University of Colorado **Boulder**

2019 Program Review

Renewable and Sustainable Energy Institute

Academic Review and Planning Advisory Committee Report

Approved

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Provost and Executive Vice Chancellor for Academic Affairs | Date

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Process Overview

The Academic Review and Planning Advisory Committee (ARPAC) review of the Renewable and Sustainable Energy Institute (RASEI) was conducted in accordance with the 2019 program review guidelines. The RASEI self-study report's responses were prepared by the unit and checked by an internal review committee composed of two University of Colorado Boulder (CU Boulder) faculty members outside of the unit. The internal reviewers submitted a summary of findings derived from the self-study report and from interviews and/or surveys with faculty, staff, and student unit members. An external review committee, consisting of two experts from outside of CU Boulder, visited the unit and submitted a report based upon review of relevant documents and interviews with faculty, staff, and student unit members and university administrators. Internal and external reviewer comments and recommendations are shared when relevant throughout this report.

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Unit Overview

The campus' standardized description of the RASEI is available on the website of [the Office of Data Analytics (ODA).](#) ODA updates the profile annually in the fall semester. This report cites data posted in October 2018, reflecting the state of RASEI as of the academic year (AY) 2017-2018.

Disciplinary context

The University of Colorado Board of Regents founded RASEI as a joint CU Boulder/National Renewable Energy Laboratory (NREL) research institute in 2009 to facilitate the development of strong joint proposals competing for federal funding in the broad field of sustainable energy. In 2015, as noted by the external reviewers, RASEI was "rebooted" under new leadership and this self-study primarily addresses work that has been undertaken since that time.

According to the institute's self-study report, RASEI's mission is to "expedite science, engineering, and public policy innovations to enable globally scalable sustainable energy solutions through research, education and technology development." RASEI's approach towards achieving its mission is two-fold: to establish CU Boulder as NREL's primary university partner and to organize and represent CU Boulder scholars conducting renewable energy research. This research by its very nature is interdisciplinary, involving faculty and other professionals from a wide range of disciplines, including the departments of Aerospace Engineering, Biochemistry, Chemical and Biological Engineering, Chemistry, Economics, Electrical, Computer, and Energy Engineering, Physics, and Sociology. The external reviewers note that the CU Boulder/NREL partnership is still in its "infancy"; the external report also emphasizes that the partners are already "having a significant impact in key research areas and are poised for much greater impact in future years."

Research and scholarship

RASEI's research is focused on four core themes:

- Materials and Chemical Sciences for Energy
- Energy Biosciences
- Energy System Integration
- Energy Policy and Analysis

The RASEI self-study describes several projects in these areas, including sub-cellular imaging of photosynthetic metabolism, microbial genetic manipulations in near-industrial scale biomass processing, perovskite solar cells, and innovative control systems for grid-interactive efficient building operation. RASEI is also advancing foundational science in quantum biology and chemistry. RASEI has provided significant leadership in developing and operating new facilities in support of energy research, including the new Facility for Electron Microscopy of Materials (FEMM). The external reviewers observe that this facility is a prime example demonstrating how "RASEI leadership has a clear vision for serving as a good citizen to CU, enabling broader outcomes for CU without direct benefit to RASEI."

The RASEI self-study documents publications for 2018 only, during which RASEI faculty and members published 112 articles. These articles are ordered by the four research themes, and the distribution across themes is large, ranging from five (energy policy) to 61 (material science and chemistry for energy). No descriptive statistics are provided about venue type (e.g., journal or conference) or the authors' affiliations (i.e., RASEI faculty). According to the ODA, RASEI's eight tenure stream faculty member appointees are productive in publishing edited books, as well as refereed books and monographs, ranking fourth out of ten and third out of ten, respectively, among the life and environmental science units undergoing reviews this year. RASEI's eight tenure stream faculty member

appointees are less productive in terms of conference presentations and refereed articles and chapters, ranking tenth out of 13 and twelfth out of 13, respectively, of units undergoing review and in approximately the middle rank for all campus units.

The ODA reports that one of RASEI's tenure stream faculty member appointees has an endowed or named chair professorship, giving RASEI high rankings compared to other units in this area: first out of 13 for units in this review year and ninth out of 64 for all units.

The self-study reports that RASEI manages an active sponsored grant portfolio of $36 million, and that the institute represents the largest single component of CU Boulder's $24 million per year energy research portfolio. As noted by the external reviewers, "it is not really possible to determine what fraction of these dollars were enabled by RASEI." The ODA lists direct expenditures of $14,493,000 in fiscal year (FY) 2019, with $1,727,000 remaining after allocation. The latter number is in line with the level of Departmentally Allocated Indirect Cost Recovery (DA-ICR) money reported in the self-study (about $250,000 in DA-ICR - the amount of indirect cost recovery on grants coming back to units before skims are taken out).

RASEI appears to have secured significantly more sponsored research last year. According to the ODA, the $14+ million in direct expenditures in FY2019 was 61% of RASEI's total expenditures over the five-year reporting period, representing 521% change over the past five years.

Collaborations

RASEI has made impressive gains over the past few years in building critical social infrastructure, between the institute and NREL, and between the institute and participating CU Boulder departments.

RASEI intends to be NREL's largest university partner for research and education, and already the institute has made significant strides towards realizing this vision. CU Boulder now ranks as NREL's leading university partner for publications in peer-reviewed journals. In turn, NREL has contributed equipment to develop new RASEI facilities (for example, an electron microscope for FEMM). To further develop this partnership, RASEI has grown a network of joint appointments for NREL scientists with CU Boulder, rising to 30 from nine a few years ago. These appointments also add to the institute's diversity: for example, a number of NREL's scientists working with RASEI are women. These appointments come with salary commitments from NREL that incentivize undertaking collaborative and co-located work. Towards this end, NREL has requested to lease co-located space in the Sustainability, Energy and Environment Community (SEEC) Building. Co-location provides exciting and unique opportunities to students, as many find themselves working with NREL scientists and often at NREL's facilities. The external reviewers note that the institute's NREL partnership requires active and often intensive administrative support, and that the RASEI staff have been instrumental in facilitating these processes. Perhaps not surprisingly, RASEI researchers told the external reviewers that some joint appointees are no longer active and contributing. Maintaining and supporting a vibrant relationship with NREL is among the institute's priorities going forward.

RASEI is also faced with cultivating relationships across an array of CU Boulder affiliated units. These units provide tenure homes for institute faculty, contribute graduate students to RASEI research labs, and share in the acquisition and maintenance of specialized research facilities. Most of RASEI's tenure-track faculty have been hired in this review period (since 2012) and hold tenure in the departments of Biochemistry, Chemical Engineering, Chemistry, Civil, Environmental and

Architectural Engineering, Electrical, Computer and Energy Engineering, or the School of Law. These units span multiple administrative groupings and RASEI works to carefully establish relationships with each as an attendant web of memoranda of understanding and agreements to share indirect cost recovery monies shows. Maintaining this level of inter-unit partnership requires extra administrative support and also extra time from institute leadership, and the level of effort RASEI leadership has devoted to creating these collaborations is commendable. However, there are also significant challenges with maintaining this cooperative array and the institute elaborates on this complexity in its self-study. This report will discuss these issues later. Notably, early career RASEI faculty affiliates voiced uncertainty over tenure expectations and promotion processes, not surprising given variations among the units that function as their tenure homes.

National and international context

The external reviewers describe the CU Boulder and NREL partnership as "positioned to have significant impact in energy" research and that they are "truly optimistic about the impact and outcomes." RASEI is uniquely well-positioned to build upon CU Boulder's institutional capacity for these types of partnerships, as well as its geographic proximity to NREL, to develop a nationally and internationally renowned partnership with the laboratory. Several of CU Boulder's research institutes have sustained unique partnerships with federal agencies and/or national laboratories over many years. In its self-study, RASEI describes its NREL partnership as conveying four types of benefit: it enables the fluid sharing of people, ideas, and resources across institutional boundaries, it provides national thought leadership on research in renewable and sustainable energy, it creates new capacity for the partnership to successfully compete for large, multi- and interdisciplinary research initiatives in this area, particularly with respect to Department of Energy initiatives, and, finally, the NREL

partnership facilitates new forms of education and training for participating students and early career scholars.

Campus context

RASEI is one of 12 CU Boulder-based research institutes. It offers no degrees. As already mentioned, one of the institute's primary goals is to serve as a coordinating and enabling force for energy research throughout the CU Boulder campus.

Faculty and research personnel

In 2012, the provost authorized 24 new faculty positions in support of the RASEI mission: 12 designated as institute faculty and 12 as matching hires in participating departments. Due to a variety of internal and external factors, RASEI grew slowly and experienced significant leadership change, with some of these positions remaining unfilled. The AY 2018-2019 ODA profile shows that RASEI employs eight tenure-track faculty members: three assistant professors, three associate professors, and two professors. These faculty appointees have tenure homes in: Biochemistry (one); Chemical and Biological Engineering (two); Chemistry (two); Electrical, Computer, and Energy Engineering (one); Civil, Environmental and Architectural Engineering (one); and Law (one). The self-study lists 11 tenure-track faculty member appointees, including seven of the eight faculty listed in the ODA data plus four others (RASEI omits the School of Law faculty member). The self-study notes the additional faculty as rostered in: Chemical and Biological Engineering (two); Electrical, Computer, and Energy Engineering (one); and Physics (one). ODA provides no faculty salary data and the institute's self-study makes no mention of the competitiveness of its salaries.

The most recent ODA profile also includes no data on other research personnel or institute staff (dated October 23, 2019). The previous ODA profile (dated October 19, 2019) showed RASEI employing 27 research faculty (not tenure stream faculty members), including three research professors, 11 senior

research associates, ten research associates, one professional research associate, and one post-doctoral fellow. As described earlier, RASEI is also home to 30 research scientists from NREL with joint appointments at CU Boulder. The self-study also lists six additional personnel, including the institute's director and associate directors, including those who oversee RASEI's four research themes.

The self-study reports two additional hires are underway for the 2019-2020 academic year, and that two additional searches have been approved for the following year. The self-study does not provide specific information about the areas RASEI is currently recruiting for. The report stresses the need for up to eight additional faculty lines, at the junior level, or fewer if senior-level hires are pursued.

Staff	According to the Office of Data Analytics (ODA) AY 2018-2019 RASEI profile, the institute employs three exempt professional university staff members and one working retiree. The self-study states that RASEI employs two staff supporting over 150 people and a grant portfolio of over $36 million. The self-study requests sufficient resources to hire two additional senior level support personnel to assist researchers with grant and other kinds of administration.
Undergraduate education	RASEI is a research unit and thus doesn't directly offer undergraduate courses. However, RASEI does operate several international exchange programs for undergraduates, including the Global Intensive Program operated in partnership with the Politecnico di Milano. This program is partially supported by a gift from an anonymous donor.
Graduate education	As with undergraduate education, RASEI is a research unit and therefore offers no graduate courses. However, RASEI is considering how to extend its workforce reach and impact.

Towards this end, it is collaborating with the Department of Electrical, Computer, and Energy Engineering to start a professional master's program focused on next generation power and energy systems. This is an exciting opportunity with potentially broad market appeal. However, it is not clear what role RASEI will play in the program's implementation or what role RASEI faculty will take in designing and offering program courses, or whether RASEI will participate in any revenue-sharing.

Postdoctoral training

The RASEI self-study makes no mention of training or mentoring programs available to post-doctoral fellows (including those classified as research associates).

Budget

In FY 2019, RASEI received $550,000 in temporary general funds ($250,000 in DA-ICR); NREL-sourced salary support and grants, and donations from anonymous benefactors (amounts not specified for these latter categories). Funds from anonymous donors are used to support RASEI's seed grant program and the aforementioned undergraduate exchange program. The temporary general funds and DA-ICR are used to support RASEI's operating expenses, which are $700,000 per year and are anticipated to increase to $800,000 per year. The self-study does not provide a breakdown of how the institute spends these funds. The self-study also reports that RASEI spent over $1 million, budgeted separately from operations, to support research infrastructure in the Sustainability, Energy and Environment Community (SEEC) Building and the Sustainability, Energy and Environment Laboratory (SEEL).

RASEI's primary means of support - the temporary general funds provided by the Provost's Office as part of the institute's incubator funding - will begin phasing out in FY2020 (decreasing from $550,000 in 2019 to $450,000 in 2020 to $350,000 in 2021). These funds cease by FY2022, at which time

RASEI will receive $250,000 in continuing general funds annually and will need to have other forms of support in place.

A portion of RASEI's budget is supported by DA-ICR. While the self-study notes that RASEI manages a grant portfolio in excess of $36 million, the institute returns a large portion of this money to participating units. According to the ODA, last year, direct funding contributed $14,483,000 to RASEI (as per ODA, seventh of 56 units university-wide and first out of 13 in the current review cycle). However, after allocation, this direct funding only contributed $1,727,000 (as per ODA, 32 of 56 units university-wide and 11 out of 13 in the current review cycle) The self-study explains that this discrepancy hinges on the challenges of establishing memoranda of understanding to guide indirect cost recovery sharing across so many different departments and that RASEI is seeking to avoid competition with its partner departments.

Space and infrastructure

In 2015-2016, when SEEC/SEEL opened, RASEI occupied 30,000 square feet of wet lab space and 20,00 square feet of office and student spaces. The self-study describes a series of shared research infrastructure efforts that have "diverted" 13,000 square feet of laboratory space and 9,000 square feet of office space away from RASEI. Furthermore, in 2018, 4,400 square feet of the remaining office space was reassigned to the National Snow and Ice Data Center. According to ODA, RASEI now occupies 38,714 square feet, ranking seventh out of the 13 units within this review cycle.

As a result of these shared infrastructure efforts and other downsizing events, the self-study states that RASEI no longer has sufficient space to accommodate its plan for four faculty hires, much less the eight additional faculty lines being requested. RASEI proposes to remodel the third Floor North Wing of SEEC to increase its office space, in partnership with

the Materials Science and Engineering Program. The cost estimate for the third floor SEEC remodel is $450,000. The self-study estimates that the institute will need to gain an additional 1,500 square feet of laboratory space for each additional faculty member.

In addition to accommodating faculty space needs, RASEI is also challenged to find other forms of mission-critical space, including a request from NREL to lease 2,000 - 3,000 square feet of laboratory space plus between two and four supporting offices in SEEC, and a request by the Materials Science and Engineering Program to to relocate two or three its faculty the from the College of Engineering and Applied Science to SEEC/SEEL.

In addition to space, RASEI has spent in excess of $1 million to build out necessary research infrastructure.

Governance
RASEI approved bylaws in March 2011 but both the internal and external reviewer reports note that the bylaws do not appear to be used to guide the institute today. According to the internal reviewers, RASEI's operational processes and governance needs to be revitalized. Towards this end, the self-study states that "processes have been initiated" to review and update RASEI's bylaws including portions defining the roles and responsibilities of the institute fellows. At the time of writing, the RASEI Council of Fellows had 43 members. The self-study discusses various proposed bylaws updates, including a new reporting structure to the vice chancellor for research and innovation and the dean of the institutes, and the introduction of procedures governing grievances, annual merit review, and promotion and tenure processes.

Inclusive excellence
In its self-study, RASEI reports on the demographic composition of its team, saying that 33% of the institute's

employees identify as women (26th out of 76). It is important to note that RASEI includes in its tabulation graduate students and professional staff, with the majority of the latter identifying as women. As with some other science, technology, engineering, and mathematics-based disciplines, RASEI struggles with recruiting and hiring diverse faculty to contribute to its inclusive excellence. According to the ODA profile, only one of the institute's tenure-track faculty appointees is a woman and no faculty members identify as belonging to an underrepresented minority racial/ethnic population. The balance of RASEI's faculty affiliates identify as white men. RASEI ranks seventh out of 13 for minority race/ethnicity status representation (41st out of 64 university-wide), and 12th out of 13 for women tenure-track faculty member appointees (60th out of 64 university-wide).

As previously noted, RASEI's self-study requests a total of eight new tenure-track faculty member appointees, in addition to the four lines already approved. It is concerning that the institute makes no mention of strategies or plans for securing appointees who might improve on the reach of the institute's inclusive excellence, other than stating that it "will continue efforts to identify and recruit women, minorities, and underrepresented groups."

Climate   ARPAC staff administered a climate survey addressed to RASEI faculty and staff members and graduate student appointees in March 2018. Sixty-six percent of the tenure-track and research faculty responded (29 respondents), and 88% of staff members (seven respondents). There were too few respondents in the graduate appointee pool, so no climate data are reported. RASEI staff reported that they were treated with respect by various institute constituencies. However, they seem to feel they are slightly less valued members of the community than other groups and two staff report that one or more RASEI

faculty members have humiliated or intimidated staff. While most faculty members report feeling like valued unit participants, there are some areas of concern. Five out of 29 report feeling excluded from informal networks. Six out of 29 report that faculty incivility is having a disruptive effect on institute functioning, and eight out of 29 (28%) disagree that there is a positive sense of community in RASEI.

When asked whether the social and professional climate is generally positive for women faculty, 31% of faculty members responded "Don't Know/Not Applicable." These responses were even higher for faculty of color (59%), faculty of different sexual orientations (52%), political affiliation (41%), and religious views (55%).

Past Reviews

This is the first time RASEI has undergone academic program review.

Analysis

The RASEI self-study and the internal and external review reports paint a picture of a strong partnership with the National Renewable Energy Laboratory (NREL) that positions the institute for strong growth and a national impact. These documents also detail the significant advances that RASEI has made over the few years since its 2015-2016 "reboot," including building up its NREL partnership and its ties with affiliated CU Boulder faculty and units. These reports also outline the substantial challenges that RASEI will face over the next few years as the institute transitions from its "start-up" phase to self-sustainability.

Strategic vision and Planning

RASEI has established a mission and a vision that includes high level goals and research themes. Among the institute's chief ambitions described in its self-study is a "doubling CU's campus-wide portfolio of energy research" to $50 million by 2025. While RASEI has already succeeded over the past few years to produce an impressive community infrastructure, the institute has arrived at a critical juncture and the next few years will require more attention to operations and governance as RASEI seeks to expand its faculty and their impact and reach.

The external reviewers identified multiple uncertainties that RASEI must face in order to realize its mission and vision.

- What are CU Boulder's expectations for RASEI's campus role: as an administrator or an enabler of research? RASEI had great success last year as a research enabler, as measured by research expenditures. However, in the long run, this may be a false dichotomy: it is difficult to secure large-scale, multi- or interdisciplinary grants without attaining the necessary capacity and expertise to effectively prepare and administer such undertakings. Incubation and support for large-scale and/or highly interdisciplinary research is an important mission driver of CU Boulder's institutes. It is work that any single department would find

difficult to carry out. The external reviewers urge people to recognize that "creating big things" and supporting large-scale and collaborative research undertakings should be at the core of RASEI's mission.

- Does RASEI's operational plan define progress towards its mission and vision in attainable one-year and five-year increments? The external reviewers observe that there is no short-term plan in place by which to judge progress. The internal reviewers also state that RASEI's operational processes need to be "revitalized." The external reviewers further note that RASEI's day-to-day activities, such as the management of grants and space use, can be difficult to recognize as aligned with its long-term goals and saps the institute's capacity to provide national thought leadership and the large-scale research footprint that it aspires to achieve. This concern is supported by self-study data: 28 out of the 31 funded proposals have only a single principal investigator; 22 out of the 31 funded proposals are relatively modest, with award amounts under $1 million. There also appears to be little to no collaborative research proposal "cross-pollination" among the four themed research groups.

- What is RASEI's future business model? Over the past few years, the provost has supplied the majority of RASEI's funding using temporary general funds. These "start-up" funds start decreasing in fiscal year (FY) 2020 and cease in FY 2022, at which time RASEI will receive $250,000 annually in continuing general funds, an amount that is consistent with that provided to other institutes of RASEI's size but that RASEI will be challenged to supplement with other forms of support.

Graduate education, postdoctoral training, and research faculty

While RASEI has few formal programs for graduate students and postdoctoral scholars, at this early stage of its development, the institute is already providing unique forms of support to these early career scholars. First and foremost, RASEI provides exceptional opportunities to work with NREL scientists and facilities. Students and early career scholars also participate in RASEI's networking activities such as the successful coffee "collider" events, and no doubt more such opportunities to meet up, share, and learn from each other would be appreciated. The extensive outreach activities described in the self-study include a wide range of workshops, symposia, and seminars, many of which are addressed to the interests of early career scholars. Despite these opportunities, students report having difficulty navigating the options for professional development that RASEI provides.

As already noted, RASEI hopes for eight more faculty hires in addition to the four already approved tenure stream faculty lines. As RASEI's faculty appointee numbers grow, the institute will need to clearly communicate expectations for promotion and tenure for faculty whose tenure homes are in different departments. As RASEI continues to establish joint appointments with CU Boulder for NREL scientists, it will also need to clarify the roles and expectations of these appointees, as well as to develop policies and procedures for addressing inactive joint appointees.

Budget

RASEI's multi-year transition away from a reliance on temporary general funds will prove to be one of its biggest immediate challenges and a considerable risk to its continued growth and operations. While most institutes depend upon DA-ICR for a significant portion of their operating budgets, this approach is challenging for RASEI for several reasons, some structural and some self-inflicted:

- Under the university's current ICR sharing guidelines, it is difficult to sustain any unit, particularly one with RASEI's complexity and ambitions, with only eight tenure stream faculty member appointees. Even if all eight faculty members are exceptionally productive researchers in terms of grant expenditures, it would be difficult to attain a level of DA-ICR support sufficient to sustain an institute. Realizing that three of RASEs eight faculty are assistant professors who are still building up their labs and programs adds to this concern. The institute's grantsmanship challenge can potentially be addressed by successfully completing its four authorized searches for FY2019 and FY 2020. If RASEI could employ 12 rostered faculty the institute would match, and in some cases exceed, the reach of other institutes of comparable size that depend on DA-ICR.

- RASEI is proposing that all of its proposed new faculty lines be targeted to hiring junior faculty. The institute should reconsider this approach. RASEI will need senior faculty to serve as mentors and to fulfill important service duties such as staffing promotion and tenure committees. Ideally, RASEI would recruit a few exceptionally strong senior faculty to provide necessary leadership and a stable funding base.

- The self-study reports that RASEI had experienced considerable difficulties in establishing memoranda of understanding to support ICR sharing. It is not clear whether RASEI has memoranda in place that define ICR terms for its core affiliated faculty. RASEI reports developing memoranda on a proposal-by-proposal basis, rather than relying on an overarching agreement that is applied to each proposal. Some institutes operate this way, while others have standing agreements for core faculty. The self-study also states that RASEI is establishing these memoranda at grant submission time, with the effect that much of this

effort is wasted on unfunded proposals. This approach is not consistent with campus practices. Indeed, the Office of Contracts and Grants no longer requires that ICR splits be specified at the time that a grant proposal is submitted.

- The self-study states that RASEI's current grant administration policy gives leeway for its affiliated faculty to decide which unit is "most convenient" to them [to administer their grant]. This policy appears to be related in part to the sensitivities of some of the participating units. This policy is in conflict with many of RASEI's needs and goals. It certainly undermines the institute's ability to support itself from DA-ICR. Furthermore, this approach significantly complicates how the institute's grant administration team builds capacity to incubate and support large, multi-unit, complex research initiatives. Now that this policy is established, it will be challenging to reverse.

In its self-study, RASEI asks the university to consider a "simplified" funding model. Rather than relying on DA-ICR, RASEI is requesting to be provided with annual stipends from the two colleges that roster its faculty: the College of Arts and Sciences (a $150,000 annual request) and the College of Engineering and Applied Science ($250,000 annually). The self-study states that this model would avoid competition over DA-ICR between RASEI and its affiliated departments. The external reviewers also emphasized concerns over competition that place the institute's relationships with departments in jeopardy. It is not clear what the source of these perceptions is. While there is often tension between institutes and departments over resource sharing, in the end, departments have successfully worked with most of the other 11 campus institutes, in some cases for decades. Why are these resource sharing tensions so high in this case?

One strength of RASEI's proposal is that it could significantly ease the institute's paperwork burden. Institute staff would no longer need to establish and maintain a complex network of memoranda of understanding, or calculate and track ICR splits. These activities are time-consuming and incur real costs. A potential weakness of the proposal is that it is not clear that it actually solves the resource allocation problem. This approach mainly pushes the locus of decision-making up a level, leaving it to the two deans to decide how to carve up resources, and whether to use DA-ICR returned to the colleges and/or departments to support these annual fees. Ultimately, for RASEI's proposal to succeed, and for the deans to justify an ongoing commitment, the institute will need to provide evidence about its sustained contributions to research productivity and expenditures.

Space, infrastructure, and support needs

Securing adequate research space is a vexing problem for RASEI. The self-study describes a situation of uncertainty and ongoing change, with worries about whether the institute will attain sufficient space to meet its anticipated growth or to support a DA-ICR-based business model, where 50% of the funds returned to units are correlated to space utilized in the proposed work. The self-study describes a "chicken and egg" problem: RASEI is unable to establish memoranda of understanding to support DA-ICR, which leads to a relatively low level of research expenditures for the amount of space the institute has been allocated, which leads to less space being allocated to the unit, which makes it difficult to generate sufficient DA-ICR. Furthermore, NREL has submitted a plan to RASEI and CU Boulder requesting a five-year lease to support co-located, joint research facilities in the Sustainability, Energy and Environment Community Building. A co-location there would be a significant and positive step forward in cementing the relationship between CU Boulder and NREL, but at the time

of the self-study university administrators indicated that there was no room to accommodate NREL's request.

Research infrastructure is also a concern and a potentially limiting factor in RASEI's growth. Many of the institute's current and anticipated faculty researchers are experimentalists, and require specialized and expensive equipment. Moreover, research facilities are critical components of new faculty start-up packages. Given RASEI's relatively small size, and standing as a new institute, it will need considerable support to finance start-up packages involving new equipment and facilities. Consideration will also need to be given to managing and sustaining these valuable resources over time. It is notable that RASEI approaches the management of its current facilities in partnership with the College of Arts and Sciences and the College of Engineering and Applied Science.

RASEI would like resources sufficient to hire two senior staff members to provide research support. As noted earlier, RASEI currently has three staff members, one or two of whom support proposal preparation and grant administration, joint appointment administration, and the coordination of administrative details with RASEI's multiple department partners. The institute's current staffing level is lean for any unit, but particularly challenging for RASEI which needs to facilitate a broad range of collaborations across NREL and CU Boulder. That said, there appears to be a discrepancy in the self-study which states that one staff member supports >$36 million in active awards. Yet, for last year, RASEI only had $250,000 in DA-ICR. Clearly, RASEI is not administering a majority of these awards. This raises questions about the research support that RASEI is asking to hire additional staff to support. It is not clear why RASEI is not using some of its annual operating funds to pay for additional staff support. Such personnel costs are typically among an institute's larger operating expenses.

RASEI's current $700,000 annual operational budget should easily cover the costs of another staff position or two. The self-study does not specify how these funds are currently being spent. For RASEI to establish itself as the go-to place for large and complex research efforts, it will need a top-flight staff with the capacity and knowledge to prepare and administer large grants. RASEI, in partnership with RIO, should articulate where grant administration fits within its plans and how it will finance the necessary additional staff.

Governance

RASEI has not updated its by-laws since 2011. Significantly, the bylaws do not reflect changes that have taken place since the institute's 2015 "reboot". In addition to being out-of-date, the by-laws enshrine an unwieldy decision-making structure (relying on a 43 person fellows council for most decisions). The internal and external reviewers' reports both note that the institute appears to disregard its by-laws in day-to-day practice (many RASEI fellows could not recall the last time they "had voted on anything"). Instead, many faculty report not understanding how the institute makes consequential decisions, such as for allocating space. Revising the by-laws to support a more agile, transparent, and inclusive decision-making process should be a high RASEI priority.

Inclusive excellence

As previously described, the ODA profile shows that RASEI employs one woman faculty member, but no one who identifies as a member of a "minority" or underrepresented "minority" population. The self-study describes RASEI's intentions to recruit more women, but does not say how it will do so. The institute makes no mention of recruitment efforts focused on underrepresented groups. This is unacceptable. RASEI needs to develop a new inclusive excellence plan, with support from the Office of Diversity, Equity and Community Engagement and the Department of Human Resources, one that outlines the steps the institute will take to improve faculty member diversity.

Climate   The previously described March 2018 climate survey showed that 28% of RASEI faculty respondents disagreed that there is a positive sense of community in the institute. RASEI leadership needs to address this perception. Given that the institute is focused on community building, as appropriate to a new organization, now is the ideal time to address climate issues and attempt to understand what factors underpin negative perceptions.

When asked how RASEI treats faculty and staff of different genders, races, ethnicities, sexual, and religious orientations, the largest answer percentage-wise is "Don't Know/Not Applicable." These responses should not be dismissed: even if the institute's roster currently lacks racial/ethnic or gender diversity, for example, fostering diversity and inclusive excellence are still critical for the scientific enterprise. All RASEI community members should see that diversity applies to them and RASEI could do more to communicate its norms and expectations for behavior to promote an inclusive climate.

Recommendations

The members of the Academic Review and Planning Advisory Committee address the following recommendations to the Renewable and Sustainable Energy Institute and to the offices of responsible administrators:

To the Unit:

1. Refine the RASEI strategic plan to ensure there is strong alignment between the institute's mission, vision, and the plans emerging from the institute's major research and development thematic areas. The institute's plan should outline the rationale for hiring priorities, including the number of proposed faculty hires, whether to target junior or senior level hires, how they would enhance RASEI's diversity, their expected research areas, and how these priorities might extend RASEI's growth and research status. This plan should describe whether and how RASEI intends to build capacity to support large multidisciplinary and interdisciplinary research efforts.

2. Develop and implement a concrete and realistic RASEI operational plan that details the steps that the institute expects to take over the next few years to realize its strategic plan. What does the institute require for space, infrastructure and staffing levels, and by when, to support anticipated faculty hires? Among the distinctions such a plan should draw is the difference between the staffing level needed to support grant preparation and administration and what is needed to support partnership development.

3. Develop and implement a business model supportive of RASEI's mission, that will enable the institute to sustain and grow its operations, as it transitions off of temporary general fund monies.

4. Develop and implement a concrete plan to improve faculty member appointee diversity that lives up to CU Boulder's

inclusive excellence standards. The plan's implementation should involve working with Office of Diversity, Equity and Community Engagement and Department of Human Resources personnel who specialize in inclusive excellence practices to help RASEI develop strategies that will help in recruiting tenure-track faculty appointees from more diverse backgrounds.

5. Develop new bylaws reflective of RASEI's updated mission and operations and current University guidelines. This work should clarify the roles and expectations of institute fellows and joint appointees, as well as mechanisms for addressing the challenge of inactive joint appointees.

6. Complete and submit an inclusive excellence narrative to the Office of Diversity, Equity and Community Engagement.

7. To address the financial sustainability of RASEI, continue to work with the Office of Advancement to provide ongoing support for RASEI's seed funding and pilot study programs, and other donor-supported research and educational initiatives.

To the Vice Chancellor of Research and Innovation and Dean of the Institutes:

8. Work with RASEI to clarify its long-term goals and expectations and to communicate and reinforce CU Boulder's intent and commitment to advance impactful energy research.

9. Support RASEI's efforts to develop and implement a suitable and sustainable business model, with a consideration for building on practices proven to be effective within other institutes. While the business models of the institutes vary considerably, reliance on DA-ICR is a common theme. Work with RASEI to streamline or eliminate the establishment of memoranda of understanding with

partner CU Boulder departments, and work with the Office of Contracts and Grants to eliminate the establishment of these memoranda at proposal submission time.

10. Provide strategies to RASEI to improve faculty member appointee diversity that lives up to the spirit of CU Boulder's standards of inclusive excellence and supports the institute's strategic plan.

11. As RASEI develops faculty search plans that adhere to strategic goals, especially regarding inclusive excellence, support the recruitment of faculty as identified, pending budgetary approval.

12. Continue to support RASEI in developing its unique partnership with NREL. Develop plans to regularly meet with appropriate NREL counterparts to continually enhance and improve partnership functioning. Consider ways to strengthen the partnership through new co-location arrangements.

13. RASEI is being asked to do significant planning and to think carefully about its financial model and operations as it shifts from a start-up mode to sustained growth and operations. Consider how RIO expertise can support RASEI in taking on this new planning work.

14. Consider how to lessen administrative paperwork and ease processes associated with highly interdisciplinary units. Work with the other deans to ensure that they understand and support common institute business practices and standard agreements, and that they communicate their support of those practices and agreements during leadership changes, such as with the appointment of a new department chair.

To the Provost:

15. Prioritize RASEI's efforts to develop and implement a suitable and sustainable business model as it transitions off of temporary general fund monies.

16. As RASEI develops strategic faculty search plans that adhere to strategic goals, especially regarding inclusive excellence, support the recruitment of faculty as identified, pending budgetary approval.

Required Follow-Up

The director of the Renewable and Sustainable Energy Institute shall report annually on the first of April for a period of three years following the year of the receipt of this report (i.e., April 1st of 2022, 2023, and 2024) to the vice chancellor for research and innovation and dean of the institutes, and to the provost on the implementation of these recommendations. Likewise, the vice chancellor for research and innovation shall report annually on the first of May to the provost on the implementation of recommendations addressed to the institute. The provost, as part of the review reforms, has agreed to respond annually to all outstanding matters under their purview arising from this review year. All official responses will be posted online.