

2019-2020: Energy Systems Research Center

Definition of Unit:

Reporting Year:

2019-2020

Providing Department:

Energy Systems Research Center

Department/Unit Contact:

Satish M. Mahajan

Mission/Vision Statement:

Mission: The Center for Energy Systems Research (CESR) is a research center and was established to advance and apply scientific and engineering knowledge and academic programs associated with energy systems and in particular with electric power while supporting the instructional program of Tennessee Technological University (TTU). Research efforts, both theoretical and experimental, are focused on solving current and anticipated problems associated with energy systems. Special emphasis is given to the needs of the electric power industry.

Vision: The center will be known and be recognized nationally for its research contributions in energy systems and Infrastructure areas.

Goals: The 5 current Goals have been developed on the basis of the mission of the Center. The numerical objectives have been arrived at using historical data with a view on advancement towards reaching the vision.

Reporting: Reporting for the center is done on a fiscal calendar to align with state funded center requirements.

Goal 1. Increase research activity in the areas of the Center

Define Goal:

Increase research activity in the areas of the Center

Intended Outcomes / Objectives:

1. Generate external funding that will contribute to the long term growth and sustainability of the Center. As a minimum, the external funding generated per year by the center should match the state funding.
2. Center faculty and the R&D Engineer will produce at least 5 publications in total. Once sufficient data is collected it will be reported on a running 3 year average to smooth differences between publication timing and research project timing. (The year reference point for this objective started in the year 2018-19).

Goal 2. Increase Student Research Activity

Define Goal:

Increase Student Research Activity

Intended Outcomes / Objectives:

1. Increase the number of MS and Ph.D. students supported in the strategic research areas of the Center by 25% during the next three years and hold steady.
2. Support at least two undergraduate research projects per year in the areas related to energy systems.

Goal 3. Increase Collaborative Research

Define Goal:

Increase collaborative research

Intended Outcomes / Objectives:

Develop and submit two collaborative proposals with interdisciplinary focus. The number of collaborative proposals submitted should be at least two per year.

Goal 4. Add Laboratory Facilities

Define Goal:

Add laboratory facilities.

Intended Outcomes / Objectives:

1. Continue to support the development of the wireless power laboratory.

Goal 5. Increase Outreach Activities

Define Goal:

Increase Outreach Activities.

Intended Outcomes / Objectives:

1. Organize a minimum of two seminars by external speakers per year.

Assessment Tool 1: External grants activated

Goal/ Outcome/ Objective:

Goal 1 and Goal 3

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

External grants activated indicate success in bringing funded research into the university, the result of which will benefit students, the scientific body of knowledge as a whole, and the funding source itself by solving some research problem. It does not address the idea that a bigger project may be better or more smaller projects is better but it does give us a general measure to compare progress. Hopefully some of these projects will also represent collaborative efforts but this tool is not a direct metric of collaboration.

Assessment Tool 2: Number of Journal Publications and Conference Publications

Goal/ Outcome/ Objective:

Goal 1 and Goal 2 and Goal 3

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

Papers represent the increase in knowledge from research activities. By concentrating on journal and peer reviewed conference papers the quality of the research is acknowledged by peers in the field of study. By examining the list of authors on these publications we can get a measure of the success in the collaboration goal.

Assessment Tool 3: Number of M.S. and Ph.D. graduates during the year

Goal/ Outcome/ Objective:

Goal 1 and Goal 2 and Goal 3

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

If the graduates this year took a long time getting their degrees then this measure might not directly correlate to effectiveness in achieving the goals but on average this assessment tool is expected to historically follow the quantity of research achieved in the center. By examining the graduate committee for each student we can get an indication of the amount of collaborative research.

Assessment Tool 4: Number of M.S. and Ph.D. students supported by the center during the year

Goal/ Outcome/ Objective:

Goal 1 and Goal 2 and Goal 3

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

While quantity of students may not directly measure the amount or quality of research being conducted by the center, it is generally perceived that statistically this metric will be relevant to the goals.

Assessment Tool 5: Number of undergraduate research projects supported

Goal/ Outcome/ Objective:

Goal 1, Goal 2, and Goal 3

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

Often undergraduate student research results in some of the best innovations since the undergraduate is not burdened knowing what can or can't be done. Including this metric with the others is important to assess the total amount of research being conducted by the center.

Assessment Tool 6: Number of collaborative proposals submitted

Goal/ Outcome/ Objective:

Goal 3

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

This metric will directly reflect energy expended toward Goal 3. By comparing proposals to activations an effectiveness can ultimately be determined to guide future proposal writing endeavors.

Assessment Tool 7: Laboratory projects completed/initiated**Goal/ Outcome/ Objective:**

Goal 4

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

The number of laboratories created, renovated, and/or expanded, etc. will directly affect the research infrastructure making more meaningful, and up-to-date research possible.

Assessment Tool 8: Number of seminars by external speakers to our faculty and students ensures exposure to new ideas.**Goal/ Outcome/ Objective:**

Goal 5

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

Seminars are important to inform researchers what the current state of the art is in various research disciplines and provide new contact opportunities to promote collaborative efforts. This tool directly reflects the efforts expended toward Goal 5.

Assessment Tool 9: Number of outreach activities planned for the upcoming year with a list of persons to be invited for the activities.

Goal/ Outcome/ Objective:

Goal 5

Type of Tool:

Tracking Spreadsheet

Frequency of Assessment:

Annually

Rationale:

This assessment tool forces Center administration to be forward thinking about Goal 5 since many of the activities related to this goal must be planned well in advance.

Result for Goal 1. Increase research activity in the areas of the center

Results:

Increase research activity in the areas of the center

- Generate external funding that will contribute to the long term growth and sustainability of the Center. As a minimum, the external funding generated per year by the center should match the state funding.
- Center faculty and the R&D Engineer will produce at least 5 publications in total, which will be reported on a 3 year moving average basis.

This goal intersects the University Flight Plan's Multidisciplinary Research Innovation sub goal. The creation of the Smart Grid and Resilient Infrastructure focus areas is to foster multidisciplinary research efforts. Even if considered to be primarily one department; getting power engineers, communication engineers, cyber security researchers, etc. to focus on a common laboratory for collaborative efforts has resulted in several collaborative proposals being prepared.

The Center Focus Areas also intersect the University Flight Plan focus areas to Create Distinctive Programs and Invigorate Faculty.

This year we are continuing to report on the fiscal year to reduce reporting efforts by aligning with our other annual report. This also brings us inline with the other centers reporting.

There were a total of 38 activations which totaled \$ 2,361,707.96 (including indirect cost recovery of \$5,130 and gifts \$300) which is more money than last year. **The history of external**

funding of the center over last 35 years indicates crossing of \$ 2M level only 4 times including the current fiscal year. It also indicates a record level of external funding for the CESR, two years in a row !!!. Of course, the external funding handily meets the goal of matching the state appropriations for the center. A full listing of activations can be found in the attachments.

The target goal of 5 publications is appropriate for the 3 researchers (Director, Research Assistant Professor, and the R & D Engineer) in the Center. The 7 publications listed in the attachment can be summarized as 3 conference papers and 4 journal articles which surpasses the goal of a total of 5 publications. This metric is to be on a 3 year average but since the metric has changed, 3 years of data has not accrued yet.

Attachments:

CESR publications 2019-2020.pdf; SM 3 List of Activations 2019-2020 - with PIs Names.xlsx

Results for Goal 2. Increase Student Research Activity

Results:

Increase Student Research activity

- Increase the number of MS and Ph.D. students supported in the strategic research areas of the Center by 25% during the next three years and hold steady.
- Support at least two undergraduate research projects per year in the areas related to energy systems.

This goal intersects the University Flight Plan's New Graduate Programs sub goal. Since the Center now has the Smart Grid and Resilient Infrastructure focus areas, students resulting from this focused Center attention will yield more hire-able graduates in these areas of recognized national importance.

The number of M.S. and Ph.D. students supported for the Fiscal Year 2019-2020 can be seen in Table 1 below.

Though CESR has traditionally focused on graduate research there are several points that can be made about progress toward the Flight Plan focus area for improving the undergraduate student experience. Encouraging faculty to utilize graduate research labs in their undergraduate teaching is the best way to meet this objective.

Thirty-nine undergraduate students (some with multiple projects) from a multidisciplinary array of departments conducted research under the umbrella of CESR (see attachment). For the second year in a row, the CESR facilitated undergraduate students through the NSF supported Research Experience for Undergraduates (REU).

The highlighted undergraduate researcher this year is William Stump who investigated unipolar capacitive wireless power transfer technology for wireless charging of Electric Vehicles (EVs).

Increasing student research activity can be partially assessed by the number of students supported. Students have been supported by the Center in a number of ways including financially, office space, and R&D Engineering support.

Table 1. Students supported by the Center.

Number of Students Supported by the CESR

during Fiscal Year 2019-2020

	B.S.	M.S.	Ph.D.
Financial Support			
Assistantships		29	17
Hourly Student Payroll	39	45	34

Table 2 shows that we did meet the goal of 25% increase over the year 2014-15 in the number of graduate students. The center is definitely holding steady the increased growth.

Table 2. Historic support of graduate students

Fiscal Year	MS/PhD Students Supported	% Increase over previous year	% Increase over first year
2014-15	37		
2015-16	49	32.4	32.4
2016-17	57	16.3	54.1
2017-18	65	14.0	75.7
2018-19	70	7.7	89.2
2019-20	79	12.9	113.5

Attachments:

SM-10 HOURLY STUDENT 2019-2020.docx; SM-11 Undergraduate Student Research 2019-2020.xlsx; SM-9 GRAS Support 2019-2020v2.xlsx

Results for Goal 3. Increase Collaborative Research

Results:

Increase Collaborative research

- Develop and submit two collaborative proposals with interdisciplinary focus. The number of collaborative proposals submitted per year should be at least two per year.

This goal intersects the University Flight Plan's Multidisciplinary Research Innovation sub goal.

The collaborative proposals listed in the Attachment include 7 proposals with an 'internal to TTU' collaborative aspect, 15 with collaborations with an 'external to TTU' component. There were also 7 project activations with a collaborative component.

Attachments:

2019-2020 Collaboration Efforts CESR Aug 18 2020.xlsx

Results for Goal 4. Add Laboratory Facilities

Results:

Add Laboratory facilities

- Continue to Support the development of the wireless power laboratory.

The Wireless Power Laboratory is an exciting area of research supported in part by the CESR.

This year we added a golf cart as a demonstration test-bed for wireless charging.



Figure 1. Golf cart wireless charging test-bed.

Results for Goal 5. Increase Outreach Activities

Results:

Increase outreach activities

- Organize a minimum of two seminars by external speakers per year.

This goal intersects the University Flight Plan's Co-Curricular Undergraduate Program sub goal and the Multidisciplinary Research Innovation sub goal. By having research area experts from outside the university come teach seminars, workshops or short courses the students will be exposed to a broader base of information and hopefully promote collaborative efforts from TTU researchers with those at other institutions.

The 4 seminars presented by external speakers in the fiscal year 2018-2019 are presented in the attachments.

Attachments:

Seminar Series for CESR 2019-2020.pdf

**New Modifications and Continuing Improvement to
Goals/Objectives/Outcomes Item**

Goal/Objective/Outcome Number:

4- Add laboratory facilities.

Program Changes and Actions due to Results:

Add two new wells ~ 250 ft. deep in the field to facilitate focusing of wireless power transferred through the earth.