMillan, C. Schoeneberger, J. Zhang, P. Kurup, E. Masanet, R. Margolis, S. Meyers, M. Bannister, E. Rosenlieb, and W. Xi. 2021. *Opportunities for Solar Industrial Process Heat in the United States*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-77760. https://www.nrel.gov/docs/fy21osti/77760.pdf.

existing fuels, particularly natural gas, and difficulties in scaling-up and integrating new technologies into existing plants and supply chains.

While these challenges may be daunting, they can create benefits in productivity, product quality, corporate competitiveness, job creation, and of course a lower energy and GHG footprint for industry.

Addressing these challenges represent an opportunity to accelerate energy and GHG reductions in industry, while forging a globally competitive, low-carbon industry of the future. Tackling development of a singular transformative technology could be very high risk for even the largest companies, and the small and medium sized manufacturers would have a low probability of developing and deploying transformative technologies alone. The institute represents an opportunity for partnerships and collaboration across industry, labor, national labs, agencies, and academia which would be essential to making rapid progress across many challenges and opportunities in the industrial sector.

CATEGORY 2 ORGANIZATION

There are multiple approaches for the interface between industry and the institute that have been tried over decades. One of the most successful was the Industries for the Future program where industry took a leading role in accelerating progress. In that program industrial associations played a leading role in defining needs, identifying the projects, developing partnerships, and guiding the work with partners from academia, national labs, agencies, and private companies. It's vital that industry play a lead, strategic role in guiding the institute and not be a sideline player. Less successful collaborations have suffered from academic institutions driving the agenda, with research eventually drifting towards pursuit of interest to academic researchers and not necessarily needs of industry for technology solutions that address sustainability and competitiveness of United States manufacturing.

Historical perspectives on past energy transitions, such as those from wood to coal, coal to oil, oil to gas suggest it can take 60-100 years for newer energy sources to be adopted by more than 80% of the market. To reach net zero GHGs by 2050 a radical, accelerated transformation is needed. While 30 years may appear a long-time horizon, multi-generation RD&D have been needed in the past to make these changes, so the Institute needs to be designed to provide durable scientific, technical, workforce capabilities that can enable industry to effectively and rapidly pursue this transition. An atmosphere of continual, agile learning will be needed that will be best realized with a longer program. The past charters for institutes of 5 years may not be sufficient to drive decarbonization for the institute to achieve its goals, so the plan and the funding should be extended so the clock should start after the institute has been set up. For example, the institute should be funded during its formation and up to 7 years after it's been fully established.